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Geospatial Crypto Reconnaissance: A Campus Self-Discovery Game

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Abstract

Campus discovery is an important feature of a university student induction process. Approaches towards campus discovery differ from course to course and can comprise guided tours that are often lengthy and uninspiring, or self-guided tours that run the risk of students failing to complete them. This paper describes a campus self-discovery induction game (Geospatial Crypto Reconnaissance) which aims to make students aware of campus resources and facilities, whilst at the same time allowing students to make friends and complete the game in an enthusing and exciting way.

In this paper we describe the game construct, which comprises of a location, message, and artefact, and also the gameplay. Geospatial Crypto Reconnaissance requires students to identify a series of photographs from around the campus, to capture the GPS coordinates of the location of the photograph, to decipher a ciphered message and then to return both the GPS coordinates and the message for each photograph, proving that the student has attended the location. The game had a very high satisfaction score and we present an analysis of student feedback on the game and also provide guidance on how the game can be adopted for less technical cohorts of students.

Keywords: Integration; orientation; retention; campus discovery; induction games; induction

Introduction

Universities, colleges and other higher education institutions - collectively referred to herein as universities - conduct an induction program, also known as orientation or registration week, for new students at the first year of their studies at Bachelors, Masters and other levels of study. Throughout this paper, we use the term induction to refer to the induction program and *course* to refer to a university program of studies such as a BSc or MSc.

Induction is a key part of the student academic experience, so vital says Tinto (1993) that one of the reasons for student withdrawal in the first six months of a university course is quite often related to the failure of a student to integrate into their university – as well as the student's own prior experiences (Tinto, 1993). These views were supported by Yorke and Longden (2008) who contend that the proactive management of the student transition into higher education is a key factor in the retention of students. Whilst there appears to be general agreement that well managed, cohesive and robust induction

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processes have a positive effect on retention and subsequent student experiences, it appears that no study to date has provided empirical evidence to demonstrate this.

Cook (2006) contends that universities are excellent at preparing students for professional life, but not as good at preparing them for academic life. Often the amount of information presented to students during induction can be quite overwhelming (Cook, 2006), and the process has occasionally been criticised for being confusing and 'overly bureaucratic' (Harvey & Drew, 2006; Lewis, 1984). This is evidenced in the amount of information that students get during induction, which is often supported with a range of hand-outs, such as contact lists, business cards, DVDs, USB memory sticks, booklets and paper hand-outs.

Given the importance of managing the transition experience of a student, the process of induction requires more consideration and research than has hitherto been given and academics must explore more enthusing and exciting methods to make induction more fun and in particular more memorable for students.

There is already a range of literature which focuses on the induction experience as shown by Harvey and Drew (2006) but what seems apparent is that there is a dearth of literature focussing specifically on campus discovery. That is the focus of the present paper which explores the issue of campus self-discovery and outlines a game played during the induction week at the University of Warwick by students on the MSc Cyber Security and Management degree.

We believe that embodied and distinctive experiences are more conducive to student learning and engagement with that learning; therefore, we aimed to make the experience of this game particularly distinctive. The purpose of the game was to encourage the students to self-discover the campus in small groups, to do so in a fun way and to get to know some of their colleagues in the process.

Induction

Induction is a key process which aids in managing two elements of the student transition into higher education: separation from the student's previous educational experience and environment, and transition and incorporation/integration into the new environment (Tinto, 1987).

Induction typically fulfils four goals related to the integration/incorporation of students into the university environment. Induction aims to: develop resource and support awareness; develop academic regulatory awareness; develop geographic campus awareness; and aid in achieving social integration.

a. *Resource and support awareness.* This includes creating an awareness of the services offered by library facilities, support services, resources, eateries, cafes, sports facilities and the various student clubs and societies.

b. *Academic regulatory awareness.* This introduces students to the structure of the course, assessment criteria, attendance requirements, health and safety regulations, academic rules and in particular the regulatory framework that governs the progress of students on their chosen program of studies. During this process, students register and enrol in their course.

c. *Campus awareness.* It is particularly important that students become familiar with the geography of the campus and, in particular, key locations, amenities and study spaces.

d. *Social integration.* Given the diverse student demography and ability range entering higher education today, a higher number of students find it difficult to integrate - many of whom begin to feel socially isolated (McLaughlin, Southall, & Rushton, 2006); this has been cited as an important factor contributing to the non-completion of studies (Yorke & Longden, 2008). A key aspect of induction therefore is to aid the social integration of students into the university, the chosen course and, importantly, the student cohort. This is usually achieved through ‘ice breaker’ activities designed to allow students to become familiar with their colleagues on the university course as well as beyond it across the university.

The structure of induction varies from course to course and can range from a one week intensive program at the beginning of studies, to longitudinal programs involving on-going sessions and activities that take place over the first few weeks and occasionally over the whole of the first year.

The induction program comprises a series of events and activities, some of which are offered as pre-entry events before the majority of students arrive on campus. These events often comprise of residential field trips, days out, ice-breaker sessions, campus tours and talks from course leaders, departmental heads, heads of support services and student unions.

The program is occasionally tailored towards particular groups of students; for instance, universities are aware that international students often require specialist assistance to help them integrate into both the country and the university. Similarly, students living in non-university accommodation, require specialist support. Students in this position find it more difficult to integrate well with other students in the cohort or across the university, particularly as campus/university accommodation based students tend to spend more time together studying as well as socialising (Lowe & Cook, 2003). This is borne out in a study by Yorke and Longden (2008) who find that students in such a position also cite financial problems, a lack of personal support from family, the demands of employment, travel difficulties, the quality and suitability of the teaching, and the amount of contact with academic staff, as contributory reasons for their non-completion.

Geospatial Crypto Reconnaissance

The University of Warwick occupies more than 720 acres of campus space on a single site. It offers a campus experience to students wherein the teaching facilities, student accommodation, a range of shops, restaurants, a cinema, theatre, music centre and sports facilities are all contained within the campus. The campus is often referred to as the ‘bubble’ as students rarely need to leave the campus.

As with many campuses, students feel quite overwhelmed when they arrive for the beginning of their studies and occasionally undergo a culture shock, often because their prior study experience is based around a much smaller campus where the resources/facilities are more closely located.

It is quite common for the student experience of lectures, tutorials and other academic engagements at the University of Warwick, to spread across the length and breadth of the campus during the time of their studies. Students often have to travel as much as twenty minutes between classes and it is therefore doubly important that students become aware of the geography of the campus quickly and at an early stage, as otherwise it can involve a series of late appearances to taught sessions in the early part of their studies.

Whilst the game in this case study was played on a large campus, the game can be adapted for smaller campuses as well as campuses spread across a city. The game play limits are that students should be able to reach an adequate number of location points, as discussed later, so as to score adequate points within the time constraints given in the task.

Traditional approaches to campus discovery typically involve guided tours led by academics or student ambassadors/representatives. During the tour, key locations in the campus are introduced in anticipation that students will remember the series of locations briefly highlighted during what may be a very busy tour. The alternative to guided tours are self-discovery tours where students are given a detailed itinerary which they must follow and complete on their own or as a group. Occasionally, self-discovery tours are constructed as treasure trails (Queen's University Belfast, 2013; University of Bath, 2013), where students visit key parts of the campus collecting ‘artefacts' which evidence their attendance at those points. However, with most self-discovery events, there is a risk that students may lack the motivation to undertake the tour and quite often such a tour remains uncompleted.

For these reasons, the course leader of the MSc Cyber Security and Management course was motivated to develop a self-discovery game which would enthuse and excite the students and, in particular, inspire them to complete the game and thereby discover important parts of the campus. The feedback from students undergoing the tour was very positive and the game is presently being developed to suit the requirements of other courses/departments around the university.

It should be noted that the previous experience of campus discovery was deemed satisfactory by the course team. The motivation behind the present case study was to enhance the campus discovery experience. There is no control data with which the experiential feedback from this case study can be compared.

Game Play, Construct and Ludology

Most good games are developed with a sound understanding of the game audience and their motivation levels. In the present example, the audience comprised of the full time student cohort on the MSc Cyber Security and Management program at WMG (Warwick Manufacturing Group, University of Warwick). This comprised of 28 MSc students from 14 countries. Four students were UK nationals who had previously been through a bachelors program in the UK. Four students came from the EU and the remaining 19 students came from outside the UK/EU. All students enter the course with a strong computing background, generally having studied computer science, information systems or (exceptionally) business information systems/business information technology.

Six students had arrived on campus two weeks before the induction week and had participated in an *international orientation* week which prepares them for university study. This is a service offered in addition to the normal induction and is designed to help students adapt to UK study and to understand UK culture.

Before proceeding to describe the game play, construct and ludology, it is worth spending a moment reflecting on game design theories. Gee (2005, p.23) defines a game as "a set of experiences a player participates in from a particular perspective". Prensky (2005) adds to this by defining five levels of learning achieved in a good game as the how, what, why, where, and when/whether. These are described more fully as:

- *How* – Players learn how to do things, particularly where real life situations are simulated in the game.
- *What* - What are the constraints and limits in a real life scenario which the game is intended to replicate?
- *Why* - Why does one take particular actions in a real life scenario and therefore how can this be replicated in a game scenario?
- *Where* – This refers to the context of a game and as Prensky (2005, p.107) puts it, understanding "the world of the game and the values it represents".
- *When and whether* – This refers to the process of contextualising decision making, the consideration of possible decisions, and the determination of when to make a particular decision.

Whilst Prensky's ideas focus on digital game design, the theory applies equally to classroom games. We add to some of this theory by positing that effective classroom games must comprise a number elements, two of which are that it should be challenging and must have a goal. The challenge in a game is often achieved by limiting the time available to complete the game, scoring points, by competing against other game players, and/or by adding adequate complexity – which, in the case of digital games, increases at each level of achievement.

The self-discovery game in the present discussion is a non-digital *serious game* that comprises of three fundamental constructs (or *content* as Gee (2005) refers to it): location, message and artefact:

i. *Location.* This comprises of a set of locations that are considered important to the student's experience at the campus.

ii. *Message.* A message that imparts information, such as a description of the location, the services available and other important information about the location and possibly about other locations.

iii. *Artefact.* This comprises of an item that the student must collect to prove that he/she attended the location; in the present example, this is the pair of GPS coordinates.

The game requires students to identify a series of photographs, to capture the GPS coordinates of the location of the photographs (to prove student attendance at the location), decrypt an encrypted message, and to return both the GPS coordinates and the deciphered messages to the course leader.

The game was made more challenging and competitive by introducing location and message points. Location points are awarded for each coordinate returned correctly to within 5 metres of the photograph location. Location points range between 1 and 3 depending on the difficulty in identifying the location. Message points are awarded for each correctly deciphered message. Message points range between 1 and 5 where 5 points are awarded for messages that are more difficult to decipher.

Students were required to work in groups of four. One team member must submit the artefacts for the whole group, but all members of the group have to complete a survey providing feedback on the game. Whilst we felt that the game play would be exciting enough to encourage student participation, it was felt that students needed to be further incentivised to complete the game so three further incentives were provided. On submission of the artefacts and the completion of the survey, all group members were given a one year full subscription to a popular anti-virus program, added to the course Facebook page and given a case study necessary for the first module of study.

Location and Artefact

Eighty nine photographs were collected widely from around the campus from locations that the course leader felt were important to the student experience. Examples of these included the student union, the central administration department, cafes, halls of residences, restaurants, learning centres and signposts to counselling services.

The photographs were collected on an iPhone 4S with the *location services* facility enabled so as to automatically collect GPS coordinates. Whilst there are no costs associated with the development of the game, there is an assumption that the user has a phone or camera which can take photos which capture GPS data.

For the game to work, the coordinates must be accurate - particularly as we need to compare student submitted coordinates against the original coordinates. GPS receivers are prone to inaccuracy problems and this results occasionally in captured GPS coordinates being inaccurate (Strawn, 2009). A number of solutions have been proposed to deal with this, one of which involves the use of Wi-Fi technology to enable better accuracy and another involves the use of Assisted GPS (AGPS) (Djuknic & Richton, 2001). However, we did not have any of these technologies available because GPS data capture took place outside of any Wi-Fi range.

For these reasons, we needed to validate the accuracy of each captured set of GPS coordinates. To do this, GPS coordinates were plotted using TagView Evigator (Evigator Digital Forensics, 2011), each coordinate was plotted and then zoomed in to see how close the plotted location was to the original captured set of coordinates (Figure 1). Through this process we found that a number of the coordinates returned by the iPhone GPS system were inaccurate; in one case, by as much as 7 meters. This was addressed by revisiting the location and taking a new set of coordinates using a Samsung Galaxy phone. Through this process a set of accurate coordinates were achieved.

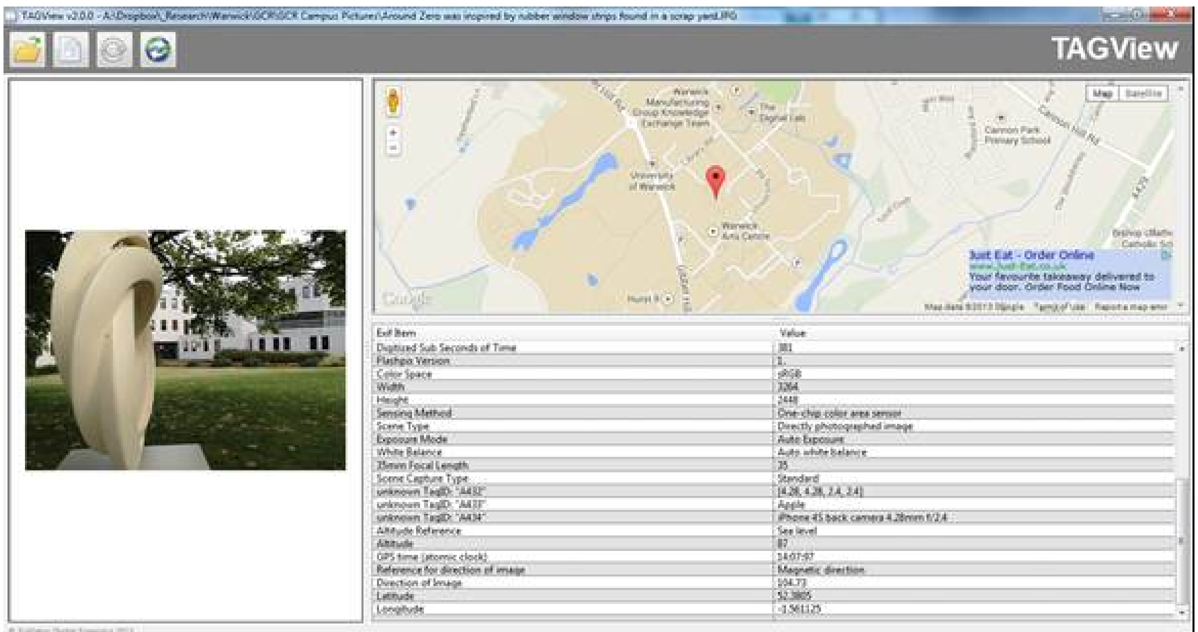

Figure 1: TagView Evigator (Evigator Digital Forensics, 2011)

The Message

Each photograph was paired with a message that typically describes the location. The message, which we refer to as *plain-text*, was encrypted to produce a *cipher-text* and this cipher-text was provided to students. A number of simple cipher systems were used to convert the plain-text to cipher-text. One of the more simple systems is the 'Caesar substitution cipher' where each character in a message is substituted for another character. In other cases the method of encrypting the plain text was somewhat more elaborate but easily solved nevertheless; for instance, the following cipher:

```
KMHESU FG KWUSDH WWXXGU QFSE WZL XG WFG VFMGJYCUST WZL
FA,WJSMIK KWUFWAUK DSAUGK WZL QT WJMLHDMUK S
```

Corresponds to the following text:

```
A sculpture by the social sciences square, in the back-
ground one of the many coffee places on campus.
```

In this example, the text has been reversed to produce the following:

```
supmac no secalp eeffoc ynam eht fo eno dnuorgkcab eht ni
,erauqs secneics laicos eht yb erutplucs A
```

and then Caesar Ciphered. To solve this the student would apply the Caesar cipher to the message and then reverse the result.

Outcome and Student Strategy

Thirty five photographs were provided to students as printouts. The photographs were of locations reasonably spread across the campus (Figure 2). Students were given a day and a half to complete the challenge. In future implementations, we may consider reducing this time to 2 or 3 hours so as to make the experience more challenging; nevertheless, a day and a half allowed students to complete the challenge in a leisurely manner.

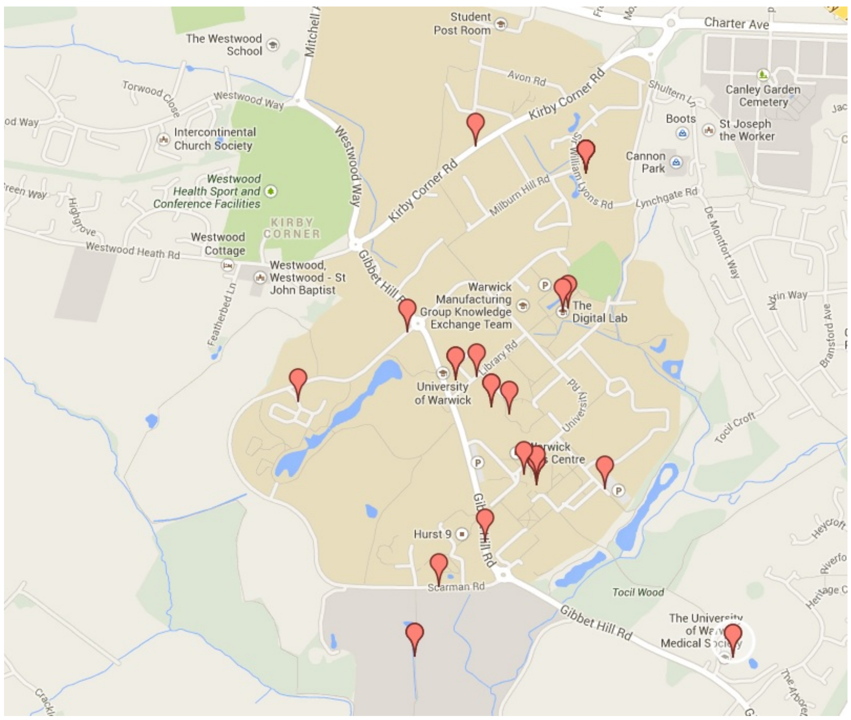

Figure 2: The range of plotted photographs

Students were encouraged to use apps such as FreeGPS, which allows a user to capture the GPS coordinates of the present position (CodeBurners, 2013). Furthermore, they were pointed to three websites that could help in the game: Simon Singh's Cryptography page, which helps in encrypting and decrypting text (Singh, 2014); Jeff Boulter's GPS page, which aids in converting GPS coordinates (Boulter, 2014); and TextMechanic.com, which aids in manipulating text and converting text to various formats (TextMechanic, 2014).

Jeff Boulter's page was important because there are at least four formats for the recording of GPS data: Decimal Degrees; Degrees, Minutes and Seconds; GPS format; and UTM. Students were required to return the coordinates using the DMS format. Jeff Boulter's tool automates the conversion process so, for instance, the Decimal Degrees coordinates 52.3821972222, 1.5555555556 can be converted into the DMS format, which becomes N52 22 55 W1 33 20.

Students were asked to capture the coordinates of each photo and to decipher the accompanying messages. The results from each group were uploaded to an online system which captured each set of coordinates and also elicited feedback. The feedback was captured in a comments box allowing students to provide open textual feedback regarding the experience. This allowed the course leader to understand the strategy adopted by students to complete the challenge and also to determine whether the students had achieved the objectives. Five of the students did not have access to the online submission system and were encouraged instead to complete a paper-based feedback form.

From the feedback, we learnt that groups adopted one or a combination of three strategies:

- *Random walking.* Groups wandered almost aimlessly around campus to discover the locations.
- *Intelligence driven.* Students who had been through international orientation were aware of some of the locations; they were able to identify these relatively easily. The group therefore needed to focus their efforts on identifying the remaining locations.
- *Skill coordination.* One group allocated a member to decipher the codes whilst other members of the same group identified the locations.

Analysis and Conclusions

The results from the game were very encouraging and suggest that we achieved our goal of taking students through a self-discovery campus tour in a fun and enthusing way. All students completed the game. Twenty-five of the 28 students either *agreed* or *strongly agreed* that the game was 'exciting and fun', 26 *agreed* or *strongly agreed* that the game allowed the student to 'learn about important places on the campus in a fun way'. All 28 students *agreed* or *strongly agreed* that the game allowed them to 'make friends and get to know some of my colleagues in a fun/friendly way'.

Twenty-two students *agreed* or *strongly agreed* that the game was 'challenging but not overly complicated'. The one area of the game that resulted in a wider-ranging response was the question of whether the game 'took the right amount of time to complete'. Here, 14 *agreed* or *strongly agreed* whilst 12 *disagreed* or *strongly disagreed* (with two neutral responses). We did not explore this further but one reason for this may have been that by allowing the students to complete the task over a day and a half, we may in fact have had an adverse effect wherein some students felt the game actually took too long.

The open feedback from students was useful and provided useful ideas to improve the game. Some suggested that *'a clue near the real environment of the picture could be very helpful; for example a sign or a quote near a statue'*. One student suggested a form of 'Reverse Geospatial Crypto Reconnaissance' wherein we provide the coordinates and a description of the location and the students return a photo of members of the group at the location.

A common complaint was that the GPS application they used was prone to inaccuracies. This was noticed when the coordinates were plotted onto a map and then compared with their physical location. However, in our view, this was part of the challenge and experience and demonstrated to students that they must not rely on a single source of data or information; furthermore, that any tools they use may need to be validated. An alternative may be, as a student suggested, to increase the distance '*to 10/15m instead of 5m as accuracy of GPS can be limited*'. This would most probably compensate for the inaccuracies as none of the coordinates in our personal test was more than 5 meters away from the target.

This game in its present format is entirely suitable for students on technical degrees, less so for students on humanities/arts related or other non-technical degree programs. In such a context, students need more detailed guidance such as how to use a GPS app to capture GPS data and how to convert formats (if that is important). The use of a ciphered message may be less suitable for such student groups; instead, a ‘Reverse Geospatial Crypto Reconnaissance’ game may be more appropriate.

Another area for future development is the development of a seamless application which manages the upload of photographs, extraction of GPS coordinates and the auto-grading of submissions. The package may also manage a leader board to provide a continual update of performance.

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Biography

Harjinder Singh Lallie (BSc, MSc, MPhil) is a senior teaching fellow in Cybersecurity at the University of Warwick (WMG). He teaches three modules on the program. He has developed and led a number of very successful university courses in Digital Forensics and Security at both undergraduate and postgraduate level.

His research focus is in the area of Digital Forensics and Information Security particularly focussing on social network analysis and is currently studying towards his PhD. He has published dozens of papers in the digital forensics/information security domain and has presented at numerous conferences/workshops. He has held a number of conference committee memberships and acts as an external examiner for three universities. Harjinder is a respected academic in the area of Teaching, Learning, Assessment and Curriculum (TLAC) and regularly organises and delivers at workshops and conferences in this domain.

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eQETIC: A Maturity Model for Online Education

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Abstract

Digital solutions have substantially contributed to the growth and dissemination of education. The distance education modality has been presented as an opportunity for worldwide students in many types of courses. However, projects of digital educational platforms require different expertise including knowledge areas such as pedagogy, psychology, computing, and digital technologies associated with education that allow the correct development and application of these solutions. To support the evolution of such solutions with satisfactory quality indicators, this research presents a model focused on quality of online educational solutions grounded in an approach aimed to continuous process improvement. The model considers of three maturity levels and six common entities that address the specific practices for planning and developing digital educational solutions, targeting quality standards that satisfy their users, such as students, teachers, tutors, and other people involved in development and use of these kinds of educational solutions.

Keywords: Online Education, Digital Educational Solution, Educational Quality Models, eQETIC Model.

Introduction

Digital technologies that drive social activities enable evolution in several areas, such as medicine, entertainment, industrial automation, and education. Specifically for education, this digital capability has enabled the availability of many products and services, i.e., digital solutions, involving an agile growth of educational ability, especially when it comes to online education.

It is possible to verify an expansive development for online education that considers the availability of automated instruction in courses offered in the distance modality and also according to the diversity of learning objects, developed using Information and Communication Technologies (ICT).

According to surveys planned in an info graphic about digital education presented by Knewton (2012), 95% of teachers felt that the engagement of students increased when they combined some type of digital technology with instruction transmission. Some projections presented herein estimate that, in 2020, at least 98% of the courses will be constituted of hybrid solutions, i.e., they will consider traditional learning approaches associated with online digital components.

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According to the Brazilian federal government reports presented by MEC/INEP (2009), a significant increase has been observed in the registration of online courses in distance mode in Brazil. The report shows that 107 courses in online mode were registered in 2004 and that the number of registered courses jumped to 647 in 2008, which represents a high growth rate of courses for this modality, 605% in five years.

This growth has required some mechanisms and criteria for evaluating educational products and services based on digital technologies from control associations and from governments, specifically by departments concerned with educational control, at all levels and in all continents. These evaluation mechanisms should meet the requirements of certification or accreditation for such products; however, they should also seek to assess the quality of these products, which implies careful studies to use a method to evaluate the quality of digital educational solutions.

For Rekkedal (2006), contemporary society requires better quality from the many products and services offered, besides demanding this for online education, offered in its varied forms. To meet this kind of demand in the educational sector, governments, associations, universities, researchers, and other related groups are increasingly engaged in formalizing mechanisms and criteria to assess the quality of this kind of solutions as shown by some examples available in IHEP (2000), ISO (2009), and MEC/SEED (2007) among others.

Thus, for technically observing the quality of such solutions, specific mechanisms should be considered to encourage their construction and subsequent measurement, generating objective results that can be observed uniformly. For constructing and evaluating digital educational products, some specific frameworks can be considered, such as models, standards, processes, and many types of tools, as well as insightful measurement mechanisms to evaluate the products, specifically the entire digital solutions and their related development processes.

Therefore, this paper aims to present a quality model for digital educational solutions, called eQETIC (Quality Model for Educational Products based on Information and Communication Technology). The model considers an approach of continuous processes improvement and the subsequent maturity for quality assurance. This approach seeks to favor the desired quality criteria and the mechanisms for quality construction.

To meet such objectives, this article is organized as follows: section two presents a literature review focused on digital educational solutions and specific concepts and frameworks for digital education; section three considers works related to this research that also have models directed to the quality of digital educational solutions; section four discusses the criteria used for defining the eQETIC Model; section five analyzes the structural features of the model and its application; lastly, section six presents the conclusion and proposals for further works.

Quality in Online Education

Online Educational Products

The digital technology capability has provided significant changes in many sectors of modern society. In education, these changes specifically promote the wide dissemination of digital educational solutions that have different objectives and ways of implementation, for different devices and different communication channels.

Various designations and terminology concerning these products are presented by Guri-Rosenblit (2005), Piva Júnior, Pupo, Gamez & Oliveira (2011), and Perkins (2008). According to Guri-Rosenblit (2005), the following terminology is identified to refer to such products: ‘distributed learning’, ‘online learning’, ‘web-based learning’, ‘virtual classrooms’, ‘online education’ and ‘I-Campus’.

Guri-Rosenblit (2005) highlights that two of the most widely used terms have conceptual differences, i.e., distance education and e-learning. Perkins (2008) confirms this difference, and many other authors make this distinction. They consider that the terms distance education and e-learning overlap each other in some cases, but do not have identical meanings. To Moore and Kearsley (2011), distance education corresponds to the planned learning that normally occurs away from the teaching place, requiring specific techniques for course creation through various technologies and special organizational and administrative provisions. For Barker (2007), e-learning represents an environment where learning occurs using both computers and the Internet.

Considered a recent phenomenon, e-learning is related to the use of electronic media for different learning proposals that can happen in the classroom environment and even replace the face-to-face virtual meetings, as mentioned by Guri-Rosenblit (2005). Perkins (2008) considers that e-learning can be roughly understood as digital technologies able to reduce costs and to improve learning.

Quality Concepts for Online Education

Quality takes different concepts that can be considered to be a subjective characteristic, inherent to a product or service, but technically it should consider objective measures. Although a single, comprehensive, definition for the term is not found, there is a common sense to many authors, such as Crosby (1979) and Humphrey (1989), who consider quality as the compliance with the requirements.

For constructing online educational products, quality should be observed from different perspectives, considering criteria that address the psycho-pedagogical, social, technological issues, etc.

Garvin (1992) proposed what is called the four eras of quality, and these can be observed differently for each product category. The four quality eras correspond to inspection, quality control, quality assurance, and strategy to quality. The author suggests that when a product category is in the era of quality assurance, it means that the quality has to be built along the product development according to its defined process.

For the software industry, the approaches of quality control and quality assurance are considered and addressed by authors such as Pressman (2011) and Sommerville (2003). For software, Godbole (2005) is emphatic in stating that quality control and quality assurance are complementary approaches, yet quality assurance is a preventive approach, while quality control is a corrective approach.

In the context of online education, Barker (2007) considers that aspects related to quality are relevant for two reasons: first, because they are able to support buyers in their decisions to purchase products; and second, because they favor those who develop and offer these kinds of products.

For Pawlowski (2007), quality is appropriately meeting the stakeholders' goals and needs. In the context of e-learning, quality is related to all processes, products, and services for learning that are mediated by the use of information and communication technologies. This scenario can be tracked by online education frameworks.

Specific Frameworks for Online Education

A diversity of frameworks has been proposed to manage the design, development, and maintenance of online educational products, sometimes with objectives concerning the certification of the products in a quality control approach.

Rekkedal (2006), Pawlowski (2007) and Shelton (2011) present a set of frameworks developed by researchers, associations, and governments that discuss the quality of online educational products. Some examples are highlighted below, including quality frameworks designed by governments and specific quality organizations:

- IHEP's Quality on the line: Benchmarks for Success in Internet-Based Distance Education;
- QAA – Quality Assurance Agency for Higher Education: Guidelines on the Quality Assurance of Distance Learning;
- Open eQuality Learning Standards;
- Sloan consortium's five pillars of quality;
- ISO International Organization for Standardization – ISO/IEC 19796-1 Standard on Quality for e-learning; and
- MEC/SEED Quality Benchmarks for Distance Education.

These examples refer to frameworks that have been defined with different objectives and methods of use, which can be applied to various purposes.

However, it is also possible to verify a set of standards in MarylandOnline (2011) that can be used to measure online educational products, called QMRubric. This framework considers eight groups of standards that collaborate in the evaluation of online courses. This program was sponsored by a U.S. fund for developing a proposal to promote evaluation of online courses and quality control and to anticipate future issues of accreditation for online courses.

Related Works

The software industry has developed models that favor the quality of the software product through continuous process improvement associated with its development. Maturity models, as they are known, generally favor the planning, development, acquisition, and maintenance of the software product and its components, thus being increasingly used by the industry in a larger scale.

Chrissis, Konrad, and Shrum (2004) present CMMI (Capability Maturity Model Integration), an example of a maturity model from the software industry. Nunes, Albernaz, and Nobre (2009) suggest the process improvement approach used by the software industry could also be replicated to define a process for digital educational solutions, such as distance education and e-learning, stimulating the development and quality of these products.

It is possible to verify related works that discuss the models which favor the quality of digital educational solutions focusing on a continuous process improvement approach, as can be seen in the eQETIC Model, which is the subject of this article. As an example, Marshall and Mitchell (2002) allow observing a proposed maturity model for e-learning called 'e-Learning Maturity Model' that considers five maturity levels: 1) Initial; 2) Planned; 3) Defined; 4) Managed; and 5) Optimization. The 'e-learning maturity model' proposed by the authors considers the same structure of maturity levels verified in the extinct model called SW-CMM (Software Capability Maturity Model).

Another model proposed by Khan (2004), called 'e-Learning P3 Model', considers people, process, and product, defining the following stages in its structure: 1) Planning, 2) Designing, 3) Production, 4) Assessment, 5) Delivery and Maintenance, 6) Instruction, and 7) Marketing.

Marshall and Mitchell (2002) also present a study aimed to apply the principles defined by the SPICE (Software Process Improvement and Capability dEtermination) project to develop e-learning processes, and in this study, the authors consider specific criteria for the following processes, 1) Learning, 2) Development, 3) Coordination and Support, 4) Evaluation, and 5) Organization, which are measured according to the following parameters, 'not adequate, 'partially adequate', 'largely adequate' and 'totally adequate'.

The EduQNet was presented by Rapchan, Cury, Menezes, and Falbo (2002) to meet the requirements of quality for distance learning courses mediated by Internet. The authors considered the application of standard ISO / IEC 12.207 (Information Technology - Software Life Cycle Process) applied to digital educational solutions. The model is organized into fourteen main activities, and each of these indicates a set of sub-activities.

These works show that the continuous process improvement approaches are being applied to the construction of models for digital educational solutions. Considering the proposals presented by Marshall and Mitchell (2002) and Khan (2004), they are verified to be restricted to the e-learning product and the proposal identified in Rapchan et al. (2002) is restricted to distance educational courses mediated by the Internet.

Similarly to these works, the continuous process improvement approach was applied to the design and structure of the eQETIC Model, as evidenced in more detail in the following sections.

Fundamentals of the eQETIC Model

Practices regarding development and construction of digital educational solutions are varied, as are the models and standards that support this activity. This highlights the need of structured mechanisms able to hold actions in a local, regional, or even in a global view.

The influences exerted on these solutions in their planning, development, and maintenance phase are diverse and, according to Hadjerrouit (2007), the construction of an e-learning product should include educational, organizational, pedagogical, and technological dimensions. This diversity of dimensions must be properly integrated in order to generate the best results.

Relevant characteristics of planning and development of courses in the distance education modality should consider the practices defined by instructional design theories. Tools and techniques associated with these theories assist the construction of such digital educational solutions giving a sense of pedagogical engineering.

The issues concerning the learning process are supported by the precepts of pedagogical engineering, but, besides these, there is an equally significant precept to be considered: the cognitive process. It must be effectively considered in the learning process in any of the learning modalities, including the modalities based on digital technologies (Gagné, Briggs, & Wager, 1992; West, Farmer, & Wolff, 1991).

Thus, the exploratory research used to develop the eQETIC Model (Quality Model for Educational Products Based on Information and Communication Technology) considers these influences, i.e., the pedagogical engineering through which the practices of instructional design and cognitive processes directed to learning can be verified.

Studies and researches have also resorted to review and detailed analysis of frameworks that exploit the quality, certification, accreditation, and development of general digital educational solutions.

Associated with these studies, the maturity model approach derived from Software Engineering contributed to the proposed model, as verified in the eQETIC Model structure, in which the principles of continuous process improvement and quality were used considering the integration of different dimensions related to digital educational solutions as in Rossi and Mustaro (2012).

These studies have provided critical insight and generated knowledge and ability that allowed defining the conceptual eQETIC model. Its structure was defined as well as its mode of application, guided by research into the models that consider the principles of continuous process improvement as presented in Rossi (2013).

Another key factor in the design of the model was the definition of which digital learning products could be considered by the model. In this sense, the model considers the courses offered in the distance education modality as one of the products: e-learning as another product, and learning objects as another kind of digital product. In this sense, some rules were created to be applied specifically to one product, but they can also be applied to the other products.

Considering the principles of continuous process improvement, three improvement levels were defined for the model, which are able to determine its degree of adherence and the degree to which an organization complies with the implementation rules defined by the model. The three improvement levels considered by the eQETIC Model are 1) Sufficient, 2) Intermediate, and 3) Global.

The improvement levels represent the view of continuous process improvement as they establish that institutional processes should be implemented and periodically improved to achieve the desired results. The three levels defined by the eQETIC Model consider the six common entities designated for the model that are repeated at each level and which have special rules for each of them. Each common entity comprises several implementation rules, unique to each level, and which favor the achievement of each level.

The common entities were based on studies and investigations that comprised the theoretical structure of this study, using book chapters, theses, scientific articles, and several frameworks issued by associations, governments, and researchers, from which are highlighted the following: 1) Khan's eight dimensions of e-learning framework; 2) IHEP's Quality on the line; 3) ISO/IEC 19.796-1 Standard of Quality for e-learning; 4) SLOAN Consortium five pillars of quality; and 5) NADE - Norwegian Association for Distance Education. Thus, each of the common entities considered by the model were defined with their respective function, with its set of rules and supported by specific references, as shown below:

Didactic-Pedagogical Common Entity (DPCE) - although the didactic and pedagogical issues are complex, they are not treated in depth by the model. Considering the context of this common entity related to applying modeling and construction of online courses, the theories of instructional design were considered, as well as the implications of cognitive processes in learning. To define this common entity, four of the main theoretical references were considered: West et al. (1991), Gagné et al. (1992), Dick, Carey, and Carey (2005), and Briggs (1977).

Technology Common Entity (TECE) - aims to define practices regarding the technological capacity of educational products. From the technology plan, the organization should possess software, security items, data storage, media, as well as the hardware infrastructure and telecommunication. The rules of this common entity were based on references such as Barker (2002), IHEP (2000), ENQA (2005), and MEC/SEED (2007).

Management Common Entity (MACE) - determines the management and operation ability to develop and to maintain digital educational solutions. Addresses strategic capability, project management and considers the implementation of quality system indicators to provide means to measure quality results, being supported by Martínez et al. (2011), Moore & Kearsley (2011), and PMI (2008).

Support Common Entity (SUCE) - considers the rules that determine the support mechanisms for learners involving all types of infrastructure, be it over the telephone, online, or in person. It also considers rules that provide support to tutors who may require detailed information to submit content-best results, and are considered in references such as IHEP (2000) and Colomina, Rochera, and Naranjo (2011).

Tutorial Common Entity (TUCE) - addresses the practical issues regarding the actions of mentoring in distance mode courses. Considers rules that address formal training, either regarding content or technological aspects that provide better performance to tutors. The practices were based on Elissavet and Economides (2003), Litto and Formiga (2009), and Pera, Cervera, and Barado (2007).

Evaluation Common Entity (EVCE) - includes considerations on the diagnostic, summative and formative assessment, and self-evaluation of the learning process. The rules of this entity consider ways of storing and disseminating evaluation and feedback controls that should be associated with the learning process. Online assessment tools are also considered in this entity, constructed based on West et al. (1991), Gagné et al. (1992), Dick et al. (2005), and Coll and Engel, (2011).

The Implementation Rules that belong to each of the common entities were also defined from these investigations that meet the needs for each of the observed improvement levels. The rules and other components that make up the structure of the model will be presented in detail in the next section.

Structure and Application of the eQETIC Model

The structure overview of the eQETIC (Quality Model for Educational Products Based on Information and Communication Technology) can be seen in Figure 1. This structure is based on a continuous process improvement approach and considers three improvement levels, each of one including the six common entities (CE) defined for the model. Each of the CE considers a set of implementation rules (IR) that are grouped according to the groups of implementation rules (GIR). The GIR and IR defined are unique and not repeated over the model implying that a given IR defined for a specific CE is unique and exclusive to this entity at this level.

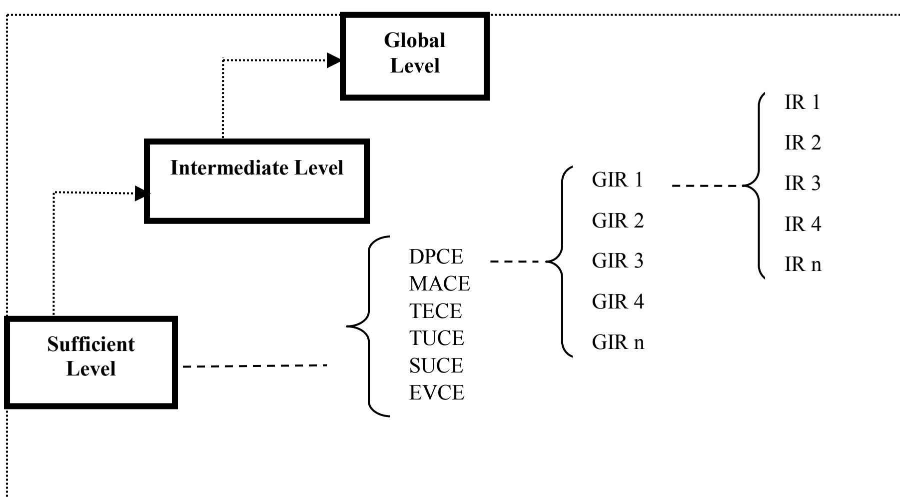

Figure 1: eQETIC Model Structure (Rossi & Mustaro, 2012)

The goal of each improvement level is highlighted below. It should be noted, however, that an organization that seeks to implement the eQETIC Model should follow the rules defined at each improvement level, implementing or adjusting their processes according to the IR of that level. Hence, after observing the rules of a given level, the subsequent levels should be met. The improvement levels considered by the model are:

- Sufficient level - allows sufficient functional condition and considers basic and fundamental implementation rules;
- Intermediate Level - allows improvement in processes according to the rules at this level, generating continuous product improvement in order to improve quality through process changes and adjustments;
- Global level - considers all the rules of the previous levels, as well as of this level, allowing global and full use of the model where the organization is considered to comply with the rules laid down therein.

The Common Entities (CE) aim to group the implementation rules that must be followed by the organization using the model. Six common entities are considered, as previously mentioned, that include rules capable of supporting the institutionalization of processes favoring the planning, development, and maintenance of digital educational solutions, as follows: Didactic-Pedagogical Common Entity (DPCE); Technology Common Entity (TECE); Management Common Entity (MACE); Support Common Entity (SUCE); Tutorial Common Entity (TUCE); Evaluation Common Entity (EVCE).

For managing its processes as prescribed by the eQETIC Model an organization must observe another element of the model that is not presented in Figure 1 and is totally relevant to the customization of eQETIC rules: the EPI (Educational Product Indicator).

Since the eQETIC Model provides rules for different ICT-based educational products, such as distance education, e-learning, and learning objects, the organization should consider a customization step of the model using the EPI. Each Implementation Rule has an associated EPI. The organization that aims to abide by the rules of the model must check which rules are relevant in accordance with the educational product. The EPI considers the following values: 'DE' for 'Distance Education' (emphasizing that, in this case, the model is suitable to the development and maintenance of courses); 'EL' which refers to 'e-learning ', and 'LO' that concerns Learning Objects.

Table 1 shows examples of Implementation Rules defined by the eQETIC Model, not restricted to a specific Improvement Level or Common Entity, just for presenting the rules as they are defined, grouped into their respective group, showing the associated EPI.

Table 1: eQETIC Model – Examples of Implementation Rules (Rossi, 2013)

Improvement Level	Common Entity (1)	EPI (2)	Group of Implementation Rules (GIR)	Code/Description of Implementation Rules (IR)
1	DPCE	DE; EL	DPGIR 101	DPIR 101.1 - Topics should be defined and documented
1	TECE	DE, EL	TEGIR 100	TEIR 100.1 – A Technology Plan must be established and maintained.
1	MACE	DE	MAGIR 102	MAIR 102.4 – A team of teachers and tutors should be defined.
1	EVCE	DE, EL	EVGIR 101	EVIR 101.1 – The types of evaluation to be applied to the learner should be relevant to the nature of the content presented.
2	EVCE	ED, EL, LO	EVGIR 201	EVIR 201.1 – Online mechanisms of learner self-assessment must be defined and implemented.
3	EVCE	DE, EL	EVGIR 301	EVIR 301.1 – General evaluation mechanisms of online learning environment supported by Central Technological Systems must be established and maintained.

Legend (1): 'DPCE – Didactic-Pedagogical Common Entity'; 'TECE – Technology Common Entity'; 'MACE – Management Common Entity'; 'EVCE – Evaluation Common Entity '.
Legend (2): 'DE – Distance Education'; 'EL – e-Learning'; 'LO – Learning Objects'.

As an example to illustrate the application of EPI, rule DPIR 101.1 (first line of Table 1) concerns only 'Distance Education' and 'e-learning' products; this rule is hence not considered for the 'Learning Object' product. The model presents rules that can sometimes be relevant to a unique product, as rule MAIR 102.4; and sometimes other rules pertain to the three products, such as rule EVIR 201.1 (fifth line of Table 1).

The Group of Implementation Rules (GIR) is another model component, as shown in Figure 1. The GIR aims to group a set of implementation rules that are totally related, allowing better understanding of the purpose of a particular group. Considering as an example rule TEIR 100.1 shown in Table 1, this rule belongs to the group TEGIR 100, which, according to eQETIC Model, refers to the process that determines that a Technology Plan should be defined by the organization. Group TEGIR 100, for example, considers two implementation rules in its totality.

Table 1 allows observing some examples of Implementation Rules (IR) defined by the model that define which should be implemented, i.e., what the institutionalized process should consider to be adherent to the eQETIC Model. As mentioned, all the Implementation Rules are unique and are associated with a Group of Implementation Rules (GIR), a Common Entity at a given Improvement Level of the eQETIC Model. According to Rossi (2013), the implementation rules represent the essence of the model being able to declare what the organization should consider for its institutional processes. Although only some Implementation Rules are highlighted in Table 1, the model has a total of 89 IR distributed among three improvement levels, as detailed in Table 2.

Table 2: eQETIC Model – Quantity of Implementation Rules

Improvement Level	Common Entity	# GIR	# IR
Sufficient Level (1)	DPCE	9	13
	TECE	5	9
	MACE	6	17
	SUCE	3	6
	TUCE	4	7
	EVCE	3	5
Intermediate Level (2)	DPCE	3	4
	TECE	1	1
	MACE	2	7
	SUCE	1	1
	TUCE	1	1
	EVCE	3	4
Global Level (3)	DPCE	2	2
	TECE	1	2
	MACE	2	4
	SUCE	1	1
	TUCE	1	1
	EVCE	2	4

With the structural view of the model, it is possible to emphasize that it is able to outline the process implementation in an organization that uses one of the online educational products considered by the model. However, the organization should consider the rules that are established by the model in their processes, favoring their continuous improvement in order to build and to improve the quality of products and services.

The organization should pay particular attention to the measurement processes creating appropriate indicators to assess their results. This is relevant to a quality system and is also provided by eQETIC Model through one of the implementation rules of the Management Common Entity, which defines that the organization should establish a measurement process. With this process, the organization should provide the results measured, comparing them and presenting them for disseminating the actions related to quality.

Conclusion and Further Works

The goal of developing a model capable of supporting steps that guide the planning, development, and maintenance of digital educational solutions was achieved by presenting the structure of eQETIC model. This model follows a continuous process improvement approach, whereas the implementation of processes in a developer organization of these types of solutions favors the development lifecycle and the quality of these solutions.

Presenting three improvement levels as maturity levels, the model allows the organization to implement the processes belonging to each level at a given time, and these levels and processes are organized in six common entities.

The model was built upon fundamental concepts of digital technologies related to education. It presents relevant principles regarding planning and development of digital educational solutions, as well as practices to operationalize organizations that seek to develop these types of solutions with better quality.

Further works associated with this may contribute to defining a model to assess and to certify the institutions using eQETIC Model. The proposal is implementing organizational processes for developing and maintaining digital educational solutions. It is feasible to define a specific framework to establish evaluation mechanisms considering activities involved in the certification process as rules and instruments to be used in the evaluation of organizations that use and apply the eQETIC Model.

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Learning English Vocabulary in a Mobile Assisted Language Learning (MALL) Environment: A Sociocultural Study of Migrant Women

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Abstract

This paper reports on a case study of a group of six non-native English speaking migrant women's experiences learning English vocabulary in a mobile assisted language learning (MALL) environment at a small community centre in Western Australia. A sociocultural approach to learning vocabulary was adopted in designing the MALL lessons that the women undertook. The women provided demographic information, responded to questions in a pre-MALL semi-structured interview, attended the MALL lessons, and completed a post-MALL semi-structured interview. This study explores the sociocultural factors that affect migrant women's language learning in general, and vocabulary in particular. The women's responses to MALL lessons and using the tablet reveal a positive effect in their vocabulary learning.

Keywords: MALL, sociocultural approach, migrant women, vocabulary

Introduction

A large volume of research has been published in the Mobile Assisted Language Learning (MALL) field over the past twenty years following the rapid development and advancement in mobile technologies (Burston, 2014; Stockwell & Hubbard, 2013; Viberg & Gronlund, 2012). As part of computer-assisted language learning (CALL), MALL utilises mobile devices such as smartphones, tablets, and iPods to support language learning (Chuang, 2009; Ozdogan, Basoglu, & Ercetin, 2012; Stockwell & Hubbard, 2013; Tai, 2012). Research has demonstrated the feasibility of MALL for language learning; however, the majority of MALL learning takes place within academic contexts, such as schools and universities where participants are literate in their native language, familiar with English, and are in a formal and structured environment. The research reported in this paper is part of a larger study investigating the learning experiences of migrant women in a non-academic context, who have lived in Australia between two and seven years, are literate in their native language, but

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are struggling with English. In Australia, proficiency of the English language is essential for general social interaction, furthering education and employment (ASIB, 2012; Bimrose & McNair, 2011; Colic-Peisker & Tilbury, 2007; Fozdar & Hartley, 2012; Smolicz & Secombe, 2003).

This study focuses on the sociocultural factors that affect migrant women's language learning in general and vocabulary acquisition in particular. This study specifically addresses vocabulary acquisition as it is a branch of language that is important for second language oral proficiency (J. Ahmad, 2011; Choo, Lin, & Pandian, 2012; Coady & Huckin, 1997). Vocabulary acquisition, centering on the speaking and listening branch of language development, is seen as useful and beneficial for migrant women to develop general English proficiency (K. S. Ahmad, Armarego, & Sudweeks, 2013). The approach to learning vocabulary adopted in this study is supported by Halliday's (2004) and Vygotsky (1978)'s sociocultural theory.

Background

For this study, the term 'migrant women' refers to women who enter Australia under the family reunion program or for humanitarian reasons. Typically, the purpose of migration is to build a new and better life for families; however, the causes of migration can be "personal and voluntary" or "forced" due to political turmoil, threats to their lives, violence, famine, or war (Kunz, 1973; UN, 2013; UNHCR, 2011; Ward, Bochner, & Furnham, 2001). Settlement into a new life includes having to learn and adapt to a new culture, dealing with emotional and psychological issues, dealing with sociocultural and socioeconomic challenges, and learning English as a new language (OMI, 2012). The lack of English language proficiency is one of the common barriers for migrants' settlement in Australia (Coates & Carr, 2005; Colic-Peisker & Tilbury, 2007; Fozdar & Hartley, 2012; Migliorino, 2011). For women, this barrier cannot be overcome as quickly as for men. To some extent, pressures of family duties, staying at home and engaging in full-time care of families, leads to isolation from the broader community for several years. As a consequence, finding employment can be a challenging and overwhelming experience. Personal and sociocultural factors are the important influences in the lives of these women (AMES, 2011; ECCV, 2009; McMichael & Manderson, 2004). It has been observed (K. S. Ahmad et al., 2013; RCOA, 2010) that, in terms of these women learning English, the programs offered by local and non-profit community-based centres are the best alternative to the formal government-funded programs. Even though the former is non-accredited and short term, it is the kind of learning opportunity and space that suits their needs for a friendly and non-rigid learning environment that allows them to learn and practise basic speaking and conversational skills.

The case study for this research is a community centre in Western Australia, which is a non-profit organization providing community access to both formal and informal learning opportunities as well as community services and referrals to other agencies. The first author of this paper is a facilitator of an English program for adult migrants at the centre. The objective of the English program is to provide a learning space for people to meet and socialise with others who also want to practise spoken English. Their main motivation for attending the program is to learn, practise, and improve their basic conversational and other language skills. The program is open to both men and women; however, the majority of participants are women.

Integrating MALL into this particular community English program includes using a mobile device, that is, a tablet as a learning tool. This inclusion of a mobile device enriches the learning experience because the features of these devices can enhance the delivery of learning materials. As suggested by Klopfer, Squire, and Jenkins (2002), these features include connectivity, context sensitivity, individuality, portability, and social interactivity. Regardless of the learners' location, they can access learning materials and activities spontaneously. The learner and the mobile devices are both *portable* as the learner can access and be connected online. The learner has a choice whether to use the mobile device individually and personalize his/her learning to or learn collaboratively with other learners (Cavus & Ibrahim, 2009). MALL can also be used in a blended setting where in-classroom instruction is combined with out-of-class instruction, thus maximising the benefits of in-class, face-to-face, and online learning (Tai, 2012). In the context of this case study, the integration of MALL also helps develop digital literacy skills among these women. This is because, by learning how to use a mobile device, the women can use it for other learning such as other life skills. Familiarity with the mobile devices facilitates access to useful websites and networks (social, government, or career), thus reducing isolation in their lives. Being proficient in English and being digitally proficient also increases the chances of being included (Migliorino, 2011) into the highly digital literate Australian culture and society (Thomson & De Bortoli, 2012).

Learning English and MALL through the Lens of Sociocultural Theory

The approach to learning vocabulary adopted in this study is supported by the sociocultural theory of Halliday (2004) and Vygotsky (1978). Both theorists emphasise that language learning is primarily a social activity and the learners should be involved in negotiating and make meaning in authentic social and cultural activities. Following Grabinger, Aplin, and Ponnappa-Brenner's (2007) idea of social cultural learning environment, learners should become familiar with the social norms and discourse of the target language. Learners should also be given the opportunity to apply them in an authentic way. Vocabulary learning is not only about acquiring the meaning and knowledge of the words or phrases but also being able to use them for meaningful communication.

According to O'Neill and Gish (2008), in learning a second language, successful cross-cultural understanding and intercultural literacy for both learners and their teacher/facilitator is required where learning experiences should take place in a variety of sociocultural settings. This can be achieved through a process of continual "constructing, interpreting, and modifying their representations of reality based upon experience and negotiation of meaning with others" (Grabinger et al., 2007, p. 2). According to Burgoyne and Hull (2007), this continual process allows individuals to become members of the group in which they play a part by assuming the *emerging identity* that is associated with the language that they are learning. In addition, the principle of participation fortifies the viewing of learning as a collaborative process and as a way of transforming knowledge making. This allows participants to shape the process and products of knowledge (O'Byrne, 2003). Through interactions, individuals engage with each other and they construct knowledge through their social and cultural practices. Martin and Rose (2005) emphasise that co-construction of knowledge makes new learning possible within the continuing practice and social environment. Billet (1998) posits that, without continual participation in social practice, knowledge will not be accessible, thus learning outcomes are likely to be inhibited. Therefore, successful communication in English requires participation in a social practice and involves all traits of an individual's sense of social identity and social resources. On this basis, a sociocultural approach is adopted in this case study in designing the MALL integrated vocabulary lessons for the participants.

In designing vocabulary lessons incorporating MALL concepts for adult learners, consideration should be given to principles of andragogy (Knowles, 1984) that are widely used for developing adult learning curricula. These principles are based on five crucial suppositions about adult learners' characteristics that differ from children's pedagogy: self-directed; equipped with experience; ready to learn; oriented toward being problem-centred rather than subject-centred; and motivated (Smith, 2002). For adult learners, learning English as a second language in general, and English vocabulary specifically, is influenced by factors such as level of education in native language (L1), culture, past experiences, age, and opportunities to speak English (Allender, 1998;

Hewagodage & O'Neill, 2010). There is also the need to consider previous psychological and emotional concerns, such as trauma, settlement, and family priorities or confidence and motivational issues (Fozdar & Hartley, 2012). There may also be different understandings among cultures about teaching methodology, teacher-learner rapport, and modern pedagogical practices. In addition, the idea of self-assessment, critical discussion, and the physical climate of the learner-centred learning environment may be alienating for some. Thus, the pedagogical approach adopted for adult migrants' English language learning in general is crucial for language learning success.

Among studies that show the feasibility of MALL in language acquisition within formal education settings are those by Alemi, Sarab, and Lari (2012), Cavus and Ibrahim (2009), Chuang (2009), Gu, Gu, and Laffey (2011), and Thornton and Houser (2005). Some of the factors central to the MALL environment are the characteristics of the mobile devices used. For example, allowing learners to access learning materials without time and space constraints is effective for delivering language learning materials to learners (Thornton & Houser, 2005). In addition, mobile devices are more cost efficient compared to desktop or laptop machines, thus they are more affordable to language learners (Wu et al., 2012). A review of the literature by K. S. Ahmad et al. (2013) suggests that these factors of MALL are potentially beneficial to English learners such as migrant women. Further, the suitable area of English language that these learners should focus on is vocabulary. According to J. Ahmad (2011), vocabulary learning is a crucial process for language learners to acquire proficiency and competence in a language. Qian (1999) states that vocabulary knowledge refers to the size as well as the depth of vocabulary, which includes knowledge about the contexts in which the word is used, the frequency with which it is used, its morphology, its syntax, whether it has multiple meanings, pronunciations and spellings, and how the word combines with other words. A wealth of words or a *word bank* facilitates fluent and effective speaking and writing, whilst other skills (listening, reading, speaking, and writing) are enriched and integrated as well. The greater the number of words in a learner's *word bank*, the more instruments they have with which to put a point on their own ideas, and dissect and examine those of others (J. Ahmad, 2011; Elgort, 2011). As such, knowledge of vocabulary is valuable and useful for a language learner.

Krashen and Terrell (2000) claim that comprehension is not possible without vocabulary. The more vocabulary is mastered, the better one's comprehension and thus more acquisition of language occurs. Kenny (2011) also suggests that, in order for humans to acquire other words and syntax, they will have to initially acquire vocabulary. It is beneficial for language learners to have vocabulary knowledge and be able to use this knowledge in their day-to-day lives. Having a range of vocabulary and feeling confident in using it leads to the ability to be clear when sharing ideas and thoughts, or simply when making conversation (J. Ahmad, 2011; Elgort, 2011; Nation & Newton, 2009). This increases the likelihood that other people will understand what is expressed. A diverse vocabulary allows learners to connect with a broader variety of people (Lightbown & Spada, 1993; Mishra, 2010). For example, knowing some business terms assists in not being taken advantage of. Also, vocabulary is essential for comprehending reading materials (Krashen & Terrell, 2000; Lightbown & Spada, 1993). Comprehension of what is being read is hindered due to unfamiliar words that tend to become little holes in the text. Vocabulary also assists learners in becoming more informed and involved. For example, learners will have a better understanding of news and currents events if they understand politics and geography. Learners will also be able to grasp ideas and think more rationally and incisively.

Case Study

The case study is a small community centre that is a non-profit organization in a suburb in Western Australia. The centre provides community services and learning programs to the surrounding community members. One of its programs is learning conversational English, which was started in 2001. The first author of this paper has been the coordinator and facilitator of this program for the past two years. The main objective of this program is to provide a non-formal learning space for people who want to practise basic conversational and survival English, whilst meeting and socializing. The program is free of charge, offers a learning atmosphere that is relaxed, supportive, non-threatening and provides a somewhat level playing field for learning. A crèche facility is also provided for mothers with small children. This program is open once a week, for two hours, during public school terms.

Attendance in the program is not compulsory. As such, attendance is irregular, contingent upon participants' availability and convenience. About 40 participants enroll in the program each term with an average attendance of 12 to 15 per session. Some participants have been regulars for many years, though they do not come to every session. The program receives new participants almost every term, but it is never known whether they will return in successive sessions. Although the program is open to both men and women, it has been observed that women attend this program as a way to be able to get out of their house. Thus, in addition to learning English, the program reduces their isolation and allows them to interact, engage, and socialise with other women.

The sessions are meant to be non-formal and non-academic, as opposed to formal and structured English classes. The physical layout of a session includes two large tables where 12 participants can sit around each table. Upon agreement with the centre's management, the facilitator plans topics to be included for the 10-session term. Activities may include the following: introducing vocabularies and phrases using pictures and realia, followed by making sentences using learnt vocabularies; eliciting discussions based on topics; role playing and listening to a CD (where participants listen to short dialogues by native English speakers, followed by a discussion); and any current issues or topics that participants want to share with their peers. The whiteboard is used to write words, phrases, or draw pictures for illustration. Participants who can read and write in the Roman alphabet are able to copy the words on the board fairly quickly. Participants who are able to read and write in their native language usually copy the words from the board and write notes in their language. Other participants who struggle or are unable to read and write use their visual and listening ability and their memory.

The sessions are not fast paced, as sometimes more time is needed to describe or explain words and concepts, and sometimes participants help and translate for each other. Some repetition drills are used to help participants become familiar with new vocabularies and phrases. It is observed that new participants who speak very little English usually only speak when spoken to during their first session. In subsequent sessions, they seem more comfortable and more proactive in the conversations. The author observes that both new and regular participants face the same challenges when they engage in conversations; mainly, they feel unsure and have limited vocabulary which impedes fluency. For example, when sharing their stories about what they did during the weekend, their facial expression and their bodily gestures show that is takes effort to form the sentences in their minds and courage to utter and speak up in front of other people. In addition to this, there are unintentional errors and/or prompts that the participants usually make, such as missing or incorrect uses of words in sentences, incorrect pronunciation, interweaving of L1 words, and pausing mid-conversation to think of the word to use or asking/confirming with a friend or the author that they are saying things correctly. Nonetheless, they are receptive when their mistakes or errors are being corrected. These issues do not hinder them from engaging in conversations, and they understand that the purpose of the program is for them to practice conversing in English.

Methodology

This study explores the experiences of a group of six non-native English speaking migrant women in learning English vocabulary in a MALL environment through the perspective of sociocultural theory. As such, they attend a non-formal English program at their local community centre. The program involves two-hour non-formal conversational sessions each week for non-English speakers. On average, fifteen people attend the program; however, only six women were selected for this study as they were regulars and attended a majority of the MALL-integrated vocabulary lessons (from this point onwards to be known as MALL lessons) that was conducted. Ten tablets were supplied by the community centre for the study. The tablet was introduced into the program in a gradual manner, so as to avoid feelings of intrusiveness and intimidation among the attendees. An important criterion for the introduction of the tablets was to maintain the naturalistic and non-formal feel to the program as much as possible. The investigation was conducted using the community centre as a case study (Creswell, 2012; Leedy & Ormrod, 2005; Yin, 2011). The six women provided demographic information and responded to questions in a pre-MALL semi-structured interview, attended MALL lessons, and completed a post-MALL semi-structured interview. Informed by the literature review, the research questions are as follows:

RQ1: What sociocultural factors affect migrant women's vocabulary acquisition?
RQ2: What MALL factors affect migrant women's vocabulary acquisition?

Pre-MALL and Post-MALL Interviews

Semi-structured interviews were conducted before participants attended the MALL lessons (pre-MALL) and after they attended the MALL lessons (post-MALL). The pre-MALL interview collected data on demographics about participants' migration histories, country of origin, the main language and other languages they speak, level of education, and familiarity with computer and mobile devices. These were followed by questions regarding their perceptions of their own English ability and their view of the importance of English. The purpose of the post-MALL interviews was to learn of participants' experience learning English vocabulary in a MALL environment and of using the tablet.

Data was collected using semi-structured interviews, as informed by the work of Creswell (2012) and Yin (2011). Semi-structured interviews have an overall structured framework but they allow for greater flexibility. The interviewer remains in control of the direction of the interview, though with some leeway. For example, for this study, the order of questions was changed and some questions were probed further for more extensive follow-up of responses. This created richer interactions and more personalised responses (McDonough & McDonough, 1997). In addition, the established rapport between the interviewer and the participants encouraged them to speak freely (Miralles-Lombardo, Miralles, & Golding, 2008). In some of the interviews, the interviewer had interpreter help from other participants, thus allowing participants to express their views more deeply and freely in their native language. These factors elicited more valid responses from participants (Burns, 1994; McDonough & McDonough, 1997). The interviews were audio-recorded then transcribed for analysis.

MALL Lessons

In designing the MALL lessons, the author had to consider the timeframe allowable for her to have access to the participants who were also part of the larger group who attended the English program. The author was permitted by the community centre to conduct research at their premises and use the same two-hour time block that is used for the regular conversational English program. The author also had to retain the similar non-formal setup of the regular English program while conducting the MALL lessons.

The tablets were introduced gradually to maintain the naturalistic and non-formal feel to the program while avoiding feelings of intrusiveness, intimidation and fear among the attendees. The majority of the program attendees are of low level English literacy; some struggle to read the words or texts on the tablet, while some were unable to read at all, let alone use the tablet and navigate the apps on the tablet. The groupings of attendees were then arranged in such a way that a higher literate person was partnered with a lower literate person. This allowed attendees to socially interact, engage, and work together in co-constructing meaning and knowledge with each other.

The topics selected for the MALL lessons considered the principles of andragogy (Knowles, 1984), the natural approach of language learning (Krashen & Terrell, 2000), and the sociocultural instructional design (Grabinger et al., 2007; Halliday, 2004; Vygotsky, 1978). Combined, the vocabulary lessons for this study exposed participants to a variety of everyday functional and conversational language use, and focused on:

- language learning rather than the grammar and technicality of language;
- seeking fluency rather than accuracy, thus direct error correction and pronunciation work is not necessary at early stages;
- treating vocabulary as an essential component of learning English rather than grammar because extensive vocabulary knowledge permits fluency in communication;
- learning vocabularies that are essential to the learners' needs, strengths, weaknesses, and aspirations, for example, learning the phrases that are commonly used to ask permission politely or phrases used to describe people's facial features; and
- building listening and speaking skills.

Material for the MALL lessons were sourced from English as a Second Language (ESL) textbooks, ESL mobile apps, and ESL websites. Table 1 shows a sample of categories of everyday conversational language developed as a mobile app for the beginner level ESL adult learner. This app is called *ThinkEnglish!* and is developed and used by the Australian Migrant English Services in New South Wales for their adult migrant students in government-funded English programs. In each category a learner can watch and listen to conversations, practice vocabulary by matching the words with pictures while listening to word pronunciation, and practice speaking in an interactive medium with an audio recording facility.

Table 1: The categories of situations for everyday conversational language on the *ThinkEnglish!* app (AMES, 2011)

Category	Sample Situations
At the shops	At the post office, at the chemist, at the library
Daily life	What's the weather like, talking to neighbours
People and places	Describing people, describing a city and country
Messages	What's the matter, taking messages, leaving a message
My news, in the news	The first day, a news story, celebrations

The following is a sample of how a MALL lesson on the topic of *Describing People* is conducted.

Step 1

Pictures were used to pre-teach vocabulary (words/phrases) such as "wears glasses", "beard and moustache", "spiky hair', "blonde hair", "tall and short", and "young" (Figure 1). The purpose of pre-teaching is for learners to understand the meaning and become familiar with the vocabulary so that it would be easier when encountering more complex sentences or texts. Each picture is of an A4 size. One picture was displayed on the board and discussion was elicited from the attendees based on this picture. With a partner, the attendees made sentences using the keyword/phrase and shared their sentences with the whole group. To encourage conversation, follow-up questions were asked from the sentence that was created and the attendees would try to compose follow-up sentences/answers. This process was repeated for the other pictures.

“wears glasses”

“moustache”

“spiky hair’

“blonde hair”

“tall and short”

“young”

Figure 1: Pictures used for pre-teaching vocabulary

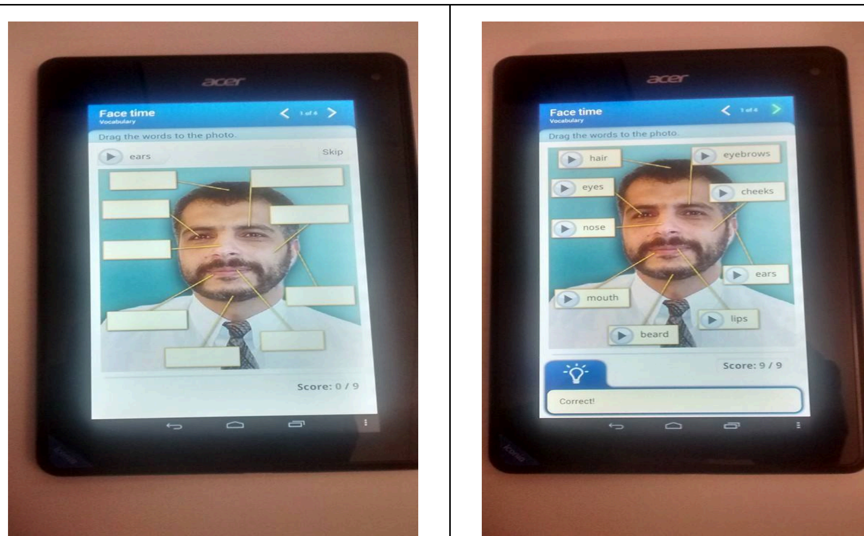
Step 2

This step is when drilling is used to help attendees practice fluency and become familiar with how the words and phrases are used. With all six pictures on the whiteboard, the following corresponding sentences are drilled:

a) “She wears glasses”
b) “He has a beard and a moustache”
c) “He’s got spiky hair”
d) “She’s got blonde hair”
e) “He’s tall”
f) “He’s short”
g) “They’re young”

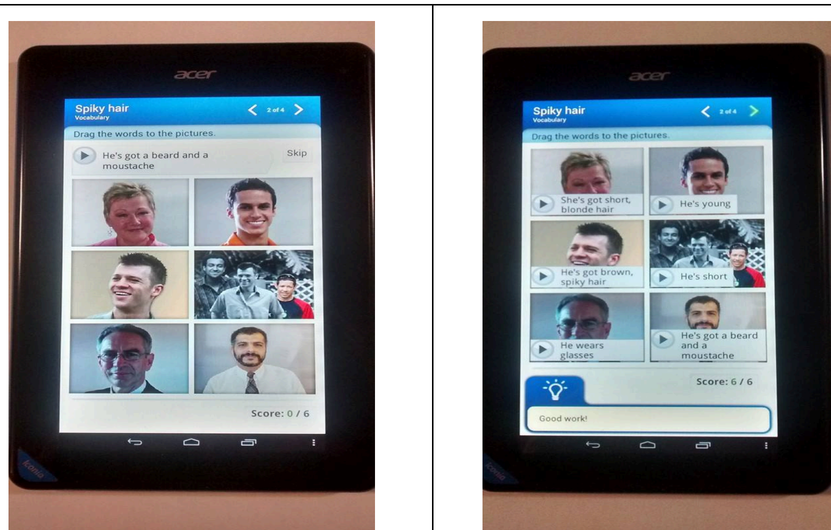
Step 3

This is when each attendee was given a tablet to work with and paired with another attendee. The *ThinkEnglish!* app was downloaded on all 10 tablets before the start of the lesson, and it was ensured that the tablets were fully charged. The *ThinkEnglish!* app was then pre-set as the start page when the tablet was switched on by the learner. Figure 2(a) and Figure 3(a) are samples of the user interfaces on the tablet that the attendees of the MALL lessons were presented with to work on. Figure 2(b) and Figure 3(b) show the finished exercises that the attendees completed.



(a) (b)

Figure 2: Sample of an interface of the app on the tablet used in this study as vocabulary exercise I



(a) (b)

Figure 3: Sample of an interface of the app on the tablet used in this study as vocabulary exercise II

Tapping on the play button lets one listen to the audio of the names of the facial item (Figure 2(a)). Attendees who struggle with reading can just tap the play button and listen to the audio, and try to recognise the word and what it means. By pressing the same button, the word can be *dragged* and placed in the correct box (Figure 2b). When the exercise is completed, as in Figure 2(b), one can tap on any of the play button to listen to the audio again. The exercise can be refreshed and repeated as many times as needed.

Results

Demographic Information

The six non-native English speaking migrant women participating in this study were selected using purposive sampling identified through the English conversational program from the case study site. They are aged between 29 to 51 years old. They have lived in Australia between 2 to 7 years. They are all literate in their native language and have completed high schools. They identified themselves as needing to improve their speaking skills to a level of English proficiency that allowed them to communicate comfortably to the wider native Australian English speakers. They also identified themselves as housewives with children going to school. Data were also collected about their country of origin, the first, second, and third language they spoke, and their level of literacy. Table 2 summarises this data.

Table 2: Demographic data

Pseudo nym	**Migration to Australia**			**Everyday Language Use (L1,L2,L3)**		
	Age	**Country of origin**	**Number of years living in Australia**	**L1; Script; [1]Reading fluency; [2]Writing fluency**	**L2; Script; [1]Reading fluency; [2]Writing fluency**	**L3; Script; [1]Reading fluency; [2]Writing fluency**
SURI	29	Indonesia	2	Indonesian Roman Alphabet High High	English Roman Alphabet Low Low	
RINA	33	Indonesia	2	Indonesian Roman Alphabet High High	English Roman Alphabet Low High	Rohingya Arabic Very Low Very Low
LIDDY	43	China	7	Mandarin Logographic High High	Cantonese Logographic High High	English Roman Alphabet Average Average
ALLY	38	China	2	Mandarin Logographic High High	Cantonese Logographic High High	English Roman Alphabet Very Low Low
KEY	51	Malaysia	2	Mandarin Logographic High High	Malay Roman Alphabet Average Average	English Roman Alphabet Low Average
ROSE	44	Congo	7	Lingala Extended Roman/Latin Average Average	French Roman Alphabet High High	English Roman Alphabet Low Low

[1] *Reading fluency:* Very high = able to read and comprehend complex texts (e.g. academic texts); High = able to read and comprehend non-complex texts; Average = able to read non-complex texts; Low = Struggle to read in general; Very low = not able to read at all.
[2] *Writing fluency:* Very high = able to write (produce) complex texts; High = Able to write (produce) non-complex texts; Average = Able to copy non-complex texts; Low = Able to copy simple words and sentences; Very low = not able to write.

Sociocultural Influences on Learning

The following provides other participant background details important to gaining an understanding of how sociocultural factors affect the women's lives and their reactions to learning English in general.

SURI (Indonesia)

Suri is a married Muslim. She and her husband and three children came to Australia as refugees. Her husband is Rohingya Burmese. Suri still experiences migration trauma due to spending ten days travelling by boat. Currently they are under a refugee protection visa while waiting for their permanent residency to be approved. Suri is restricted socially due to her cultural and religious background. She rarely mixes with English-speaking people in the society. She only mixes with other multicultural community members when she attends programs organized by the community centre.

Suri completed primary and high school in Indonesia. She learned basic English in both schools. The medium of reading and writing was Roman alphabet. However, she writes slowly now because of lack of practice and she is unsure of the spelling. Suri values the importance of being proficient in English because of living in Australia but she is still quite embarrassed about speaking English. She always worries about making mistakes. She also finds it hard to understand native Australian speakers when they speak.

RINA (Indonesia)

Rina is a married Muslim. She and her husband and their two children came to Australia as refugees. Her husband is Rohingya Burmese. Rina was pregnant with her third child when they travelled by boat for ten days to Australia. Rina would like to work but her refugee protection visa status prohibits her to do so. They have been waiting for their permanent residency to be approved for one and a half years. Rina completed primary and high school in Indonesia. Basic English was taught in both schools. The Roman alphabet was used as the medium of reading and writing. Rina has no problem writing/copying words from the board.

Rina can speak basic English very confidently. She is not embarrassed to speak English and make mistakes. Rina takes her two-year old daughter and her three year old son to a playgroup near her housing complex. At other times, Rina mostly stays at home caring for her children. Rina is currently pregnant with her fourth child. Rina finds it hard to understand the Australian accent. This is one of the reasons she feels very strongly that she needs to be good at speaking English, so that she can communicate better with her son's teachers, to other Australian native speakers and people at the government office. She would also prefer to not have to rely on her 13 year old son to interpret for her.

LIDDY (China)

Liddy lived in New South Wales and Victoria before moving to Western Australia. She has 17 year old twin boys. She has work experience in a meat factory in Victoria. That work experience gave her exposure to English. Liddy has developed proficiency in basic English due to living in Australia for seven years. However, she feels she can do better and that she needs to improve her reading and writing to prepare her for other courses that will enable her to find a better job. Liddy completed primary and high school in China. Non-alphabetic Chinese characters or logographic was used as the medium of reading and writing. She learnt basic English and Roman alphabet writing.

Liddy is eager to start formal learning but at the same time she does not feel ready because she thinks she needs to improve her speaking, reading, writing, and listening skills. She thinks the listening skill is important because she still finds it hard to understand the Australian accent and when speaking with native English speakers. Liddy plans to take aged-care certificates when she is ready.

ALLY (China)

Ally married her Australian husband two years ago and moved to Australia. Her husband is a proficient Mandarin speaker who spent three years learning the language. Ally and her husband speak more Mandarin at home than English, which is her motivation for attending the conversational English program at the community centre. Ally is not eligible for the government-funded English program due to her visa status. Ally spoke only a few words of English when she first joined the conversational English program. Ally has slowly increased her word bank, which allows her to use a greater variety of words when communicating. Ally also seems to be more confident in speaking English.

Ally completed primary and high school in China where non-alphabetic Chinese characters or logographics was used as the medium of reading and writing. She did not learn English and Roman alphabet reading and writing at all. This causes Ally to not have confidence in reading and writing in English. Ally struggles when reading English words and short sentences, but she has no problem writing (copying) words and short sentences.

Ally finds it hard speaking to Australian native English speakers because of the Australian accent. Ally wants to improve her English so that she can communicate with her husband’s family and be able to do courses and to find jobs. She feels that she needs to prepare herself by improving all four English skills (reading, writing, speaking, and listening). Ally plans to work in the marketing sector when she is ready and after her permanent residency visa is approved.

KEY (Malaysia)

Key is a Malaysian Chinese who married her husband two years ago and moved to Western Australia. Her husband is a Malaysian Chinese who is now an Australian citizen. Key is still adjusting to a new life in Australia. Key finds it hard to understand Australian native speakers when they speak, thus she relies a lot on her husband or his son to interpret for her.

In Malaysia, Key went to a Chinese school for her primary education and mainstream school for her secondary education. Key is fluent in Mandarin (reading, writing, and speaking) and average in Malay (reading non-complex texts, writing basic Malay, and speaking basic Malay). The Malay language uses Roman alphabets. Key has no problem writing (copying) texts that use the Roman alphabet, but struggles when reading English texts. English was taught as a second language in the Malaysian school system but the language was not used extensively by the students when outside of the classroom. Key explains that she was too embarrassed to speak English because of her fear of making mistakes and being called a “snob”.

Since moving to Australia, Key has a different perspective of the English language and appreciates how important and useful it is in Australia. Since joining the conversational English program at the community centre, Key has slowly overcome her fears and speaks more in the program. Key plans to work in dressmaking or massage and facial therapy after she obtains her permanent residency visa. Her visa will also permit her enroll in government-funded English classes.

ROSE (Congo)

Rose came to Australia under a religious visa with her husband and five children seven years ago. Rose’s husband is a pastor at a local church that serves members who are of African background. Rose is active in the Church programs. The languages used for communication include French, Bantu, Kituba, Lingala, and Tshilumba. Rose speaks French, Lingala, and Tshilumba. Rose attends the conversational English program at the community centre to practice her English, get involved with other programs at the centre, and also meet friends and make new ones.

Even though Rose has lived in Australia for seven years, she still finds it hard to speak with Australians because of the accent. Rose has completed Certificate III in English and Certificate III in Health Service Assistant. Rose has experience working in aged-care but had to stop working for a while. She has been trying to get back to work but has found that jobs in that industry are now scarce and very competitive. Rose plans to further her studies and go into the Children Services industry.

Responses to Learning Vocabulary using the Tablet

Table 3 provides examples of direct responses given by the six participants and also some observations. This data was collected during the post-MALL interview, that is, after the women had experienced using the tablet to learn vocabulary.

Table 3: Direct responses by participants and observations from post-MALL interview

Pseudonym	**Perception of using the tablet for learning English vocabulary**
SURI	"I don't have a tablet at home. I like to use it because it's like using my phone, it's easy to use" Shares some of the words and phrases learnt from the MALL lesson "the lock is broken", "the tap is leaking", "spiky hair", "I learn how to describe hair colours. Now I know there's red hair and ginger hair" When learning English, prefers using the tablet than the book because "they have colourful pictures… can listen how they say things" "I like to share the tablet with my friend (during lessons) because we can practice together. Sometimes I don't know how to do some things on the tablet. I like when you are here because you can tell me what to do" If she were given the tablet to bring home, she would prefer to learn in a quiet place or room by herself, so that she could hear better and no distraction from her children
RINA	"It's easy to use this tablet. My children have them… like my phone" Prefers using tablet than books for learning English because "I can just use one tablet...I don't have to carry many books… heavy. We can find a lot of things (information) from the tablet, like the big computer, it has internet" "I use the Indonesian-English dictionary (app)". Prefers to work by herself and at her own pace "...sometime I can do (things on the tablet) very fast, sometimes my friend is too slow". Prefers to have the author present during the lesson to provide instruction and guidance because "you have plan what to teach us" Uses her tablet to find information such as recipes, reading the news about Indonesia and Myanmar.

LIDDY	Does not own a tablet and considering purchasing one for herself. It is easy to carry compared to a laptop and she can slip it in her handbag. Likes to use the tablet because it is easy to use, has similar features like her smartphones, she can listen to pronunciations and conversations in Australian. Shares the words/phrases learnt from the MALL lessons – “side burn”, “moustache” “spiky hair” “the toilet’s overflowing” “I sometimes need teacher and sometimes don’t. Sometimes I need to ask some questions.” “Sometimes I like to share (the tablet) with my friend, we can discuss…she’s funny…(the lesson) not boring”
ALLY	“The tablet is easy to use…the size fit in my bag” Thinks that the tablet is a good tool for learning English because “it has colour(ful) pictures...can watch movies…can listen to conversation” Depends on the learning environment, sometimes prefers to learn alone and sometimes with friends. The advantages of learning with friends are that, they can discuss and practice together. Shares the words/phrases learnt from the MALL lessons – “menu” , “have here or take away?”, “Can I have a coffee, please?”, “Can I have a juice, please?”, “I’d like”, “I’ll have”
KEY	“I learn more words now” Likes the size, the pictures and the playing movies features “I like (the) tablet. (It’s) easy to use. I always take it in my bag. I can find information anytime. I can take pictures and videos” “Sometimes I like to learn by myself, sometimes with friends because it’s nice to share” “I like teacher to teach me… teacher can confirm whether I do things right or not” Shares the words/phrases learnt from the MALL lessons – “the toilet’s overflowing”, “the lock is broken” , “she wears glasses”
ROSE	“It’s easy to use… quite (the) same with my phone. But it’s bigger, I can read the bible” “The tablet (works) like the laptop (computer) but I cannot type letters. I can get Internet...I can get a lot of information and answers” Prefers to use the tablet by herself if she’s learning French/English, prefers sharing with a friend and work in small group when doing the MALL lesson. “I cannot focus so much. I always think about my children” Shares the words/phrases learnt from the MALL lessons – “The computer is broken”, “the tiles are cracked”, “Can I have my receipt, please?”, “What would you like today?”, “I’ll have a coffee, please?”

Discussion

Allender (1998) and Hewagodage and O'Neill (2010) maintain that adult learners learning English as a second, third, or fourth language in general, and English vocabulary specifically, are influenced by factors such as level of education in native language (L1), culture, past experiences and knowledge, age, and opportunities to speak English. The results from interviews with the six women in our study reflect this notion clearly, where all six participants are literate in L1 and completed both primary and secondary education. They have experienced formal and structured schooling. Even though they struggle in English, some of their previous learning experience was useful for them. For example, Sri, Rina, Rose, and Key used the Roman alphabet for L1. They can copy English words or phrases from the board into their personal notebook fairly quickly.

Ally and Liddy, on the other hand, used Chinese characters to write notes in their native language. Being able to go back to their notes is obviously an advantage for them as this helps them to recall and retain the memory of the words and phrases that they have learnt.

In addition to culture, family and religion play major roles in women's lives (AMES, 2011; ECCV, 2009; McMichael & Manderson, 2004). The participants, like other women who are of ethnically diverse background, usually can stay out of the house only for a restricted time as they need to, for example, cook lunch, take their baby home for nap time, or simply have to be home by a certain time. These are some of the factors that illustrate how some women, like Suri and Rina, are restricted socially. Furthermore, they are prohibited by the law from finding employment due to the restriction on their visa status, and they are unable to further their education due to financial difficulty. As a consequence, they have fewer opportunities to mix with other Australians, thus leading to isolation from the broader community and taking a longer time than men to overcome language barriers and adjust to life in Australia (Colic-Peisker & Tilbury, 2007; Fozdar & Hartley, 2012).

Although all six participants have lived in Australia between 2 to 7 years, they still feel uncomfortable speaking English with native English Australian speakers. They identify that they need to improve their speaking skills to a level of English proficiency that allows them to communicate comfortably. Key, Suri, and Ally had a common concern of feeling embarrassed to speak English outside the program because of their fear of making mistakes. They all have slowly overcome these feelings and each week they are speaking more within the group. Rina, Rose, and Liddy did not have these issues. They had a positive attitude that they could do better and wanted to advance to being able to seek employment. However, they faced a different kind of fear; that is, not feeling ready. They plan to go on to the next step after they have improved their speaking, writing, reading, and listening skills.

All six women expressed concerns of having difficulty understanding the Australian accent. This may be the factor that is causing their fears since it is a problem that they consistently encounter and it becomes a challenge for them. The Office of Multicultural Interests (OMI, 2012) recognizes that, alongside learning and adapting to a new culture, and dealing with emotional, psychological, sociocultural, and socioeconomic challenges, learning English is one of the challenges faced by migrants settling in Australia. The community centre plays a significant role in the lives of the participants. As reported by K.S. Ahmad et al. (2013) and RCOA (2010), the programs offered by such centres provide an alternative to the formal government-funded programs by providing the opportunity and space in a friendly and non-rigid learning environment.

The MALL lessons undertaken by the participants follow three steps: Step 1 – pre-teaching of vocabulary and phrases; Step 2 – drilling to help attendees practice fluency and become familiar with how the words and phrases are used; and Step 3 – completing the exercise using the app downloaded on the tablet. The interactivity and multimedia features of the tablet allow for authentic content (such as a short video of a conversation between two native Australian English speakers) to be presented to participants. The MALL lessons were designed based on the sociocultural approach of Grabinger et al. (2007), Halliday (2004) and Vygotsky (1978), that is, the idea of a social cultural learning environment where learners are exposed to the social norms of and interactions in the target language, and are able to use what they learn for meaningful communication.

The use of the tablet and the MALL learning environment was revealed to have positive effects on participants' vocabulary learning. The apps that were used addressed the topics that were relevant to non-native adult migrant English learners. The contents of the apps were designed in such a way that it gave examples of the Australian culture and language through learning vocabulary. All participants could recall the topics that they had learnt in the MALL lessons and the vocabularies (words or phrases) that were associated with the topic. The participants demonstrated that they not only acquired the meaning and knowledge of the words and phrases but also were able to use them in the right context.

Some of the words and phrases that participants could recall were:

> "the lock is broken", "the tap is leaking", "spiky hair", "side burn", "moustache", "the toilet's overflowing", "Have here or take away?", "Can I have a coffee, please?" "Can I have a juice, please?", "I'd like…", "I'll have…", "Can I have my receipt, please?"

This is a positive indicator, as vocabulary acquisition is important for second language oral proficiency (J. Ahmad, 2011; Choo et al., 2012; Coady & Huckin, 1997) and the larger the participants' word bank, the more tools they have for processing and communicating their ideas and processing those of others (J. Ahmad, 2011; Elgort, 2011). Kenny (2011), Krashen and Terrell (2000) and Nation and Newton (2009) posit that vocabulary has to be acquired before language acquisition can occur.

In learning a second (or third or fourth) language in a sociocultural learning setting, it is important that cross-cultural understanding and intercultural literacy is embraced by teachers/instructors and learners (Burgoyne & Hull, 2007; O'Neill & Gish, 2008). As the facilitator of the group, the author uses MALL lessons that reflect authenticity and suitability for participants of diverse cultures and backgrounds. She also encourages group work and considers Knowles' (1984) principles of andragogy. As noted by Burgoyne and Hull (2007), O'Byrne, (2003) and Martin and Rose (2005), it is essential for participants to engage with each other in co-constructing the knowledge, in this case, the knowledge of the English language. As such, in Step 1 and Step 3, participants were paired to work on tasks and exercises. Participants responded positively about working with a partner when doing the MALL lessons as it allowed them to discuss and practice together.

Depending on their level of English proficiency, familiarity and confidence in using the table, and the level of complexity of the topics presented in the MALL lessons, some level of teacher/instructor presence and support is necessary. Participants felt *safe* when the teacher/instructor was present because she could provide instruction and guidance and provide answers to question, for example, questions about vocabulary or how to navigate the app on the tablet.

The MALL learning environment enriched and provided positive vocabulary learning experiences to the six participants. The tablet, as the mobile device for MALL, has the features that make this possible. These features are *connectivity*, *context sensitivity, portability*, *individuality*, and *social interactivity* (Klopfer et al., 2002).

Connectivity refers to the ease of connecting the tablet to the internet for access to learning material. In this study, the app was downloaded using the Wi-Fi connection available at the community centre. The internet was used by participants to search for information, such as translation of an English word to their native language.

Context sensitivity refers to the *context awareness* of the app with user's interaction. For example, in the vocabulary exercise, participants interact with the app interface by tapping, dragging, or swiping their finger/fingers on a button or a bar. The app is designed for easy navigation for beginner English learners. The participants are also alerted, by highlights or blinking cues and prompts, for correct or incorrect answers. Alerts are also shown when participants have completed an exercise and are supposed to move on to the next level. Participants, whether already familiar with using a tablet or not, all commented that this feature made the apps easy to use and navigate. Moreover, the usage is similar to their smartphones, only the tablet has larger screen. Liddy thought that it was easy to use the tablet because it had similar features as her smartphone. Rina said “It’s easy to use this tablet. My children have them… like my phone.”

Portability is a feature of the tablet that provides convenience of use for participants. The tablet has the dimensions of 200x130x13mm and 340g in weight. It is small and can fit into a medium size handbag. Portability also refers to how both the user and the tablet is portable and that the tablet can be used online and offline. The app that is used for the MALL lesson was downloaded onto the tablet, thus learning can take place without constraint, anytime and anywhere, provided the tablet has battery life available. A participant, Key, owns an iPad and likes the convenience of use and the capabilities of the tablet: “I like [the] tablet. [It’s] easy to use. I always take it [my iPad] in my bag. I can find information anytime. I can take pictures and videos”. Rina does not own a tablet, but she prefers using a tablet than books for learning English because “I can just use one tablet… I don’t have to carry many books… heavy. We can find a lot of things [information] from the tablet, like the big computer, it has internet”.

The *Individuality* and *social interactivity* features of the tablet refer to personalized or customized learning that the participants can choose. Participants can learn vocabulary at their own pace, repeat the lesson, replay audio or video, pause, go back, forward or skip some parts of the app. Participants have a choice of using the tablet individually and personalizing their learning, or learning collaboratively with other participants (Cavus & Ibrahim, 2009). The multimedia capability of the tablet is also an appealing factor. Liddy said that she can use the app on the tablet to listen to conversations and learn pronunciations in Australian. Ally thinks that the tablet is a good tool for learning English because “it has colour[ful] pictures ... can watch movies … can listen to conversation”. Suri prefers using the tablet than a book when learning English, because “they have colourful pictures … can listen how they say things”. The app included other element for learning vocabulary including flashcards, audio, video, digital worksheet, pronunciations practices, and conversations in Australian accents with accompanying transcript.

Conclusions

This paper reported the positive effects in six migrant women’s vocabulary learning after undertaking a series of MALL integrated vocabulary lessons in a non-formal learning environment. The participants have lived in Australia between two to seven years, but still struggle with English. The study was undertaken at a small community centre in Western Australia that has a 2-hour weekly program for people who are non-native English speakers to practice conversational English. The study demonstrated that it is feasible to utilize MALL for migrant women to learn vocabulary, in a non-formal environment, provided the design of the MALL lessons are based on the sociocultural theory of language learning. The sociocultural approach requires a teacher/facilitator to ensure that the learning material delivered to learners is authentic and essential to the learners’ needs. The learners should be given the opportunity to collaborate, engage, and interact with their peers in co-constructing meaning and knowledge. The learners should also be able to use what they have learnt and able to communicate it meaningfully. The naturalistic and non-formal feel of the learning environment should be maintained, even with the insertion of the tablet as a learning device.

Migrant women’s vocabulary acquisition is affected by both their personal and sociocultural backgrounds that include culture, family responsibility, religion, education background, literacy in L1, past experiences and knowledge, age, and opportunities to speak English. Having some level of literacy in L1 is advantageous for Step 1 of the MALL lesson. Step 2 would benefit all learners. Including MALL in language learning enriches learners’ vocabulary learning experiences because of the features of the tablet as a learning device. These features include *connectivity*, *context sensitivity, portability*, *individuality*, and *social interactivity.*

This study has provided an understanding of the effects of MALL to migrant women's English language acquisition in general, and vocabulary acquisition in particular. It can be concluded from the discussion that the participants were satisfied with the MALL lessons, had an expanded word bank, and enjoyed the enriched vocabulary learning experience.

Other potential benefits to participants of this study include increased vocabulary skills that lead to confidence in communication thus increasing the participants' potential of becoming socially inclusive within the Australian society. Participants will become capable of taking responsibility of their own learning, possibly using their own mobile device, thus leading to lifelong learning. Familiarity with the mobile devices will increase digital literacy levels as well as facilitate access to useful websites and networks (social, government, or career), thus reducing isolation in participants' lives. These benefits will eventually lead to increased opportunities for employment.

A limitation of the study is the relatively small sample size. As indicated before, this study is part of a larger research project with a larger cohort of participants. Despite the small sample discussed in this paper, these findings provide insight into the broader community of migrant women English learners.

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Communicating and Sharing in the Semantic Web: An Examination of Social Media Risks, Consequences, and Attitudinal Awareness

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Abstract

Empowered by and tethered to ubiquitous technologies, the current generation of youth yearns for opportunities to engage in self-expression and information sharing online with personal disclosure no longer governed by concepts of propriety and privacy. This raises issues about the unsafe online activities of teens and young adults. The following paper presents the findings of a study examining the social networking activities of undergraduate students and also highlights a program to increase awareness of the dangers and safe practices when using and communicating, via social media. According to the survey results, young adults practice risky social networking site (SNS) behaviors with most having experienced at least one negative consequence. Further, females were more likely than males to engage in oversharing as well as to have experienced negative consequences. Finally, results of a post-treatment survey found that a targeted program that includes flyers, posters, YouTube videos, handouts, and in-class information sessions conducted at a Mid-Atlantic Historically Black College or University (HBCU) increased student awareness of the dangers of social media as well as positively influenced students to practice more prudent online behaviors.

Keywords: Cyber awareness, Cyber Safety, Facebook, Internet Safety, Negative Consequences of Social Media, Oversharing, Privacy, Social Media, Social Media Safety, Web-Safety

Background

Social media come in many forms from bookmarking services like Delicious, Pinterest, and BibSonomy, to 3D Virtual Worlds like Second life, professional networking systems like LinkedIn, Blogging tools like Blogger, microblogging tools like Twitter, collaborative content creation tools such as Wikipedia or Wikispaces, photo sharing services like Flickr and Instagram, profile and friend/social management systems like Facebook and MySpace, video sharing services like YouTube, and micro-video blogging services like Vine. Inherent to all is the concept of user generated content, sharing, and social commentary, which have been found to encourage social expression and participation (Buzzetto-More, 2014a). Further, they have all been found particularly effective at appealing to digital natives (Buzzetto-More, 2013).

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The major tools and services are best expressed by the infographic shown in Figure 1: Social Media Landscape 2013, which is provided courtesy of Fred Cavazza (2013) (www.FredCavazza.net,), and which categorizes social media tools into the areas of publishing, sharing, networking, and discussing and places Facebook, Twitter, and Google+ at the epicenter.

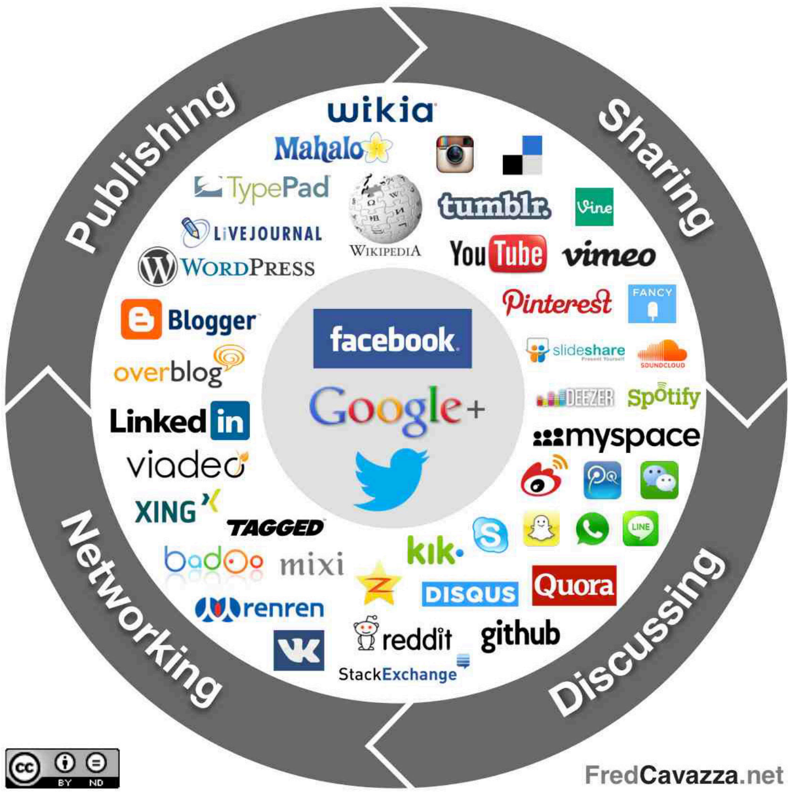

Figure 1: Social Media Landscape

A study (Duggan & Smith, 2013) reported that as of September 2013, 73% of all online adults use social networking sites with 90% of adults ages 18-29 being social media users. Additional findings included in the report are as follows:

- Social networking sites are increasingly used to keep up with social ties,
- Facebook users are more trusting than others,
- Facebook revives "dormant" relationships,
- The majority of Facebook users check the site multiple times per day,
- Most social media users are active across multiple platforms (Duggan & Smith, 2013).

Today's college students are habituated to using technologies that have changed practices of identity formation and self-expression. This raises issues about the unsafe activities of teens and young adults who frequently fall victim to invasion of privacy, unauthorized disclosure of personal information, inappropriate self-disclosure, internet addiction, cyber-bullying, stalking, scams and hoaxes, identity theft, and defamation (Buzzetto-More, 2012a). More specifically, when Facebook use is considered, the following are among the most significant dangers for young adults (Buzzetto-More, 2014b):

- Social media can harm a user's image by presenting them in a less than desirable and/or unprofessional light. This can stop a young adult from obtaining a job or internship.

- Services like Facebook keep everything forever. Whether something has been deleted, untagged, hidden, removed, Facebook keeps a record of it. Click on a profile, upload a photo, update your status, change your profile, Facebook remembers.
- Social media sites encourage users to enter and share as much as possible. However this data is exposed to cyber criminals. Further, the social networking systems themselves are not secure from hacking.
- Social media is plagued by scams, hoaxes, computer viruses, identity theft, malware, and click jacking.
- ALL social media sell user information. Also, once a user approves a website or app to interact with Facebook or another social network, all activity will be automatically shared with Facebook, whether the user is logged in or not.
- When Facebook saves photos, they don't just make a copy of the original, but instead they make multiple copies to use in various ways. And each photo that is uploaded to Facebook carries with it the metadata that digital cameras include with each image. On some cameras, such as the iPhone, metadata can also include the precise GPS location of where the photo was taken.
- Bad behavior on social networks is cause for termination by many employers. Complaining about one's job and/or sharing work information violates many employer acceptable use policies. Something as simple as sharing a sexist image or racy joke can also violate company policy. Further, most human resource managers consider a potential employees social media behavior.
- It is easy, and common, for people to hijack social media accounts and post on other's behalf. Often these posts are particularly damaging. Further, cyber bullying remains a very real concern on social media.
- Social media can invite crime. When users post updates about where they are or "check in" they may be providing information and an incentive to would be criminals.

This study seeks to enhance the body of literature that focuses on young adults and risky online behaviors. More specifically, the paper explores the risky social media activities of students attending a Mid-Atlantic HBCU with an additional investigation into the negative consequences experienced. The research procedures included distribution of a detailed survey that examined the communication patterns and social media behaviors of undergraduate management students, followed by the delivery of an awareness campaign that included course level lectures, posters, and videos, and concluded with a post-treatment survey that examined the impact and efficacy of the awareness. Six hypotheses were developed and explored as part of this study and were as follows:

- H1: College students practice risky social networking behaviors
- H2: Students have experienced negative consequences as a result of SNS use
- H3: Females are more likely than males to overshare information via social media
- H4: Females are more likely than males to have experienced negative consequences as a result of SNS use
- H5: Individuals who had a social media profile before the age of 16 are more likely to have had a negative experience than those who opened their first profile after age 16.
- H6 A targeted program can increase awareness of SNS safety

Literature Review

Today's youth use social media to build and affirm relationships by engaging in self-expression and information sharing online (Buzzetto-More, 2014a). This raises issues about the unsafe activities of teens and young adults. In particular, during times of heightened emotions people have been shown to be more likely to express private or emotional information (Berger, 2011) that Cohen (2012) refers to as having engendered the current “culture of oversharing”.

In a 2011 Pew survey about the future impact of the Web, most technology experts and stakeholders participating agreed that the Millennial generation is changing the way society considers personal disclosure and information-sharing via their use of social media (Hampton, Sessions, Ranie, & Purcell, 2011). Further, the report found that many experts surveyed hoped that society will become forgiving of those whose youthful mistakes remain on display in social media in perpetuity.

A number of researchers have postulated that youth identity formation in the modern age is best examined within the self-authored identities available on Facebook (Ryan & Xenos, 2011). The way personality specific traits impact Facebook use, or non-use, was investigated by Ryan and Xenos (2011) who based their findings on a sample of 1158 Facebook users and 166 non-users who responded to questionnaires that included aspects of the Big Five personality inventory. According to the findings, Facebook users tend to be more extroverted, more narcissistic, and exhibit a lower level of conscientiousness than non-users and, concurrently, seem to experience a higher level of social loneliness than non-users.

Nadkarni and Hofmann (2012) introduced a model to explain Facebook user’s motivation supported by two basic needs: (1) the need of affiliation and belongingness, and (2) the need of self-presentation. They explained that demographic and cultural factors are mostly related to the need of affiliation, while personality traits like neuroticism, narcissism, timidity, and self-esteem correlate with the need of self-presentation.

Enhancement of one’s online identity, which in turn impacts self-esteem, has consistently been shown to be a motivator for social media use that in turn impacts self disclosure. A study by Muise, Christofides, & Desmarais (2009) concluded that Facebook is a forum where information is readily shared by users because of the site’s influence on a user’s need for popularity. The correlation between social media disclosure and self-worth was further explored by Rui & Stefanone (2013) who found that the drive for self-worth via public evaluations increased the intensity of social media posts and photo sharing.

Studies have found that teenagers have few concerns about privacy, and this disinterest leads to unsafe behavior on SNS (Vanderhoven, Schellens, &Valcke, 2013). Further, during times of heightened emotions people are more likely to share highly private or emotional information (Berger, 2011) with an expectation of acceptance to their emotionally laden postings (Wizenburg, 2012). Cohen (2012) explains that this culture of oversharing has created a phenomenon known as “status anxiety” that feeds on the insecurities of individuals.

According to Weitzenkorn (2013) the Web may seem safe and social media services relatively innocuous, but oversharing on social media can result in real-life negative consequences impacting almost all areas of a person’s life. More specifically, a devastating influence can occur on an individual’s reputation, relationships, finances, and even physical well-being.

A study of 1,000 online individuals conducted by Retrovo (2010), asked people if they had ever posted anything online about themselves that they regretted. According to the findings (32%) of respondents admitted to having posted something online that they regretted. When age was specifically examined, respondents under the age of 25 were found more likely to have regretful posts than their over 25 counterparts.

Vanderhoven, Schellens, and Valcke (2013) explained that privacy attitudes also need to be taken into account if we want to decrease the amount of unsafe behavior on social networking sites. Further, they explained that there was almost no research on the impact of school education on privacy attitudes or actual safe behavior on SNS. As a result, they conducted a survey study of

636 teenagers examining their attitudes towards privacy on SNS. According to the findings, rather low levels for privacy care on SNS were found. Especially younger teenagers and boys were found to exhibit no concern about privacy issues on SNS.

In a large-scale study conducted by the Pew Center, Lenhart, Madden, Smith, Purcell, Zickher, and Ranie (2011) examined the experience and behaviors of teenagers on social networking sites. A summary of their findings include that:

- 88% of social media-using teens have witnessed other people be mean or cruel on SNS;
- 15% of teen social media users have experienced harassment in the past 12 months;
- 41% of teens who use social media have had at least one negative outcome;
- 25% of social media using teens have had an experience on a social network site that resulted in a face-to-face argument or confrontation with someone;
- 22% have had an experience that ended their friendship with someone;
- 13% have had an experience that caused a problem with their parents;
- 8% have had a physical fight with someone because of something on a SNS;
- 30% of participating teens reports sharing one of their online passwords with a friend, boyfriend, or girlfriend.

A 2013 follow-up Pew study (Madden, Lenhart, Cortesi, Gasser, Duggan, Smith, & Beaton, 2013) found that teens had become even more forthcoming with personal information than they had been in previous studies as well as highly likely to manipulate their profile and timeline content in order to garner the maximum number of likes.. Additionally, the study found an increase in teen Twitter use as well as the following:

- 59% of respondent have deleted or edited something that they posted in the past,
- 53% of respondent have deleted comments from others on their profile or account,
- 45% of respondent have removed their name from photos that have been tagged to identify them,
- 31% of respondent have deleted or deactivated an entire profile or account,
- 19% of respondent have posted updates, comments, photos, or videos that they later regretted sharing,
- Girls are more likely than boys to delete friends from their network (82% vs. 66%) and block people (67% vs. 48%),
- African-American teens that use social media are more likely than white teens to say that they post fake information to their profiles (39% vs. 21%),
- Online girls are more than twice as likely as boys to report contact from someone they did not know that made them feel scared or uncomfortable (24% vs. 10%).

Additional studies have shown that Facebook abuse shows a significant positive correlation with mental health deterioration, mainly with anxiety, stress, and pathological depression of users (Hughes, Rowe, Batey, & Lee, 2012.) Even more concerning is that individuals suffering from social anxiety or depressed people are more prone to engage in online communication and relationships, instead of engaging in face-to-face interactions, which in turn propagates the vicious cycle of loneliness and isolation (Sheldon, 2008).

An article that focused on online disclosure as portrayed in Facebook profiles, which examined hundreds of students at a north-eastern university found that women were more likely to disclose personal and relationship information about themselves on social networking sites like Facebook, whereas men were more likely to share information on activities they're engaged in or opinions on politics and sports (Kolek & Saunders, 2008). It also found that as age increases, self-disclosure on social networking sites decreases. Further, in a recent study published in the Journal of Social Media and Society (Sheldon, 2013) women were found to disclose to their exclusive face-to-face friends and exclusive Facebook friends more than men.

In an article that sought to raise awareness of oversharing via social media, Weitzenkorn (2013) advised SNS users not to disclose political views, to be careful what they “like” since the record is maintained and is searchable, avoid posting when angry or upset, change profile settings to private, avoid commenting on a controversial issue, disable the ability to be tagged in photos, change passwords monthly, and remove personal information from social media services. Weitzenkorn’s advice is for users to search themselves on all major search engines, delete undesirable/questionable posts and photos, and lockdown accounts with the most private settings possible.

What is the best way to increase awareness and thus decrease risky online behaviors? Vanderhoven et al. (2013) explored the impact that school education has on both privacy care and the safety of teenagers’ behavior on SNS. According to the findings, education conducted in schools has a positive impact on increasing students concern and awareness of issues of privacy, which in turn results in less risky behaviors conducted on social networking sites. They explained that more effort is needed in schools as the topic remains inadequately and sporadically addressed in most curricula. It has been found that the implementation of the topic of online safety is inconsistent despite the fact that a variety of educational packages about safety and security in SNS have been developed.

Methodology

Participants

Founded in 1886, the University of Maryland Eastern Shore (UMES) is a Historically Black, 1890 land grant institution. It is a member of the University system of the state of Maryland, the U.S. state with the highest population of African Americans. UMES primarily serves first generation, low income, and minority learners. The student population is approximately 4500, with a student body that is approximately 78% African-American, 9.6% white, 1.4% Hispanic, and 11% international, primarily coming from the continent of Africa and/or from the Caribbean region. The gender distribution of the University is 64% female and 36% male. The freshmen-to-sophomore retention rate is 71%, and the graduation rate is 41%. The school was ranked in the top 25 among HBCUs in 2014 and the acceptance rate for applying students is 62.4% with the majority of students coming from the Mid-Atlantic region, more specifically the Baltimore and Washington D.C. urban centers.

By conducting this study at an HBCU, it provides research on a population that has previously not received sufficient focus. Whereas a handful of studies have been conducted at majority institutions and a number with K-12 students, this is the first study of this magnitude that has been conducted at Historically Black Colleges and/or Universities. Further, examinations conducted at Historically Black Colleges and/or Universities are important because the critical mass of African American college students can be found at HBCUs, which represent less than 3% of U.S. colleges and universities but produce 25% of our nations Black college graduates as well as the preponderance of African American doctoral degree recipients (Adams, 2012).

Materials

All students enrolled at the University of Maryland Eastern Shore are required to complete a general education sequence of courses that include a discipline specific/major related freshmen professional development course, a computer concepts course, and professional communications course. A study conducted in the spring of 2014 at a Mid-Atlantic minority serving institution sought to examine the perceptions and risky behaviors of students with respect to social networking services. In order to examine student perceptions, a survey was developed and delivered using the Zoomerang/Survey Monkey system. Pre-testing was done in order to inform the survey design process. The developed survey was comprised of a combination of dichotomous, Likert-scaled, ordinal, ratio, short answer, and contingency questions. The survey was evaluated by several content and methodological experts in order to examine bias, vagueness, or potential semantic problems. Finally, the survey was pilot tested prior to implementation in order to test the efficacy of the research methodology. It was then modified accordingly prior to distribution to potential participants.

An educational campaign that included custom developed posters, a prepared YouTube video, handouts, and live presentation/informational in-class sessions was launched. The poster used during the campaign were hung in public areas across campus, placed on bulletin boards where the Department of Business, Management and Accounting is housed, hung in the classrooms where the live in-class informational sessions were delivered, and posted adjacent to the campus cafeteria. Two of the custom posters created as part of this program are presented as Figures 2 and 3.

Figures 2 & 3. Posters

A video presentation was created and posted to YouTube in order to support the educational awareness campaign. The video titled *Social Media Risks and Safety* can be found at http://youtu.be/zIFqNXmqiVE. Additionally, aspects of the awareness campaign included the delivery of live informational in-class sessions and the distribution of factual handouts.

Post treatment an online survey was distributed to the students who had completed the first survey as well as who had participated in the educational awareness campaign. The purpose of the survey was to measure changes in opinions as well as student perceptions of the efficacy and effectiveness of the awareness campaign.

Procedures

During the data collection process, students who were enrolled in several sections of targeted general education service courses received an automated email with a personalized link to the online survey. Using the email invitation collector component of Survey Monkey, a unique link was generated for each recipient. While individual responses were anonymous, this linked each response directly to an email address which was used to track completions and not specific responses. Additionally, students were given the option of opting out of the study.

The automated email message was not the only point of contact. Response rates were tracked and following the initial invitation, two reminders were sent to non-respondents in two week intervals following the initial invitation.

The survey was distributed to 414 potential participants and completed by 253 respondents, representing a response rate greater than 60%. During the data analysis process the raw data was exported from the Survey Monkey system and imported into Microsoft Excel where descriptive statistics such as mean, skewness, standard deviation, and confidence level were examined and frequency distributions in the form of counts and percentages considered. In order to consider the hypotheses appropriate testing measures were performed and included examination of frequency distribution and/or descriptive statistics (as appropriate) as well as conduction of crosstabulations and T-tests where fitting.

Following the distribution and collection of the survey, an educational campaign that included design and development of posters hung across campus as well as in program delivery classrooms, development and use of a custom YouTube video, handouts, and in-class delivered informational sessions was launched.

Post treatment a second online survey was distributed to the 225 students who had participated in phase 1 resulting in 99 completed surveys and a 44% response rate. The raw data was exported from the distribution system and imported into Microsoft Excel where descriptive statistics such as mean, skewness, standard deviation, and confidence level were examined and frequency distributions in the form of counts and percentages considered. Additionally, comparisons of student responses to questions pre and post treatment were made.

Six hypotheses were developed and explored as part of this study. These hypotheses focused on the risky behaviors and negative consequences of social media use, the differences between male and female respondents, the impact of age on negative experiences, and the success or failure of a program delivered to increase awareness of SNS safety.

- Hypothesis 1 considers a range of activities considered risky such as oversharing via social media, whether users allow others to tag them in posts or post on their profile, and profile settings that make their profile available to either everyone or friends of friends.
- Hypothesis 2 focuses on negative outcomes. It is addressed by considering responses to a series of five Likert scaled agreement questions:
  - I have experienced at least one negative outcome as a result of social media use
  - I have posted or tweeted something on a social media site that I later regretted
  - I had a friend post an embarrassing or inappropriate picture of me
  - I have had someone post something about me that I found embarrassing
  - I have gotten into an argument with someone via social media.

- Hypothesis 3 considered whether females are more likely than males to overshare by comparing means by gender and via a two-tailed T-test. More specifically, it compared the responses of males and females to the Likert scaled statement.
    - On at least one occasion, I have overshared information via social media
- Hypothesis 4 considered whether females are more likely than males to experience a negative consequence as a result of social media use by comparing means by gender and via a two-tailed T-test. More specifically, it compared the responses of males and females to the Likert scaled question.
    - I have experienced at least one negative outcome as a result of social media use
- Hypothesis 5 examined whether individuals who had a social media profile before the age of 16 are more likely to have had a negative experience than those who opened their first profile after age 16. It was based on responses to a dichotomous question that asked individuals if they had their first social media profile before the age of 16 and responses to the Likert scaled statement
    - I have experienced at least one negative outcome as a result of social media use
- Hypothesis 6 examined the effectiveness of the targeted social media safety program and campaign. It was based on an evaluation of students' responses to the following Likert scaled statements included in the post treatment survey.
    - As a result of the campaign, I am more aware of the dangers of social media use.
    - As a result of the campaign, I am more aware of how to be safe when using social media.
    - As a result of the campaign, I plan to be more cautious when using social media.
    - As a result of the campaign, I plan to make my social media accounts more secure.
    - Universities should educate students about the potential dangers of social media use.

Additionally, several questions purposely included on the pre and post survey were compared in order to examine changes in perception pre-treatment verses post-treatment.

Results

In total 96% of respondents were between the ages of 18 and 29 with 90% of respondents specifically between 18 and 22. With respect to gender distribution, 57% of respondents were female and 43% of respondents were male. When distribution by degree progress was considered, the majority of students were either freshmen (35%) or sophomore (28.1%) standing, with fewer juniors (21.3%) and seniors (15%).

A dichotomous question was used in order to explore participants' prior exposure to and use of social networking sites with 92% of respondents reporting that they have a profile on a social networking site. Taking a contingency approach, those who currently have profiles on social networking site were asked how likely they are to use social networking sites in a typical week most respondents (>50%) said "extremely likely". These results are represented in Table 1.

Participants were asked how many of their "friends" on social networking websites have they met in person. According to the results, only 14.5% of respondents have met all of their online friends in person with rest (85.5%) not having met in person all of their online friends.

Table 1: Frequency of Social Media Use

In a typical week, how likely are you to use social networking websites?		
Answer Options	**Response Percent**	**Response Count**
Extremely likely	57%	128
Likely	28.7%	67
Moderately likely	12%	28
Slightly likely	2%	5
Not at all likely	1.7%	4
	answered question	**233**
	skipped question	**0**

Participants were asked to estimate how much of their time on social networking sites is spent posting things about themselves with 16% estimating that all of their time is spent dedicated to self-promotion, 19% reporting that most of their time is dedicated to self-promotion, 23% estimating that self-promotion represents half of their social networking activities, 36% saying some of their time is self-promotion based, and 6% saying that they spend no time on social media posting anything about themselves.

All participants were asked what age they joined their first social networking site, 61% responded that they were under the age of 15 (>15) and 33% said that they were between the ages of 16 and 18. The full response distribution to this question is represented in Table 2.

Table 2: Age That Participants Started Using Social Media

At what age did you start using social networking services		
Answer Options	**Response Percent**	**Response Count**
15 or under	60.6%	151
16-18	32.5%	81
19-23	3.6%	9
24-30	2.8%	7
31-40	0.0%	0
41-50	0.4%	1
50	0.0%	0
I have never joined a social networking site		3
	answered question	**249**
	skipped question	**4**

The following section will present the results from the six hypotheses that were considered as part of this study. In order to consider each hypothesis, appropriate testing measures were performed and included examination of frequency distribution and/or descriptive statistics (as appropriate) as well as conduction of crosstabulations and t-tests where fitting. In the following section, each hypothesis will be discussed individually, and in turn.

A. Hypothesis 1: College students practice risky social networking behaviors

In order to explore H_1: "College students practice risky social networking behaviors", participants were asked to respond to several five-point Likert-scaled statements. According to the results, the participants have been guilty of oversharing via social media with a mean of 3.06, venting frustrations via social media with a mean of 3.01, posting something that they would not want their parents to see with a mean of 2.79, and posting something that they would not want a potential employer to see with a mean of 3.02. The results from these Likert-scaled question are presented in Table 3.

Table 3: Risky Online Behaviors

	I have been guilty of over-sharing via social media	*I can't help it, sometimes, I vent my frus-trations via social media*	*I have posted pic-tures, updates, comments, etcet-era that I would not want my par-ents to see*	*I have posted something I would not want a potential employ-er to see*
Mean	3.06	3.01	2.79	3.02
Skew	-0.0351	-0.0879	0.1059	-0.1097
Standard De-viation	1.341763	1.3324	1.281268	1.374
Confidence @ 95%	0.0741409	0.0736239	0.0707982	0.0759327
Mode	4	4	3	4

In order to further explore Hypothesis one, a series of questions examined participants' SNS profile settings; none of the participants had a closed profile that is not available for viewing, 24% said their profile is open to everyone, 23% said it is available to friends and friends of friends (FOF), 25% said just friends, and 26% said "no idea I never changed the default" which at the time of this survey meant that there profile was open. Additionally all respondents allow others to post on their timeline, see what is on their timeline, tag them in posts or photos, and allow others to see posts where they have been tagged.

These results are represented in detail in Table 4.

Table 4: Student Profile Settings					
Answer Options	No Idea I never changed from the default	Everyone	Friends and Friends of Friends	Friends	Nobody/ Not Allowed
My profile is open	26.6%	24.2%	23.6%	25.6%	0%
Who can post on your timeline?	20%	23.6%	31.3%	25.3%	0%
Who can see things on your timeline?	17.5%	37.7%	18.5%	26.1%	0%
Who can see posts you've been tagged in on your timeline?	13.7%	27%	29.1%	30%	0%
Who can tag you in posts or photos?	15.5%	23.4%	24.2%	36.9%	0%

B. Hypothesis 2: Students have experienced negative consequences as a result of social media use

Several negative outcomes were explored in order to test H_2 "Students have experienced negative consequences as a result of social media use" in the form of five-point Likert-scaled questions; 60% of respondents said that they have had at least one negative consequence as a result of their use of social media. Further, 58% have been upset by something someone posted or tweeted; 44% have posted or tweeted something that they later regretted; 41% had a friend has post an embarrassing/inappropriate picture of them; 40% have gotten into an argument via social media; 36% have had someone post something about them that they found embarrassing; and 39% have received a nasty comment from a post or tweet that they had made. The results for this series of Likert-scaled questions are represented in Table 5.

Table 5: Negative Consequences					
	Mean –	**Stdv.**	**Conf**	**Skew**	**Mode**
I have had at least one negative consequence/experience as a result of using social media	3.33	1.27661	0.0705413	-0.4649	4
I have been upset by something someone posted or tweeted	3.32	1.326104	0.0732757	-0.5238	4
I have posted/tweeted something I later regretted	3.01	1.361934	0.0752555	-0.1486	4

I have had a friend(s) post an embarrassing picture of me on Facebook or another social networking site	3.01	1.253958	0.0692892	-0.1032	4
I have gotten into an argument with someone through Twitter, Facebook, or another social networking site	2.95	1.302267	0.0719585	-0.0460	4
I have had another person post something about me that I found embarrassing	2.88	1.314206	0.0726182	0.0549	4
I have received a nasty comment to a post/tweet I made	2.85	1.312778	0.0725393	0.0301	4

C. Hypothesis 3: Females are more likely than males to overshare information via social media

In order to explore whether females are more likely than males to overshare, the mean responses to the statement "On at least one occasion, I have overshared information via social media" was considered and the results were compared by gender. Additionally, a Two-tailed T-Test set to .05 was performed in order to test, and subsequently affirm, H_3: "Females are more likely than males to overshare information via social media". These results are presented in Table 6.

Table 6: Gender and Oversharing

	MALE		**FEMALE**	
	Mean	***Stdv.***	***Mean***	***Stdv.***
On at least one occasion, I have overshared information via social media	2.63	1.447048	3.17	1.187603
	Comparison of Means			
	T-Test CI @ 95%			
	P=.00161			

D. Hypothesis 4: Females are more likely than males to have experienced negative consequences as a result of SNS use

In order to explore whether females are more likely than males to have experienced negative consequences as a result of social media use, the mean responses for each gender were to the statement "I have had at least one negative consequence/experience as a result of using social media" were compared. Additionally, a Two-tailed T-Test set to .05 was performed in order to test, H_4: "Females are more likely than males to have experienced negative consequences as a result of SNS use". These results are presented in Table 7.

Table 7: Gender and Negative Consequences

	MALE		FEMALE	
	Mean	*Stdv.*	*Mean*	*Stdv.*
I have had at least one negative consequence/experience as a result of using social media	2.86	1.313367	3.60	1.092811
	Comparison of Means			
	T-Test CI @ 95%			
	P=.05			

E. Hypothesis 5: Individuals who had a social media profile before the age of 16 are more likely to have had a negative experience than those who opened their first profile after age 16.

In order to explore H_5: Individuals who had a social media profile before the age of 16 are more likely to have had a negative experience than those who opened their first profile after age 16, participants were asked whether they had their first social media profile before age 16. The means of those who said that they had their first profile before age 16 were compared to those who responded that they did not with respect to agreement to the Likert-scaled statement "I have had at least one negative consequence/experience as a result of using social media". According to the responses those who had a social media profile <16 had a mean of 3.41 compared to a 3.0 for those >16. Additionally, a Two-tailed T-Test set to .05 was performed which resulted in a P value of greater than .05 (P=.96). The full results are presented in Table 8.

Table 8: Age and Negative Consequences

I had my first social media profile before age 16	**YES= 70%**		**NO=30%**	
	Mean	***Stdv.***	***Mean***	***Stdv.***
I have had at least one negative consequence/experience as a result of using social media	3.41	1.29445	3.00	1.162
	Comparison of Means			
	T-Test CI @ 95%			
	P=.96			

F. Hypothesis 6: A targeted program can increase awareness of SNS safety

An educational campaign that included posters, a custom YouTube video, handouts, and presentation/informational sessions was launched. Post treatment an online survey was distributed to the 225 students who had participated in phase 1 resulting in 99 completed surveys and a 44% response rate and used to test H_6: "A targeted program can increase awareness of social media safety." According the findings, 90% agreed that as a result of the campaign they were more aware of the dangers of SNS and how to be safe when using SNS (91%), plan to be more cautious (92%), and make their SNS accounts more secure (86%). Finally, respondents agreed that Universities should educate students about the potential dangers of SNS use (88%) and safe use practices (89%). The descriptive data for these responses are presented in Table 9.

Table 9: Student Perceptions of the Awareness Campaign

	As a result of the flyers, lecture, and/or other information I have received I am more aware of the potential dangers of social media use	*I am now aware of how to be safe when using social media*	*I plan on making a greater effort to be cautious when posting to social media*
Mean	**4.381443299**	**4.367346939**	**4.434343434**
Standard dev	0.994184119	0.912544365	0.847103301
Confidence	0.195838158	0.17975645	0.166865621
Skewness	-2.066951495	-2.131040527	-2.20576935
	I plan on making (or have recently made) my Facebook account more secure	*Universities should make an effort to educate students about the potential dangers of social media use*	*Universities should make an effort to educate students about social media safety*
Mean	**4.375**	**4.295918367**	**4.323232323**
Standard dev	0.943119125	0.943880821	0.912814473
Confidence	0.185779182	0.185929223	0.179809656
Skewness	-1.8213382	-1.755329595	-1.842019857

Additionally, questions included on the pre and post survey were compared and there was a measured increase in the belief that employers are likely to review SNS activities for potential candidates (from 51% pre-treatment to 86% post-treatment); and the belief that undesirable activities can hurt the ability for a candidate to find employment (from 63% pre-treatment to 91% post-treatment). These results are presented in Table 10.

Table 10: Pre and Post Treatment Comparison		
	Pre-Treatment	Post Treatment
I think potential employers are likely to look at my social networking activities	3.54	4.41
Social networking activities that are undesirable to a potential employer can hurt a candidates ability to obtain employment	3.75	4.38

Discussion

The current study under consideration discusses student perceptions and behaviors focused on the risky social media activities of students, negative consequences experienced as a result of social media use, differences in perception based on gender, and the impact of an awareness campaign. The analyzed data and hypotheses testing was presented in the results section. In the discussion section, the meaningfulness of the results of the tested hypotheses will be explored and related to the existing body of literature.

Hypothesis 1: "College students practice risky social networking behaviors" represents the first time that this topic has been explored through an examination of students attending a Historically Black College or University (HBCU). The findings in this study supported Hypothesis 1 and are consistent with what has been reported in the literature through such studies as those published by Cohen (2012); Lenhart et al., (2011), Vanderhoven et al. (2013), and Wizenburg (2012) who also reported that young adults practice a number of risky behaviors via social media.

Hypothesis 2: "Students have experienced negative consequences as a result of social media use" was affirmed by the analyses of the data collected as part of this study. Additionally, these findings are similar to what has been reported by in the literature by Lenhart et al., (2011), Retrovo (2010), and Weitzenkom (2013) who have reported on the dangers and damages that can coincide with social media use. Since this study was conducted at a HBCU, the findings provide initial evidence to suggest that race has no bearing on whether a college student experiences negative consequences as a result of social media use.

Hypotheses 3 and 4 examined gender differences with respect to social media use. Hypothesis 3 postulated that "Females are more likely than males to overshare via social media" and was supported by the results. Further, the findings are consistent with what has been reported in the literature (Kolek, & Saunders, 2008; Sheldon, 2013) who found that college-age females are more forthcoming with their self-disclosure via social media than males. Hypothesis 4, which examined whether "Females are more likely than males to have experienced negative consequences as a result of SNS use" was supported and is consistent with what has been reported in studies conducted by Lenhart et al. (2011) and Madden et al. (2013).

Hypothesis 5 explored the role of age by testing whether "Individuals who had a social media profile before the age of 16 are more likely to have had a negative experience than those who opened their first profile after age 16." This is an area that has received limited attention in the literature. As a result of the analyses conducted, hypothesis five was not affirmed, which is inconsistent with such findings as those reported by Retrovo (2010) which found that when age was specifically examined respondents under the age of 25 were found more likely to have regretful posts than their over 25 counterparts. As a result, of the limited focus on this topic in the literature as well as the inconsistent findings across reports, more research into this particular topic is needed.

Hypothesis 6 examined the efficacy of an awareness program by testing "A targeted program can increase awareness of SNS safety." This is an area which has received very little focus in the literature As a result of the data analyzed, hypothesis 6 was affirmed with results consistent with what has been reported by Vanderhoven et al. (2013)

Limitations

The most significant limitation of this study is that it focused solely on business students attending a single small-sized U.S. public minority-serving university. In order to remedy the shortfalls inherent in this research, the researcher is looking to replicate this study at additional institutions of higher education.

Conclusion

Social media is making Marshall McCluhan's image of a global village (McCluhan, 1964) become a reality as the social software movement promotes virtual spaces which emerge as zones for information-sharing, collaboration, exploration, and community formation and extension (Branch, 2006). Social networking tools are engendering a redefinition of our concepts of community (Thomas, 2007). They are expanding the diffusion of new ideas and are serving as mechanisms for change agents and opinion leaders (Smith, 2009). If we take a technologically deterministic approach, social networking will continue to shape society and culture by permanently altering concepts of privacy, information exchange, friendship, self-expression, teaching and learning, and public discourse.

The pervasiveness of mobile technologies, combined with the ease of access to multiple communication networks, have globalized communication exchanges in a way that is unprecedented. Compelled to receive constant information updates from their ever expanding peer networks, the average person has been transformed to a hyper-connected habitué of social media (Buzzetto-More, 2012b). Permanently tethered to their electronic devices they traverse the social media landscape seeking engagement and enlightenment all the while sharing virtually all aspects of their daily lives with personal disclosure no longer governed by traditional privacy norms. According to the survey results presented in this paper, young adults practice risky social networking site (SNS) behaviors with most having experienced at least one negative consequence. Further, females were more likely than males to engage in oversharing as well as to have experienced negative consequences. Finally, results of a post-treatment survey found that a targeted program that includes flyers, posters, YouTube videos, handouts, and in-class information sessions conducted at a Mid-Atlantic HBCU increased student awareness of the dangers of social media as well as positively influenced students to practice more prudent online behaviors.

The results of this study provide further evidence regarding the pitfalls and perils faced by today's Net-generation of students with respect to the use of social networking services. Additionally, this paper illustrates the efficacy of a social media safety and awareness program initiated with undergraduate learners. It is advised that additional universities consider adopting similar curricula and further exploration into effective methodological practices and approaches to delivering such programs be encouraged.

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Biographies

Dr. Nicole A. Buzzetto-More is a Professor, Program Coordinator, and the Assurance of Learning and Assessment Chair in the Department of Business at the University of Maryland Eastern Shore. She is also Director of the Maryland State Department of Education Program Affiliate for Business, Management, and Finance. She received doctorate and masters degrees in communications from Columbia University and earned a post doctorate in management and marketing from Tulane University. She also earned a masters degree from the College of New Rochelle and a bachelor's degree from Marist College. Dr. Buzzetto-More is a frequent invited presenter at conferences across the globe; is on the editorial board of several journals; has authored numerous publications; and has been recognized with awards from the American Distance Education Consortium, Global Digital Business Association, and the Informing Science Institute. She published two books in 2007, *Principles of Effective Online Teaching* and *Advanced Principles of Effective ELearning*. In 2010 her third book *The E-Portfolio Paradigm: Informing, Educating, Assessing, and Managing with E-Portfolios* was published by the Informing Science Press. She has also published a number of chapters in edited volumes, including a 2012 contribution to the book *Transformation in Teaching: Social Media Strategies in Higher Education*. In 2013, she redesigned the official State completer programs for the Business, Management, and Finance (BMF) Pathways for the Maryland State Department of Education. Currently, she is involved in the redesign of the general education sequence for her university.

Dr. Robert Johnson is an Associate Professor and Chair of the Department of Mathematics and Computer Science at the University of Maryland Eastern Shore. Dr. Johnson has centered his professional efforts on identifying, securing, and establishing resources that create awareness and stimulate interests in the vast opportunities that exist in the Science, Technology, Engineering, and Mathematics (STEM) fields. He and a team of faculty members have secured over $3,000,000 in federal, state, and industry funds to aid students in completing financial obligations related to collegiate study, gateway course completion, completing intense research projects, and matriculation to graduation.

Ms. Muna Elobaid is an instructor and coordinator in the Department of Mathematics and Computer Science at the University of Maryland Eastern Shore. Originally from Sudan, she earned her MSc. in Computer Science from the University of Maryland Eastern Shore and is currently pursuing her Ph.D in leadership. She has published papers in referred journals and made scholarly presentations on such topics as e-books, wireless communications, and currency exchange rates. A certified Microsoft Office Specialist, the courses she teaches include: Computer Concepts and Applications, Business Software Applications, and Office Technology and Records.

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Taxonomy of Students' Use of The iPad in Education: A Pilot

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Abstract

This study attempts to present the variety of possible uses for iPads, in the learning process. The objective is to evaluate a unique implementation model that was tried out at a teacher training college in Israel. The methodology is based on a qualitative research paradigm. The findings show that students' use the iPads in various contexts: (a) for ongoing personal use; (b) for planning lessons; (c) for active integration in the classroom; and (d) for reading and developing content and games. These findings are summarized in a chart that shows the different uses as levels in a hierarchical taxonomy. Analysis of the iPad's pedagogical uses may shed light on the various skills students need to acquire in order to become teachers in 21st century. In addition, understanding the various iPad uses and their frequency can affect decision-making at the level of policy in the field of implementation of the use of mobile technologies in educational institutions.

Keywords: iPads in education, integrating tablets in classroom, iPads in Teacher Training, Taxonomy

Introduction

The growing use of mobile technologies presents new challenges in the field of teacher training and classroom instruction. Mobile technologies include smart phones, laptop computers, electronic reading devices, and tablets – all of which are easy to carry and connect to the internet.

A review of literature indicates that the field of mobile learning encompasses a variety of terms, each of which reflects a different perspective. These terms include m-learning, mobile learning, ubiquitous learning, and handheld learning.

The review of literature shows that mobile learning has yet to be defined unequivocally. One of the accepted definitions is "any type of learning that takes place in learning environments and spaces that take account of the mobility of technology, mobility of learners, and mobility of learning" (El-Hussein & Cronje, 2010, p. 20). Other researchers address the different uses of mobile technology, such as support for the learners and their participation in creative, cooperative, critical, and communicative learning activities (Cobcroft, Towers, & Smith, 2006).

Traxler (2007, 2010) suggests that mobile learning is intended to provide support for authentic and personal learning processes, is situation-dependent, and that in the future mobile learning will

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enable a wide range of learning methods. Rossing, Miller, Cecil, and Stamper (2012) define mobile learning as the most effective use of digital and wireless technology in empowering the learning.

In summary, the distinguishing factor between mobile learning and other learning methods supported by technology, including e-learning, lies in the way that learning experience is mediated and enabled (Peters, 2009). The learning process takes place in a situational context and is affected by the interaction between the learner and the technology used individualy or/and in cooperation with others (Melhuish & Falloon, 2010).

Mobile Device Types

A wide range of devices are classified as mobile technology, with the term mobile reflecting the ability to move from place to place, or from situation to situation. Mobile technologies can be classified on a continuum from regular or static use to the full range between personal use to collaborative use (Naismith, Sharples, Vavoula, & Lonsdale, 2004).

The first group of technologies is characterized by mobility and personal use. These are the most common technologies such as mobile phones, PDAs, tablets, and laptops. These technologies also include hand-held video game consoles, the use of which has been reported in the context of learning (Lee, Luchini, Michael, Norris, & Soloway, 2004; Rosas et al., 2003). Because these technologies are usually for a single user, they are perceived as personal devices. The online nature of these devices allows communication and information sharing. Thus, while the devices themselves are personal, it is easy to share the information and content they contain. In addition, these devices are classified as mobile because you can move them from place to place, and because they are available for use in different locations (Naismith et al., 2004).

A second group of technologies is characterized by less mobility, but still enabling personal interaction, for example, the various remote control devices (like Clickers) handed out to students for the completion of multiple choice tasks and questionnaires.

A third group of technologies enables greater interaction, but less mobility. This group includes smart boards and video conferencing capabilities. It should be noted that these technologies are viewed as static in principle, thus they do not comply with the accepted definition of mobile technology. However, this classification is important to an understanding of the catalog of technologies presented above (Naismith et al., 2004.).

A fourth group of technologies enables the sharing of information and availability in different places. At the same time, the technologies themselves are not necessarily mobile. For example, they can be computer work stations in the work place, interactive displays in museums, and other facilities where the devices provide access to knowledge and its dissemination. In these cases, the technology is not itself mobile; it is the learner that is in movement. Larger screens enable simultaneous use by multiple users (Naismith et al., 2004.).

Potential of Mobile Technologies

Mobile technology offers several advantages in the educational context (The separation is for emphasis, but there is a close link and mutual influence):

Access to learning anywhere, anytime, without the need for extra resources – In today's schools, a transition is taking place from computer laboratories to the use of laptop computers and other hand-held devices (Johnson, Levine, Smith, & Stone, 2010). The relatively small size and weight of mobile technologies make them easy to transport from place to place – a clear advantage. An added advantage lies in the ability to use this "invisible" technology in the learning process and its potential for facilitating interaction and collaboration between the learners.

The smart phone is indeed the most convenient technology for mobility and creating asynchronous communication between learners, but the tablet offers added value due to the relatively low cost of computing power offered. It seems that learners are more comfortable using a tablet when working in groups than using a laptop or smart phone, mostly due to the larger screen size and ease of transfer from hand to hand (Melhuish & Falloon, 2010). Moreover, the mobility of the tablet allows learners to take it outside of the classroom, for “field work”, such as transferring electronic documents and books, recording observations, accessing information sources, and more (Johnson et al., 2010). These characteristics contribute to the tablet’s ability to offer learners greater convenience and availability than other mobile devices (Melhuish & Falloon, 2010).

Learning that has an environmental impact – The potential of mobile learning lies not only in the technological advantages listed above. This type of learning has an impact on the values of the physical and virtual environment. It can be more situational, personal, collaborative, or life-long (Naismith et al., 2004).

Informal learning enables constructivist teaching – The use of a tablet allows informal learning suitable to the learner’s existing knowledge and frame of reference. These characteristics might enable the advancement of constructivist methods in education, in the framework of which teachers function as facilitators (Mouza, 2008). This way, you can learn within the situational context through ongoing dialogs with colleagues, in support of the social constructivist learning approach — an approach that we encourage in teacher training with the goal of seeing it implemented both in classrooms where student-teachers gain practical experience, and with their pupils in the future. The construction of knowledge takes place through collaboration. The learner’s extensive autonomy will enhance the learner’s meta-cognitive abilities and make it possible to consider complex and authentic problems in the practice environment in real time (Herrington, Mantei, Herrington, Olney & Ferry, 2008). Mobile technology enables learners to share and create knowledge, and become acquainted with a wide variety of content and persons anywhere and anytime (Dew, 2010).

Development of interpersonal and social ties – Different mobile applications enable the learner to create, share, and connect with others within the context of authentic learning and to participate in online learning communities. This can be done, for example, over wireless networks or using Bluetooth technologies, though these require infrastructure and technical support. An effective mobile learning environment requires a robust institutional infrastructure, which will expand the range of relevant resources and provide the necessary technological and financial support (Melhuish & Falloon, 2010).

Personal, individual learning experience – The tablet is a device that is used by a single user, although a tablet can be shared between users or used for collaboration. The learner can choose which applications to use and adapt them to meet their needs and goals.

Support for the development of visual and textual literacy – The tablet enables learners to take a photograph and immediately upload it to the Internet, edit videos easily, and use applications that teach languages, math, problem-solving and strategy games, drawing tools, as well as learning aids such as spoken texts (Kelly & Schrape, 2010; Valentino, 2010). These endless possibilities make the tablet a powerful tool for teachers and learners alike.

However, as with any technology, the use of mobile technology in learning is not without its limitations. There are technological limitations, for example, the relatively small screen size, which might not suit all learners. There are also issues related to lapses in internet connectivity (Alexander, 2004), limited memory size, and the need to frequently recharge the battery (Georgiev, Georgieva, & Smrikarov, 2004). There are also obstacles related to socio-economic factors, for example, the fact that not all learners are able to purchase the device. Nonetheless, in my opinion, the more pointed questions related to the use of mobile device center around its educational and pedagogical contribution to learning, and the relationship between educational processes and the technological environment.

Teachers who employ technology need to be aware of its advantages and disadvantages, and be proficient in its use. This is to mediate its use for the learners and make the learning process as effective as possible (Melhuish & Falloon, 2010).

Models for Tablet Use in Education

There are those who maintain that learning in itself does not change, it is only the mode of learning that changes. In this respect, tablets are a mean for advancing empowerment processes. This approach is reflected in the 3-E education model – Enabling, Engaging and Empowering (SpeakUp 2010, 2011, p. 3). According to this model, teachers need to recognize that learning has to *enable* learners to reach their potential though increased access to information sources; *engage* learners in a rich and challenging educational experience, that will develop their knowledge and skills, especially through problem solving, creativity, and critical thinking; and *empower* learners to take responsibility for the learning process, to explore knowledge and their own creativity, and create live long learners (SpeakUp 2010, 2011, p. 3).

A different model for the use of mobile learning integrates number components, including, first and foremost, the learner and the teacher-facilitator. Technology enables educators to design and develop interactive learning activities. When presented with these activities, the learner can take full advantage of the tool and use it to explore the available knowledge (Monahan, McArdle & Bertolotto, 2008; Price & Rogers, 2004). For example, the learner can access information anytime and anywhere, without extra effort. Because you can document the mobile learning process, the teacher-facilitator can gather information from the technology used by the learner. The facilitator can guide the learner to additional sources of information as needed, and present learning materials appropriate to the learner's current stage in the learning process. The learner receives feedback during the process, enabling individualized study and optimal adaptation to the learner's needs. The role of the facilitator is to monitor the needs of the learner and provide the necessary support (Jeng, Wu, Huang, Tan, & Yang, 2010).

The improvement of learning processes is also a component of the mobile learning model. This can be accomplished using various tools such as a blog that features informative articles that help advance the learning process. Blogs can be used to collect data and information, and as a platform for shared learning (Wang, Huang, Jeng, & Wang, 2008). In addition, you can enhance the learning process through the development of applications designed to support learners and which serve as a kind of coach or support to help the learner through the process, with their presence gradually reduced as they become less necessary (G. D. Chen, Chang, & Wang, 2008; Y. S. Chen, Kao, & Sheu, 2003).

Another component of the mobile learning model is the *situation-based learning environment.* For example, you can use the functions of sensors that are found in mobile technology to locate and identify factors in the learning environment. You can create a simulated environment for the learner and allow him to practice under conditions that are closest to the real situation (Yang, 2006).

The last component in the model is the development of *virtual group awareness and strategies.* Various studies describe the benefits of using mobile technologies as a group (Zurita et al., 2005). The group dynamic methodology can be applied to learning activities that require cooperation. Virtual group membership might strengthen the learner's involvement in the material studied.

Other researchers focus on the unique potential of tablet devices that might be developed in specific fields. Eagleton and Dobler (2007) examined how the use of tablet devices impacts on teaching and learning in the context of reading. In their opinion, the use of digital books creates an opportunity for the development of literacy. Digital books are available on tablets and offer advantages in that they allow the readers to interact with the text and at the same time manipulate it based on their needs. In this way, the reading experience becomes individual, interactive and involved (Larson, 2010). In addition, the tablet includes apps that are free or relatively inexpensive and which promote reading skills such as reading, taking notes and commenting on the text, adding images and symbols, graphic organization of text, and even sharing text and working on it together with a colleague (Hutchison, Beschorner, & Schmidt-Crawford, 2012).

Tablets in the Israeli Educational System

Recognizing the power of learning using tablet devices, tablets have been purchased in schools in Israel and around the world. There are abundant examples; however, the author will relate in particular to innovative initiatives for tablet integration in education in Israel, because the range of available Hebrew educational applications is relatively limited.

One of the most innovative initiatives was implemented by the AMIT Educational Network. AMIT integrates learning with tablets using a newly developed Israeli technology platform called AURA. AURA is designed to enable learners and teachers to conduct ongoing private dialogues, and it has been adapted to the pedagogical approach in the schools. Since the introduction of tablets, it has been found that teachers spend less time in class on each topic because the pupils have used the tablet to practice/review the material in advance. This makes it possible to maintain the social heterogeneity of the class, without holding back stronger students because of their weaker classmates.

Another educational network, AMAL, initiated a wide-scale pilot project for the use of iPads in technological studies (new media, Mechatronics). In addition, in one high school that was fully equipped with iPads, the tablets were used for project-based learning (PBL). AMAL also developed a unique curricula for the study of Augmented Reality technology, which enables the interactive integration of virtual elements in the real environment, in real-time.

One of the most impressive projects uses iPads for place based learning. The project is a digital tourism project based on augmented reality, in which teenagers have developed a tourist route at the ‘Sarona’ Tel Aviv compound, containing historic buildings that have been renovated and has recently become a leisure and entertainment complex with a rich heritage. The pupils were divided into working groups, each of which built several stations located on the route. They studied and interviewed key personnel for the production of historical videos to illustrate the route. Accessibility was a main concern in the creation of the route. It was examined in collaboration with special education pupils from a nearby school. QR code landmarks were placed on the trail, so that each visitor can inspect the route through an application, get the relevant information and follow the leads. The project serves as a contribution to the community and as a public service.

There are also localized initiatives for the integration of tablets in elementary schools throughout Israel: Three elementary schools in Pardes Hanna-Karkur switched from printed books to digital books during the last year (2014-2015). This project is part of the national program “Adapting the education system to the 21st century,” which brings together all of the community’s elementary schools, with the support of the local council, to invest in the infrastructure necessary for the program’s implementation – a projector in each classroom, internet connectivity, and laptops for teachers. These schools will no longer have only print versions of the textbooks; digital versions will become available as well. At the first stage, language, science, geography, social studies, and some of the math books were converted into digital format. Later on, all of the text books were converted to this format.

Bat-Yam municipality also decided to provide all seventh graders with iPad devices, with the participation of parents. These will replace traditional textbooks. Since the socio-economic level of this city is not high, parents protested regarding the heavy financial costs imposed on them. Studies on the educational value of this project have yet to be presented.

One of the most promising areas in which the use of tablets is particularly prevalent is in special education frameworks in Israel. The Ministry of Education initiated special projects where entire classes of learners with special needs and their teachers use iPads in the learning process. Some of these initiatives have been accompanied by research; it appears that the effectiveness of the use of iPads among learners with communication-related disabilities is particularly high.

Technology in Teacher Education Programs

Vast resources are invested in the implementation of tablets and in training teachers on their intelligent use in the learning process in the schools. Implementation is carried out on various levels, ranging from the technical level – usually there is a technical support system for the municipality or the supervisory body – to the didactic level – with national computerization facilitators regularly visiting the schools to guide the teachers in the integration of the new technology. Researchers from academia also volunteer to help in the implementation process and advise school principals regarding educational pedagogical processes and the like. Nonetheless, these assimilation processes do not guarantee the success of these initiatives to integrate the tablet. There are studies that indicate that, despite the dedicated work of teachers, there is no relationship between the new media and the teaching and learning methods. The integration of mobile devices has not brought with it a corresponding change in teaching methods and didactic operating strategies. Teaching remains traditional. Another reason for the lack of success of such initiatives is that teachers are not always given the freedom of operation needed to create linkage between the curriculum and the learning spaces adapted to integrate this technology (Shamir-Inbal & Blau, 2013).

Studies show that intervention should be based on training that helps teachers to acquire competency in the technological tools, as well as experience in applying new pedagogical ideas in order to understand the relationship between pedagogy and technology (Eyal, 2012; Fishman, Best, Marx, & Tal, 2001). Therefore, to prepare future teachers for a better start in their first year of teaching, especially in those schools equipped with the technology, there is room to consider the implementation of tablets in the teacher training process, similar to the implementation of computerized communication processes in colleges of education in the context of stationary and laptop computers, Although technology courses have not been prioritized in teacher preparation programs, Betrus' (2012) study noted that the number of institutions offering an introductory technology course for teacher education students decreased from 80% in 2000 to 64% in 2010. The same study also noted that while more than half of the topics taught had changed over the ten year period, the emphasis remained on office applications rather than emerging technology.

Studies indicate that the mastery of different technology skills is not a function of age, instead differences are related to experience with technology (Eshet-Alkalai & Chajut, 2010).

For instance, a case study at University of Southampton Management School (Morrison, 2014) assessed the staff and student perspectives trying embedding the iPad as learning and teaching tool. Staff and students on the Master of Business Administration (MBA) program were provided with an iPad at the beginning of the 2013-2014 academic year. The results of initial research indicate that while the overall reaction was positive, acknowledging the benefits of 'new' technology or different ways of teaching and learning, there are also barriers to uptake or use. Students used the iPads quite extensively in the first week and indicated that they had underestimated the potential of the iPad as a learning tool. Staff also explicitly stated that they saw considerable potential in iPad use in their teaching and were happy to trial new technology. There was a clear preference for more support in their use, even from experienced technology users.

A relevant study at the Pennsylvania State University in USA by Tohill (2014) examined pre-service teachers' experiences with iPads during their student teaching experiences and supported previous research studies that suggest technology education must be an integral part of teacher preparation programs in an effort to improve teaching and learning with modern digital tools. Teacher preparation programs must continue to encourage pre-service teachers to innovate and explore with technology in ways that support both personal and professional development and that improve learning experiences for students.

The Research

The research under discussion studied a pilot program at an Israeli teacher training college, in the framework of which tablet devices were loaned to the students. The subjects were 18 students from the pilot group who were studying in the college's honors program in a variety of specializations, for example, special education, early childhood education, mathematics instruction, English instruction, science instruction, and so on. The students in the honors program have relatively high levels of academic achievement, and approximately a third of their curriculum is unique and customized. The students received the tablets in their first year studies (except two who were in their second year), and the tables were in their possession for two years.

Unlike an existing implementation sample of this pilot, this study examines the ways students' use the tablets based on an implementation model that does not include training, pedagogical guidance, or support from an ICT faculty expert. The students were given the freedom to use the devices as they saw fit. They were given the possibility of consulting with an expert on the integration of advanced technologies in education, on both the technical and pedagogical levels. Some students also enrolled in elective courses that address the integration of technology in education.

The objective of this study was to examine and characterize students' use of tablets on two levels: 1) the general and personal level; 2) as a pedagogical device in the classrooms, in order to evaluate the success of the implementation model where the extent of intervention is particularly low.

Research Questions

The research questions were:

A. How do education students use the iPads?
B. What pedagogical uses of the iPads did the education students implement to advance the learning process?
C. What model can be proposed for using iPads based on the students' uses (both personal and pedagogical)?

Research Method

The study was conducted based on a qualitative research paradigm based on the approach of the construction of a grounded theory. This genre of research focuses on the study of a phenomenon from the perspective of the informants, while the accompaniment of a theoretical analysis based on the interpretation and comparison of literature and analysis with existing theories (Charmaz, 2000).

Data were collected from a variety of research tools and were cross-referenced (triangulation). The research tools included semi-structured personal and group interviews, online questionnaires in Google docs, students' reflective performance reports, lesson plans, observations of practical experience at schools, and documentation of discourse on social media.

The unit of analysis was a statement (e.g., from a reflective performance report or social network) or a description (e.g., from a questionnaire or a record of observation) indicating use of the iPad. Each unit of analysis was coded and received a representative name (primary categories), reflecting the students' prominent uses of the device the subjects' language (emic). The data was then sorted accordingly (the axial and directed coding phase). After determining the first primary categories, the units were then organized into secondary and tertiary categories, and the category names were updated based on existing literature, creating a hierarchy of categories. The number of units in each category was counted to gain a sense of the frequency of each type of device use.

The resulting model was consolidated by linking the findings and the theoretical literature about the pedagogical uses of iPad devices, and this enabled broader conclusions to be drawn, which are presented in a graphical model.

Findings

A. How do education students use the iPads?

The findings reflected the following division:

- 63% of the students made extensive use of the iPad
- 27% of the students made very little use of the device, and at the end of the semester they were asked to return it. The devices returned were then loaned to different students.

The reasons that students cited for making minimal use of the device included the following: inadequate technological literacy; they did not see its value in classroom teaching; or many of the same applications are found on their smart phones, making the use of the iPad redundant.

The findings show that the students' primary uses for the iPad were (a) for ongoing personal use, (b) for planning lessons, (c) for active integration in the classroom, and (d) for creating and developing content and games.

Ongoing personal needs

Students incorporated the iPad in their day-to-day routine at home or at college, for both personal and academic purposes. Common uses included calendar and schedule management, reminders, photography, drawing, scanning materials, documentation, recording, and getting information from newspaper articles and books.

> "As a student who spends most of my time at the college, doing my practicum, at work, or on the road, the iPad helps me in my daily routine. I use it as a notebook, film activities that I implement (one of its best things for me), read articles, and write papers. The iPad helps me be more efficient and meet deadlines in the busy life I currently lead."
> (From the online questionnaire)

In this respect, students claim that the device is comfortable to use and easy to carry, therefore it can be taken anywhere, making it possible to take advantage of free time.

In addition, it is commonly used for recording college lectures, taking notes lists and summarizing lessons:

> "I have an app that creates a kind of notebook for each lesson, even the notes I take are sorted according to subject."

Although the students mentioned that the iPad is not a particularly comfortable tool for editing complex documents, some students indicated they use it for writing drafts, making use of different applications that allow the editing of texts. Students also noted that the device saves them on printing and photography costs, because they use it to photocopy articles and academic information items.

Planning and instructional design

The second category of iPad use includes self-learning related to the student’s specialization, locating information, and reading relevant academic articles and books. In addition, as part of their studies at the teacher’s college, students gain practical experience as student-teachers in schools and kindergartens. As part of the learning strategy, students are required to document themselves teaching in the classroom. Use of the iPad enables the students to view the recording multiple times, reflect on the their teaching encounters in the classroom or kindergarten, draw conclusions regarding their performance for the purpose of better planning, revising, and improving their teaching in the future.

The use of the iPads by students also created a ripple effect, impacting on how the pedagogic counsellors monitor and guide the students in the practicum. One of the teachers asked students to video record the lessons given in class and then to describe their experience to their classmates, instead of the traditionally submitted written reports. Most students said that they used the iPad in the lessons planning process, especially when they are traveling. In addition, students used the device to locate applications and unique materials for teaching specific subject matter and to find ideas on how to implement those materials in the classroom.

B. What Pedagogical Uses of the iPads did the Education Students Implement to Advance the Learning Process?

As part of the practicum, students integrated the tablet into the teaching and learning process in a variety of ways. Observations and lesson plans show that the main uses identified are the following.

1) Enhancement of frontal teaching

By connecting the iPad to a projector, students used the device to display presentations, website, or games).

For example: Figure 1 shows a simulation of the microscopy separation principle (i.e., how the microscope works). The tablet captures the skin and gives a sense of how it zooms in, demonstrating the difference between the magnified size and the regular size, and the microscopes role in separating objects.

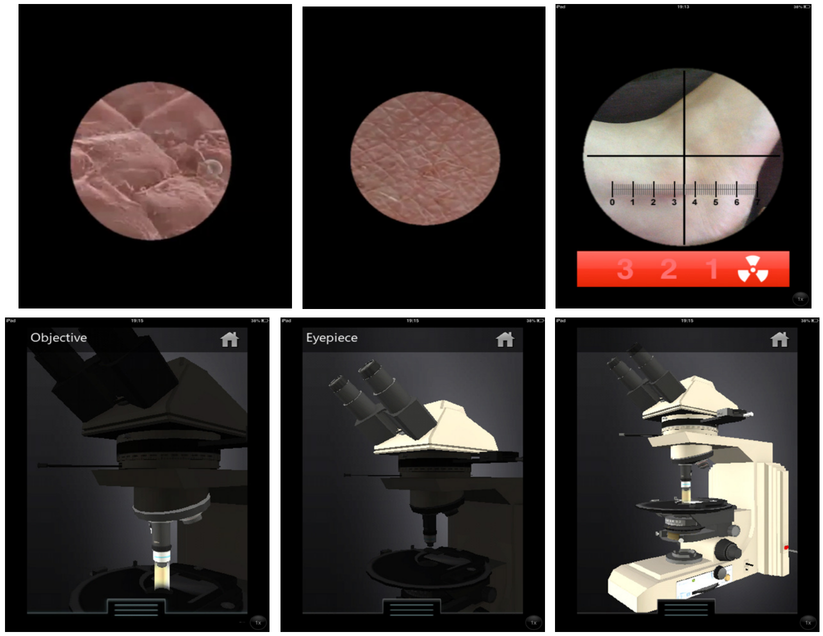

Figure 1. Screenshots of an application simulating a microscope

Pupils in the classroom were shown the microscope simulation and its parts were explained. According to a student specializing in science instruction, the added value of the application lay in solving the problem of excess stimuli that occurs when microscopes are placed on the pupils' desks. The application demonstrated the principle of separation in a clear and interesting way, providing an authentic sense of true magnification. The demonstration was accompanied by a theoretical explanation, given by the teacher, and provided the linkage to reality. In this context, the use of the tablet is more effective than a presentation or a teacher's hands-on demonstration of the microscope, when not all 35 pupils are able to use it. In addition, pupils used their mobile phones to photograph what they saw under the microscope (as observed by teacher Y.)

2) Teaching in groups

Another example is that of students in the early children education program, who used the tablet in the kindergartens. The necessary technologies for presenting computerized visual content are not always available. Future kindergarten teachers indicated that they used the device primarily to show clips to young children, followed by a discussion of what they saw. The clips were selected based on the subjects being taught in the kindergartens.

3) Active learning – Integration of dedicated applications

Lessons that integrated applications dedicated to the students' area of specialization, where the learners use the device as individuals or in groups. The integration was implemented in one of two ways: free use of an application that focused on a subject or skills, without guidance from the teacher; or by assigning defined tasks to the learners.

For example, Figure 2 shows the use of an application in the framework of English instruction. The application enables the learner to highlight text, cut it, and copy it.

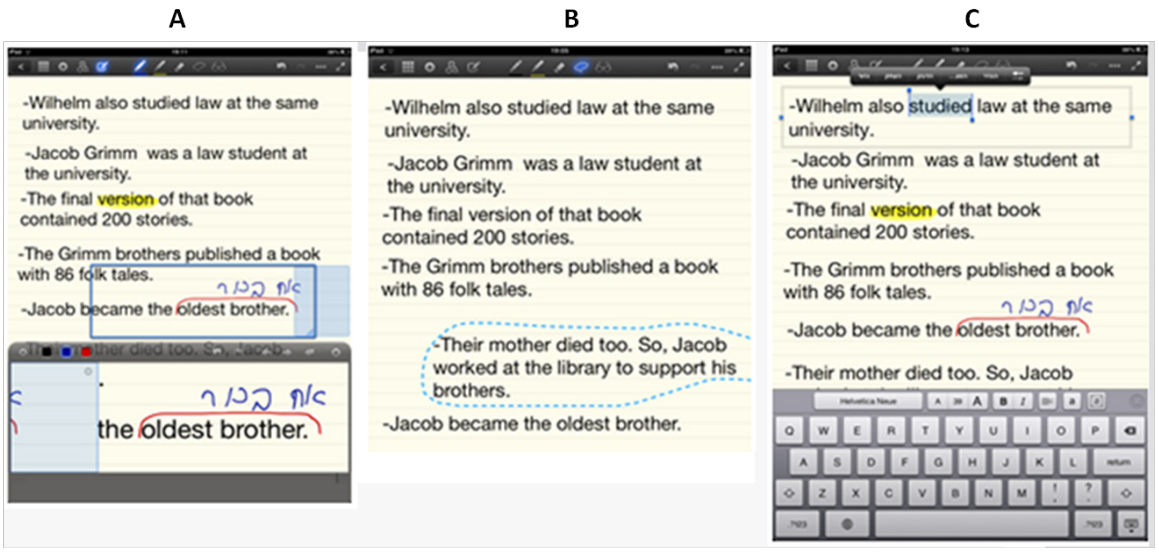

Figure 2. Working with Texts: (A) Highlighting text, enlarging select areas, and adding hand-written comments; (B) Cutting and moving text; (C) Editing text, copying words

The application enables the learner to highlight text, cut it, and copy it. In addition, the Google translate application was used.

The pupils worked in groups of three, and each group was given a different sentence. First, the pupils needed to arrange the sentences in logical chronological order (A). Then they cut and moved the sentence (B). When the first team finished, they were given an additional task – to copy all the verbs (C). They copied the text to a new page, where they processed and analyzed the verbs (translating, highlighting tense indicators, and so on).

The student teaching English in the class describes the added value of using the table in this activity:

> The activity created interest and motivated the pupils, time was saved (no need to copy words, cut pages, etc.), it was possible to focus on and analyze the original texts, highlighting words it contained, and assigning additional tasks that would not be feasible on paper (because of the ease in copying and duplicating text). (B. reflective diary, Oct 15, 2012)

Students used specialized applications for teaching math, writing, and drawing as part of the group tasks. They also used gaming applications, for example, an application that simulates an aquarium where you see the movement of the water.

Students indicated that they created databases of applications and users on a dedicated social network set up for the sharing of tools that they had tried out and found successful. They also noted that in many instances they used the device as an education tool beyond the content-based educational objectives. For example, one of the science student-teachers who was teaching about the states of matter asked the pupils to draw gas particles. After the drawing was photographed using the tablet, it was projected on to a screen, for the entire class to discuss. In this way, she strengthened students' self-confidence and belief in their own capabilities:

> Games on the iPad are also served as a tool for reinforcement (children are eager to play with the device) and as a means of learning – with my choice of games for their use based on their overall and educational quality. In the special kindergarten, the children particularly like the game Awesome Eats – which combines fine motor skills with an under-

> standing of the process of a healthy diet of fruits and vegetables. In a great game for naming, matching and sequencing skills, SpeakApp (the version that you can buy), children can record themselves and create new events. (D. reflective diary, Jan 23, 2012)

In one of the lessons that the author observed, the student-teacher planned activities for teaching English using the tablet in a group of four students. During the activity there were many disruptions, the students fought over the device, shouted and treated one another disrespectfully. The student-teacher threatened to take away the device and the next time to invite another group to work. In a feedback conversation, the student-teacher realized that the she needed to determine explicit rules and norms of behavior. She set a goal to establish a relationship of mutual respect between pupils in subsequent lessons. Through her experience in using the device in the class, the student learned some of the skills necessary to for optimal classroom management.

4) Media stimuli or media support

A special education student-teacher indicated that the device has important advantages in the area of media support. In one of the lessons the author observed, the tablet helped a learning disabled pupil who was integrated into a mainstream classroom to express her feelings and take an active part in the language lesson.

The pupil used the tablet to express her joy and excitement at being part of an integrated classroom and displayed a smiley to all of her friends (from observation of A.'s lesson on Nov 12, 2012). While younger students learned about different animals, the student-teacher helped the pupil to find a picture of a chicken. She learned to write the word with help from the student-teacher, who guided her finger through the process. She moved among her classmates, proudly pointing out the picture and the caption above it. She moved among the tables and received reinforcement from her classmates.

Other special education pupils used the table to create cards that express emotions (not at all like the traditional cards). The tablet expanded the pupils' communication options, assisted by the student-teachers who worked with them.

In her reflective report, one student wrote:

> I also use the application 'ShowMe' to edit and paste photos. I have already taken lots of pictures during lessons. It ties the girl to the language aspect of the words because fine motor skills are problematic. Now the motor skills are less of a problem, before the iPad there was nothing she could do when the class worked on the questions and wrote with a pencil. As soon as she felt that she herself can write the name with the picture, she also participates in the lesson. With mental retardation illustration is important. The picture in the book was a drawing of a chicken, and it was important to show her a real chicken to link it to reality. The iPad empowers the pupil and raises her to a higher level. It also strengthens her social ties with her classmates. (G. reflective diary, Apr 20, 2012)

5) Motivational tools

According to students' reports, the tablet also serves as a means of motivation and strengthens communication between them and their students. For example, one student reported that in order to increase learning motivation, she promised a pupil that she could choose a game on the device, and that she would play it with after he completed the assigned task. Students used it for activities that the pupils like to participate in, and they utilize them in the learning process. Another example is taking pictures of the children at play and during creative activities. They noted that this use often serves as form of positive reinforcement to promote creativity. The children love to take pictures and be photographed, including while putting on plays/drama presentations.

C. What Model Can Be Proposed for using iPads Based on the Students' Uses (Both Personal and Pedagogical)?

6) Creating and developing content and games

Although this use of the tablet could be included in the category of integration of the tablet in the active learning, the author chose to treat it as a separate category to emphasize the difference between using existing applications (closed or open), and the development and creation processes, for which not all students have the necessary capabilities or interest. This category refers to the development of games using dedicated platforms that enable the teacher to insert the relevant content matter into some genre of games. A limited number of students participating in the study developed tutorial or other educational and social games for use outside the classroom.

For example, students specializing in early childhood education developed games to use in their practicums in the kindergarten. The students used the 'TinyTap' platform to create these games. The game they developed allowed them to take a personalized approach, to adapt the learning content to individual educational programs, to adapt the level of the game to the cognitive skills of the learner, and to provide appropriate reinforcement according to the emotional and learning needs of the child, all through the use of an attractive and stimulating visual display, as shown in Figure 3.

Figure 3. Screenshot from a game for preschool children developed by students

In their reflective reports, students indicated that the children enjoyed using the tablets during the session; it captured their attention, they were excited by the immediate stimuli and the immediate reactions they aroused in them. In individual learning, where the objective was to teach didactic content, especially when working with special needs children, it is highly advisable to approach the material in an experiential way that helps the learner concentrate and take an active part in the learning.

Another student used the games as a platform for creating games as an activity in and of itself, for example in the teaching of English. She presented an overview of the platform and gave the pupils an opportunity to create a game based on new and difficult vocabulary that they had not previously encountered in the text. The pupils prepared games in groups, which were then played by their peers from other groups.

Discussion and Conclusions

A review of the findings about the students' uses of the tablet in various contexts shows that they are similar to findings of other researchers; the students took advantage of the device's inherent range of possibilities and technological opportunities: mobility – access to information and learning anywhere and anytime, time management and organization of information, photography and editing options, and integration of applications in the study of various subjects (Dew, 2010; Johnson et al., 2010; Kelly & Schrape, 2010; Melhuish & Falloon, 2010; Valentino, 2010).

In addition, students integrated the use of the device in the teaching and learning processes in classrooms, in working in groups, while promoting constructivist learning methods, while the learners gain experience, research and read information, watch simulations and discover the patterns in the course of the game and dialogue with their peers. This finding corresponds to the viewpoints of other researchers who treated the tablet as a tool that enables learners to be engaged in challenging, creative, and collaborative experiential learning (Herrington et al., 2008; Mouza, 2008).

There was a change not only in the quality of teaching in the classroom, but also in the students' outlook on their future professional development. The development of learning materials in the form of computerized games is not a routine activity for teachers. For the most part, it is time consuming, and requires high level planning and thinking, and design skills. When the students developed the material, they each brought their own unique talents – academic and professional – to a high level of expression; they had a better understanding of the material being studied, greater preparedness for the teaching process, and greater satisfaction. The empowerment of learners was especially reflected when students used the tablet as a means for improving and supporting communication with students.

Observations of the education students in the classroom showed that the students most often used the tablet in the context of more traditional teaching, based on the frontal transfer of knowledge. At the same time, in lessons where the tablets were placed in the pupils' hands, the students demonstrated guidance strategies, providing support for the learners, and engaging the learners in collaborative learning and dialogue. The very presence of the device in the learners' hands created a change in the students' perception of their role as teachers. They planned their lessons in advance, acting as mentors and coaches in their implementation. This finding is also supported by other studies (G. D. Chen et al., 2008; Y. S. Chen et al., 2003; Jeng, Wu, Huang, Tan, & Yang, 2010).

In the unique implementation model tested in this study, students did not receive pedagogical support for planning and implementing lessons using the device. Still, it seemed that the more they experienced they gained in school with the device, the more sophisticated and creative the lessons they developed became, to the point where they created open use of creative learning materials, simulation, and games. The user friendliness of the device and its intuitive interface require almost no special training.

This finding is consistent with the findings of the researchers who suggest a link between the duration of experience and the degree of control of the device (Eshet-Alkalai & Chajut, 2010). However, this finding contradicts the findings of other studies that maintain that there is need for a training program to acquire the technology skills for establishing and implementing innovative pedagogy.

Either way, the findings of this study can't be generalized, due to the fact that there is no data on those students in this research population who chose to return the device. In addition, the group of students was relatively small, with unique characteristics (students at excellence program). It is important to emphasize that in order to develop the students' understanding of the innovative pedagogies, which they acquire as they gain experience, and their ability to engage in reflective thought, the role of the reflective dialog between the pedagogical coach, the teacher-facilitator, and the student-teacher is important. In this study, reflective thinking was made possible through interviews and reports submitted as part of the study. Some of the dialogue could take place on a social network, such as the one established for that purpose in this study. Social networks provide opportunities for open, accessible, and dynamic discussion, creating interaction between students at different points in the experience for the exchange of knowledge and opinions, and sharing applications reading materials.

Linking between the findings of this study and the findings of the theoretical literature on the pedagogical uses of iPad devices made it possible to formulate a model (Research Question 3) based on the principles shown in Figure 4. Figure 4 presents the overall uses of the iPad, as reflected both in the literature and in this study.

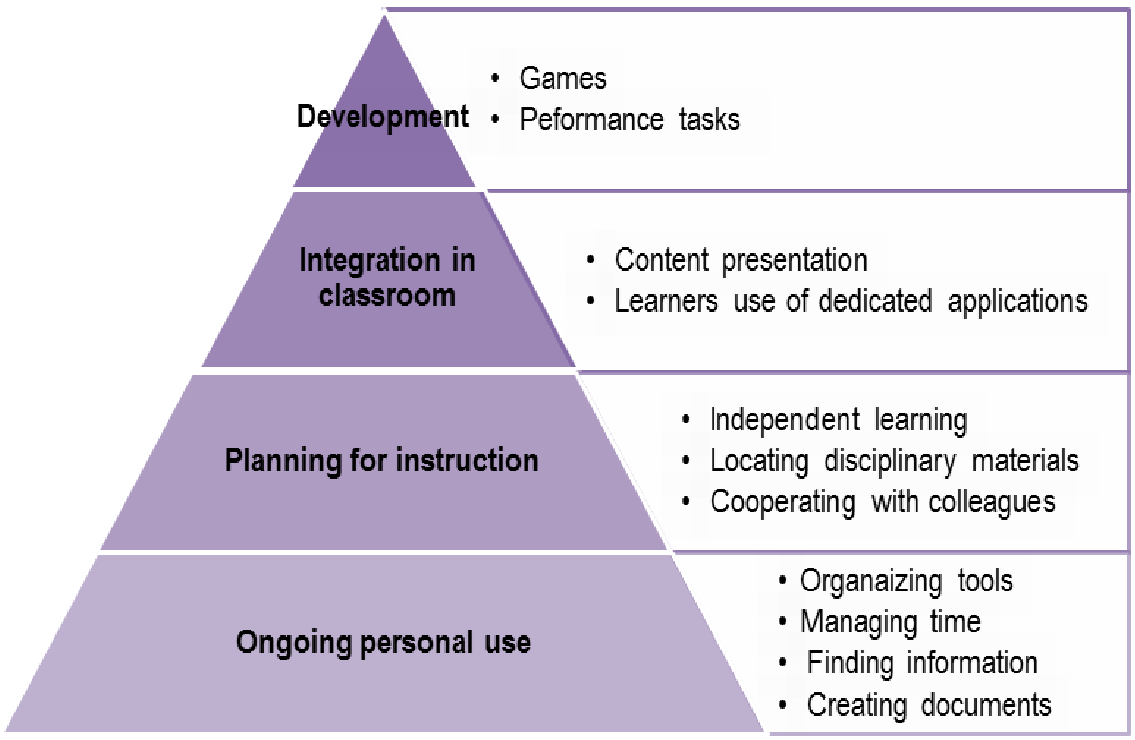

Figure 4. Taxonomy of students' use of the iPad in education

This chart presents the different uses as levels in a hierarchical taxonomy. Taxonomy is a hierarchical classification of things or concepts. Each level in the diagram includes the levels below it. The principle is that the greater the knowledge and experience of students, the more sophisticated is their use of the device.

The process of acquiring the skills of using iPads in teaching reveals different levels of use. The first two levels at the bottom of the pyramid represent basic uses: A) Personal Uses: Creating documents and lists, consuming information, calendar management, summaries of lessons, and recordings, and B) Instructional Design - including instructional context uses, locating disciplinary articles as part of curriculum development, self-learning, and communication with colleagues. Two higher levels of integration of iPads in teaching include C) Integration in the classroom - for the purposes of displaying content up to the level of constructive learning, for example, a group of pupils working together and using relevant applications. The highest level, D) Development, includes games development and planning performance tasks using open platforms.

This study investigated the diversity of students' use of the tablet, though the quality of the activities prepared by the students for tablet use in the classroom has yet to be examined. It is thus recommended to analyze the lesson plans and activities, as well as the levels of thinking required of learners in classes where the tablet is integrated.

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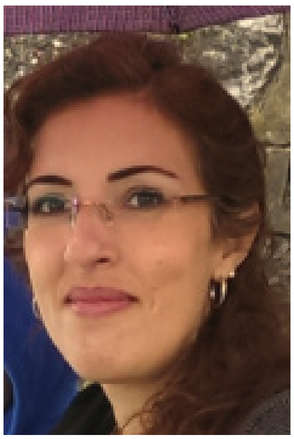
Biography



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Analyzing the Quality of Students Interaction in a Distance Learning Object-Oriented Programming Discipline

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Abstract

Teaching object-oriented programming to students in an in-classroom environment demands well-thought didactic and pedagogical strategies in order to guarantee a good level of apprenticeship. To teach it on a completely distance learning environment (e-learning) imposes possibly other strategies, besides those that the e-learning model of Open University of Portugal dictates. This article analyses the behavior of the students of the 1st cycle in Computer Science while interacting with the object-oriented programming (OOP) discipline available to them on the Moodle platform. Through the evaluation of the level of interaction achieved in a group of relevant selected actions by the students, it is possible to identify their relevancy to the success of the programming learning process. Data was extracted from Moodle, numerically analyzed, and, with the use of some charts, behavior patterns of students were identified. This paper points out potential new approaches to be considered in e-learning in order to enhance programming learning results, besides confirming a high level of drop-out and a low level of interaction, thus finding no clear correlation between students' success and the number of online actions (especially in forums), which reveals a possible failure of the main pillar on which the e-learning model relies.

Keywords: eLearning, student's behavior, distance learning of programming language.

Introduction

Teaching programming is difficult. Much research from many different perspectives has been devoted to the topic during the past couple of decades, but there is still no consensus on what is the most effective way to teach programming (Vihavainen, Paksula, & Luukkainen, 2011). Most universities are still using a traditional format in the introductory programming courses. The traditional format consists of lectures, take-home assignments, and perhaps also demo sessions where model solutions to the exercises are shown.

One of the most challenging aspects of any information systems or computer science curriculum involves helping students learn the concepts of computer programming (Shehane & Sherman, 2014). This task involves many com-

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plexities, including skill development, different learning styles, helping students transition from a problem statement to algorithmic logic, developing programming code from that logic, debugging and resolving the program code, to produce a working program that meets the problem requirements. This learning process is even more challenging when students are also being introduced to a new programming language and development interface. Things can become a little bit more complicated when you have to teach object-oriented programming in a totally e-learning environment.

This article analyses the students' behavior while interacting and using the object oriented programming discipline material available on the Moodle platform of the Open University (UAb) of Portugal, with the undergraduate students of the 1st cycle in the Computer Science degree. The UAb is a University that operates entirely on a distance learning environment. All teaching and learning activities were developed online (with an emphasis on asynchronous communication), and this discipline is taught in the first year of the undergraduate course (second semester). A relevant problem to be investigated is the cause for the high level of drop-outs and overall failure in learning. The numerical analysis of the data retrieved from the Moodle actions report helped the authors to identify some correlations between student's actions on the platform and their overall learning performance in the discipline. The goal is to verify if the actions rate per student (the student's interaction profile) has some correlation with success or failure.

Despite recent advances of electronic technologies in e-learning, a consolidated evaluation methodology for e-learning applications is not available. Maybe the main cause for this is the complexity that the evaluation of an e-learning environment demands. Many different perspectives and, thus, dimensions in the analysis process can be considered, such as the quality of learning, teaching, learning environment, and interaction (Ardito et al., 2006). Each of these dimensions can be evaluated according to a group of pre-defined and chosen indicators. In the case of interaction, we may consider that the quality of students' interactions is one of the most relevant indicators of successful learning.

This paper is organized in four main sections. The first will provide a short background of some relevant studies and work that has been being carried out to understand better the behavior of users' interactions in an e-learning environment, which served as an inspiration for this article. The second section will give a brief description of how the discipline is structured and presented to the student. The third section will describe the data that was used and the analysis carried out. The fourth section will list the main findings, followed by a section discussing the results and proposing some approaches to modify practice.

Background

E-Learning refers to the use of ICT to transform and support the learning process (Kahiigi, Ekenberg, & Hansson, 2007). E-Learning is defined as the acquisition and use of knowledge which is distributed and facilitated primarily by electronic means. Such electronic means may include internet, intranet, extranet, CD-ROM, video tape, DVD, TV, and personal organizers. E-Learning can be carried out in several ways, which include computer based, asynchronous, and synchronous learning (Loncar, Barrett, & Liu, 2014). This facilitates an environment where the students take ownership of their learning.

Although modern technologies allow for synchronous communication (such as Skype), the e-learning model (Pereira, Mendes, Morgado, Amante, & Bidarra, 2007) is based primarily on asynchronous communication as an aid to learning. Asynchronous learning is a student-centered teaching method that uses online learning resources to facilitate information sharing outside the constraints of time and place among a network of people. Asynchronous learning is based on constructivist theory, a student-centered approach that emphasizes the importance of peer-to-peer interactions. This approach combines self-study with asynchronous interactions to promote learning, and it can be used to facilitate learning in traditional on-campus education, distance education, and continuing education (Northey, Bucic, Chylinski, & Govind, 2015). A special emphasis is given to discussion forums, which aim to promote reflection and knowledge sharing (a higher level of learning). Other asynchronous approaches may be adopted in the future with the development of Web 2.0.

E-learning systems store large amounts of data based on the history of users' interactions with the system. These pieces of information are usually used for further course optimization, finding e-tutors in collaborative learning, analysis of students' behavior, or for other purposes. The interest in analyzing this data is gradually increasing within the academic community. The overall purpose is to enhance the learning experience. A research area, referred to recently as learning analytics, has been created to focus on automatic analysis of educational data (Chatti, Dyckhoff, Schroeder, & Thüs, 2012).

Slaninová, Kocyan, Martinovic, Drázdilová, and Snásel (2012) presented the comparison of selected methods of process mining and sequential mining to find the students' behavioral patterns performed in the e-learning system. The patterns were visualized by the methods from graph theory. Their obtained patterns and relations between them are presented using complex networks, such as visualization and pattern clusters extraction optimized by spectral graph partitioning. They have found that the sequences are order dependent and it is better to respect this fact while comparing the sequence similarity. Due to this reason, the methods for finding the longest common subsequence were used.

Hogo (2010) introduces an evaluation methodology for e-learners' behavior that can feed back to decision makers in e-learning systems. His work presented the use of different fuzzy clustering techniques as fuzzy c-means and kernelled fuzzy c-means to find the learners' categories and predict their profiles.

Rovai & Barnum (2007) analyzed nineteen on-line graduate courses in order to determine how perceived learning varies by course and its relationship to active and passive participation by students in on-line discussions. Study results provided evidence that significant differences existed by course, suggesting that quality assurance is an issue in Internet-based instruction. Moreover, female students felt that they learned more than their male counterparts. Only active interaction, operationalized by the number of messages posted by students per week, was a significant predictor of perceived learning. Passive interaction, analogous to listening to but not participating in discussions, and operationalized by the number of accesses to the discussion boards of the e-learning system each week, was found not to be significant.

Sriwardiningsi & Siswono (2014) conducted a survey on 274 e-learning students from Online Binus University and Indonesia Open University (UT). Ten hypotheses were proposed but only some hypotheses were recognized as valid. Variables such as motivation, digital literacy, and satisfaction would affect directly the outcome of understanding of student learning, while the curriculum material and interaction with the e-learning website did not affect the understanding of student learning.

Several case-studies are illustrated by Murphy, Walker, and Webb (2013) in their book about the e-learning experience. They illustrate the key concepts, giving some hints about how the educators should use technology to motivate learners and encourage productive interaction.

Although these studies focused on analyzing e-learning student's behavior or the e-learning experience and practice, none of them actually looked at their behavior in terms of Moodle usage, nor in the context of a typical programming discipline, or even tried to establish any correlation between student's actions and programming learning success. This article focuses on the impact of an e-learning environment on the success in learning programming and tries to perceive how these students explored the content that is made available to them, especially material most relevant to help them acquire object oriented programming skills.

Discipline Content and Organization

The object oriented programming (OOP) discipline being studied here aims at providing students with fundamental knowledge and practices regarding the principles, main concepts, models, and main techniques related with computer programming based on the object-oriented paradigm. Teaching the discipline syllabus uses analysis of the object-oriented programming paradigm, algorithms, and blocks of code. Different problems are analyzed and provided to be solved using an object-oriented programming approach. The students are stimulated to design and implement new tactics or improvements of existing ones. The programming language and environment adopted in this case are C++ and Eclipse IDE, respectively. The Moodle environment is used to provide material and provision for communication with peers and tutors.

The syllabus assumes a total workload of 156 hours; including 26 contact hours (this contact is not face-to-face, but instead asynchronously, preferably via forums or, in extremis, synchronous, via teleconference). The students' assessment is done through 2 digital written documents (called e-folios) during the semester and a classroom assessment (called p-folio) in the end of the semester. If the student fails to be approved in the p-folio, an extra classroom assessment (called extra p-folio) can be completed during September. The e-folios contribute 40% to the final grade, while the p-folio or extra p-folio is 60%. They can also be assessed through a unique classroom exam. If they fail, they have a last chance of being approved with an appeal exam. The e-folios within the context of this discipline are C++ projects that are implemented for a given problem scenario.

The Moodle environment provided for the discipline is composed of 7 topics, in which the students face an increasing degree of complexity and are asked to execute a learning activity (that does not compute to the final grade and is not obligatory, called AF). Each topic lasts 2 weeks (except the first one) and didactic material (with vast examples of codes and relevant links, and even videos) specially developed for the students, are made available, besides the solution of the learning activities and e-folios, on the Moodle learning environment. All the topics have a forum where support for topic content is guaranteed by the teacher asynchronously. The teacher always answers the questions within 48 hours at the weekend, or on a daily basis from Monday to Friday, besides motivating the students to participate. Table 1 shows in detail how the discipline is organized:

At the end of topics 4 and 6, e-folios A and B respectively were given out to the students. The p-folio was given out after the end of topic 7. The appeal exam took place before the beginning of the next semester (usually September, because the semester is from March to July). All the AFs and e-folios are graded by the teacher and made available to the students after the deadlines applied to each of them.

The discipline for this study had a total of 124 students subscribed and two classes, each with 62 students. It took place in the 2014 academic year.

Table 1: Discipline organization

Topic	Content	Goals	Duration
1	Introduction to object oriented programming	Familiarization with the concept of programming and object oriented software quality; installation of Eclipse IDE and configuration;	1 week
2	Programming resources not specific related to OO	Learn the features available in C ++ that are not directly related to OO programming, but inherited in large part from the C language; implement a program in C ++ with the use of functions and all other features not directly related to OOP	2 weeks
3	Definition and creation of classes and their attributes	Familiarization with the concept of class, object and its attributes; use of constructors, destructors, access controls, friends and nested classes	2 weeks
4	Overload, conversion and arrays of objects	Learn to create overload member functions and operators; conversion between objects and simple types; arrays and lists of objects	2 weeks
5	Single inheritance	Creation of classes and methods with single and simple inheritance mechanism	2 weeks
6	Multiple inheritance and polymorphism	Creation of classes with multiple inheritance mechanism; virtual classes	2 weeks
7	Library streams, templates and exception handling	Using and creating templates and exception handling; using the streams library	2 weeks

Analyzing the Data

The data was extracted directly from the Moodle platform, through its reports feature. The activity record report gives detailed information about each student's behavior during the year. It informs what, when (date and time) and from where (IP address) individuals have executed some interaction with the discipline.

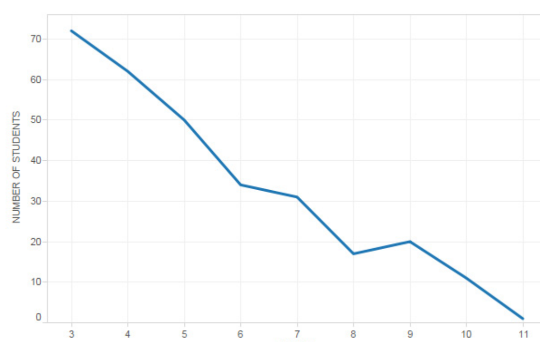

Figure 1: Total of students interacting per month

Although we had 124 students subscribed (7 female and 117 male, 9 from outside Portugal), only a small number of them actually attended (32%) and were approved in the discipline (passed) (26%). The period of time under consideration is from the end of March to November of 2014. The academic semester is divided in different periods of time: 13-14 weeks of classes, starting usually by the end of February, to the beginning of June; a period of 4 weeks of normal classroom exams, starting in June and ending at the beginning of July; finally a period of 4 weeks of extra exams, realized during September. Figure 1 shows the total number of students that interacted per month on Moodle. In March, a total of 72 students executed some action, although only about half of them actually tried to be approved and by July (end of the semester) only 32 remained active. Table 2 illustrates the scenario we had and the respective figures:

Table 2: Totals of students in the discipline along time

SCENARIO	*TOTALS*
Subscribed students	124
Interacting at least once with the discipline	115
Completed e-folio A	35
Completed e-folio B	30
Completed p-fólio	27
Completed only final exam	5
Completed appeal exam	2
Approved	31
Highest number of accesses per student	529
Average number of accesses per student	153
Minimum number of access per student	1

Actions in the Moodle VLE can take the form of any of those listed below. In the context of this discipline, it is expected that all students will have some interaction especially at those actions marked with an asterisk:

- assign submit (*)
- assign view (*)
- assign view all
- assign view submission grading table
- assign view submit assignment form
- book print
- book print chapter
- book view (*)
- book view all
- book view chapter (*)
- choice choose
- choice choose again
- choice view
- choice view all
- course view (*)
- folder view (*)
- folder view all (*)
- forum search (*)
- forum subscribe all
- forum unsubscribe all
- forum user report
- forum view forum (*)
- forum view forums
- imscp view all
- label view all
- page view all
- resource view (*)

- resource view all
- url view all
- user view
- user view all

There are four types of reports in Moodle that the teacher can easily export to other software, including the possibility of applying some filters to it:

- Logs, that are activity reports of the site or course;
- Activity reports that sum the number of views per activity and resource;
- A participation report, which allows tutors to see who has completed a certain action, like a quiz;
- Statistics allowing for tracking the number of posts and views from a certain time frame graphically.

Some reports were produced directly using a tool available in the Moodle platform and exported in .xls format and loaded into an Excel sheet. After extraction, the data was treated to find out totals, average values, and detect potential trends. Based on the numerical analysis, graphs were produced to more easily present the results that were thus being obtained.

Although all of these interactions are important to evaluate the level of interactivity between the students and the platform, before proceeding with the analysis, it is necessary to clarify the meaning of the actions with (*) in the list above and according to the discipline structure, the minimum number expected in each case:

- **Assign view/submit** –E-folios are two programming tasks (more complex than the learning activities) and they contribute to the final grade of the students. An assign submit happens each time the student uploads an e-folio, while an assign view is when he consults the grade and evaluation comment left by the teacher. The student should execute at least 2 assigns views and 2 assigns submit during the semester;
- **Book view** – The discipline is fully described (goals, methodology, evaluation, bibliography, etc.) and organized in a timetable (tasks to be executed by specific dates and weeks each month). The student should consult or download this information at the very beginning of the semester. This action should be executed at least once per student.
- **Course view** – Each time the student enters the Moodle space of the discipline, this action happens, if he is going to do any action further.
- **Folder view** – didactic material is available for self-study. This material includes tutorials specially developed for the discipline by the teacher and several code examples to test and run. The folder view action is executed each time the students view or download the material. Although it is helpful, the students may use other resources to support their studies (books, online tutorials, etc.). A minimum of 7 folders view per student is expected in order to download all the available material;
- **Forum actions** – The asynchronous conversation between students and teacher is one of the most important premises in the e-learning model in UAb. The goal is to achieve a high level of message exchanges between all the students and between the students and the teacher. The students should post their queries and cooperate with other students, exchanging points of view and deliberations. Within these messages, links to other web resources are normally made (videos, articles, etc.). There are a total of 10 forums within the discipline. Each forum may have several threads. It is expected that each student par-

ticipate at least once in each available forum. The minimum number should be 10 forum actions (this number represents a weak level of interaction);

- **Resource view** – Learning activities are proposed along the semester. These activities are programming tasks in C++ (development of a C++ project) and, although they do not contribute to the final grade, they are very relevant to the learning process and are identified as resources. A resource view occurs whenever a student executes an upload of a learning activity or consults the comment left by the teacher about solutions. Each student should at least execute 14 resources view per semester.

Even though they are the most relevant actions, we may state that their relevancy does vary in terms of the programming learning process. Table 3 shows the relevancy of each one of them, classifying it in 3 distinct levels (high, medium and low).

Table 3: Relevancy of the action within the context of programming learning

Action	*Relevancy within the context of programming learning*
Assign submission	High
Assign view	Medium
Book view	Low
Course view	Low
Folder view	Medium
Forums actions	High
Resource view	High

Based on the structure and timetable of the discipline (total number of topics, folders, learning activities, and forums), each student should perform a minimum number of actions per semester, to be able to download all the material, upload and consult resources and e-folios, consult and post at least once at each forum, and consult the discipline structure and timetable at the beginning. Table 4 summarizes the minimum number of actions each student should perform to show some evidence of participation. Minimum numbers are quite acceptable for all the actions except for the forum and course view actions.

Table 4. Minimum number of actions expected per student

Action	*Minimum expected number per student*	*Minimum per total (162)*	*Minimum per total approved(31)*
Assign submission	2	(2 x 162) = 324	(2 x 31) = 62
Assign view	2	(2 x 162) = 324	(2 x 31) = 62
Book view	1	(1 x 162) = 162	(1 x 31) = 31
Course view	(2 + 2 + 1 + 7 + 10 x 2) = 32	(32 x 162) = 5184	(32 x 31) = 992
Folder view	7	(7 x 162) = 1134	(7 x 31) = 217
Forums actions	10	(10 x 162) = 1620	(10 x 31) = 310
Resource view	(7 x 2) = 14	(14 x 162) = 2268	(14x 31) = 434

Figure 2 illustrates the totals per action. Course view (38.5%) is the most recurrent action performed by the students followed (in this order) by the book view chapter (17.5%), folder view (12.5%), resource view (10.5%), assign view (7.8%) and book view (3.4%). All the other actions are less significant and have approximately the same total values.

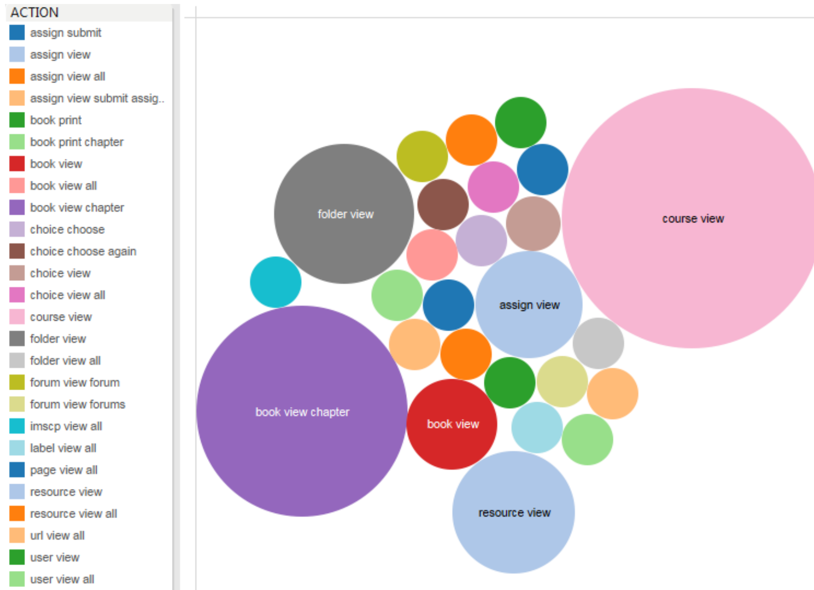

Figure 2: Totals per actions

Figure 3 shows the total number of actions only by weekdays and by weekdays per month. Most of the students in UAb are workers with average age 30-40 years. Surprisingly, the weekend is not when the highest accesses happen, but instead on Monday (24%). Topics are usually made visible to the students on Mondays and e-folios, on Fridays. As time passes we can also notice that the activity decreases significantly and, although Monday is always when more actions are registered, in April (Month 4), Tuesday has slightly more actions, while Thursday, Friday, Saturday or even Sunday, have almost the same number of actions.

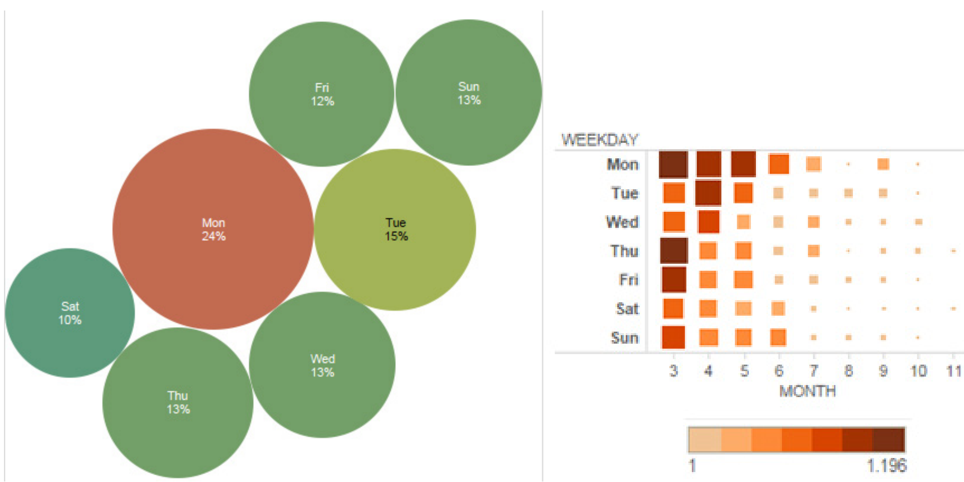

Figure 3: Totals actions per weekdays and per weekdays x months in the period

In terms of time of day, Figure 4 illustrates the total number of actions for each day in the period: first as totals and secondly as stacked totals for each weekday. The students' behavior indicates that they gradually increase their number of actions between 7 to 10 pm, decreasing their activity after that time. There is also a significant increase in lunch time or between 7-10 am, being coincidental with the general profile of our students (employed people) who are more active in less demanding working hours.

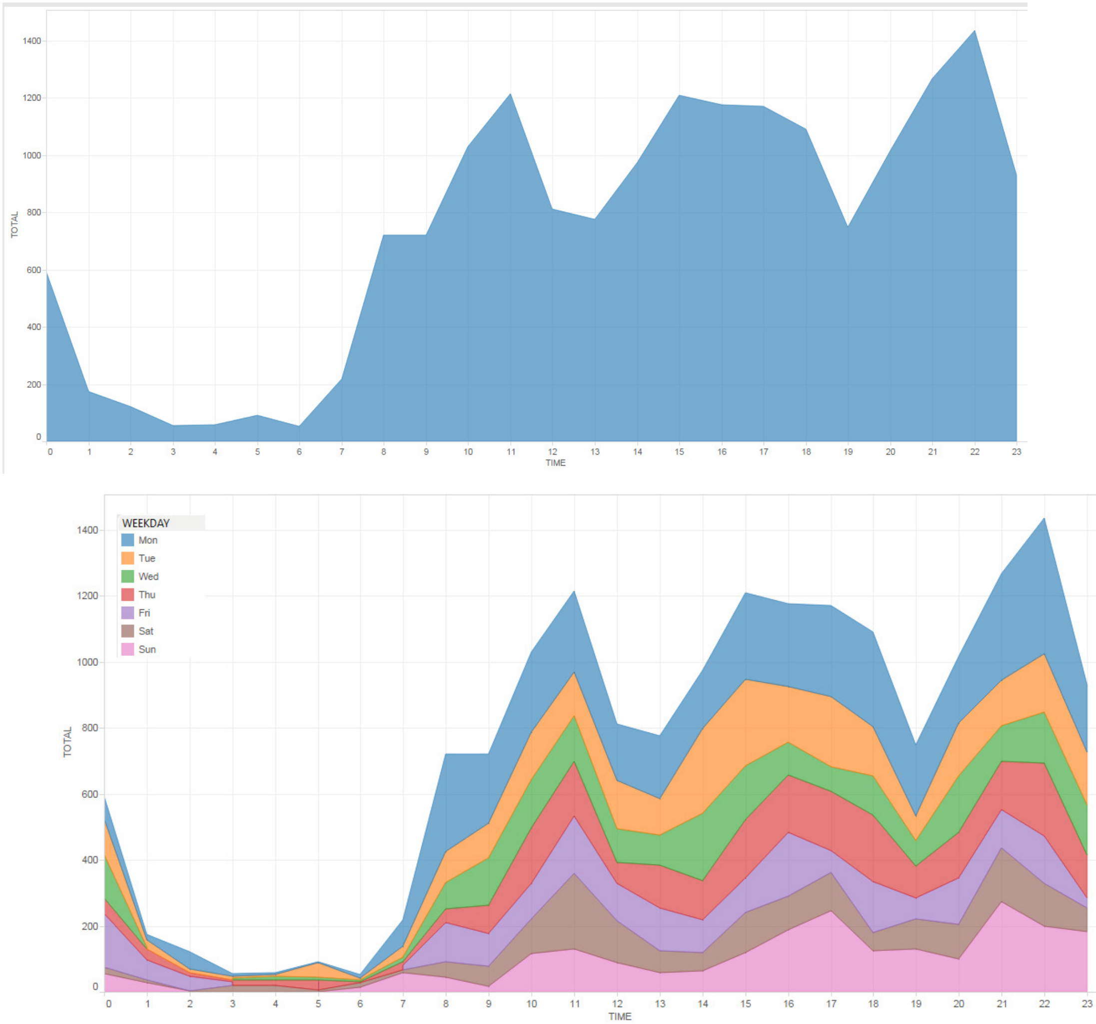

Figure 4: Totals actions per time of day in the period and per weekday

The decrease in participation, and thus interaction of the students, increased significantly with time. Although some of the graphs shown above already give a hint of this, taking a close look at the most repeated action (Course view), it is clear that there is a decrease in the rate of participation of the students. In March, 61% of the students that had accessed the discipline at least once were considered active. In July, this figure drops to only 26%. Figures 5 and 6 give a better view of this happening through highlight tables.

	WEEKDAY						
MONTH	Mon	Tue	Wed	Thu	Fri	Sat	Sun
March	486	272	239	342	329	198	254
April	346	423	302	139	201	159	173
May	317	172	93	172	175	104	161
June	243	86	75	60	53	132	145
July	129	69	107	83	83	26	37
	1.521	1.022	816	796	841	619	770

Totals
26 486

Figure 5: Course view action execution during the period

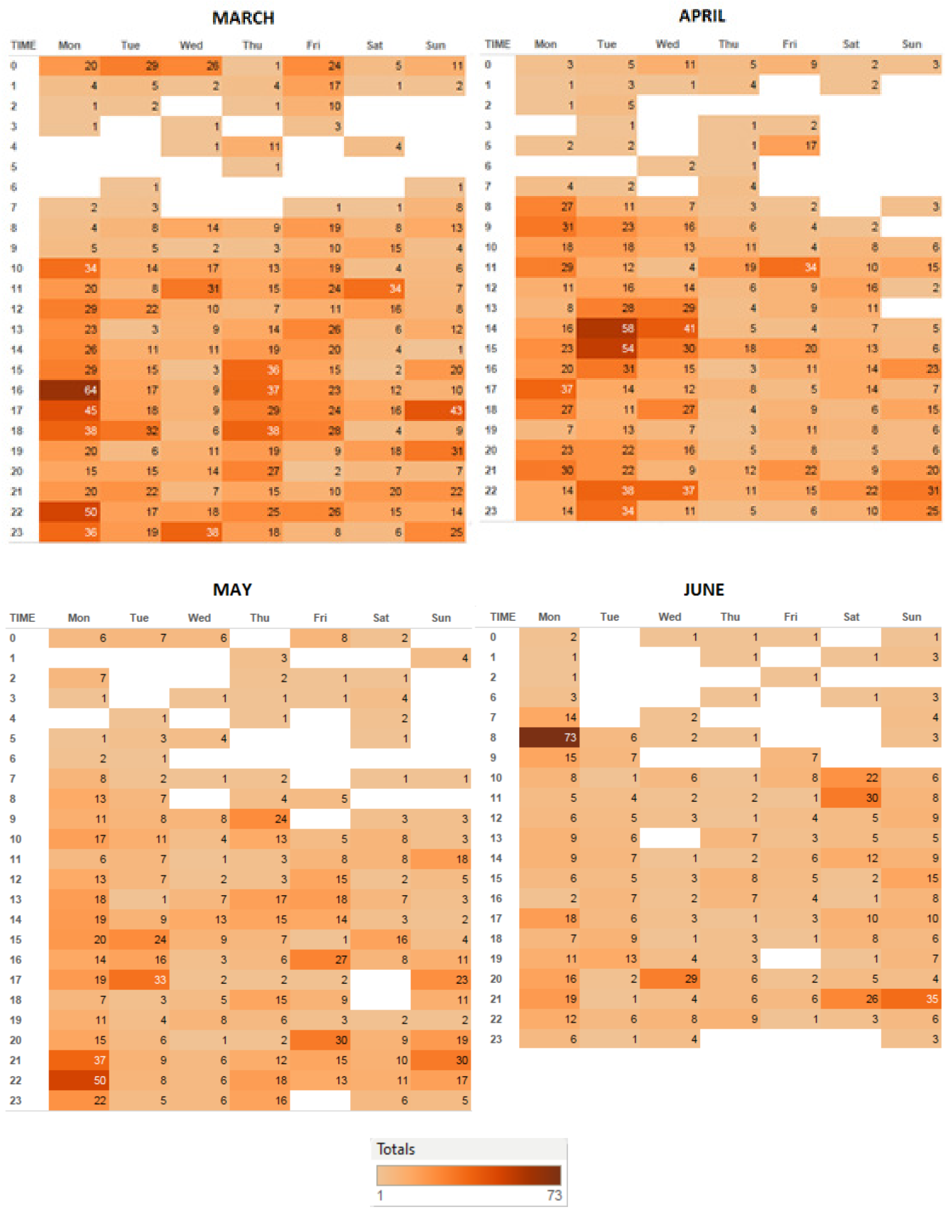

Figure 6: Course view action execution per weekday and time of day during the period

Findings

Based on the results, the drop out of students is very high, although most of them access the discipline and do some minor interaction at least once – there were students that accessed Book view and Course View only once. The quality of their interaction is very low in terms of using (posting or/and reading) the several forums available for asynchronous communication. For instance, only a set of 30 students actually accessed a forum. The highest number of times that the action forum view was executed by a single student (from this set) was 16, where 3 accesses was the average result to the set as a whole. This reveals a possible failure of the main pillar on which the e-learning model relies. In other words, in the UAb e-learning model (Pereira et al, 2007) the process of teaching-learning is continuous, taking place independently of the time and place where the students and teachers are physically. This means that both students and teachers may participate in the disciplines and learning units from where they are, at any time, and there is no requirement for being online at the same time. This is a fundamental aspect in terms of flexibility – the asynchronous communication, which is provided by the discussion forums.

Another interesting outcome is that only 38 students have accessed the discipline, at least 182 times (in different dates). If we assume that they spent 1 hour per day on the platform, this reveals that these students were more interested in navigating and participating actively than those with lower figures (the other 77). If we assume this rate of usage, this figure also indicates that these 38 students exceeded the expected 156 hour of workload only while interacting with the platform (the highest number of times was 529). In fact, most of this group of students were those that tried to be approved on this object-oriented discipline. Figure 7 illustrates the relation between final grades of the approved students and their percentage of actions with high relevancy (see Table 4) to the programming learning process. We can see a range of behavior amongst the approved students. Two of the students with the highest score had the lowest level of actions. Both of them had less than 5% of the total number of actions.

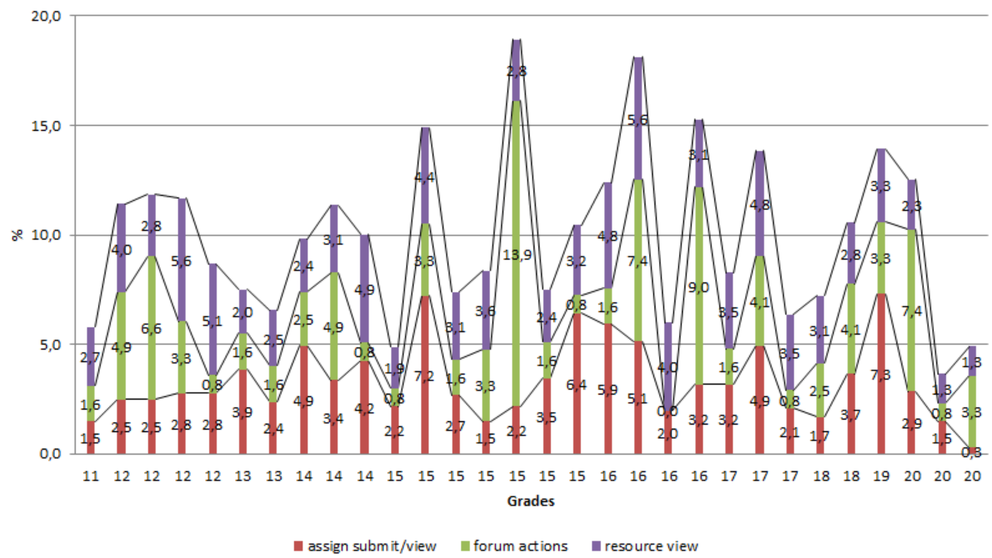

Figure 7: Percentage of the total actions per final grades of approved students

An additional significant outcome is that a divergence occurred between the grades and the number of total forum actions. The interaction through the asynchronous forums is another key premise behind the e-learning model. We can notice clearly in the chart in Figure 8 that the highest grades were achieved by students with low numbers of forum actions.

The students in this discipline presented an irregular profile of usage during the week, with Monday being the most accessed day. Most of the interactions occurred by night, around 10 p.m.

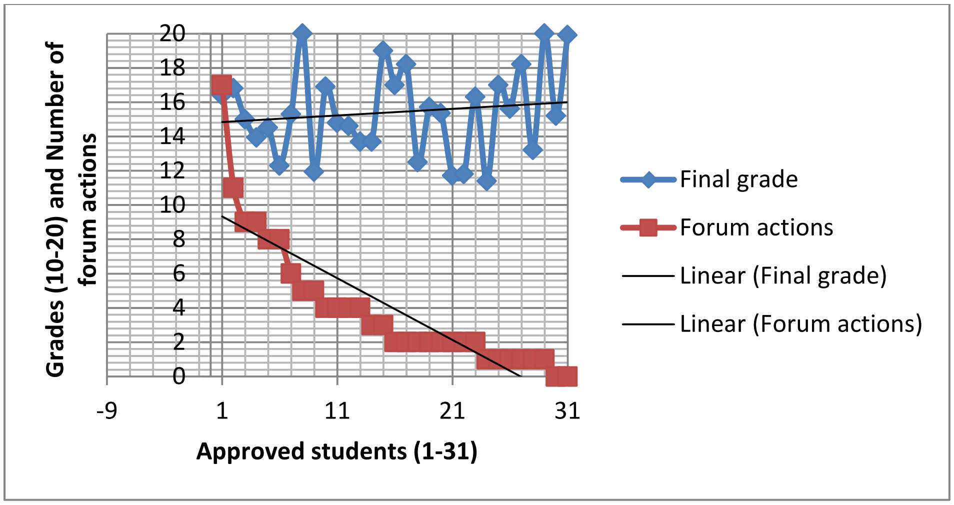

Figure 8: Final grades x total of forum actions per approved student

Conclusions and Further Work

In general, based on the results, we can say that the quality of the students' interaction is lower than would be expected to be ideal. This indicates that possibly the e-learning model is not well tailored to work with disciplines such as those where programming languages are taught, and other didactic and pedagogic strategies have to be added in these cases. Although this is important, we should also take into account that online education has raised some concerns regarding high student attrition rates in online courses and programs. In general, online courses have higher dropout rates compared to face-to-face courses (Bowers & Kumar, 2015).

One very important conclusion is the significant underuse of the forums by all of the students and the lack of evidence that their underuse leads to a failure to be approved. Some of the shortcomings may be caused by the fact that the majority of the students are mature and regular workers, thus have limited time (because of family and work responsibilities) to devote to study. Another pertinent factor is the specificity that learning programming demands. According to Nandi, Hamilton, and Harland (2012), the content for the programming course needs to be more prescriptive, algorithmic, and more narrowly focused; hence, opportunities for direct discussion and asking questions are limited. In their study, often a single solution posted by a student in answer to a problem raised by another student was sufficient, and the instructor ended the discussion at that point. The same situation is applied to assignments. Once the solution is presented to the students, there is little discussion and alternative suggestions for solutions provided. This may explain the low activity in the forums.

The high activity observed during late hours and on Monday is possibly due the mature age of the students and because Monday is always the day when a new topic is made available to the students, generating more accesses.

Taking into account only the 31 students that were approved and actions with a high level of relevancy to the programming learning process, we can identify another interesting outcome, which is that the resource view and assign submit actions had a positive correlation towards the programming learning process. In Table 5 the quality of interaction is evaluated against the minimum number of actions acceptable per student (Table 4) within this discipline and the average of those 31 approved students.

Table 5: Approved students quality of interaction

Average number of actions per approved student	*Minimum expected per student*	*Quality of interaction*	*Action*	*Relevance to the programming learning process*
4	2	Good	Assign submit	High
25	14	Very good	Resource view	High
4	10	Very weak	Forum actions	High

The introduction of regular synchronous meetings, or the development of multimedia content to teach interactively how to program, may be possible future e-learning tools to explore (e.g., using virtual and augmented reality). Another useful thing would be to run a survey to understand better what limitations and drawbacks may cause so many students to drop out or to have a low quality level of interaction in the distance learning environment in the case of OOP. Also future work suggested is to compare these results against those achieved from other programming disciplines that the Computer Science degree offers in UAb.

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Distance Learning: Effectiveness of an Interdisciplinary Course in Speech Pathology and Dentistry

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Abstract

Objective: Evaluate the effectiveness of distance learning courses for the purpose of interdisciplinary continuing education in Speech Pathology and Dentistry. Methods: The online course was made available on the Moodle platform. A total of 30 undergraduates participated in the study (15 from the Dentistry course and 15 from the Speech Pathology course). Their knowledge was evaluated before and after the course, in addition to the user satisfaction by means of specific questionnaires. The course was evaluated by 6 specialists on the following aspects: presentation and quality of the content, audio-visual quality, adequacy to the target public, and information made available. To compare the obtained results in the pre- and post-course questionnaires, the test Wilcoxon was carried out, with a 5% significance level. Results: the teaching/learning process, including the theoretical/practical application for the interdisciplinary training, proved to be effective as there was a statistically significant difference between the pre- and post- course evaluations ($p<0.001$), the users' satisfaction degree was favorable and the specialists evaluated the material as adequate regarding the target public, the audio-visual information quality and the strategies of content availability. Conclusion: The suggested distance-learning course proved to be effective for the purpose of Speech Pathology and Dentistry interdisciplinary education.

Keywords: Distance Learning, Speech, Language and Hearing Sciences, Dentistry, Interdisciplinary Research.

Introduction

Overview of Distance Learning

The global improvement of the information and communication technology is an unquestionable reality, and people have more possibilities to access online sources every day. Based on this trend, the health field has the opportunity to

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increase its benefits, mainly on continuing the education of professionals.

Distance learning allows the student to study independently, according to his/her pace and spatio-temporal planning, and face-to-face meetings may occur offering opportunities for the socialization and the collaborative learning (Aretio, 2001).

Reports on distance learning are found in literature in the medicine field (Gardella, Guarin, & Vive, 2003; Llambí et al., 2007; Pinto et al., 2008; VanLue et al., 2007) and, mainly, in the nursing field (Campbell, Gibson, Hall, Richards, & Callery, 2008; Edwards, 2005; Holtslander, Racine, Furniss, Burles, & Turner, 2012; Teles Filho & Cassiani, 2008; Xelegati & Evora, 2011). The quality of the service of tele-education and tele-assistance has been proved by different authors (Eskenazi, Martins, & Ferreira, 2013; Hersh, Junium, Mailhot, & Tidmarsh, 2001; Rafiq & Merrell, 2005; Roine, Ohinmaa, & Hailey, 2001; Shaikh, Lehmann, Kaleida, & Cohen, 2008; Vucković et al., 2003); however, the cost-effectiveness relation still deserves investigation (Soirefmann, Blom, Leopoldo, & Cestari, 2008).

In the nursing field, Teles Filho and Cassiani (2008) developed and evaluated a module on Medication Administration offered on a web-based virtual learning environment. The researchers used the Engagement Theory as a theoretical and methodological approach in the study carried out in two stages: the creation of the module and its evaluation by specialists. The instructional material had little amount of information on each screen and different font styles, sizes, and colors were used to highlight the contents. It also had images to ease the understanding and make the environment more attractive. The specialists (nurses, postgraduates, and professors) evaluated the material as to the content and informatics. They evaluated the module positively regarding the content distribution and accessibility, the use of images, and the explicitness and easiness to execute the program. So, the researchers concluded the module is appropriate to be used with students from the Nursing course.

Xelegati and Evora (2011) developed a virtual learning environment (VLE) for continuing training in order to manage and prevent adverse events in the nursing field. The authors used a three-stage model, known as Computer Assisted Instruction (CAI), to develop the VLE. This model consists of exercise and practice, tutorial and simulation, as well as problem solving. The structure used for the VLE was the non-linear “interactive book” that encompasses some resources such as interactions of hypertexts, videos, sounds, static images, or animations. The authors initially identified the target public, chose the theme, and defined the objectives to be addressed, the resources available, and the instructional design. Then, the course was offered in five modules that consisted of contents, exercises, references, and supporting texts. They concluded that the development of a virtual learning environment addressing the management of adverse events will contribute to the awareness of nurses regarding the types of events, risk factors, classification, and incidence. However, a technical and content evaluation of the VLE is necessary to enable the use of the material in the continuing education of nurses in health institutions.

Regarding the distance learning in the medical field, Hersh, Junium, Mailhot and Tidmarsh (2001) developed and evaluated a distance learning course to be used in continuing education in medical informatics. The course was offered in the Blackboard Course info software as it presents a much simpler and consistent user’s interface, which was compatible with the teaching modalities the authors planned on using. In addition to the course, the authors aimed at providing students with some parallel experiences through lectures, readings, and interaction among students and professors. The course resources consisted of online lectures that were developed by means of streaming audio plus slides in PowerPoint, discussion boards to promote the students interaction, and homework (multiple choice). A subject and different assignments were provided each week throughout the three-month course. Students were assessed by multiple-choice tests and a take-home final examination. They showed a strong satisfaction with the teaching modality, course content, and system performance. The authors observed the performance of distance learning students was superior to the performance of on-campus students and concluded that the course on medical informatics was successfully implemented by means of distance learning technologies, had a favorable satisfaction from students, and demonstrated learning.

Eskenazi, Martins, and Ferreira (2013) aimed at verifying the increase in knowledge and the counseling skills of students in the fifth year of a graduate course in medicine regarding the practice of oral health after a course of interactive tele-education. The study assessed 148 students that were divided into four groups (a control group and three others) that received progressive face to face and distance learning interventions. Only one of the groups was also in touch with specialists in oral health promotion. The knowledge increase was measured by a written test applied before and after the course. The authors observed the knowledge increase of the experimental groups was statistically superior to the control group and the performance of the group that was in touch with the specialists in oral health promotion was significantly superior to the other groups.

Based on the satisfactory results observed in the pioneering studies involving distance learning in the health field, it is relevant to consider that other areas can also benefit with this learning method. Therefore, the extension and application of distance learning courses in the other health fields will also contribute with the teaching and learning process.

Distance Learning: Dentistry and Speech Pathology

The growth of tele-dentistry has increased in the past years (Cartes-Velasquez & Bustos-Leal, 2012), and the enforcement of distance learning in Dentistry can be exemplified by MEDICOL, a website whose goal is to be an addition to learning (Broudo & Walsh, 2002), as well as by the development of an online atlas on Pediatric Dentistry with photos, illustrations, and x-rays, which has had a high level of users' approval. There is also a report on a distance learning pilot study in periodontics for graduate programs in European Countries. Such study used a virtual classroom, synchronous and asynchronous communication, in addition to the access to online libraries and multimedia material (Mattheos, Nattestad, Schittek, & Attström, 2001). Since 2009, in the University of Missouri – Kansas City School of Dentistry, a faculty member teaches a hybrid online course (synchronous and asynchronous communication) with a highly specialized content in oral embryology and histology for students in dental hygiene and dentistry (Gadbury-Amyot, Singh, & Overman, 2013). Distance learning specialization, update, and extension courses in Dentistry were found in Brazil (Masotti, Jardim, Oshima, & Pacheco, 2002; Olival, Curvino, Faria, & Groisman, 2008), as well as support material to undergraduate students (Skelton-Macedo et al., 2007).

In Speech Pathology, Smythe and Hughes (2008) studied the enrolled students' performance in an online program/course in basic human anatomy, which included online and face to face classes. The results showed the students' performances decreased whenever the themes were approached only online.

In audiology, Lieberth and Martin (2005) proved the efficiency of the use of a web-based pure-tone audiometry simulator by Speech Pathology undergraduate and graduate students. Inglês, Rojesky, and Branham (2000) developed a distance learning course for graduate students and speech pathology professionals, which approached the training of counseling skills in audiology provision services, and noticed that, despite the limitations related to the electronic instruction, the learning resembled that obtained in the conventional classroom. A study (Blasca, Maximino, Galdino, Campos, & Picolini, 2010) evaluated a model of interactive tele-education for audiology teaching, and they concluded the educational material was effective in the teaching and learning process.

Regarding the knowledge on voice, the Educational CD "The Voice: speech pathology and medicine" developed along with the Virtual Man Project of the Telemedicine Discipline, Universidade de São Paulo (USP), has information about the anatomy and physiology of voice and speech production, and it has demonstrated to be effective as an auto learning instrument to speech pathology and lyric singing students (Vieira, Berretin-Felix, & Brasolotto, 2009).

By means of a literature review on tele-health in speech pathology, a study (Spinardi, Blasca, Wen, & Maximino, 2009) noted the scarcity of publications aimed at distance learning as well as the centralization in the audiology field, showing the need to develop other projects, seeking the improvement of the services offered and the easiness to access them, generating a more effective impact on prevention, diagnosis and intervention of communication disorders.

There are no reports in literature about distance courses involving the interdisciplinary training or relation among health professionals.

Significance of the Study and Purpose

Among the different speech pathology specialties, there is the Orofacial Motricity, which approaches the disorders related to the stomatognathic system (Conselho Federal de Fonoaudiologia, 2006). Such alterations can be evidenced in dental cases, considering that functional abnormalities such as oral breathing, swallowing with tongue interposition, unilateral chewing, and orofacial muscle abnormal posture can be related to malocclusion (Yamaguchi & Sueishi, 2003).

Since 2002, authors Jorge, Duque, Berretin-Félix, Costa, and Gomide have already suggested the importance of the performance of an interdisciplinary team, being constituted specially by pediatric dentists and speech audiologists, in the treatment of some deleterious oral habits in children as such habits may influence the development of the stomatognathic system.

Accordingly, these authors aimed to sensitize dentists and speech pathologists to the importance of the early intervention and the referrals that might be necessary in order to reestablish the orofacial functions and the muscle balance that might be altered due to deleterious oral habits.

Nobre, Gushiken, Periotto, and Araújo (2004) also referred to the importance of conducting longitudinal interdisciplinary studies, mainly in the performance between phonoaudiology and dentistry. The relation between form and function of the stomatognathic system was established as the authors frequently observed oral myofunctional disorders in mouth breathers with Angle Class II malocclusion.

The study carried out by Amaral, Bacha, Ghersel, and Rodrigues (2006) investigated the opinion of dental surgeons that are specialists in Orthodontics/Dentofacial Orthopedics and Pediatric Dentistry in addition to speech pathologists specialized in Orofacial Motricity. Unanimously, the researchers agreed on the need of interaction between the areas in order to avoid cases of orthodontic recurrences. The stomatognathic system is the common area for the performance of these professionals.

Other studies in literature have also confirmed the importance of the interdisciplinary performance between these two fields to favor a differential diagnosis and a better design of intervention in children (Verrastro et al., 2009) and even in the elderly (Dias & Cardoso, 2009).

A more recent study (Silva & Canto, 2014) reinforces the importance of the interdisciplinary work in all health fields, besides the focus on the association between dentistry and speech pathology. The interdisciplinary performance between speech pathologists, dentists, doctors, psychologists, physiotherapists, among others, promotes the improvement of therapies and treatments, a humanized and integrated care, which result in patients' satisfaction and health. The study also reinforces that such team work skills must be taught and learned since the academic life.

Given that the collaborative performance among health professionals has promoted quite favorable practical results (Benkert, 1997) and that experiences of computerized environments to support interdisciplinary teaching and clinical practice in Speech Pathology and Dentistry haven't been described, this study aims to evaluate the effectiveness of distance learning courses for a continuing interdisciplinary training in Speech Pathology and Dentistry, aiming not only at the best training for the professionals of the field, but also at bringing benefits to the patients from a better training for the professional that will serve them.

Material and Methods

Ethical Aspects

The Ethics Committee on Human Research of the Faculty of Dentistry of Bauru, Universidade de São Paulo (FOB / USP) approved the project, under the process N.101/2011. All participants were clearly informed about the study objectives and procedures, all of them read and signed the Consent Form.

Study Participants

Thirty students took the course and participated in the evaluation of this study teaching/learning process; they were 15 from the Dentistry course and 15 from the Speech Pathology course, officially enrolled in the eight term. They all had a six-month period to complete the course. Besides that, six specialists (three speech therapists and three dentists), with lato or stricto sensu post-graduation courses related to the interdisciplinary performance in Speech Pathology and Dentistry, were invited to carry out the technical and scientific evaluation of the course.

Distance Course / Educational method

The theoretical content was presented by means of an online course, approaching the following contents, which were developed in the Project "Distance Learning Proposal in the Speech Pathology and Dentistry Interdisciplinary Practice".

1 - Stomatognathic system anatomy

2 - Embryology, craniofacial growth and development

3 - Oral physiology and stomatognathic functions development

4 - Stomatognathic system evaluation;

5 - Orofacial myofunctional disorders: etiology, manifestations and treatment

6 - Interdisciplinary performance – clinical cases

Such contents were updated according to the literature review and submitted to an analysis by teachers and students related to the departments of Biological Science and Orthodontics, in addition to the Speech Pathology Department of the Bauru School of Dentistry – Universidade de São Paulo (FOB/USP).

Besides the theoretical content, a selection and update of illustrative images were performed in order to provide a more dynamic and attractive virtual environment, thus helping in the teaching/learning process.

The material was shown in six modules, by means of Power Point, audio, text, image, and video classes. Evaluation instruments were also introduced to direct the students' progress in the teaching/learning process. It was standardized, adapting the design of the slides and texts according to the virtual environment template and made available on the Moodle (modular object-oriented dynamic learning environment) platform.

Moodle is a free software that supports learning, executed on a virtual environment. It is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalized learning environments. It is an evolving and active project based on the constructivist philosophy. Moodle has been designed to be fast and accessible, its interface is easy to navigate in desktops and mobile devices and it also has the possibility of customizing the site design and layout. It presents a personalized panel that allows the user to organize the exhibition of courses as desired and visualize current tasks and messages instantly. Moodle presents tools and collaborative activities such as forums, wikis, glossaries, database activities, assignments, calendar, chats and surveys. It has tools to handle files and a simple and intuitive text editor. It also permits doing and visualizing notifications, the progress of students, individually or as a group, as well as making detailed reports on students' activities and participation in the course and assessing through a questionnaire that can be edited as multiple choice, true or false, brief answer, etc. The questionnaire setting involves the definition of the period it will be available, an automatic feedback, varied assessment systems and the possibility of many attempts.

In this study, we chose to make available the contents of each module for 24 hours a day for a period of one month, so this was the time that the students had to accomplish each module. Thus they could take the course on time, in the place and hour of the day that they judge most appropriate. The course contained six modules and the students have six months to complete it. The course also used the "chat" tool in which students could communicate in real time with fellow students or administrators. They also had the option to leave messages with questions, which would later be answered if there were no online managers at the time of the question. This tool was used in order to ensure greater interactivity of the students.

The integration of audio features, videos, images, texts, and Power Points archives were also used in this course in order to provide a more attractive virtual environment, to be interesting, dynamic and pleasurable, to facilitate understanding of the content, and to complement the teaching-learning process.

Evaluation of the Program's Effectiveness

Assessment of students' knowledge

Students underwent cognitive skills evaluation, before and after taking the online course, by means of specific questionnaires. Both questionnaires (before and after the course) involved the evaluation of the same type of knowledge by presenting the questions in a different way or order from the way it was initially presented. Each questionnaire consisted of 13 multiple choice questions about aspects related to embryonic processes, development of stomatognathic structures since birth, identification of structures in oral and/or oronasal cavities, concepts of cephalometry, concepts related to the function during occlusal movements, definition of some terms, clinical case related to the performance between dentistry and speech pathology, malocclusion installation causes, deleterious oral habits, speech, swallowing and chewing problems, questions involving the relation between the swallowing function with changes and the mouth breathing, Class II malocclusion, inadequate head posture, changes in orofacial sensitivity, tonus or mobility, functional and structural aspects of the stomatognathic system, and process of a speech pathology diagnosis.

As a criterion aimed at evaluating the effectiveness of the program in relation to the cognitive skills, a comparison was carried out between the numbers of correct answers regarding the questions that were relevant to the theoretical contents presented in the online course, looking for statistically significant differences between both analyzed periods.

Evaluation of students' perception

Each module was individually evaluated by a poll made of 7 questions (Appendix) to be answered by each student at the end of the activity. Such questionnaires addressed the following aspects: contribution to the training; quality of the contents presented; quality of the illustrations presented, amount of contents presented; complexity level of the dentistry content presented; complexity level of the speech pathology content presented; access to navigation on the virtual learning environment. In addition to that, at the end of the poll, the students had the opportunity to criticize, suggest, or comment on the module being analyzed.

Evaluation of specialists' perception

In a period of 30 days, the specialists were asked to access and analyze the course, as well as to fill in the evaluation protocol suggested by Spinardi (2009), which evaluates the presentation and quality of the content, audiovisual quality, adequacy to target public, and information available.

Statistical Methods

The comparison between the results obtained in the pre- and post-course questionnaires was carried out with the administration of the Wilcoxon test, considering the significance level of 5% ($p<0.05$). The comparison between the modules regarding the user's satisfaction was carried with the administration of the Kruskal-Wallis test, considering the significance level of 5% ($p<0.05$).

Results

The results will be described in two steps: the course development process and the course effectiveness evaluation.

Development Process of the Interdisciplinary Course in Speech Pathology and Dentistry

According to the obtained results, we can see (Table 1) that the only content which did not need modification was the anatomy content. However, the other modules needed an update in the complementary texts, files, and images. Such contents were made available on the Moodle platform, presented in six modules, in classes with PowerPoint, audio, pdf texts, and videos.

Table 1 – List of updated materials and the type of file provided module by module.

MODULE	Type of file provided	Updates/Modifications
1 Stomatognathic system anatomy	PowerPoints, audios and texts.	No modification required
2 Embryology, Craniofacial growth and development	PowerPoint, texts and images	Update the text and images
3 Oral Physiology and Stomatognathic functions development	Text with images	Update the text and inserting images
4 Stomatognathic System Evaluation	PowerPoints and texts with images.	Update the text, images and the PowerPoint file.
5 Orofacial myofunctional disorders: etiology, manifestations and treatment	Texts with images	Update the text and images
6 Interdisciplinary Performance – Clinical Cases	Texts, images and videos	Update the text

Effectiveness Evaluation of the Speech Pathology and Dentistry Interdisciplinary Course

Cognitive Skills

The evaluation of the student's performance, which reflects the effectiveness of the course in relation to the teaching/learning process, was carried out by means of the administration of the Wilcoxon test to compare the number of correct answers obtained in the pre- and post-course evaluation questionnaire (Table 2).

Table 2 - Presentation of the number of correct answers obtained in the evaluation questionnaire administered before and after the completion of the Speech Pathology and Dentistry interdisciplinary course.

	Correct answers before course	Correct answers after course	p-value
Minimum	3.0	5.0	
Maximum	10.0	13.0	
Median	7.000	8.000	<0.001
Average	7.0	8.4	
Standard Deviation	±1.7	±2.5	

The results showed there is difference, statistically significant, between the pre- and post-course evaluations (p<0,001), pointing out that the material promoted the students' effective learning.

Users perception / satisfaction degree

The poll has shown the students' satisfaction degree in different aspects module by module. Generally, it was observed that the different modules were well evaluated. It was possible to notice that regarding the contribution for training, the illustration quality, and the presented contents, as well as the access and navigation on the virtual learning environment, for most students, the evaluation varied between excellent, very good, and good.

Similarly, the satisfaction degree of users who considered the complexity level of the dentistry and speech pathology content adequate varied from 89 to 96% (dentistry content) and 91 to 96% (speech pathology content).

Analyzing the open question, we can see that the modules obtained higher amounts of positive comments than negative comments, as illustrated in Figure 1.

	Positive comments	% and N of comments	Negative comments	Nº of comments
1st Module	The module was interesting and it served as a review of anatomy mainly.	19,23% (n=25)	This module was a bit lengthy, demanding too much time for reading texts.	25,49% (n=13)
2nd Module	This module content was presented in an objective and straightforward manner, it contained the necessary information.	15,38% (n=20)	Could have more illustrations to exemplify.	11,76% (n=6)
3rd Module	Excellent material for study and review.	13,85% (n=18)	This module showed an extensive content but very relevant.	11,76% (n=6)
4th Module	I like a lot these speech therapy issues related to orthodontics. I think it is a very important integration!	16,15% (n=21)	This module was the most tiring so far. Presents many lessons.	21,57% (n=11)
5 Module	Module was very interesting and related the areas of dentistry and speech therapy.	18,46% (n=24)	The texts are still extensive.	11,76% (n=6)
6 Module	The module is presented in an interesting and interactive way due to the presentation of clinical cases.	16,92% (n=22)	Could there be a greater number of clinical cases to illustrate the multidisciplinary treatment.	17,65% (n=9)
Total of comments	-	100% (n=130)	-	100% (n=51)

Figure 1 – Main positive, negative and number of comments (nº of comments) reported by the students in each module.

In Tables 3 to 5, it is possible to note, with more details, the students' opinions when evaluating, in each module, the aforementioned aspects. The highlighted cells represent the concept that showed more answers.

Table 3 – The users' satisfaction degree as to the contribution for the training; quality of the content presented; quality of the illustrations presented, and access and navigation on virtual learning environment.

Module		Satisfaction Degree								
		Excellent	Very Good	Good	Fair	Poor	Median	First Quartile	Third Quartile	p value
Contribution for the training	1	36% (n=20)	32% (n=18)	30% (n=17)	2% (n=1)	0% (n=0)	4.000	3.000	5.000	
	2	36% (n=20)	32% (n=18)	30% (n=17)	2% (n=1)	0% (n=0)	4.000	3.000	5.000	
	3	37% (n=21)	28% (n=16)	33% (n=19)	2% (n=1)	0% (n=0)	4.000	3.000	5.000	
	4	32% (n=17)	34% (n=18)	34% (n=18)	0% (n=0)	0% (n=0)	4.000	3.000	5.000	
	5	35% (n=18)	29% (n=15)	37% (n=19)	0% (n=0)	0% (n=0)	4.000	3.000	5.000	
	6	38% (n=20)	28% (n=14)	30% (n=16)	4% (n=2)	2% (n=1)	4.000	3.000	5.000	
										0,999
Quality of the content presented	1	38% (n=21)	34% (n=19)	29% (n=16)	0% (n=0)	0% (n=0)	4.000	3.000	5.000	
	2	38% (n=21)	34% (n=19)	29% (n=16)	0% (n=0)	0% (n=0)	4.000	3.000	5.000	
	3	30% (n=17)	35% (n=20)	33% (n=19)	2% (n=1)	0% (n=0)	4.000	3.000	5.000	
	4	34% (n=18)	30% (n=16)	32% (n=17)	4% (n=2)	0% (n=0)	4.000	3.000	5.000	
	5	31% (n=16)	35% (n=18)	35% (n=18)	0% (n=0)	0% (n=0)	4.000	3.000	5.000	
	6	34% (n=18)	26% (n=14)	34% (n=18)	4% (n=2)	2% (n=1)	4.000	3.000	5.000	
										0,803
Quality of the illustrations presented	1	25% (n=14)	45% (n=25)	27% (n=15)	4% (n=2)	0% (n=0)	4.000	3.000	4.750	
	2	25% (n=14)	45% (n=25)	27% (n=15)	4% (n=2)	0% (n=0)	4.000	3.000	4.750	
	3	32% (n=18)	23% (n=13)	40% (n=23)	5% (n=3)	0% (n=0)	4.000	3.000	5.000	
	4	28% (n=15)	28% (n=15)	30% (n=19)	4% (n=2)	4% (n=2)	4.000	3.000	5.000	
	5	27% (n=14)	31% (n=16)	37% (n=19)	4% (n=2)	2% (n=1)	4.000	3.000	5.000	
	6	38% (n=20)	19% (n=10)	43% (n=23)	0% (n=0)	0% (n=0)	4.000	3.000	5.000	
										0,895
Access and navigation	1	32% (n=18)	36% (n=20)	29% (n=16)	4% (n=2)	0% (n=0)	4.000	3.000	5.000	
	2	32% (n=18)	36% (n=20)	39% (n=16)	4% (n=2)	0% (n=0)	4.000	3.000	5.000	
	3	33% (n=19)	32% (n=18)	32% (n=18)	4% (n=2)	0% (n=0)	4.000	3.000	5.000	
	4	25% (n=13)	34% (n=18)	40% (n=21)	2% (n=1)	0% (n=0)	4.000	3.000	4.500	
	5	27% (n=14)	31% (n=16)	38% (n=20)	4% (n=2)	0% (n=0)	4.000	3.000	5.000	
	6	28% (n=15)	40% (n=21)	30% (n=16)	2% (n=1)	0% (n=0)	4.000	3.000	5.000	
										0,809

Table 4 – Users' satisfaction degree as the amount of content presented

	Module	Sufficient	Insufficient	Excessive	Median	First Quartile	Third Quartile	p value
Amount of content presented	1	96% (n=54)	0% (n=0)	4% (n=2)	3.000	3.000	3.000	
	2	96% (n=54)	0% (n=0)	4% (n=2)	3.000	3.000	3.000	
	3	88% (n=50)	5% (n=3)	7% (n=4)	3.000	3.000	3.000	
	4	83% (n=44)	2% (n=1)	15% (n=8)	3.000	3.000	3.000	
	5	88% (n=46)	0% (n=0)	12% (n=6)	3.000	3.000	3.000	
	6	89% (n=47)	7% (n=4)	4% (n=2)	3.000	3.000	3.000	
								1,000

Table 5 – Users' satisfaction degree as to the level of complexity of the dentistry and speech pathology contents.

	Module	Adequate	Little complex	Very Complex	Median	First Quartile	Third Quartile	p value
Dentistry content	1	89% (n=50)	7% (n=4)	4% (n=2)	3.000	3.000	3.000	
	2	89% (n=50)	7% (n=4)	4% (n=2)	3.000	3.000	3.000	
	3	93% (n=53)	2% (n=1)	5% (n=3)	3.000	3.000	3.000	
	4	89% (n=46)	2% (n=1)	9% (n=5)	3.000	3.000	3.000	
	5	96% (n=50)	2% (n=1)	2% (n=1)	3.000	3.000	3.000	
	6	94% (n=50)	4% (n=2)	2% (n=1)	3.000	3.000	3.000	
								0,614
Speech pathology content	1	96% (n=54)	2% (n=1)	2% (n=1)	3.000	3.000	3.000	
	2	96% (n=54)	2% (n=1)	2% (n=1)	3.000	3.000	3.000	
	3	91% (n=52)	0% (n=0)	9% (n=5)	3.000	3.000	3.000	
	4	94% (n=50)	0% (n=0)	6% (n=3)	3.000	3.000	3.000	
	5	94% (n=49)	0% (n=0)	6% (n=3)	3.000	3.000	3.000	
	6	94% (n=50)	2% (n=1)	4% (n=2)	3.000	3.000	3.000	
								0,836

Technical and scientific quality

We will show below the results obtained through the evaluation of specialists for the following aspects according to the questions of the evaluation protocol: presentation and quality of the content, audiovisual quality, adequacy to target public, and information available.

The first question evaluated the aspects related to the content presentation and quality through the following items: scope, vocabulary, instructional sequence of topics, and way of presenting the concept. The values attributed by the specialists are in Table 6.

Table 6 – Specialists' satisfaction degree related to the content presentation and quality.

	Scope		Vocabulary		Instructional sequence of topics		Way of concept presentation	
	N	%	N	%	N	%	n	%
Excellent	5	83.33	5	83.33	5	83.33	4	66.67
Satisfactory	1	16.67	1	16.67	1	16.67	1	16.67
Reasonable	-	-	-	-	-	-	1	16.67
Unsatisfactory	-	-	-	-	-	-	-	-

Additionally, the main criticism made (cited by two specialists) through the open question, when evaluating the content presentation and quality, was related to the absence of commands to forward, rewind, or skip classes, which hinders the progress of the class. Two experts also suggested the standardization of the content presentation of the modules.

The second question assessed the aspects related to the audiovisual quality through the items: quality of the pictures, quality of the videos, and quality of the animations. The evaluation results can be observed in Table 7.

Table 7 – Specialists' satisfaction degree related to the audiovisual quality.

	Quality of the pictures		Quality of the videos		Quality of the animations	
	N	%	n	%	n	%
Excellent	1	16.67	2	33.33	2	33.33
Satisfactory	4	66.67	2	33.33	3	50
Reasonable	1	16.67	-	-	-	-
Unsatisfactory	-	-	2	33.33	1	16.67

Three of the specialists reported that some classes were too long or had too much written content (one cited the PDF files part of module 1) and suggested that a greater amount of illustrative figures and dynamic images should be inserted in these classes.

Three specialists reported it was not possible to access some videos that were available in the course, hampering the evaluation process. Given that such criticism was not mentioned by the other three evaluators or by the students, it is possible that it was probably a problem regarding the personal software of each evaluator.

Question three evaluated the adequacy of the content to the target public and obtained 100% positive responses (adequate). Therefore, all specialists considered the material appropriate to the target public.

Finally, the fourth question assessed aspects related to the information available, regarding reliability, update, research sources, and spelling and grammar. The values attributed by the experts are in Table 8.

Table 8 – Specialists' satisfaction degree related to the information available.

	Regarding reliability		Update		Research sources		Spelling and gramar	
	N	%	n	%	N	%	N	%
Excellent	6	100	4	66.67	3	50	4	66.67
Satisfactory	-	-	2	33.33	1	16.67	2	33.33
Reasonable	-	-	-	-	2	33.33	-	-
Unsatisfactory	-	-	-	-	-	-	-	-

Therefore, according to the specialists, the course can be considered from excellent to satisfactory, and regarding the criticism and suggestions exemplified above, we observed a higher number of positive (23) than negative (13) comments.

Discussion

Distance learning aims, not only to reduce physical and temporal distance, but also to increase the appreciation of "learning to learn", enabling the students to acquire knowledge while respecting their own rhythm of study, their time, and their personal characteristics (Spinardi, 2009).

Actions directed to this training modality are found in some areas of health, especially in nursing (Campbell et al., 2008; Edwards, 2005; Holtslander et al., 2012; Teles Filho & Cassiani, 2008; Xelegati & Evora, 2011), and in some specialties of medicine (Gardella et al., 2003; Llambí et al., 2007; Pinto et al., 2008; VanLue et al., 2007).

However, there are studies in literature that describe learning tools similar to the ones proposed in this study that involve the interdisciplinary training in speech pathology and dentistry practice, favoring the performance in a collaborative manner among health professionals, enabling the achievement of quite favorable practical results (Benkert, 1997).

The tool used for the development of the distance learning course was the Moodle platform. The Moodle environment was chosen because it presents the main features of a virtual learning environment (VLE), that is, tools that allow doing assessments, opinion polls, questionnaires, and chat rooms, thereby ensuring interactivity, integration of resources, learning services, and communication (Bollela, Grec, & Matias, 2009; Martins & Campestrini, 2004). Literature shows the importance of virtual environments providing the learning, creation, development, and management of Web courses (Ribeiro & Lopes, 2006; Telles Filho & Cassiani, 2008).

The resources provided by Moodle reached the needs requested and, although some specialists found some difficulty to access the videos, in the open question the students did not criticize the working of the virtual environment. Moreover, the users' satisfaction degree as to the access and navigation in the virtual learning environment varied between the concepts excellent, very good, and good, proving it to be also an appropriate instrument for students.

In the present study, it was possible to find a statistically significant difference between the pre- and post-course evaluations performed by the students, demonstrating the effectiveness of this material as an educational tool. We can compare these results to studies (Blasca & Bevilacqua, 2003; Ribeiro & Lopes, 2006) that also verified an improvement in the students' accomplishment by the application of pre- and post-test questionnaires, with favorable results as to the students learning.

The students who participated in this research expressed satisfaction about the general quality of the course, as well as about the use of distance learning. According to Kemczinski, Bringhenti, Castro, and Heinneck (2000), to evaluate the students' satisfaction (target public of the study) it is essential to verify their level of satisfaction in relation to aspects of classroom environment organization, didactic aspects, self-assessment, the performance of those organizing and monitoring the course, as well as the technical staff.

Most comments were positive. For example, Module 1 was considered interesting and served as a review for the anatomy content. Module 2 was praised for presenting the content in a simple and objective way with the necessary information. Module 3 was described as having an excellent content to review and study. In Modules 4 and 5, the interdisciplinary aspect was praised and the content was found to be interesting. Finally, the format of Module 6, which was of an “interactive book” to present clinical cases, was considered adequate.

Regarding the negative comments, most of the opinions were basically related to the excess of content in Module 1, lack of figures in Module 2, and extensive, but relevant, content in Module 3. Module 4 was described as being more tiring and Module 5 as having an excessive amount of texts. However, participants suggested Module 6 should have a greater number of clinical cases to illustrate the multidisciplinary treatment.

Despite the large number of positive aspects in the open questions, it is important to emphasize that the criticisms and suggestions revealed the peculiarities and needs of each module, important information that will serve to guide the improvement of the course content for future applications since the highest percentage of criticisms was in relation to the excessive amount of content in some modules and very large texts, which was detrimental to the learning process. According to Zen-Mascarenhas and Cassiani (2001), the evaluation of the educational virtual environment is very important as it aims to ensure that the proposed objectives and goals could be achieved and that the material reached its purpose.

Additionally, there were no statistically significant differences between the modules with respect to contribution for the training, quality of the content presented, quality of the illustrations presented and access and navigation (Table 3). Furthermore, no differences were found between the modules in relation to the amount of available content and as to the level of complexity of the displayed contents about dentistry and speech pathology (Table 4 and 5).

With the evaluation of the course content by specialists, it was possible to verify that this material is appropriate to the target public; it discusses the content, considering the different learning strategies, possibilities and intelligence; it has simple, clear and objective language, without errors and according to the current grammatical rules; and it also respects the hierarchy for learning based on integrated knowledge and respecting stages. All these main concepts cited by the evaluators are corroborated by Aretio (1999), according to whom, in the distance learning course, the didactic material plays an important role, assuming the function of informing, motivating, and controlling. It should be able to fill the course objectives, have clear and well defined content, have a modular structure to facilitate the understanding of the theme, have vocabulary according to the level of the target public, and use audio resources, videos, and/or images whenever possible. Thus, the "Interdisciplinary Course in Speech Pathology and Dentistry” can be considered appropriate for distance learning programs or as a complementary material in formal education programs.

Conclusion

The present study evaluated the effectiveness of a distance course for the purpose of interdisciplinary continuing education in speech pathology and dentistry, finding that, based on the results, the distance course was effective for interdisciplinary training in both undergraduate courses.

The resources provided by the platform chosen to be used in this study (Moodle) fulfilled the needs required. Although some specialists found some difficulties in accessing some videos, the students did not report any criticism regarding the virtual environment. In addition, the users’ satisfaction degree as to the access and navigation on the virtual learning environment varied between excellent, very good, and good, proving it to be an adequate tool for students.

In this study, it was possible to find a statistically significant difference between the evaluations applied to the students before and after the course, demonstrating this material's effectiveness as a training tool. Students who participated in this study showed satisfaction regarding the quality of the course in general, as well as the use of distance learning.

Despite the high number of positive aspects observed in the open questions, the criticisms and suggestions were much valued as they reveal each module particularities and needs, important information that will serve to guide the improvement of the course content for future applications. Most criticisms were about the excessive quantity, which hinders the learning process.

The content evaluation carried out by the specialists enabled us to verify that this material is adequate to the target public; it approaches the content, taking into account different strategies, possibilities and learning intelligences; it has simple, objective and clear language; it has no errors, follows the current grammar rules and respects the hierarchy for learning based on the integrated knowledge and its respective stages.

The results showed the course needs to be improved, but it was considered adequate to the use in programs of Distance Learning or as a complementary material in formal learning programs. The information obtained also contributed to the development of strategies and methodology of interdisciplinary teaching in fields that are complimentary in the speech pathology and/or dentistry training. Thus, the distance learning course was effective for the purposes of Speech Pathology and Dentistry interdisciplinary training.

It is worth considering that the study had limitations. The small sample size allowed us to conclude that the results we found are true for the population in question only. Another important limitation was the lack of similar studies that could guide the methodology to be applied in a better way.

From the evaluation process carried out in this research, it will be possible to improve the interdisciplinary course, enabling its application/offering to the target public, besides contributing with the methodological design of future researches that will study the programs and the application of distance learning courses.

At the same time, the study also shows the importance of the interdisciplinary, or even transdisciplinary, perspective to be worked with Distance Learning, that is, the participation of many other professionals (health field, information and technology, pedagogues, designers) interacting and working in a team will provide a greater quality didactic material, a complete virtual environment and the development of a humanized professional.

Conflict of interest

The authors declare there is no conflict of interest.

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Appendix
Questionnaire of Evaluation of the Scientific Content

1- Regarding the contribution to your training, the module can be considered:
( ) Excellent
( ) Very good
( ) Good
( ) Regular
( ) Bad

2- The quality of the contents presented in the module can be considered:
( ) Excellent
( ) Very good
( ) Good
( ) Regular
( ) Bad

3- The quality of the illustrations presented in the module can be considered:
( ) Excellent
( ) Very good
( ) Good
( ) Regular
( ) Bad

4- The quantity of contents presented in the module can be considered:
() Insufficient
() Sufficient
() Excessive

5- The level of complexity of the dentistry content presented can be considered:
( ) Little complex
( ) Adequate
( ) Very complex

6- The level of complexity of the speech pathology content presented can be considered:
( ) Little complex
( ) Adequate
( ) Very complex

7- As to the access and navigation in the virtual learning environment, it can be considered:
( ) Excellent
( ) Very good
( ) Good
( ) Regular
( ) Bad

8- Make criticisms, suggestions and / or comments about the module you just took.

Biographies

Janine Santos Ramos graduated in Speech Pathology from the University of São Paulo (2012), specialization in Voice by Voice Studies Center (2015) and Master of Science degree, concentration area: Processes and Communication Disorders, Bauru School of Dentistry – University of São Paulo (2015). She developed research on orofacial myology and telehealth during graduation. Currently, she is an audiology substitute professor in the graduate course of Speech Therapy of the Federal University of Santa Catarina (UFSC).

Leticia Korb da Silva graduated in Speech Pathology from the Itajaí Valley University (2010), upgrading in orofacial myology by CEFAC (2010) and Master of Science degree from Bauru School of Dentistry, University of São Paulo-USP (2013). Currently, she is a PhD student at Bauru School of Dentistry, USP. She developed research regarding orofacial myology during graduation and post-graduation. Her main activity is in dental cases, which involve orthodontic treatment, orthognathic surgery, temporomandibular disorders and oral rehabilitation. Recently (2014), she concluded an update in Occlusion, TMD and Orofacial Pain by the Institute of Dental Education of Bauru (IEO-Bauru).

Arnaldo Pinzan graduated in Dentistry from the University of São Paulo (1974), Master's degree in Dentistry (Orthodontics) from the University of São Paulo (1978) and a PhD degree in Dentistry (Prosthodontics), University of São Paulo (1982). He is currently an Associate Professor level III of the University of São Paulo. He is a reviewer of the Journal of Post-Graduation of FOUSP, a reviewer of the Brazilian Oral Research Journal and the Virtual Magazine of Brazilian Academy of Dentistry. He is also a member of the editorial board of the Orto Science.

Antonio de Castro Rodrigues graduated in Biology from the Universidade do Sagrado Coração (1981- Bauru), Master (1987) and PhD (1992) degree in Anatomy, Universidade Estadual Paulista Julio de Mesquita Filho of Botucatu-São Paulo. Postdoctoral degree from the University of Copenhgen / Denmark (1995) and Full Professor at Universidade Estadual Paulista Julio de Mesquita Filho (Unesp / Botucatu) since 1998. He is currently an Associate Professor at Bauru School of dentistry- University of São Paulo–USP, advisor of the graduation program in Oral Biology at FOB / USP (2014), and regional Delegate of the BSA (Brazilian Society of Anatomy) of the Southeast of Brazil.

Giédre Berretin-Felix graduated in Speech Pathology, Bauru School of Dentistry (1996), master's degree in dentistry from the University of Campinas (1999), PhD in Pathophysiology in Clinical Medicine from the Universidade Estadual Paulista Julio de Mesquita Filho (2005) and postdoctoral degree in swallowing disorders from the University of Florida (2010). She is currently an Associate Professor of the Department of Speech Pathology, Bauru School of Dentistry, University of São Paulo. She is a tutor from Tutorial Education Program in Speech, and an advisor of the Graduation Program in Speech, FOB / USP. She is the coordinator of the Department of Orofacial Myology of the Brazilian Society of Speech.

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Software Quality and Security in Teachers' and Students' Codes When Learning a New Programming Language

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[NOTE: A short version of this paper, highlighting the main results, was presented at the 7th International Conference on Educational Data Mining (EDM 2014).]

Abstract

In recent years, schools (as well as universities) have added cyber security to their computer science curricula. This topic is still new for most of the current teachers, who would normally have a standard computer science background. Therefore the teachers are trained and then teaching their students what they have just learned. In order to explore differences in both populations' learning, we compared measures of software quality and security between high-school teachers and students. We collected 109 source files, written in Python by 18 teachers and 31 students, and engineered 32 features, based on common standards for software quality (PEP 8) and security (derived from CERT Secure Coding Standards). We use a multi-view, data-driven approach, by (a) using hierarchical clustering to bottom-up partition the population into groups based on their code-related features and (b) building a decision tree model that predicts whether a student or a teacher wrote a given code (resulting with a LOOCV kappa of 0.751). Overall, our findings suggest that the teachers' codes have a better quality than the students' – with a sub-group of the teachers, mostly males, demonstrate better coding than their peers and the students – and that the students' codes are slightly better secured than the teachers' codes (although both populations show very low security levels). The findings imply that teachers might benefit from their prior knowledge and experience, but also emphasize the lack of continuous involvement of some of the teachers with code-writing. Therefore, findings shed light on computer science teachers as lifelong learners. Findings also highlight the difference between quality and security in today's programming paradigms. Implications for these findings are discussed.

Keywords: cyber security, code metrics, software quality, software security, teachers' learning, data mining

Introduction

In its very essence, the (cognitive) constructivist theory argues that knowledge and meaning are generated from interactions between people's experiences and ideas, that is, people construct their own understanding of the world (also, of themselves) through experiencing things and reflecting upon these experiences

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(cf. Perkins, 1999; Phillips, 1995; Piaget, 2013). The constructivist theory has drawn huge attention in the educational theory and practice, and many pedagogical terms still in use today have been developed based on its philosophical roots, e.g., problem-based learning, situated learning, teacher as a coacher, learner-centred education (cf. Duffy & Cunningham, 1996; Richardson, 2003). Of a special interest to the current work is the development of many educational programming languages as part of the constructivism-as-pedagogy wave; the use of computer-based learning to complement Piaget's constructivism is mostly attributed to Seymour Papert (1980). Since then, "learning to program" has become by many a synonym to "learning" per se (cf. Mayer, Dyck, & Vilberg, 1986; Soloway, 1986) and "computational thinking" is often considered as key to learning (Barr & Stephenson, 2011; Gazdial, 2008; Wing, 2006). Still today, many believe that learning to code should be an integral part of any school curriculum[1]; additionally, lifelong computer training programs often include—along with more traditional modules that teach how to work with popular software (like Microsoft Word or a Web browser)—modules that teach how to code (e.g., Seals, Clanton, Agarwal, Doswell, & Thomas, 2008).

However, learning to program might be perceived as a Sisyphean task, as new programming languages are often being introduced and adopted by different communities. In other words, in practice, learning to program should not be considered as a one-time experience, but rather anyone involved with programming must be a true lifelong learner. Indeed, in recent years attention has been given to the preparation of computer science students as lifelong learners, with the presentation of various teaching methods—like problem-based learning, intentional learning environment, and collaborative learning—aimed on developing their capacity for self-direction and metacognitive awareness (Cheong, 2013; Dunlap & Grabinger, 2003). One prominent group of such lifelong programming learners are computer science teachers who often need to adapt their curriculum based on the changing popularity of programming languages. In many cases, teachers from within the system are quickly trained to be acquainted with the new curriculum. This scenario might lead to teachers teach material with which they are not fully familiar and in which they are not fully confident (Lapidot, 2004; Thompson, Bell, Andreae, & Robins, 2013).

Another concern in such cases, taking into consideration that today's young generation has easy access to vast amounts of information, is that students will progress with the new material faster than their recently-trained teachers can catch-up. This is often a result of teachers' lack of knowledge of current trends in the field and of the state-of-the-art technology, or of their difficulty to quickly adapt new technologies while their students already master them (Kordaki, 2013; Prensky, 2007).

A striking example encompassing these two issues is the adaption into schools' and universities' curricula of cyber security (also known as computer security or IT security), that is, the practice of protecting computer systems from unauthorized access, change, or destruction. This step might seem only natural, as cyber security has caught much attention of governments and industries (cf., Andrijcic & Horowitz, 2006; Cavelty, 2008; Rowe & Gallaher, 2006; Stolfo et al., 2008). Furthermore, cybersecurity may be seen as a bridge between the two classic domains of CS (software and hardware), hence requiring a new point of view on the practice of programming (Lukowiak, Radziszowski, Vallino, & Wood, 2014). In Israel, where the reported study was taken, a cyber security program has been offered in a few high-schools as part of their computer science programs. In these schools, existing computer science teachers are asked to teach the new domain which is also new to them; they are being trained in a special course that is given during after-school hours and start to teach cyber security the following school year.

[1] See, for example, the activity of the non-profit organization, Code.org, supported, among many others, by the high-tech industry giants, like Apple, Microsoft, Google, and Amazon.

The current study aims on understanding how teachers and students learn the new material from an empirical, data-driven, multi-view approach, in order to explore the differences between teachers' and students' learning. This is done by automatically extracting measures of quality and security from students' and teachers' codes (submitted during their learning) and applying data mining techniques to find patterns in them. This understanding might contribute to the pedagogy of teaching new materials, as well as to teacher development. In general, it highlights the advantages of a solid background in computer science for supporting lifelong programming learners.

Related Work

In this section we will review related work from two lines of research that are most relevant to the current study: differences between novices' and experts' programming, and code analysis (quality and security).

Novices' and Experts' Programming

Although the teachers participating in this study have not been trained before in either cyber security or in Python (one of the most popular programming language for cyber security), they may be considered as experts in the field of computer science (as well as in teaching it). The students, on the other hand, are novices in programming. Research on novices' and experts' programming knowledge had been flourished in the 1980s, with explicit comparison between these two populations and some interesting implications on teaching and learning this domain. Comparing accuracy and reaction time in solving simple text-book style programming tasks, Wiedenbeck (1985) had found that experts were significantly faster and more accurate than novices (undergraduate and graduate students) even in rather easy syntactic decisions; this finding is surprising, as the task involved consisted of merely "reading" simple code, hence supporting Wiedenbeck's automation hypothesis, according to which experts automate some simple subcomponents of the programming task. But more than automation, it was also found that experts and novices might represent differently problems they tackle; while novices begin problem representation with the problem literal features, experts first abstract an algorithm to solve it (Weiser & Shertz, 1983). This finding was later supported by Adelson (1984) and Pennington (1987), who found that experts' mental representation of programs tend to be based on procedural/abstract rather than functional/concrete units. Later, these findings were replicated by Bateson, Alexander, and Martin (1987), who found that experts did better than novices in syntactic memory (related to Wiedenbeck's automation hypothesis), strategic skills and problem solving (related to Weiser and Shertz's high-level problem representation approach).

However, as Soloway and Ehrlich (1984) found, experts' and novices' performance can be essentially the same when the program structures involved do not conform to the experts' knowledge about programming rules. Furthermore, as Adelson (1984) demonstrated, novices can perform better than experts on abstract problems once they are aided in forming an abstract representation. Without support, novices' level of abstractness of mental representation of computer programs might be poorly developed (Fix, Wiedenbeck, & Scholtz, 1993). Hence, the importance of supporting each learner with the mental model best fit to them.

The studies mentioned above used various measures to assess experts' and novices' programming skills and knowledge; these measures were mostly based on qualitative data collection (mainly programming-related tasks and interviews), rather than on assessment of the programs written by the novices/experts. Our approach is to compare between novices and experts, using automatically extracted software quality and security features. Similar approaches have been used recently for studying programming learning, mostly with a limited number of metrics, usually a-priori chosen to be mostly relevant to a given target variable (e.g., Jbara & Feitelson, 2014; Kasto &

Whalley, 2013; Piech, Sahami, Koller, Cooper, & Blikstein, 2012; Whalley & Kasto, 2014). Continuing this line of research, we take a bottom-up, rather explorative approach, relying on a comprehensive set of metrics, and assuming no relationships to any target variable.

Software Metrics

The need in defining and quantifying software quality emerged shortly after the development of the new domain of software engineering, in the late 1960s. The seminal works in this field not only defined theoretical frameworks of code quality, but also suggested explicit metrics for measuring different dimensions of it (Boehm, Brown, & Lipow, 1976; McCall, Richards, & Walters, 1976). These two frameworks share a few dimensions (e.g., correctness, reliability, and reusability), but each holds a few unique features (e.g., testability in McCall et al., 1976, and understandability in Boehm et al., 1976). In both cases, each dimension was described and detailed by means of specific metrics to be measured. Furthermore, metrics were defined with their automation in mind; as setting a numerical value for metrics might be time-consuming, subjective, and expensive, "one would prefer for large programs an automated algorithm which examine the program and produces a metric value" (Bohem et al., 1, p. 596).

Automatic evaluation of software metrics has been used in a wide variety of studies, including in the educational context. One of the most striking examples of using automated scores of code quality was suggested by Truong, Roe, and Bancroft (2005); based on automatic analysis of their programs, students were provided with immediate help, which identified correctness and logic errors and assisted them to fix these errors. Similar approaches were used to better support students' programming in real-time (e.g., Ala-Mutka, Uimonen, & Jarvinen, 2004; Vujošević-Janičić, Nikolić, Tošić, & Kuncak, 2013), as well as to auto-grade and find cheating in student assignments (e.g., Leach, 1995; Tryer, 2001; Wang, Su, Ma, Wang, & Wang, 2011). In recent years, educational data mining (EDM) and learning analytics (LA) have emerged as promising methodologies for educational research. EDM and LA are inter-disciplinary approaches to analysing data sets originated in educational contexts, using various methods and tools (cf. Siemens & Baker, 2015). These methods were incorporated into the line of research discussed here, and using these techniques, some new and exciting metrics have been added to code-analyzing, including more complex structure-based features, as well as variables measuring student-computer interaction (e.g., Berland, Martin, Benton, Smith, & Davis, 2013; Blikstein, 2011; Taherkhani & Malmi, 2013; Vihavainen, Luukkainen, & Kurhila, 2013). In this paper, we take an EDM approach, in particular applying clustering analysis and building a prediction model, based on a comprehensive set of software metrics for both quality and security.

Quality metrics

There has been a lot of research in recent years about software metrics, however with no aggregated knowledge about which metrics are more suitable to be used with which research question (cf. Kitchenham, 2010). As the main purpose of the current study was to explore the way novice students and experienced teachers learn a new topic (cyber security) – which also involves learning a new programming language (Python) – we chose to focus on software metrics derived from the standards of that language. Applying their acquired programming skills later in their working life will require current-students following some kind of style guides (for example, the ones adopted by the organization they would work for), hence the importance of this kind of measure. Therefore, sticking to coding standards/conventions of a given language is an important step within that language learning process (Pádua, 2010); this is most relevant with the modern programming languages, e.g., Java, which are more trusting and that rely on the programmer to bullet-proof her or his own code (Zaidman, 2004).

Considering the above, the Style Guide for Python Code (PEP 8) was used as the basis to the metrics involved in the current study. It is important to emphasize that keeping in mind coding style was not a goal of the courses which the participant teachers/students took, nor was it learned during these courses.

Security metrics

As mentioned earlier, the context of the current study is teachers and students who learn cyber security. Hence, it is not sufficient to consider only program quality, as security measures are mostly relevant as well. Obviously, unlike quality metrics – which have been extensively discussed for almost half a century – security metrics have been given attention only lately. But like quality metrics, there is a wide range of interpretations and meanings for the term "security metrics" (Jansen, 2010; Savola, 2009).

Consistent with the approach based on which quality metrics were chosen for this study, security measures too are based on standards of a specific programming language. However, as there are yet no such standards for Python, we referred to the commonly used *C++ Secure Coding Standard*, by Carnegie Mellon University's CERT (*SEI CERT C++ Coding Standard,* 2015). C++ seems to be a good choice, as both languages are multi-paradigm (object oriented and procedural). Furthermore, Python "is a mixture of the class mechanisms found in C++ and Modula-3" (*The Python Guide*, n.d.). Full details on both quality and security specific metrics are discussed in the following section, under Feature Engineering.

Methodology

Participants and Data

Participants in this study were 11th- and 12th-grade students (N=31) from two Israeli high-schools (one is located in a town in the outskirts of Central Israel, the other is located in the southern part of the country), 17-18 years old; and high-school computer science teachers (N=18) from different parts of Israel, 31-53 years old. The participating students were taught by two of the participating teachers.

Participant teachers attended one of two dedicated programs in cyber security, sponsored by the Israeli Ministry of Education, held between June 2012 - March 2013 and September 2013 - January 2014 (each teacher attended only one of these programs); this was done as part of their training to teach the topic the following year. The participant students took a curriculum-based cyber security program, as part of their computer science studies, during 2012/3 school year. Both of the programs had taught programming in Python. Designed in 1990, Python is an open-source, interactive, high-level programming language that supports multiple programming paradigms and offers high-level data structures (Sanner, 1999). It is free to use (even for commercial purposes) and runs across multiple platforms (including Windows, Linux, Unix, and Mac OS X). Due to its extreme power and suitability to large-scale projects, it has become the default language for Web security applications. In addition, as it is easy to learn and easy to use, Python has become one of the most popular introductory teaching languages (cf. Guo, 2014).

During these programs, the teachers and the students were assigned with programming tasks. In both cases, they started working on the tasks during class and continued it at home. All assignments had due dates. The solutions to these tasks were collected and analyzed. Overall, 109 source files were collected (68 were written by the teachers, 41 by the students), including a total of 6246 code lines. The teachers were assigned four different exercises; each focused on a different aspect of network programming using client-server architecture:

1. UDP echo server – UDP (User Datagram Protocol) is a connectionless protocol located on the "Transport Layer" of the OSI (Open Systems Interconnection) model. An echo server receives a string from a client and sends that string back to the client. In this exercise, the teachers were asked to develop an echo server using the UDP protocol.
2. Basic TCP command server – TCP (Transmission Control Protocol) is a connection-oriented protocol located on the "Transport Layer" of the OSI model. In this exercise, the teachers were asked to build a server that received TCP messages, using an application protocol that they design, and performed specific commands like sending the name of the server, sending a static number, and more.
3. Advanced TCP command server – This exercise is an enhancement of the previous one, the teachers were asked to add support for additional commands (also included the expansion of the application protocol) to the server such as retrieving date and time from the server, performing calculations on given numbers, and more.
4. Web server – A web server is a TCP based application, which accepts HTTP (Hyper Text Transfer Protocol) requests and returns relevant HTTP responses. The HTTP responses can include different content types such as HTML, pictures, video content or error messages. In the exercise, the teachers were asked to build a program and parse HTTP request. In case of a valid file request the web server sent the content of the file encapsulated in a HTTP message with valid headers.

The students were assigned three different tasks; each focused on a different aspect of network programming using client-server architecture:

1. UDP echo server – An echo server receives a string from a client and sends that string back to the client. In this exercise, the students were asked to develop an echo server using the UDP protocol.
2. Advanced TCP command server – In this exercise, the students were asked to build a server that received TCP messages, using an application protocol that they designed, and performed basic commands like sending the name of the server, sending a static number and advanced commands such as retrieving date and time from the server or performing calculations on given numbers. This exercise was a combination of both the second and the third exercises done by the teachers.
3. TCP-based Chat – A chat is a way of transferring messages between Internet users in a real-time manner. In the exercise, the students needed to design and implement a TCP based chat protocol that supported sending messages to a specific user or group and managing chat rooms.

Data is summarized in Table 1. Difference in assignments is due to the nature of the programs: While the teachers—as learners—participated in a full, planned-ahead training, the students had studied the subject as part of their regular school duties; therefore, the teachers—as instructors—were acting under the school schedule limitations, hence had time for only three tasks for their students to take.

During the pre-processing stage, we encountered tasks that were submitted by pairs or triples. In cases in which the same pair/triple had submitted all of the exercises during the program – we assigned this group's submissions to one of the group members, arbitrarily, omitting the other group members from the analysis. In cases in which pairs/triples had changed over the course of the program, we arbitrarily chose one representative for each submission and assigned this submission to her or him solely. Therefore, number of represented participants in the analysis was decreased to 17 teachers and 15 students, as shown in Table 1.

Table 1: Dataset description

Group	N	Unique exercises	Source files	Code lines
Full population				
Teachers	18 (9 males, 9 females)	4	68	3032
Students	31 (29 males, 2 females)	3	41	3214
Total	49	5	109	6246
After pairs/triples reduction				
Teachers	17 (9 males, 8 females)	4	60	2831
Students	15 (14 males, 1 female)	3	27	1878
Total	32	5	87	4709

Feature Engineering

Overall, we have engineered 32 features of three categories (details about the features are following):

- General features. A few general features were calculated for each source file, measuring, among other metrics, volume and documentation.
- Quality features. These features measure the code quality, based on the Style Guide for Python Code (PEP 8).
- Security features. In cyber security, vulnerability is a weakness that allows an attacker to perform actions not intended by the creator/owner of the application/system. As mentioned above, security-related topics were derived from CERT C++ Secure Coding Standard (which describes code-based vulnerabilities in C++). Topics related to the preprocessor were filtered out from the security standard, as Python does not have a preprocessor. Also, topics that were relevant to specific C/C++ functions not used in Python were filtered out.

Both PEP 8 and CERT's standards are widely used in code evaluation. While the programming features were automatically extracted using a standard code analysis tool, as described below (see Quality Features), the security features were extracted using scripts written by the research team. All the features are measured using a static analysis, i.e., the code is analyzed without actually executing the programs.

General features (6 Features)

For each source file, the general features are the following:

- Number of Statements, measuring the code volume;
- Number of Comment Lines;
- Documentation Rate, computed as the ratio of Number of Comment Lines to the Number of Statements;
- Number of Lines (including statements, comments and empty lines);
- File Name Length (number of characters; excluding the extension.py);
- File Name Meaningfulness –represents whether the file name hints on what the code is implementing. The values are: 1 – file name is not meaningful at all (e.g., 1.py, from which one cannot tell anything about the program implemented in this file); 2 – partly meaningful (e.g., Client.py, which does not explain to which application/protocol this

code is a client); 3 – very meaningful (e.g., ChatClientTCP.py, which means that the program implemented is a client of a chat program and that the chat protocol uses TCP as its transfer protocol). The values were given jointly by the two authors upon agreement.

Quality features (20 features)

These features were automatically extracted by running Pylint (http://pylint.org), a common source code bug and quality checker for Python which follows PEP 8 style guide. Pylint defines five categories of standard violations/errors, each of which consists of a few measures:

(1) Convention (C; 18 measures). Conventions are a set of guidelines that recommend programming style, practices, and methods for each aspect of a program. These guidelines are mainly focused on software structural quality. Convention measures indicate a standard violation, for example, when the name of an attribute/class/function/variable does not match a regular expression defined in the standard;
(2) Warning (W; 61 measures). This type refers to Python-specific problems, that is, not matching Python's best practices. Such problems may cause bugs in run time. For example, the existence of unused import from wildcard import;
(3) Error (E; 32 measures). This indicates probable bugs in the code that relate to general programming concepts. For example, the use of a local variable before its assignment;
(4) Refactor (R; 15 measures). This means a "bad smell" code. Code refactoring (also known as decomposition) is the process of restructuring existing computer code without changing its external behaviour, mainly for reducing its complexity, easing its readability, and improving its maintainability. An example to this violation might be a function or a method which takes too many variables as input;
(5) Fatal. This is triggered if an error occurred which prevented Pylint from processing the code. Since fatal messages represent errors in Pylint processing and not in the source file itself, we excluded them from this study.

Pylint scans the code and returns a list of measures for which violations/errors were found, along with their count (a 0-value was considered for non-triggered measures). Based on Pylint output, the following features were computed under each category:

- Mean Count (C/W/E/R) – for each category, count of violations/errors was averaged across all this category's measures.
- Normalized Mean Count (C/W/E/R) – for each category, Mean Count divided by the code size (Number of Statements);
- Rate of Triggered Measures (C/W/E/R) – for each category, number of triggered measures divided by total number of measures in this category;
- Triggered Category (C/W/E/R) – for each category, this feature indicates whether at least one measure of it was triggered.
- Normalized Triggered Category (C/W/E/R) – Triggered Category, normalized by the code size (Number of Statements).

Security features (6 features)

As mentioned above, security features are derived from CERT C++ Secure Coding Standard. The following are the features extracted, all are binary, indicating whether the relevant mechanism was implemented (1) or not (0). An implemented mechanism (i.e., a 1-value) is an indication of the programmer's attempt to protect the code from potential security vulnerabilities; pay attention that the last feature, Client-Side-Only Security, refers to a bad practice (security check should always be done at least on the server-side), hence its meaning is reversed and for it a 1-value denotes a possible security vulnerability.

- Input Validation (the process of ensuring that a program operates on clean, correct and expected input);
- Anti-Spoofing Mechanism (spoofing attack is a situation in which an attacker masquerades as another entity by sending specially crafted data that seems as it was send from the legitimate source);
- Bound Checking (any method of detecting whether a variable is within some range before it is used. It is usually used to ensure that a number fits into a given data-type, or that an array index is within the bounds of a given array);
- Checking for Errors (not checking return codes for errors can cause logical security bugs/crashing of the program that can cause Denial of Service attacks).
- Sensitive Data Encryption;
- Client-Side-Only Security (a scenario in which the server relies on protection mechanisms placed on the client side only. In such cases, an attacker can modify the client-side behavior to bypass the security mechanisms, which can lead to unauthorized, not intended interactions between the client and the server).

For the participant-level analysis (descriptive statistics, hierarchical tree), each feature was averaged across each participant's source files.

Results

We first present descriptive statistics of the software metrics (general, quality, and security). Then, we present the results of the hierarchical clustering that was run on the full, combined population, in order to examine a data-driven partition of it based on the metrics. Finally, we build a prediction model at the code-level, for examining whether the software metrics can differentiate between teachers' and students' codes.

Descriptive Statistics

As described above, 60 source files of 17 teachers and 27 source files of 15 students (after reducing due to submissions in pairs/triples) were analyzed, and 32 software metrics were computed for each source file. Then, values of the different metrics were averaged for each participant across all of her or his source files (analysis at the code-level will be presented in Teacher/Student Classification). We will now present a comparison between students' and teachers' feature values.

General features

Means (and standard deviations) of the general features for teachers and students are summarized in Table 2, along with two-tailed t-test results of comparing between the two groups. Differences in means of four (out of six) general metrics are significant: Number of Statements ($p<0.05$), Number of Lines ($p<0.05$), File Name Length ($p<0.01$), and File Name Meaningfulness ($p<0.01$); on average, students' programs were longer than the teachers', and teachers' file names were longer and more meaningful than the students'. The difference regarding code size (Number of Statements and Number of Lines) might indicate the teachers have a better grasp of the concept of programming with Pyhton, as "Python is a very expressive language, which means that we can usually write far fewer lines of Python code than would be required for an equivalent application written in, say, C++ or Java" (Summerfield, 2010, p. 1).

Regarding file names' length and meaningfulness – teachers demonstrate a better practice of file naming, which might be a result of their experience in programming and/or teaching computer science classes. No significant differences were found between the means of the two documentation-related features. Average Documentation Rate was 0.1, a reasonable documenting practice in Python.

Table 2: Descriptive statistics, two-tailed t-test results for general features (one decimal place representation unless mean<0.1); grey-shaded rows have significant difference

Variable	Mean (SD) N=32	Mean (SD), Teachers, N=17	Mean (SD), Students, N=15	$t(30)^a$
Number of Statements	51 (28.3)	40.5 (19.7)	62.9 (32.3)	2.3^*, $df=22.6^b$
Number of Comments	6.1 (7.4)	5.5 (7.8)	6.8 (7.0)	0.5
Documentation Rate	0.1 (0.1)	0.1 (0.2)	0.1 (0.1)	-0.4
Number of Lines	56.9 (29.6)	45.4 (23.8)	69.7 (30.9)	2.5^*
Name Length	10.8 (5.1)	12.9 (4.0)	8.4 (5.2)	-2.8^{**}
Name Meaning	1.3 (0.5)	1.6 (0.4)	0.9 (0.5)	-4.3^{**}

* $p<0.05$, ** $p<0.01$. ^{a} Unless otherwise stated, df=30.

^{b} Levene's test for equality of variance was significant, hence equal variances not assumed.

Quality features

Means (and standard deviations) of the software quality features for teachers and students are summarized in Table 3, along with two-tailed t-test results of comparing between the two groups.

Means of eight (out of twenty) quality metrics are significantly different between groups, all are of the convention and warning categories: Mean Count C, Mean Count W, Normalized Mean Count C, Normalized Mean Count W, Rate of Triggered Measures C, Rate of Triggered Measures W, Trigged Category W, and Normalized Triggered Category C (all at p<0.01, except Triggered Category W, at p<0.05). On average, the students had more convention- and warning-type violations than the teachers (with only one exception, Normalized Triggered Category, which will be addressed immediately). As convention guidelines help improve code readability and make software maintenance easier, these differences might indicate that the teachers, based on their experience, migrate rather smoothly to programming in a new language.

Pay attention to the opposite direction difference between students and teachers in Normalized Triggered Category C. This is a direct result of Triggered Category C getting a value of 1 for both students and teachers and of Number of Statements being larger for students that it is for teachers (as presented in General Features); the variable Normalized Triggered Category C is a ratio of these two variables.

Table 3: Descriptive statistics, two-tailed t-test results for quality features (one decimal place representation unless mean<0.1 or difference needs to be shown); grey-shaded rows have significant difference

Variable	Mean (SD) N=32	Mean (SD), Teachers N=17	Mean (SD), Students N=15	t(30)[a]
Mean Count C	72.3 (56.7)	40.8 (28.8)	108.0 (60.0)	4.0^{**}, df=19.6[b]
Mean Count W	56.9 (70.9)	20.7 (37.6)	97.8 (78.4)	3.5^{**}, df=19.5[b]
Mean Count E	1.4 (1.5)	1.3 (1.0)	1.5 (2.0)	0.5, df=19.5[b]
Mean Count R	0.2 (0.3)	0.1 (0.4)	0.2 (0.3)	0.6
Normalized Mean Count C	0.11 (0.04)	0.09 (0.04)	0.13 (0.03)	3.6^{**}, df=26.7[b]
Normalized Mean Count W	0.02 (0.03)	0.01 (0.02)	0.04 (0.03)	2.9^{**}, df=21.6[b]
Normalized Mean Count E	– [c]	– [c]	– [c]	0.05
Normalized Mean Count R	– [c]	– [c]	– [c]	1.1
Rate of Triggered Measures C	0.4 (0.1)	0.3 (0.1)	0.4 (0.1)	4.5^{**}
Rate of Triggered Measures W	0.05 (0.04)	0.03 (0.03)	0.07 (0.04)	3.5^{**}
Rate of Triggered Measures E	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	-0.1, df=21.6[b]
Rate of Triggered Measures R	0.01 (0.02)	0.01 (0.02)	0.01 (0.01)	0.7
Triggered Category C	1 (0)	1 (0)	1 (0)	N/A
Triggered Category W	0.7 (0.4)	0.6 (0.4)	0.9 (0.3)	2.7^{*}, df=28.1[b]
Triggered Category E	0.4 (0.3)	0.4 (0.3)	0.4 (0.4)	-0.6, df=23.8[b]
Triggered Category R	0.2 (0.3)	0.1 (0.3)	0.2 (0.3)	1.2
Normalized Triggered Category C	0.03 (0.02)	0.04 (0.02)	0.02 (0.01)	-3.1^{**}
Normalized Triggered Category W	0.02 (0.01)	0.02 (0.02)	0.02 (0.01)	0.6
Normalized Triggered Category E	0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	-1.1
Normalized Triggered Category R	– [c]	– [c]	– [c]	0.2

* $p<0.05$, ** $p<0.01$. [a] Unless otherwise stated, df=30.

[b] Levene's test for equality of variance was significant, hence equal variances not assumed.

[c] Mean value was smaller than 0.01.

Security features

Overall, both teachers and students showed low levels of implementing security mechanisms. Results are summarized in Table 4. Both teachers and students implemented none of Anti-Spoofing Mechanisms and Sensitive Data Encryption. As for Input Validation and Checking for Errors – on average, students implemented more mechanisms than teachers regarding these features ($p<0.05$). This might be a result of the teachers, learning from their own fresh experience, emphasizing these subjects to their students.

As for Client-Side-Only Security, recall that a 0-value for this feature denotes a proper security implementation. As seen from Table 2, mean value for this feature was 0 for the teachers; however, as the teachers had barely implemented any security mechanism, this value cannot be interpreted as a good security practice. The students, with relatively a high mean value of Client-Side-Only Security (0.5, significantly different from the teachers' mean, at $p<0.01$), demonstrate poor security design that is focused mostly at the client-side.

Table 4: Descriptive statistics, two-tailed t-test results for security features (one decimal place representation unless mean<0.1); grey-shaded rows have significant difference

Variable	Mean (SD) N=32	Mean (SD), Teach. N=17	Mean (SD), Stud. N=15	t[a]
Input Validation	0.06 (0.17)	0 (0)	0.13 (0.23)	2.3*, df=14.0
Anti-Spoofing Mechanism[b]	0 (0)	0 (0)	0 (0)	N/A
Bound Checking	0.10 (0.20)	0.04 (0.12)	0.17 (0.25)	1.9, df=20.1
Checking for Errors	0.18 (0.35)	0.04 (0.12)	0.33 (0.45)	2.5*, df=15.8
Sensitive Data Encryption	0 (0)	0 (0)	0 (0)	N/A
Client-Side-Only Security[c]	0.21 (0.42)	0 (0)	0.5 (0.52)	3.3**, df=11.0

* $p<0.05$, ** $p<0.01$.

[a] Levene's test for equality of variance was significant, hence equal variances not assumed.

[b] For this case, for students, N=12. [c] For this case, for teachers, N=16, and for the students, N=12.

Hierarchical Clustering of the Participants

In order to explore similarities between the participants, with regards to their code metrics, we used a hierarchical cluster analysis. This method makes a partition of the population into groups where subjects in each group are similar (or closer) to each other than subjects in other groups, by terms of a given metrics; this is a bottom-up, unsupervised method that makes no prior assumptions on the way the data is categorized (cf. Kaufman & Rousseeuw, 2009). In recent years, and mainly since the emergence of the educational data mining (EDM) and learning analytics (LA) approaches to educational data, cluster analysis has been extensively used in educational research (cf. Antonenko, Toy, & Niederhauser, 2012; Baker & Siemens, 2014; Peña-Ayala, 2014; Romero & Ventura, 2010). As our purpose was to discover hidden patterns in the data, no assuming on any a-priori partition of the population, we find this approach most suitable to our needs; the metrics by which the population is partitioned is based on the calculated metrics. We used Ward's method (Ward, 1963) for clustering by Pearson correlation. Features were standardized using Z-scores before clustering. Analysis was computed using SPSS 18. A dendrogram representing the clustering process is presented in Figure 1. The vertical lines determine which participants were grouped together and at which stage of the algorithm (from left to right). As can be clearly seen, the process resulted with a division to two clusters, holding 9 and 23 participants. The small cluster holds teachers only; the large one holds all the students (15) and 8 additional teachers. Examining mean feature values between the two clusters, and comparing these with the descriptive statistics presented in previous section, raises some interesting insights.

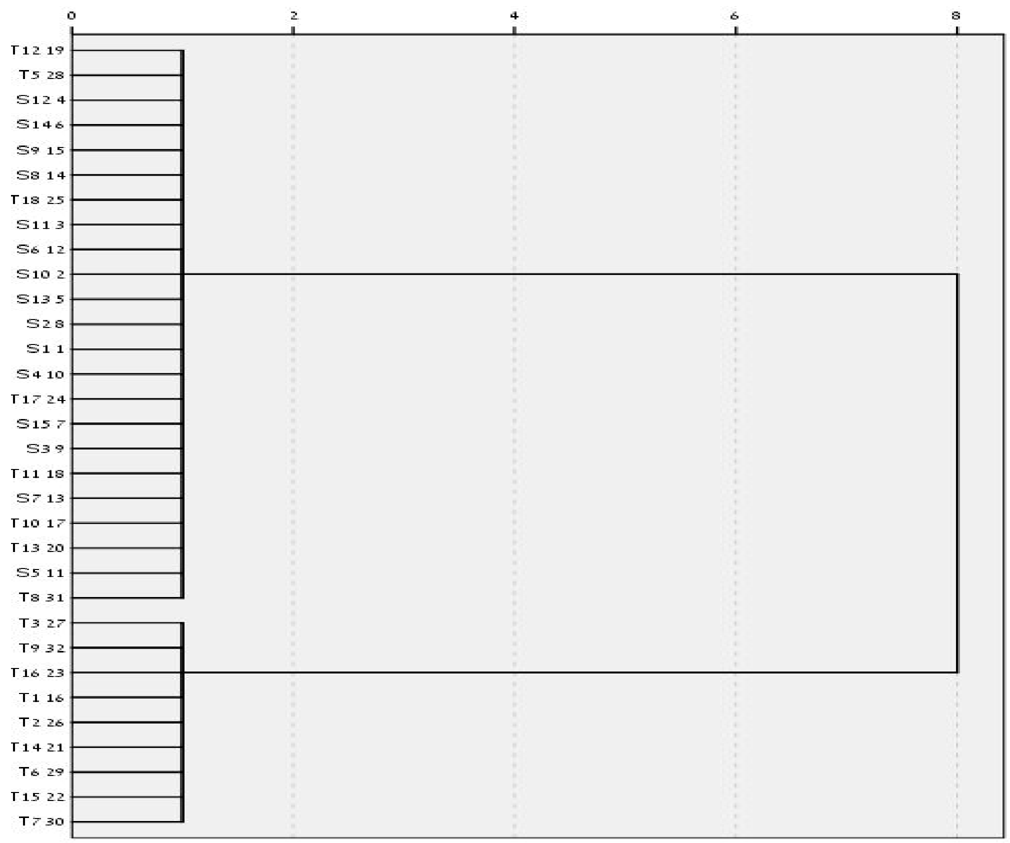

Figure 1: Dendrogram of the hierarchical clustering process. X-axis represents distance between clusters

First, we will examine mean differences between the clusters and will compare these results with mean differences between students and teachers (presented in the previous section). These comparisons are summarized in Table 5, where each variable is noted for significance/insignificance difference when its mean is compared between clusters and between students/teachers. Full results of mean comparison between the two clusters are presented in Tables 6-8. We will now focus only on these variables the means of which were found to be significantly different when comparing between cluster and were not significantly different when comparing between teachers/students, and vice versa.

Table 5: Significance (p<0.05, marked with +) or insignificance (-) mean difference in two-tailed t-tests regarding the research variables

Variable	Comparing Students, Teachers	Comparing Clusters
General Features		
Number of Statements	+	-
Number of Comments	-	-
Documentation Rate	-	-
Number of Lines	+	-
Name Length	+	+
Name Meaning	+	+
Quality Features		
Mean Count C/W	+	+
Mean Count E/R	-	-
Normalized Mean Count C/W	+	+
Normalized Mean Count E/R	-	-
Rate of Triggered Measures C/W	+	+
Rate of Triggered Measures E	-	-
Rate of Triggered Measures R	-	+
Triggered Category C	N/A	N/A
Triggered Category W	+	+
Triggered Category E	-	-
Triggered Category R	-	+
Normalized Triggered Category C	+	-
Normalized Triggered Category W/E/R	-	-
Security Features		
Input Validation	+	+
Anti-Spoofing Mechanism	N/A	N/A
Bound Checking	-	+
Checking for Errors	+	+
Sensitive Data Encryption	N/A	N/A
Client-Side-Only Security	+	+

Significant Difference between Clusters, not between Teachers/Students

Interestingly, means of two of the Refactor features are significantly different when comparing between clusters, both refer to the overall triggering of measures under this category: a) Rate of Triggered Measures R, with $t(df=20.5)=2.2$, at $p<0.05$; and b) Triggered Category R, with $t(df=24.4)=2.2$, at $p<0.05$. Levene's test for equality of variance resulted with a significant result in both cases, hence equal variances were not assumed. Recall that none of the Refactor features was significantly different between teachers and students. In both cases, the means in the teachers-only cluster were lower than the means in the mostly-students cluster (i.e., the teachers had demonstrated better security design). As Refactor measures refer to a "bad smell" code, the differences in this category might indicate that the teachers in the teacher-only cluster are more experienced in regulating their own programming and recognizing seemingly-suspicious code than the students and the other teachers.

Bound Checking was also found significantly different between the two clusters, with $t(df=19.1)=2.2$, at $p<0.05$ (again, equal variances were not assumed as for Levene's test significant result). Here, mean value for the teachers-only cluster is lower than the mostly-students cluster, indicating poorer security design of members of the former comparing to the latter. This is probably because, as was shown in the previous section, the Bound Checking security mechanism was mostly implemented by the students.

Overall, these differences highlight that the teacher-only clusters hold an important subset of the teachers, the member of which differ not only from the students, but also from their other peers. The data-driven partition taken here made it possible to distinguish between the two groups based not on their role in class, but rather on their actual code-writing measures, hence finding some hidden patters.

Significant Differences between Teachers/Students That Became Non-significant

Means of two of the General features previously found significantly different between teachers/students are now non-significant when comparing between clusters: *Number of Lines*, *Number of Statements*, and *Normalized Triggered Category C*. As Normalized Triggered Category C is the ratio of Triggered Category C – for which all of the participants got a value of 1 – to Number of Statements, and as Number of Statements and Number of Lines are highly correlated– with Pearson's $r=0.983$, at $p<0.01$ – these three features are related. Hence, the teachers-only cluster and the mostly-students cluster do not differ from each other with regards to their general code characteristics.

The cluster analysis resulted with a clear distinction between two groups of learners. Specifically, it found a sub-group of the teachers that is different from the rest of the teachers – and along with that from all the students – mostly in its quality features (convention-, warning-, and refactor-related). This subgroup's members produce code that is higher in its quality measures compared to the other participants; this might indicate that teachers in the teacher-only cluster facilitate their learning of new material differently than the rest of the participants. To this end, gender issues might be relevant, as the teachers-only cluster holds 2 female teachers and 7 male teachers, while the mostly-students cluster holds 2 male teachers and 6 female teachers (as mentioned before, almost all participant students were males, making any gender-wise comparison impossible). This brings to mind an interesting recent finding about gender differences in adopting computer curricular changes. Investigating a rapid change in CS curriculum in New Zealand, Thompson et al. (2013) found that only 73% of the female teachers intended to use the new programming and CS standards presented in the new curriculum, compared to 91% of the male teachers.

Table 6: Mean comparison (two-tailed t-test) for the general features among the two clusters (one decimal place representation unless mean<0.1); grey-shaded rows have significant difference

Variable	Mean (SD), Mostly-students Cluster, N=23	Mean (SD), Teachers-only Cluster, N=9	t(30)[a]
Number of Statements	56.0 (30.6)	38.3 (16.0)	-0.8
Number of Comments	6.1 (7.6)	6.2 (6.2)	-0.04
Documentation Rate	0.08 (0.07)	0.2 (0.2)	-1.4, df=8.9[b]
Number of Lines	62.2 (31.1)	43.1 (20.7)	1.7
Name Length	9.0 (4.6)	15.2 (3.2)	-3.7**
Name Meaning	1.1 (0.5)	1.7 (0.4)	-2.9*

* $p<0.05$, ** $p<0.01$. [a] Unless otherwise stated, df=30.

[b] Levene's test for equality of variance was significant, hence equal variances not assumed.

Table 7: Mean comparison (two-tailed t-test) for the quality features among the two clusters (one decimal place representation unless mean<0.1); grey-shaded rows have significant difference

Variable	Mean (SD), Mostly-students Cluster, N=23	Mean (SD), Teachers-only Cluster, N=9	t(30)[a]
Mean Count C	90.7 (56.7)	25.5 (13.4)	5.2**, df=27.2
Mean Count W	75.9 (75.4)	8.2 (13.3)	4.1**, df=25.2
Mean Count E	1.3 (1.7)	1.6 (1.0)	-0.4
Mean Count R	0.2 (0.4)	0.05 (0.1)	1.8, df=27.9
Normalized Mean Count C	0.1 (0.03)	0.06 (0.03)	6.1**
Normalized Mean Count W	0.03 (0.04)	0.003 (0.004)	3.8*, df=23.4
Normalized Mean Count E	0.0 (0.001)	0.001 (0.001)	-0.8
Normalized Mean Count R	0.0[c] (0.0[c])	0.0[c] (0.0[c])	2.0, df=26.7
Rate of Triggered Measures C	0.4 (0.08)	0.3 (0.05)	4.1**
Rate of Triggered Measures W	0.07 (0.04)	0.02 (0.02)	3.3*
Rate of Triggered Measures E	0.01 (0.01)	0.02 (0.003)	-0.8, df=27.3
Rate of Triggered Measures R	0.01 (0.02)	0.002 (0.004)	2.5*, df=27.2
Triggered Category C	1.0 (0.0)	1.0 (0.0)	N/A
Triggered Category W	0.8 (0.4)	0.5 (0.4)	2.4*
Triggered Category E	0.4 (0.4)	0.5 (0.1)	-1.0, df=29.8
Triggered Category R	0.2 (0.3)	0.05 (0.1)	2.5*, df=29.8
Normalized Triggered Category C	0.03 (0.02)	0.04 (0.01)	-1.2
Normalized Triggered Category W	0.02 (0.01)	0.02 (0.02)	0.2
Normalized Triggered Category E	0.008 (0.01)	0.01 (0.01)	-1.1
Normalized Triggered Category R	0.003 (0.01)	0.0[c] (0.0)	1.3

* $p<0.05$, ** $p<0.01$. [a] Unless otherwise stated, df=30.

[b] Levene's test for equality of variance resulted with a significant result, hence equal variances not assumed.

[c] Value was smaller than 0.01.

Table 8: Mean comparison (two-tailed t-test) for the security features among the two clusters (one decimal place representation unless mean<0.1); grey-shaded rows have significant difference

Variable	Mean (SD), Mostly-students Cluster, N=23	Mean (SD), Teachers-only Cluster, N=9	t[a]
Input Validation	0.09 (0.2)	0.0 (0.0)	2.2*, df=22
Anti-Spoofing Mechanism[b]	0.0 (0.0)	0.0 (0.0)	N/A
Bound Checking	0.1 (0.2)	0.01 (0.04)	2.4*, df=25.5
Checking for Errors	0.2 (0.4)	0.0 (0.0)	3.0*, df=22
Sensitive Data Encryption	0.0 (0.0)	0.0 (0.0)	N/A
Client-Side-Only Security[c]	0.3 (0.5)	0.0 (0.0)	2.9*, df=18

* $p<0.05$, ** $p<0.01$. [a] Levene's test for equality of variance resulted with a significant result, hence equal variances not assumed.

[b] For this case, for the mostly-students cluster, N=20.

[c] For this case, for the mostly-students cluster, N=19.

Code Writer Prediction Model

As a final step, and in order to highlight the findings from yet another angle, we tried to build a classifier, at the code-level, that will predict whether a program was submitted by either a student or a teacher. In this case, the analysis is supervised, as we know ahead which code was written by a student and which was written by a teacher, and our goal is to predict it based on the code metrics. That is, we would like to build a classifier (a binary predictor) that, based on a code's features, will predict who wrote this code. For doing this, we chose to use a decision tree model, mostly because of it being simple and easily interpretable (cf. Quinlan, 1996); decision trees have been extensively used in the educational research in recent years (cf. Baker & Siemens, 2014; Peña-Ayala, 2014; Romero & Ventura, 2010).

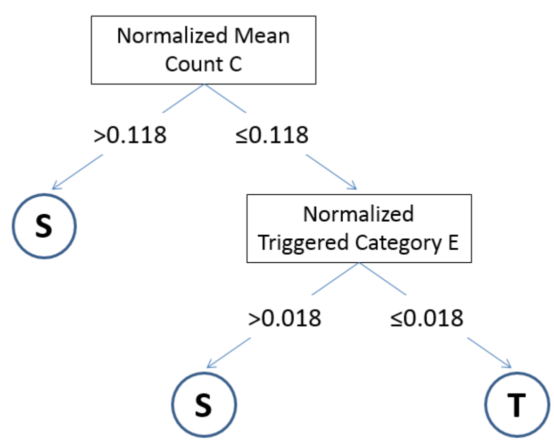

Figure 2: Best prediction model (S=Student, T=Teacher)

As detailed in Participants and Data section, 87 code source files were used. This set of codes, along with their features (at this stage, back to code-level calculation of features), had served for the prediction model building. We developed a decision tree model, using RapidMiner 5.3 (Mierswa, Wurst, Klinkenberg, Scholz, & Euler, 2006), with its default parameters. Forward feature selection was implemented manually. Performance was tested using kappa and was validated using leave-one-out cross-validation.

The best model found, presented in Figure 2, is relatively simple, having only two features – Normalized Mean Count C, and Normalized Triggered Category E – three leaves and a total height of two. This model has a very good kappa value of 0.751, indicating on its high level of generalizability.

Based on this tree, a code with Normalized Mean Count C>0.118 is predicted to be written by a student. A code with a lower value of Normalized Mean Count C is then tested for Normalized Triggered Category E; higher values (>0.018) are predicted to be written by students, lower values (≤0.018) are predicted to be written by teachers. This model highlights the already known difference in convention violations between teachers and students. However, it also highlights an interaction between the convention feature and a feature that refers to errors. Error-related features did not show significance earlier. This interesting result suggests that students and teachers that are relatively good in convention-keeping, might still pay attention differently to probable bugs. Here again, teachers might use their experience in programming (or in teaching programming) for thinking about different scenarios and extreme cases that might lead to bugs.

It is important to emphasize that security-related features, as well as general features, are absent from the model, highlighting the fact that students and teachers are mostly differed by the quality of their code. The non-differentiability of the general features might indicate that the submitted codes are straightforward solutions to relatively simple tasks; the non-differentiability of the security features is probably related to the very low levels of security mechanisms implemented by both students and teachers, as was previously shown; therefore, the only inherent meaningful difference at the code-level remains in the quality features, indicating the main advantage experienced teachers have over students when it comes to studying a new programming language.

Discussion

In this study, we analyzed students' and teachers' computer programs for both quality and security; the programs were given as exercises in a cyber security training, a topic new for both populations. Software quality measures indicate that both groups have violations/errors, mainly in the Python-specific features (convention, warning), which demonstrate the difficulty of learning a new programming language. Students' (obviously novices) difficulties are expected; teachers' difficulties may be looked at in two opposite ways: on the one hand, teachers did better than students in all software quality metrics, demonstrating their experience and expertise; on the other hand, the very existence of these violations/errors may hint that the teachers had struggled with the new material just like novices do. In this light, our findings support Liberman, Ben-David Kolikant, and Beeri's (2012) preliminary results about the "regressed experts", stating that in such scenario, the teachers practice some elements of novices but use their experience as a leverage to improve knowledge in the new content. Recall that about half of the teachers were clustered together with the students when defining similarity based on the software metrics (using hierarchical clustering). This group of teachers, the members of which proved a slower adaptation to the new curriculum, might demonstrate the problem in the training of secondary school computer science (CS) teachers. As Ginat (2000) put it, "many teachers remained with a rather narrow perception of CS. In particular, many still perceive the teaching of introductory CS as tutoring of language syntax and technicalities, and fail to recognize the importance of design and analysis consideration." While Liberman, Ben-David Kolikant, and Beeri's description relates to our surface-level findings (based on descriptive statistics), shedding light on the more severe problem presented by Ginat was enabled by using a bottom-up analysis approach (based on data mining). This demonstrates the advantage of our multi-view approach. Additionally, the prediction model highlighted some further fine-grained differences between students and teachers, emphasizing the role of quality-related features, in which teachers most benefit from their experience. Repeating the current study in a larger population is recommended in order to empirically measure the extent of these two phenomena, both of which are strongly related to the ability of CS teachers to be trained in new programming languages, as required in today's ever-changing curriculum era.

Viewed from a broader perspective, these findings shed light on CS education as a lifelong learning experience. The rapid technological developments over recent years make CS an ever-changing field, and as a result, people engaged with it are required to be lifelong learners (Fischer, 2000; Guzdial & Weingartn, 1995). Among these are CS teachers who need to be constantly updated in order to teach their students the most relevant content. Sometimes, the need to get updated is forced on these teachers as a result of curricular changes. Indeed, lifelong learning has been noted as an integral part of CS teacher preparation, side by side with expertise in knowledge and in teaching strategies (East, Bentley, Kmoch, Rainwater, & Stephenson, 2011). As we showed in this study, it might be advisable to emphasize the need for lifelong learning in CS teacher training. This need should also be accompanied by research focusing on the most efficient ways for CS teachers to keep updated in content-, technology-, and pedagogy-related topics.

On top of these two explanations to CS teachers' training in new material, gender issues might explain some differences too, as was pointed out in our findings and was recently found by Thompson et al. (2013). As Paechter (2003) suggested, teachers' reactions to curriculum change are strongly related to teacher identities, in specific gender: while female teachers see themselves as teachers first, content experts second, for male teachers the order of importance is reversed. This observation might dramatically affect teachers' attitude towards curricular changes. In addition to demonstrating different attitudes towards changes in the curriculum, compared with their male peers (which might, in turn, affect their learning of new material), female CS teachers might also learn the new content differently than their male colleagues, due to previously observed gender differences in CS learning (e.g., Beyer, Rynes, Perrault, Hay, & Haller, 2003; Murphy et al., 2006; Vilner & Zur, 2006). Generally, our finding regarding gender differences is in line with many other studies that have pointed out to gender-differences in computer science education (cf. Hayes, 2008; Mihalcea & Welch, 2015; Webb & Miller, 2015). These differences should be taken into consideration by policy makers and teacher development program leaders, in order to ease the processes of female CS teachers adapting to curricular changes.

Meanwhile, a simple solution might assist both students and teachers to learn in the CS with programming tasks: measuring software quality and security metrics in real-time (i.e., while writing the code), hence enabling contextual feedback that might result in a better code and promote better learning (cf. Ala-Mutka, 2007; Ng, Vee, Meyer, & Mannock, 2006; Truong et al., 2005; Wang et al., 2011). Popular IDEs (Integrated Development Environments) already provide integration with tools like Pylint (e.g., Emcas, VIM, Eclipse, Komodo, WingIDE, gedit, and pyscripter), so using such software might ease the measuring task, as was indeed reported in Robles and González-Barahona (2013). This idea is in line with a strand of research that suggested supporting novice programming learners by adding components during program writing, running or debugging (e.g., Brusilovsky, 1994, Egan & McDonald, 2014; Hundhausen & Brown, 2007; Kiesmuller, 2009). Hence, this is another important direction for further research that might eventually assist people to acquire a new programming language more efficiently.

As our results suggest, codes with higher software quality are not necessarily better secured. Overall, codes of the participant teachers were of higher quality comparing to the students' codes; however with regards to the measurable security features, the opposite was observed. In recent years, much attention has been put on exploring the relations between software quality metrics and software vulnerability; most of these studies have found that the former can predict the latter (e.g., Chowdhurry & Zulkernine, 2011; Moshtari, Sami, & Azimi, 2013; Shin & Williams, 2013). However, most of these studies were analysing big (in terms of code size) commercial software (e.g., Mozilla Firefox, Linux Kernel, Eclipse, etc.) that are usually written collaboratively by hundreds, sometimes thousands, of people. Hence, their findings are barely interpretable at the programmer level. The current study sheds light on the individual code-writer, so we can conclude from it about educating software engineering students and lifelong programming learners.

From what we have found, educating in secure programming might probably be done in parallel to teaching programming practices.

Generally, due to the fact that most of the features (quality features and cyber security features) shown in the study are relevant to other programming languages (such as C/C++/C#/Java/Ruby), our findings might generalize to other environments, and we plan on running similar, extended studies in other programming scenarios.

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A Decade of Chais Conferences: Introduction to the IJELL Special Series of Chais Conference 2015 Best Papers

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Abstract

The seventh issue of the *Interdisciplinary Journal of e-Skills and Lifelong Learning* (IJELL- formerly *Interdisciplinary Journal of E-Learning and Learning Objects* - IJELLO) special series includes a selection of best papers presented at the 10th Chais Conference for the Study of Innovation and Learning Technologies: Learning in the Technological Era. The Chais conference 2015 was held at The Open University of Israel, Raanana, Israel, on February 10-11, 2015, and was organized by its Research Center for Innovation in Learning Technologies.

This preface presents the mission and activities of the Research Center for Innovation in Learning Technologies at the Open University of Israel. It describes the objectives and themes of the Chais conference 2015, explains the special series synergies with IJELL and the Informing Science Institute, chronicles the topics that have been published in the series, and introduces the papers included in this special selection.

Keywords: learning technologies, e-learning, information and communication technology (ICT) integration in education, diffusion of innovation, human-computer interaction, digital competencies, e-skills, lifelong learning.

Introduction

Lifelong learning is becoming a global necessity due to the rapid changes of our daily environment. E-learning is a major force for lifelong learning, whether in formal academic settings or in semi-formal settings, such as Massive Open Online Courses (MOOCs), or informal searching using the vast resources available online. The Open University of Israel (OUI) is based on distance and blended learning models and is committed to continuing reflection on and improvement of its teaching quality, through the integration of innovative learning and educational technologies. The Research Center for Innovation in Learning Technologies is the dedicated research arm of the OUI for exploring emerging technologies and developing models and strategies for their integration in teaching and learning. The main

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purpose of the Center is to promote research related to improvement of instruction, using innovative learning technologies. The Center consists of a consortium of about fifty faculty members from the various OUI academic departments, who together conduct a wide range of academic activities, such as symposia, workshops, conferences, and research seminars, to encourage collaboration among researchers and to enhance the discourse on innovative learning technologies among researchers and practitioners.

The following are some of the fields of research in which the Research Center for Innovation in Learning Technologies is engaged:

- The theoretical foundations of learning, educational technology and distance education;
- Integration of innovative information and communication technologies into educational systems;
- Defining and characterizing the variables necessary for developing flexible and adaptive technology-enhanced educational strategies that accommodate students' individual needs;
- Studying the pedagogical and cognitive contributions of emerging technologies to teaching and learning.

Table 1. A Decade of Chais Conferences

	Milestones	**Chais Conference Papers**	**Chais Conference Posters**	**IJELL Special Series Papers**
2006	The first Chais conference held on March 1, 2006	34		
2007	Collaboration with EDEN	40	8	
2008		47	17	
2009	IJELLO (currently IJELL) special series of Chais conference best papers launched	47	11	13
2010	The Research Center for Innovation in Learning Technologies is inaugurated	39	15	9
2011		42	9	9
2012	• Chais conference becomes a two-day event • The first Best Student Paper Award conferred	40	30	8
2013		40	32	5
2014		36	41	5
2015	The tenth Chais conference held on February 10-11, 2015	34	34	10
	A Decade of Chais Conferences	**399**	**197**	**59**

"Learning in the Technological Era" is a series of annual national research conferences on innovation in learning technologies, initiated in 2006 by the Chais Research Center. The Research Center for Innovation in Learning Technologies is committed to continue this important research activity, under the name of the Chais conference, which commemorates the contribution of the late Stanley Chais, who funded the establishment of the Chais Center, later closed in 2010. The Chais conference contributes to the formation of a community of Israeli researchers in the field of learning technologies and to the positioning of the Open University of Israel as a leading organization in the study and implementation of learning technologies. During the first years, the Chais conference collaborated with EDEN, The European Distance and E-Learning Network, and abstracts of the conference papers were distributed to EDEN members, in an effort to encourage international research collaborations. This year we celebrated a decade of Chais conferences. Table 1 depicts some milestones of the Chais conference, along with quantitative data about the number of papers and the posters that were presented at the conference, as well as the papers published in the IJELL (formerly, IJELLO) special series of Chais conference best papers. The main topics of the Chais conference during this decade are elaborated below.

The 600 participants attending the two-day Chais conference 2015, represented most of Israel's universities and academic colleges, as well as organizations and corporations dealing with learning and training. The opening keynote guest lecturers were Yochai Benkler (Harvard University, USA), whose talk was entitled "Open Network Innovation and Exploration: Drivers, Benefits, and Challenges", and Sarah Guri-Rosenblit (The Open university of Israel), with a talk entitled "Distance Education in the Digital Era: an Identity Crisis?". The closing lecturers were Sarit Kraus (Bar-Ilan University, Israel), whose lecture's title was "Intelligent Computer Systems which have Human Communication Skills", and Yoav Yair (The Interdisciplinary Center Herzliya, Israel), who talked about "Sustainability, Technology and in Between". The videos of these keynotes, as well as those of all the prior Chais conferences, many of them in English, are available on the website of the Research Center for Innovation in Learning Technologies (http://www.openu.ac.il/innovation/keynotes.html).

The purpose of the special series of selected Chais conference best papers is to increase the international impact of the Chais conference by distributing high quality papers from the national conference to a worldwide audience. The Informing Science Institute (ISI) is supporting this enterprise for the seventh time. ISI is a natural partner for this mission since it draws together researchers and practitioners of information technologies, who seek effective ways to inform clients about sharing their knowledge with others (http://www.informingscience.org/). The informing science transdiscipline studies the informing process, defined as providing a specific clientele with information in a form, format, and schedule that maximizes its effectiveness (Cohen, 1999, 2009; Cohen & Lloyd, 2014). Technologies for learning, teaching and training, are a certain type of information technologies, which aim at providing students and other learners with information and tools to enhance their learning. Within the ISI journals, the *Interdisciplinary Journal of e-Skills and Lifelong Learning* (IJELL) publishes high quality scholarly articles on theory, practice, innovation, and research that cover all aspects of e-skills, e-learning, and lifelong learning (http://www.ijell.org). IJELL is the new name of the *Interdisciplinary Journal of E-Learning and Learning Objects* (IJELLO), and the journal's current focus on e-skills and lifelong learning strengthens its synergy with the scope of the Chais conferences.

The first selection in the IJELL special series of Chais conference best papers was published six years ago. Table 2 depicts the main themes of the papers that were published during the first six years of the series. The preface of each selection provides an overview of the papers that were published in that year (Eshet-Alkalai, Caspi, Eden, Geri, & Yair, 2009, 2010; Geri, Caspi, Eden, Kalman, Yair, & Eshet-Alkalai, 2012, 2013; Geri, Caspi, Kalman, Silber-Varod, Yair, & Eshet-Alkalai, 2014; Geri, Yair, Caspi, Eden, & Eshet-Alkalai, 2011). All the papers in the special series are listed on the website of the Research Center for Innovation in Learning Technologies (http://www.openu.ac.il/innovation/ijello.html), with links to the full versions, which are available on the IJELL website (http://www.ijell.org), as per the open access policy of the Informing Science Institute.

Table 2. Themes of former IJELL special series of Chais conference best papers	
	Main Themes
2009	Various aspects of technology integration in teaching and learning, collaborative learning environments, quality of mobile learning, motivation for technology use
2010	Integration of technology in education systems, diffusion of innovation in learning environments, mobile culture, school versus home learning, collaborative learning, social aspects of learning and online communication
2011	The role of teachers in integrating innovative educational technologies, effectiveness of electronic performance support systems, online video-based distance learning, Smart Classrooms, teachers in a world of change, collaboration among teachers
2012	Innovative technologies for teaching and learning, instruction in technological environments, perceptions of online teaching and learning, cognitive aspects of learning in technological environments, simulations for instruction and learning
2013	Effectiveness of open educational resources, evaluation of technology-enhanced teaching and learning, learning from digital content and e-books, virtual reality applications for learning, technology in the service of people with special needs
2014	Effectiveness of educational gamification, increasing student interest and motivation via online learning environments, teachers and teaching in a digital world, Twitter as an e-mentoring mechanism, technology integration in a teacher-education program, accountability in educational organizations

The seventh selection of the Chais conference 2015 best papers comprises ten papers presented in the following Section. The Chais conference best student paper award was given for the fourth time. Sixteen of the papers that were accepted for presentation at the Chais conference 2015 were candidates for the Best Student Paper Award. This special issue includes extended versions of five of the eight finalists of the Chais conference 2015 Best Student Paper Award.

Chais Conference 2015 Best Papers

On its tenth year, 87 papers were submitted to be considered for presentation at the Chais conference 2015. After a double-blind peer-review process, 34 papers and 34 posters were accepted for presentation at the conference and were included in the conference's proceedings volume (Eshet-Alkalai, Blau, Caspi, Geri, Kalman, & Silber-Varod, 2015). This seventh selection of the IJELL Special Series of the Chais Conference Best Papers contains ten of the most remarkable Chais conference 2015 papers, which have been expanded and edited for publication in IJELL and were subject to a full review process by IJELL's Editors and reviewers.

The papers in this special selection represent diverse aspects of e-skills and lifelong learning. The first paper by Dorit Geifman and Daphne R. Raban is entitled "Collective problem-solving: The role of self-efficacy, skill, and prior knowledge". Their novel research investigates the manifestation of self-efficacy in computer-mediated collaborative environments and its effect on the collective outcome. Geifman and Raban conducted a controlled experiment, which involved 632 participants in 47 prediction markets who traded a solution to a complex problem. Geifman and Raban's findings demonstrate that predictive markets are resilient to traders' self-efficacy and are an effective collective problem-solving platform. These results have important insights for collective learning, as well as crowdsourcing and reliance on the wisdom of the crowd.

The second paper, by Yair Levy and Michelle M. Ramim, "An assessment of competency-based simulations on e-learners' management skills enhancements", considers competency-based learning (CBL). As the trend of crediting higher education students for skills and competences grows, there is an increasing need to evaluate the added value of certain tools and learning methods in helping students gain or improve their tangible skills and competences, especially in e-learning settings. Levy and Ramim developed a quasi-experiment and used surveys to collect data on a set of 12 management skills from a group of e-learners attending courses that included competency-based digital simulations, and a control group of e-learners whose courses did not include such simulations. Their findings demonstrate the added value of digital simulations and competency-based projects, beyond the mere instruction of the subject matter, in increasing management skills of e-learners.

Noa Aharony and Miri Shonfeld's paper, "ICT use: Educational technology and library and information science students' perspectives – An exploratory study", investigated the extent of influence that several factors may have on information and communication technology (ICT) use. The theoretical factors were drawn from the Diffusion of Innovation theory and the Big Five approach, as well as motivation. Their findings suggest that instructors who would like to enhance their students' ICT use should be aware of individual differences, as well as emphasize the advantages of ICT for increasing student motivation to use ICT. Furthermore, second and third year students used more ICT than first year students suggesting that, although both were technology oriented, as these programs of study progressed, students adapted their ICT use.

The following three papers are focused on instructors and concern design of teaching or training materials. The paper written by Keren Sarah Levy, Yael Kali, and Tali Tal, "Teachers as designers of technology-enhanced outdoor inquiry", was a finalist for the best student (Keren Sarah Levy) paper award of the Chais conference 2015. Their design-based research involved 24 teachers in a professional development (PD) program who were engaged in adapting a learning environment, which included mobile technologies and was intended for supporting outdoor inquiry. The in-depth study, which examined the whole PD process, included analysis of observations, questionnaires, interviews, as well as the adapted learning-environments. Levy et al.'s findings demonstrate that a "Teachers as Designers" approach may support learning, growth and professional development of teachers.

Open Educational Resources (OERs) may serve for organizational training. Although there is substantial literature on OER usage in education, there is limited research of OER usage in business settings. The paper "OER usage by instructional designers and training managers in corporations" by Eli Merkel and Anat Cohen, was also a finalist for the best student (Eli Merkel) paper award of the Chais conference 2015. The study distinguished between Little OER repositories such as YouTube, which were not necessarily designed for educational purposes, and Big OER repositories. Merkel and Cohen's main findings reveal greater use of Little OER repositories that involve revising, modifying, and combing resources by the users, and they suggest such adaptation is required due to the general nature of the materials.

The next paper concerns acquiring pedagogical e-skills. Yehuda Peled, Ina Blau, and Ronen Grinberg's paper, "Does one-to-one (1:1) computing in a junior high-school change the pedagogical perspectives of teachers and their educational discourse?", was a finalist for the best student (Ronen Grinberg) paper award of the Chais conference 2015. This longitudinal study, which lasted three years, was conducted in 1:1 classrooms, in which both teacher and students have personal digital devices, and included interviews and lesson observations. The main conclusion from this study is that transformation of a school from traditional teaching and learning to a 1:1 classroom should start with teachers' perceptions and attitudes. The mere application of personal technology is not enough for eliciting pedagogical changes.

The next two papers discuss social aspects of learning, and study social network sites (SNSs). Both investigate Facebook, while the first paper deals with general use of the SNS and the second one concerns dedicated online learning groups on Facebook. The paper “Teacher-student relationship and SNS-mediated communication: Perceptions of both role-players” by Alona Forkosh-Baruch, Arnon Hershkovitz, and Rebecca Ang, examines perceptions of both teachers and students of communication via SNSs. This controversial issue is sometimes regulated, and in some countries, such as Israel, communication of teachers with elementary, junior-high, and high school students via SNSs is banned. Findings of this survey-based research, which included 160 teachers and 587 students, suggest several differences between those who are willing to connect versus those who are not willing to connect via SNSs, and may provide some interesting insights for future research, as well as for policymakers.

The mere availability of learning technologies is not enough for increasing social inclusion. As the next paper demonstrates, adopting a design-based approach, which includes carefully planned interventions, may improve social inclusion of minority groups. The paper written by Meital Amzalag, Nelly Elias, and Yael Kali, “Adoption of online network tools by minority students: The case of students of Ethiopian origin in Israel”, was another finalist for the best student (Meital Amzalag) paper award of the Chais conference 2015. The findings show that before the intervention, the main pattern of college students of Ethiopian origin participation in online social learning groups was peripheral and limited to content viewing. However, after a series of two interventions, the level of their online activity increased, and indicators of their social integration were slightly improved. Furthermore, a change was observed in the usage of online learning groups by the students of Ethiopian origin, from social to academic uses.

Increasing student interest in Science, Technology, Engineering, and Mathematics (STEM) is one of the main global challenges of education systems. The paper “‘Will a black hole eventually swallow the earth?’ Fifth graders’ interest in questions from a textbook, an open educational resource and other students’ questions”, by Hani Swirski and Ayelet Baram-Tsabari, was also a finalist for the best student (Hani Swirski) paper award of the Chais conference 2015. The paper provides some interesting insights regarding ways to increase elementary school students’ interest in science. The paper highlights the potential of Open-Educational-Resource (OER) websites, such as Ask-An-Expert, as a promising indicator of student interest in science, which could contribute to improved interest in the science curriculum.

The final paper of this special selection, written by Karen Spektor-Precel and David Mioduser, presents a pioneering study, titled: “5-7 year old children’s conceptions of behaving artifacts and the influence of constructing their behavior on the development of Theory of Mind (ToM) and Theory of Artificial Mind (ToAM)”. The study used quantitative and qualitative methods for investigating whether and how children develop ToAM, which is a new theoretical scheme that is distinct from their ToM. The authors used a special robot, designed for young children, “RoboGan”, as a behaving artifact. Spektor-Precel and Mioduser’s quantitative findings indicated that for both age groups, interaction with the robot, whether as observers or constructors, brought children’s ToM into awareness, and affected their understanding of the independent behavior of robots. Their qualitative analysis revealed that the ToAM, of both constructors and observers, was influenced by their participation in the intervention.

These diverse 10 papers represent the main themes discussed at the Chais conference 2015. Additional major themes presented at the conference that were not included in this special selection are visual-based learning; mobile learning; technology in the service of people with special needs; ethics on the net.

Conclusion and Acknowledgements

This seventh issue of IJELL's special selection of the Chais conference best papers provides discussions of some of the current research in learning technologies, which serve as a main means for supporting lifelong learning. We hope these papers will be of interest to the readers and will encourage future innovative and synergistic learning technologies research. We look forward to the IJELL next issue of the best papers of the eleventh Chais conference for the study of innovation and learning technologies. The Chais conference 2016 will be held on February 16-17, 2016, at the Open University of Israel campus in Raanana, Israel.

The publication of this special selection is enabled by the efforts and help of many people. We are grateful to Gila Kurtz, the Editor-in-Chief of IJELL for continuing this special series of Chais conference best papers and for enthusiastically supporting this editorial project.

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We would like to praise and thank all the contributing authors and reviewers for their excellent work. Finally, many thanks to the community of Israeli researchers and practitioners of learning technologies, for their ongoing participation in Chais conferences, and for contributing to the development of this important field.

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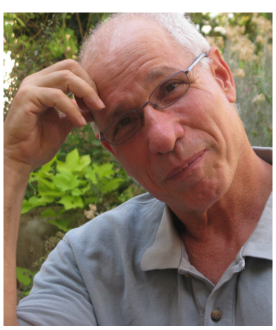

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Collective Problem-Solving: The Role of Self-Efficacy, Skill, and Prior Knowledge

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Abstract

Self-efficacy is essential to learning but what happens when learning is done as a result of a collective process? What is the role of individual self-efficacy in collective problem solving? This research examines the manifestation of self-efficacy in prediction markets that are configured as collective problem-solving platforms and whether self-efficacy of traders affects the collective outcome.

Prediction markets are collective-intelligence platforms that use a financial markets mechanism to combine knowledge and opinions of a group of people. Traders express their opinions or knowledge by buying and selling “stocks” related to questions or events. The collective outcome is derived from the final price of the stocks.

Self-efficacy, one’s belief in his or her ability to act in a manner that leads to success, is known to affect personal performance in many domains. To date, its manifestation in computer-mediated collaborative environments and its effect on the collective outcome has not been studied.

In a controlled experiment, 632 participants in 47 markets traded a solution to a complex problem, a naïve framing of the knapsack problem. Contrary to earlier research, we find that technical and functional self-efficacy perceptions are indistinguishable, probably due to a focus on outcomes rather than on resources. Further, results demonstrate that prediction markets are an effective collective problem-solving platform that correctly aggregates individual knowledge and is resilient to traders’ self-efficacy.

Keywords: collective problem-solving, self-efficacy, prediction markets, social influence.

Introduction

Collective problem-solving is a process whereby individuals are tasked with solving a problem and the sum total of the individual solutions yields a collective solution. Summation is done by a variety of online platforms which aggregate individual knowledge, decisions, and creativity into a pooled intelligence

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artifact. Prediction markets are a genre of collective-intelligence platforms used for problem solving. They use financial markets as an underlying mechanism to aggregate dispersed information, predict future events, and combine knowledge and opinions of a large and distributed group of people. In such markets, stocks represent a statement to be evaluated or an event to be predicted. The price of the stocks traded reflects the market's opinion as to the probability of the occurrence of the event or the correctness of the statement. Price also serves as a signal for traders and as such provides a learning opportunity for improvement of the individual solutions. Prediction markets are deployed as public platforms on the Web as well as within organizations.

Self-efficacy, the belief in one's own ability to act in a manner that leads to success, affects individual performance by determining goal selection, course of action, and persistence (Bandura, 1997). There is a general consensus among researchers that self-efficacy is not a general trait but a disposition that is linked to the specific task and the circumstances in which it takes place (Bandura, 2012). People who use computers to perform knowledge work engage simultaneously in two tasks. The first is coping with the technical aspects of operating the computer application used for the task and the other is the intellectual task itself. Previous studies addressed the interplay of perception dimensions of self-efficacy at such complex tasks (Looney, Valacich, Todd, & Morris, 2006; Marakas, Yi, & Johnson, 1998) and other studies demonstrated that individuals who exhibit higher degrees of self-efficacy perform better at problem solving (Bandura & Wood, 1989; Bouffard-Bouchard, 1990; Pajares & Kranzler, 1995).

In prediction markets, there is a high degree of integration between the technical and functional perspectives of the trading task, as traders need to interpret market price and implement trading decisions accordingly. The first objective of this research is to study the interplay of the technical and functional perspectives of trading on traders' self-efficacy.

Opinions on the effect of behavioral biases on the outcome of prediction markets differ. Some scholars claim that prediction markets are resilient to behavioral and cognitive biases (Forsythe, Rietz, & Ross, 1999), while others claim that biases affect market accuracy (Cowgill, Wolfers, & Zitzewitz, 2008; Gjerstad & Hall, 2005). This research investigates the effect of self-efficacy on problem-solving in prediction markets.

This paper presents a controlled experiment examining the effectiveness of prediction markets as a collective problem-solving platform and the effect of traders' self-efficacy on the market resilience. It starts with a review of literature on individual and collective problem solving followed by the theory of self-efficacy and its relevance to problem-solving, paying special attention to the measurement of self-efficacy at complex tasks. The paper then describes collaborative platforms that are used for collective problem solving delving into a specific family of such platforms, prediction markets. Next, we report the experimental research method, the results and their discussion, and a summary of the findings.

Problem-Solving

Intellectual challenges come in various forms that involve different kinds of cognitive tasks, solving strategies, and heuristics. Problems lie on a spectrum that spans between well-structured problems that converge into a conclusive deterministic solution and ill-structured problems that are set in vague and ambiguous context, are not subject to a deterministic solution, and involve uncertainty in the problem domain and the solution space. Stasser and Dietz-Uhler (2001) devised a two-dimensional classification to distinguish the cognitive abilities that people employ to cope with diverse intellectual challenges. The first dimension comes from the decision-making domain and relates to the structural characteristic of the problem, the response format. It distinguishes between selection from several options and rating, i.e., identifying a solution along a continuum (Payne, 1982). The second dimension of the classification is the demonstrability of the solution which distinguishes between intellective tasks that deal with problems for which there exists a demonstrable correct solution and judgmental tasks that are evaluative and do not result in an objective outcome (Laughlin & Ellis, 1986). The classification renders four categories of cognitive tasks: choice, judgment, problem-solving, and estimation (Table 1). This paper focusses on the category of problem solving tasks.

Table 1: Cognitive task classification (Stasser & Dietz-Uhler, 2001)

		Response format	
		Select	Rate
Demonstrability	Judgmental	**Choice**	**Judgment**
	Intellective	**Problem-solving**	**Estimation**

It is not surprising that information processing models are dominant theories of problem-solving in the field of cognitive psychology. Research into cognitive models that explain the process of problem solving gained momentum with the introduction of computers, notably with the important work of Herbert Simon, a pioneering scholar in the fields of artificial intelligence and cognitive psychology. By modeling complex systems as Artificial Worlds, Simon (1969) created the basis for a theoretical framework of problem solving that consists of two associated sub-processes: understanding the problem and search processes. His cognitive models were implemented as computer simulation, the General Problem Solver (GPS), and established the symbiotic relationships between the disciplines of cognitive psychology and artificial intelligence (Newell & Simon, 1972). The terminology used by the two disciplines and their respective theories and models may differ, but in essence both identify three components: givens, goals, and operations that are associated with a certain problem space. The givens are the information and resources available for the task. The goals are the desired outcomes of the process, and the operations are the rules and actions that are applied on the givens to achieve the goals (Janssen, 1997; Wang & Chiew, 2010).

In general, problem-solving approaches follow one of two strategies: an iterative strategy or decomposition and synthesis. The selection of a strategy mainly depends on how readily the solving task can be divided into sub-tasks. In the iterative strategy, the problem solver gradually approaches the final solution in incremental or iterative steps. In decomposition and synthesis strategy, the problem is decomposed into sub-problems and the solutions to the sub-problems are then synthesized into a combined, final solution.

The similarity between the cognitive psychology and artificial intelligence continues when we move from individual problem solving to collective or distributed problem-solving, where several agents, human or computerized, collaborate on the task. In both domains, scholars and practitioners believe that cooperation among multiple actors in solving a problem will improve the efficiency of the process. This led, on one hand, to the development of cooperative and distributed systems, where automatic agents cooperate in solving a problem, and on the other hand, to group problem-solving, where teams of individuals work together to reach a collective decision or solution. While the motivation of computerized distributed problem solving mechanisms was mainly to improve the efficiency of the "operation" component of the problem-solving process, members of problem-solving teams were expected to extend the scope of the information inputs, the "givens", as well as the diversity in solving strategies and heuristics.

The effectiveness of groups in collective problem-solving and decision-making is debated. Some studies suggested that, in many cases, the outcome of collective decision methods outperforms individual judgment (Brown, 2000; Stasser & Dietz-Uhler, 2001). However, deficiencies, be they theoretical or practical, were identified in most types of group processes. Previous studies identified informational influence and polarization in small deliberation groups (Burnstein & Vinokur, 1977; Gigone & Hastie, 1993; Isenberg, 1986; Stasser & Titus, 1985) and the Groupthink phenomenon demonstrated the normative social influence, which may prevail in group processes (Janis, 1982). The current study focuses on the effect of individual differences on collective problem-solving.

Self-Efficacy

Self-efficacy is one's beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments. According to the self-efficacy theory, pioneered by Albert Bandura (1977), self-efficacy determines goal selection, the initiation of coping behavior and effort, persistence in the face of obstacles, and, consequently, affects task performance. The theory suggests that cognitive, social and affective processes, which differ among individuals, play an important role in the acquisition, regulation, and retention of behavior patterns. These processes, combined with environmental stimuli and reinforcements, may strengthen or weaken effective behavior.

Bandura identifies four informational cues that influence self-efficacy: enactive mastery, vicarious experience, verbal persuasion, and emotional arousal. Enactive mastery means that a successful accomplishment feeds back into one's efficacy expectations as reinforcement. It is the most influential source of self-efficacy as it raises mastery expectation and decreases fear and other inhibiting feelings. Vicarious experience is the symbolic modeling of the right behavior by looking at others performing a task. The efficacy expectations induced from vicarious experience are likely to be weaker than those arising from own accomplishments, as they do not present an authentic experiential basis. A third factor, verbal persuasion, i.e., leading a person through suggestion into believing that he or she can cope successfully with a task, was also found to have a lesser effect on efficacy expectations than enactive mastery. Lastly, stressful situations and fear reactions, or positive mood, generate emotional arousal that may greatly influence efficacy expectations (Bandura, 1997).

A large body of research established that self-efficacy shapes the effective performance of individuals in a wide variety of areas such as learning and academic achievements (Bandura & Schunk, 1981; Chemers, Hu, & Garcia, 2001), organizational behavior (Bandura & Wood, 1989; Krueger & Dickson, 1994), coping with health conditions (Condiotte & Lichtenstein, 1981; O'Leary, 1985), attaining goals (Bandura & Wood, 1989; Locke, Frederick, Lee, & Bobko, 1984) and more.

In tasks that rely on cognitive skills, self-efficacy beliefs affect cognitive states of the individual as well as his or her thinking processes. When looking into the achievements of a large cohort of 15-year old students in the Programme of International Student Assessment (PISA), Parker, Marsh, Ciarrochi, Marshall, and Abduljabbar (2014) found a significant relationship between math self-efficacy and math achievements. Bouffard-Bouchard (1990) demonstrated that differences in efficacy perceptions were related to the number of problems completed, the efficiency of problem-solving strategies, and the accuracy of self-evaluation of responses. People with high personal efficacy focused their attention on analyzing and finding solutions to problems in contrast to people with lower efficacy, who were beset with doubts, tended to turn their attention inwardly, and became self-occupied (Bandura & Wood, 1989). People who perceived themselves more efficacious at the task were quicker to dispose of faulty thinking directions and are less inclined to reject good solutions prematurely (Bouffard-Bouchard, Parent, & Larivee, 1991).

Measuring Self-Efficacy

Self-efficacy varies across activities and circumstances; therefore, Bandura (1977) suggested that it is not a global disposition and that its estimate is strongest and most accurate when determined by domain-linked measures. To fully capture the richness and the subtleties of the self-efficacy agency, its measurement should reflect the composition of the task and relate to its different modalities. Bandura (1986) recommends using multidimensional constructs to capture the richness of efficacy beliefs, which are invoked by the different modalities of the task and its environment.

When using a computer application to perform knowledge work, people are faced with a composite task, which consists of a technical skill component, i.e., the use of the computerized tool, and a functional domain skill component that is needed to accomplish the knowledge task. Often, the two skill components evoke different efficacy beliefs and impose differences in behavior, which affect the overall outcome (Mackay & Elam, 1992). Therefore, it was suggested that the measurement of self-efficacy at computer-mediated tasks should relate to both dimensions of the task: the execution of the knowledge assignment and the use of the computerized tool or application. Previous studies proposed a model of computer self-efficacy, which is composed of General Computer Self-Efficacy that spans across multiple computer applications, and task specific Computer Self-Efficacy, e.g., word-processing tasks (Marakas et al., 1998). Another study described a three-level model of self-efficacy in the area of online investment (Looney et al., 2006). The model defines the relations among the perceived efficacy in the technical component of the task, Computer Self-Efficacy in this case, efficacy at the functional domain component, Investment Self-Efficacy, and their combination, i.e., Online Investment Self-Efficacy.

Similarly, solving problems by means of prediction markets relies on two distinct skill sets. Traders need to form their opinions regarding the solution to the problems, and at the same time, they need to evaluate the market price signals with respect to their solution and decide whether to buy or sell stocks. These call for a definition of a dual facet self-efficacy construct that measures traders' efficacy beliefs at both perspectives of the task. Accordingly, the first research hypothesis is:

> **H1**: Problem solving self-efficacy in prediction markets yields two distinct constructs that distinguish between efficacy beliefs at trading and problem-solving

Online Collective Problem-Solving

Collective intelligence platforms offer an online ecosystem that enables a group of people to collectively tackle a common intellectual challenge. Today, such platforms are common in the workplace, in learning environments, and in the public Internet sphere and are used to create knowledge repositories such as Wikipedia, software products in open-source projects (Github), make decisions (Loomio), or solve problems (Innocentive). Collective intelligence platforms combine the advantages of human cognition in handling intellectual, unstructured tasks with the benefits of the Internet as communication, aggregation and organization infrastructure, and are expected to alleviate some of the deficiencies of traditional group processes.

Collective intelligence platforms come in different flavors but they generally feature a low barrier of entry for a diverse and distributed population, they facilitate access to a large body of dispersed information, and they support diverse social and governance structures. A proposed classification places collective intelligence platforms on a continuum of social structure cohesiveness that ranges from heavyweight social structures, which maintain a community form of persistent structures and norms, to lightweight social structures, which are based on the independent operation of group members (Budhathoki & Haythornthwaite, 2013). Open-source development projects, where programmers collaborate under different governance models, exemplify a highly cohesive community. GalaxyZoo (www.galaxyzoo.org), which is a platform that builds on a community of amateur astronomers to collectively create a morphological classification of galaxies, is an example of a loose group.

Social computing platforms are not to be confused with crowdsourcing platforms. In the latter, the complete task is handed out to a single entity, an individual or a team, and the platform does not mediate the social interaction. Kaggle (www.kaggle.com), as an example, facilitated a competition for a 3-dimensional algorithm that maps dark matter in the universe. While the activity may seem similar to that of GalaxyZoo, it does not involve an online collective process.

Prediction markets are lightweight collective-intelligence platforms that are used in the current research as a collective problem-solving platform.

Prediction Markets

Prediction markets use financial markets as an underlying mechanism to aggregate dispersed information, collect opinions of a large and distributed group of people, and predict future events (Wolfers & Zitzewitz, 2004). In prediction markets, stocks are created so that their final cash value is tied to the outcome of a particular statement or question. It may refer to an event (e.g., will a nuclear arms disarmament treaty be signed with Iran before the end of the year?), to a parameter (e.g., how many tons of salt are there in the Dead Sea?) or to an opinion (e.g., will an increase of budget deficit decrease unemployment?). Traders express their opinions regarding the probability of the event or the value of the parameter by buying or selling a certain amount of stocks at the current price. The market mechanism updates the market price, which is interpreted as the collective opinion of all traders. Figure 1 displays a typical prediction market trading interface.

Figure 1: A typical prediction markets screen

Prediction markets can be configured to address the four types of cognitive tasks that were identified in the Stasser and Dietz-Uhler (2001) classification (Table 1), but they function better for intellective tasks (Slamka, Jank, & Skiera, 2009). In the public Internet sphere, prediction markets address a variety of topics ranging from sports and entertainment to scientific innovation and politics. Due to anti-gambling regulations most markets use play-money and social incentives. The promise of prediction markets as a collective-intelligence platform lies in the corporate environment, the public sector, and civic debate (Cowgill et al., 2008; Polgreen, Nelson, & Neumann, 2007; Slamka et al., 2009). There, they are used for innovation management, business forecasting, problem solving, and elicitation of knowledge and opinion (Geifman, Raban, & Rafaeli, 2011).

The present study uses prediction markets to facilitate collective problem-solving. The aim of the second research hypothesis is to confirm their viability for the task:

> **H2**: Prediction markets perform better than individuals at solving complex problems.

The accumulation of various market anomalies brought to the flourishing of the field of behavioral finance (Shiller, 2003). Prediction and financial market similarity leads to expect behavioral phenomena similar to those studied in the field of behavioral finance. Some studies in the field show that behavioral biases are evident in prediction markets (Cowgill et al., 2008; Gjerstad & Hall, 2005), while others demonstrate market resilience to cognitive biases (Forsythe, Nelson, Neumann, & Wright, 1992; Forsythe et al., 1999). The current research is interested in the influence of social-cognitive biases on the outcome of prediction markets. Specifically, we investigate the influence of self-efficacy on the outcome of prediction markets that perform as a collective problem-solving platform:

> **H3**: Controlling for market-level knowledge, higher level of combined self-efficacy of traders in the market positively influences the collective solution

Method

Behavior of traders in prediction markets can be inferred from the market price or analyzed from transaction data. In the first case, studies analyze traders' behavior and biases by examining market price and its deviation from actual or from the expected price (Erikson & Wlezien, 2008; Forsythe et al., 1999; Rhode & Strumpf, 2006; Rothschild, 2009). To analyze the behavior of the individual trader, researchers must use transaction-level data and link it to traders' personal data. Public prediction markets do not allow access to trader-level personal data and studies that addressed individual behavior derived their data from markets that operated within organizations, where personal data on traders was accessible (Chen, Fine, & Huberman, 2004; Cowgill et al., 2008; Spears, LaComb, Interrante, Barnett, & Senturk-Dogonaksoy, 2009). To gain access to traders' personal characteristics and individual transactions, we designed an experiment and implemented prediction markets in a controlled laboratory setting that reflected a realistic environment. The markets were configured to collectively solve a complex problem, the Burglar problem, and the experiment procedure included a questionnaire by which the subjects reported their self-efficacy. A detailed description of the research instrument follows.

The Burglar Problem

> *A burglar broke into a house and filled his sacks with loot. Each sack weighs differently and contains different worth of goods. But alas!! When trying to leave the house, the burglar could not carry all the sacks with him, as the burden was too heavy.*
>
> *Help the burglar choose the sacks he is able to carry while maximizing his profit*

This seemingly naïve and simple riddle is a non-technical framing of the knapsack problem used in the fields of operational research and computer science to simulate a large family of combinatorial optimization problems. The formal presentation of the knapsack problem is:

$$\text{maximize} \sum_{j=1}^{n} p_j x_j$$
$$\text{subject to} \sum_{j=1}^{n} w_j x_j \leq W, \qquad x_j \in \{0,1\}$$

Where w_j and p_j are item j's weight and profit respectively, x_j is the selection flag for item j (in/out), and W is the weight constraint. Table 2 illustrates a sample case of the problem (the player's goal is to find X):

Table 2: Illustration of the knapsack problem

W=1500

j	1	2	3	4	5	6	7	8	9
p	37	72	106	32	45	71	23	44	85
w	50	820	700	46	220	530	107	180	360
x	1	0	1	1	1	0	0	0	1

The knapsack problem is computationally complex and solving it poses algorithmic challenges. In the general case, finding the items that form the optimal solution is computationally hard (NP-complete). Heuristics may be applied to specific cases of the problem, but there is no one-fit-all heuristic. The problem does not always lend itself to a decomposition and synthesis strategy nor to an iterative strategy. Sometimes, the solver may need to drop the current course of solution and start the process anew.

Several reasons led to the selection of the Burglar problem for the current experiment. The Burglar problem is an intellective task, which has a demonstrable correct solution, but this solution is difficult to verify. As demonstrated by Meloso, Copic, and Bossaerts (2009), the complexity of the problem can be controlled by generating instances of the Burglar problem at various levels of complexity. The naïve framing of the problem, however, is easy to comprehend. Participants can quickly grasp the idea behind the problem and focus on its computational challenges. Its computational and context-neutral nature lowers the threat to validity of the experiment that may originate from unexpected interpretations of the scenario.

The Prediction Market Platform

We used a commercial prediction market platform (www.inklingmarkets.com), which was configured with the parameters of the Burglar problem. Each stock represented a sack, and its continuous price changes reflected the opinions of traders regarding the probability of the sack to be part of the solution. Ideally, at market closing, stocks of sacks that belonged to the solution would reach the price of 100 (local currency) and the price of others be nullified. In practice, however, a stock rarely reached 100 as market activity diminished before stock prices reached this point. A market correctly solved the problem when all stocks corresponding to sacks that constitute the solution were listed highest in price. We can envision the burglar examining the market prices and selecting sacks one by one from highest scoring to lowest scoring price until he can carry no more.

The user interface of the original platform was translated to Hebrew and slightly modified to facilitate better integration into the experiment flow. The new interface combined the information required during the experiment into two screens, the marketplace main screen (Figure 2) and the trading screen (Figure 3), which opened once the trader clicked on the "quick trade" button. The main trading screen presented the Burglar problem solution form and continuously displayed market-price changes and trader's holdings. This modification made it easier for the traders to re-evaluate their own solution with respect to changing market-price signals. The platform recorded individual initial solutions to the Burglar problem, market price changes, and individual transactions for further analysis.

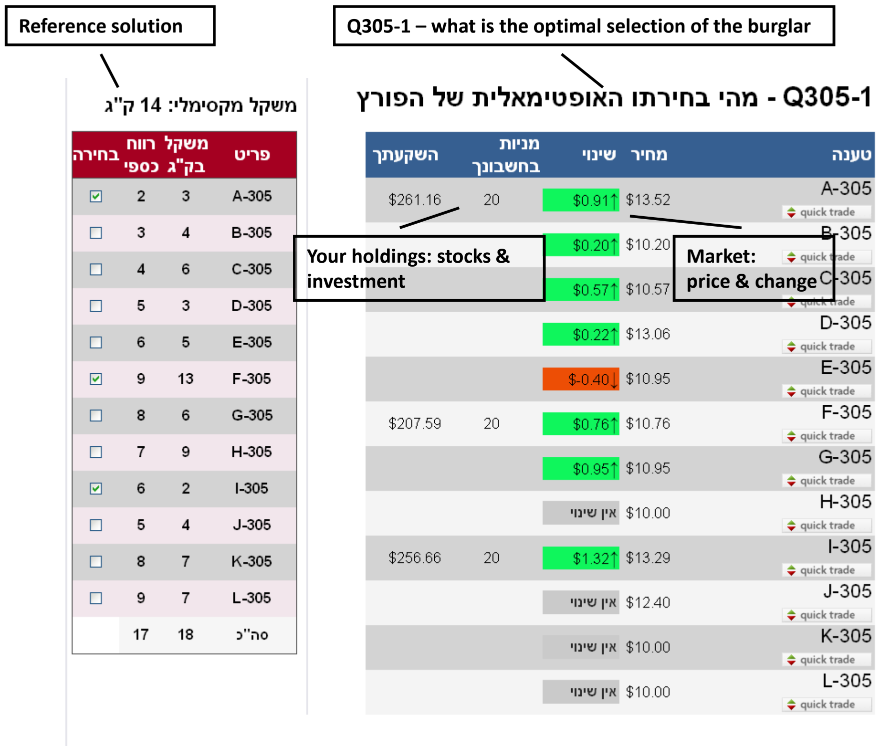

Figure 2: Marketplace screen (English translation added)

Figure 3: Trading screen (English translation added)

The Self-Efficacy Scale

Solving problems by means of prediction markets comprises of two interleaved modalities. The trading activity requires that traders apply their skills and experience in the knowledge domain to form an opinion regarding the expected outcome of a future event or a complex problem. At the same time, by understanding how the current stock price relates to the opinion they formed on the topic of trade, they need to apply their trading skills to form a transaction that will optimize the use of their funds and maximize their profits. Both task modalities involve an element of uncertainty and ambiguity, which makes the judgment of perceived efficacy even more challenging.

To capture the complex nature of the task, the design of the self-efficacy scale included two types of items (Table 3). Four of the items, Prediction Markets Self-Efficacy (PMSE), related to self-efficacy at the trading. They were based on a scale developed by Looney et al. (2006) for measuring individual perceived efficacy at utilizing online technologies to accomplish investment-related tasks such as employing investment strategy or identifying good investments.

Self-efficacy at solving the Burglar problem, Burglar Problem Self-Efficacy (BPSE), was measured by two items. The design of these items followed Bandura's (1977) recommendation for measuring unidimensional tasks along the magnitude dimension, i.e., the difficulty level, and the dimension of self-efficacy strength. All items used a 6-point Likert scale following suggestions by other researchers (Gist & Mitchell, 1992; Lee & Bobko, 1994; Marakas et al., 1998).

Table 3: The self-efficacy scale

Scale	Item
PMSE	I will succeed in applying a strategy that will maximize my profit when trading in online prediction markets
	I will succeed in identifying the correct solution while trading in online prediction markets
	I will succeed in profiting from trading in online prediction markets
	At market closing the value of my portfolio will be one of the top three in the market
BPSE	I will succeed in solving a medium level Burglar problem before the opening of the market
	I will succeed in solving a difficult Burglar problem before the opening of the market

The Experimental Procedure

Participants in an experiment, which was framed as a competition, were asked to solve a Burglar problem and trade their solution in the marketplace. The experiment combined the questionnaire for eliciting participants' self-efficacy, a burglar problem module, and a marketplace for trading individual solutions into a streamlined flow. The experiment took place in a computer lab under controlled conditions. Each participant was assigned a dedicated computer and participants were not allowed to exchange information.

Participants reported their self-efficacy by filling a questionnaire, which included demographic questions and the 6 items of the self-efficacy scale. Upon completion, the participants were exposed to the main experiment scenario.

In the main scenario, participants had two minutes to solve an instance of the Burglar problem individually and form their own solution to the problem. When time expired, participants entered the marketplace to trade their solutions. During the trading process, participants could react to market-price signals, change their original solution, and revise their trading decisions. Trading time lasted 10-12 minutes, until market activity slowed to a halt. When the market closed, the final price of the stocks reflected the collective solution and the market was resolved according to the correct solution known to the experimenter. The account balance of the participants was updated based on their holdings and was displayed on a scoreboard. The highest ranking participant received a symbolic prize.

As most of the participants were not familiar with the Burglar problem or with prediction markets before the experiment, a training stage preceded the main part of the experiment. Training was divided into two steps. First, participants were asked to cope for five minutes with the Burglar problem only. This allowed participants sufficient time to understand the problem and experiment with different solving techniques. In the second step, they trained on the complete experiment scenario. It should be noted that the threat to internal validity of the experiment was reduced as the Burglar problem does not lend itself to a fit-all heuristic, which the participant can learn during the training sessions. Furthermore, after the training sessions the participants were not informed of the correct solutions to the Burglar problems and could not objectively evaluate their performance.

The variables that were derived from the questionnaire and system logs are described in Table 4. Trader level variables were used to calculate the market level variables, which were used in the analysis.

Table 4: Analysis variables

Variable	Description	Source
t_correct*	A binary indication of the correctness of the trader's individual solution	Experiment platform logs
t_SE	Trader's self-efficacy at the task. A 6 items, 0-5 Likert-type scale	Self-report
m_correct	A binary indication of the correctness of the market solution. True if highest price ranking stocks represent all sacks that constitute a correct solution, False otherwise.	Market platform logs
m_accuracy	Complement of the Root Mean Squared Error (RMSE) of the final market price with respect to the ideal price	Market platform logs
m_knowledge	Initial knowledge in the market. The proportion of traders in the market who correctly identified the solution before entering the market	Experiment platform log
m_SE	Mean t_SE for traders in the market	Calculated

*(t=trader, m=market)

Results

632 Participants grouped in 47 markets participated in the experiments. The majority of the participants were undergraduate and graduate students, studying a variety of fields in different colleges and universities in Israel. In order to reach an older and more mature population a number of experiment sessions were conducted in a community setting, where the participants were invited to a social event that included a lecture on information markets followed by the experiment. Figure 4 describes the distribution of participants by age and gender.

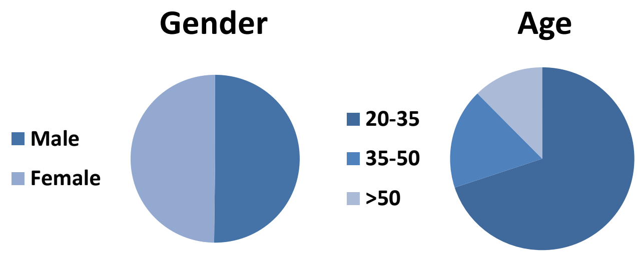

Figure 4: participants' age and gender

Individually, 21% of the traders succeeded in solving the Burglar problem before entering the market to trade. Collectively, 40% of the markets correctly identified the solution as measured by the m_correct flag (explained in Table 4). In 8 of the 47 markets no trader reached a correct solution before entering the market and none of these markets identified the correct solution. Out of the remaining 39 markets that included at least one solver, 19 markets identified the correct solution.

The trader self-efficacy scale (t_SE) demonstrated high reliability (Cronbach $\alpha = 0.935$) and formed a unidimentional scale with all items loading above 0.85 on a single factor that explained 75% of the variance.

For each market a mean of traders' self-efficacy (t_SE) was calculated to form the aggregate measure of market self-efficacy (m_SE). The mean reliability within group, the rWG index (an estimate of the interrater agreement per market), was calculated to justify the use of m_SE as an aggregate measure (LeBreton & Senter, 2008). In this case, the rWG index measured the variance of the self-efficacy of traders in a market with respect to the uniform distribution variance. Theoretically, its values may range from 0 – when market-level self-efficacy is completely random – to 1 – when all traders in the market exhibit the same level of self-efficacy. The resulting mean value of 0.63 (n=47 markets) was slightly below the recommended value of 0.7 (Cohen, Doveh, & Eick, 2001).

The correlations presented in Table 5 demonstrate that market-level knowledge is positively correlated with market accuracy and so is market-level self-efficacy, but to a lesser extent. A positive correlation is also evident between knowledge and self-efficacy.

Table 5: Market-level correlations

	accuracy	knowledge	m_SE
Knowledge	$.628^{**}$		
m_SE	$.329^{*}$	$.339^{*}$	
Mean	-.611	.22	2.53
SD	.135	.162	.403

$^{*}p<0.05$, $^{**}p<0.001$

Hierarchical regression was applied to determine the marginal contribution of market-level self-efficacy to the initial market-level knowledge in predicting the accuracy of the market. Knowledge was introduced first to the model, followed by m_SE. With all variables in the equation, the model was statistically significant ($F(2, 44)=15.27$, $p<0.001$) and the adjusted R^2 indicated that the model predicted 38% of variance in market accuracy. It is, however, evident from Table 6 that market-level self-efficacy did not contribute to the model.

Table 6: Market accuracy hierarchical regression

Step	Variable	R^2 change	F change	β
1	knowledge	.394	29.317	.584**
2	m_SE	.015	1.132	.131

***P*<0.001

Discussion

Crowdsourcing for solutions to scientific, business and other problems has become common and is supported by commercial platforms, e.g., Innocentive (www.innocentive.com) and NineSigma (www.ninesigma.com), as well as non-commercial platforms such as Nasa Tournament Lab (http://www.nasa.gov/coeci/ntl) and Challenge.gov. By providing access to independent and diverse individual problem solvers, crowdsourcing platforms facilitate original solutions to complex problems. These platforms, however, support processes that are sponsored by an organization and the "crowd" is directed and managed by these organizations. They do not entail collaboration, coordination, or aggregation mechanisms that facilitate collective problem solving (Brabham, 2012). The current research studied the process of collective problem-solving by collective-intelligence platforms, prediction markets, which facilitate online collaboration among individual problem-solvers through online interactivity and lie on the lightweight end of the social cohesion spectrum of social computing platforms (Budhathoki & Haythornthwaite, 2013). The Discussion will first elaborate on the interplay between the technical and functional perspectives of self-efficacy at computer mediated problem-solving and will then explain how prior knowledge and self-efficacy influence collective solutions in online collaborative environments.

Trading individual solutions on prediction markets involves two distinct yet interwoven activities. Traders process information and knowledge to form their own solutions to the problem and at the same time, they need to evaluate market signals conveyed through the market price, and decide whether to take an action in the market or revise their solution. If they decide to trade, they need to transform their judgment into a buying or selling transaction in a manner that will optimize the use of their funds and maximize their profits. The complexity of the task and the operational environment called for two self-efficacy measures (Table 3): PMSE measured self-efficacy at trading in prediction markets, and BPSE measured self-efficacy at solving the burglar problem. Hypothesis H1, which assumed that the measurement of self-efficacy at trading individual solutions on prediction markets will yield two distinct constructs, rested on previous studies (Compeau & Higgins, 1995; Looney, Valacich, & Akbulut, 2004; Marakas et al., 1998).

Factor analysis of PMSE and BPSE rendered a unidimensional construct, implying that participants did not differentiate between their efficacy at solving the Burglar problems and at trading on prediction markets, as a result H1 is rejected. We suggest three possible explanations. The first claims that since the two tasks are interleaved, the relation between their related efficacy beliefs is not straightforward. The second explanation looks into aspects of experience and familiarity with the task and the third suggests that the framing of the task has an important role in forming efficacy beliefs. In the following we unpack these explanations.

Looney et al. (2006) distinguish between activities that involve different skills, each confined to a discrete domain, and activities that employ a blend of skills from two or more domains. In their study of online financial trading they viewed computer self-efficacy and investment self-efficacy as two distinct components, but combined online trading self-efficacy and perceived efficacy at making the investment decisions into single construct that consisted of items in the form of: "I can use an online investment web-site to choose investments wisely". It is suggested that as the use of computer is more common in daily activities, especially for the millennial generation, self-efficacy at both task components is blended into a single perception and individuals do not distinguish between their technical and functional efficacies. This may call for a revisit of earlier studies in the area of computer self-efficacy.

The dynamics of and interplay between the technical and functional components of composite tasks, from the perspectives of performance and self-efficacy, mature over time as experience builds up (Agarwal, Sambamurthy, & Stair, 2000; Mackay & Elam, 1992). Mackay and Elam (1992) found that expertise in the computerized tool dominated the performance in the problem-solving task and that functional knowledge was not enough to overcome lack of technical proficiency. Agarwal et al. (2000) demonstrated that while computing self-efficacy has a significant effect on the perceived efficacy in training of the first computer application, its effect diminishes at the training of the next application. As most participants were not familiar with the Burglar problem or trading on prediction markets, we may assume that self-efficacy at trading, i.e., the technical skill, dominated the perceived efficacy at solving the Burglar problem and was the one that was actually measured. Additional research, which would manipulate the maturity level of the two self-efficacy components, can provide further insights into the maturation process of self-efficacy in composite tasks.

Prior studies defined measurement models for self-efficacy at composite tasks by focusing on the skill-sets required to accomplish the task (Agarwal et al., 2000; Compeau & Higgins, 1995; Looney et al., 2006; Marakas et al., 1998). The lack of discrimination between the perceived efficacies at the two skill components may suggest that cognitive processes that build efficacy beliefs focus on the outcome of the activity rather than on the resources that are required to accomplish it. The participants in our experiment were advised that as individuals, success would be measured by the value of their account at market closing. They must have been aware that success in solving the problem would improve the chances of personal success; however, the measurement of their personal success was linked to the market and not to the problem. We offer here a new perspective to understanding the roots of efficacy beliefs and suggest that when individuals judge their efficacy, they do not distinguish between the skill-sets that they apply; instead they focus on the stated performance measure. This hypothesis, however, requires further research.

Another objective of this research was to evaluate the effectiveness of prediction markets as a collective problem-solving platform and their resilience to behavioral biases. Benchmarking the effectiveness of group processes dates back to early research in the field. Scholars compared the percentage of individuals who correctly solved a problem to the percentage of groups who solved the same problem and demonstrated that groups were more effective in solving an intellective problem (Shaw, 1932). Later researchers claimed that this averaging method does not reflect the potential of the collective process and that the effectiveness of the group should be evaluated with respect to the effectiveness of the best of its members, especially for problems that cannot be decomposed into discrete components (Steiner, 1972).

The current research demonstrated that while 21% of the traders correctly solved the problem before entering the market, 40% of the markets reached the correct solution when measured by the m_correct flag. This means that the market mechanism significantly amplified the ability of the average individual to solve problems. However, when looking at market performance through the "best member" performance lens, we see that markets with no individual solver did not identify the correct solution, and only 50% of the markets that included at least one correct solver arrived at the correct solution. Does this mean that prediction markets are not effective platforms for collective problem-solving? We claim that the effectiveness of social computing platforms in solving problems should be measured by the averaging method and not by the best member method.

When an expert or knowledgeable person in a certain domain is available, there is no need to revert to methods of collective problem solving. However, it is often the case that finding the best problem-solver is like finding a needle in a haystack. Crowdsourcing platforms like Kaggle and Innocentive offer prizes and rewards in order to draw the best problem-solvers out of the "crowd". Social computing platforms take a different approach. They facilitate access to a large diverse pool of potential problem solvers and information resources with no guarantee that the best problem-solver is present in the group. At the same time, they provide an infrastructure such as an environment of social interaction, community building and aggregation methods, with the hope that the combined effort will produce a good collective solution. As it is not guaranteed that the expert participates in the collective effort, it is suggested that the performance of social computing platform be measured by comparing the probability of the group coming up with the correct collective solution to that of the average individual. Based on this consideration we suggest that prediction markets are an effective problem solving platform, confirming hypothesis H2. Furthermore, this research claims that by adding an aggregation mechanism to crowdsourcing platforms, the process of problem-solving can significantly improve.

In line with the efficient markets theory (Fama, 1970), the analysis of the data exhibited a high positive correlation between the performance of the market, measured by its accuracy, and the knowledge that traders introduced to the market ($r=.628$, $p<0.001$). The aim of this research was to investigate the effect of self-efficacy, a personal social-cognitive disposition, on the collective solution. While market-level self-efficacy positively correlated with the accuracy of the market ($r=.339$, $p<0.05$), a hierarchical regression model demonstrated that it did not contribute to the market accuracy beyond the prior knowledge of the traders. By rejecting hypothesis H3, this research supports the position of the neoclassical economists and demonstrates that the market mechanism is robust and prediction markets are resilient to self-efficacy biases.

This research relies on two theories that touch on social influence. Self-efficacy is a social-cognitive theory that suggests that personal efficacy beliefs are mainly affected by the experience of personal mastery, yet affective and social factors, such as vicarious experience and verbal persuasion, also play a role in the formation of the perception of self-efficacy. Theories of normative and informational influence explain social influence in group processes. Normative influence theory focuses on the position of the individual in the group, emphasizing motives such as seeking social rewards and interpersonal relations. Informational influence theory emphasizes the task dimension and the drive of the individual to reach an accurate outcome.

In prediction markets, the potential of normative influence is low as persistent social structures are not created. Informational influence, however, may be present as the traders derive cues about the opinions of other traders from the changing market price and the amount of stocks traded (Guarnaschelli, Kwasnica, & Plott, 2003). These cues can be interpreted as vicarious experience, which play a role in self-efficacy perception. The other social factor that affects self-efficacy, verbal persuasion, does not play a role in this case as traders in real-life are anonymous and in this experiment were asked not to interact with each other. Kaplan and Miller (1987) show that informational influences are predominant in groups that deal with intellective issues; it was therefore hypothesized that self-efficacy perception of the individual will affect the collective outcome. In the case of prediction markets, this hypothesis was rejected.

It would be interesting to investigate the influence of self-efficacy in collaborative problem-solving platforms that exhibit more cohesive social structures. Two potential candidates for such research are Polymath (Ball, 2014; Cranshaw & Kittur, 2011) and MathOverflow (Tausczik, Kittur, & Kraut, 2014). The first addresses complex mathematical problems and incorporates an established governance structure. The second is geared towards smaller mathematical problems and engages a broad community of mathematicians, who are rewarded with kudos and badges.

Conclusion

The objective of this research was to understand the manifestation of individual self-efficacy in collective-intelligence processes and specifically, its effect on the collective outcome of prediction markets that function as a problem-solving platform. To this end, 632 participants traded in 47 markets possible solutions to a complex, structured problem, the Burglar problem. Findings show that prediction markets form an effective instrument for solving complex structured problems. On average, the collective solution of the market was better than the individual solution as 40% of the markets produced a correct solution to the problem vs. 21% of the individuals who succeeded in solving the problem. This confirms hypothesis H2, which states that prediction markets perform better than individuals at solving complex problems. Hypothesis H3, which states that controlling for market-level knowledge, higher level of combined self-efficacy of traders in the market positively influences the collective solution, was rejected. Individual self-efficacy had no contribution to the quality of the collective outcome beyond the knowledge that participants introduce into the prediction market. These findings indicate that (a) the aggregation mechanism of prediction markets, the market's price function, is efficient and is resilient to biases that may arise from individual perceived efficacy and (b) the market aggregates knowledge rather than affective influences.

Another important finding of the research relates to the measurement of self-efficacy at computer-mediated knowledge tasks, specifically those performed in a collective environment. It stems from the rejection of hypothesis H1, which states that problem solving self-efficacy in prediction markets yields two distinct constructs that distinguish between efficacy beliefs at trading and problem-solving. The research demonstrated that although the task of trading in prediction markets involves two distinct skill-sets, one that relates to the knowledge component of the task and one to its technical aspect, individuals perceive their activity in the task as holistic. From the perspective of their self-efficacy, the participants did not differentiate between the two components. This finding contests earlier models of self-efficacy in the area of computer-mediated activities that differentiate between computer proficiency and the knowledge skills. One of the reasons may be that computers are no longer regarded by us as a tool but rather as a transparent extension of our cognitive faculties.

The contribution of this research is two-fold. It enhances self-efficacy theory with the understanding of self-efficacy at tasks that combine technical and functional components, tasks that are common in today's daily activities. Furthermore, it contributes an additional perspective to the effectiveness of prediction markets as collective decision-making and problem-solving mechanism. The findings substantiated their position as a collective platform within the plethora of organizational social computing platforms.

The research focused on collective problem-solving using prediction markets. It addressed only one of the four categories of cognitive tasks that can benefit from social computing environments, problem-solving, and studied it on a platform that entails limited social interaction. Further research in needed to confirm that the findings of the current research hold for tasks of choice, judgment, and estimation that are performed in cooperative computer mediated platforms with more cohesive social structures.

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An Assessment of Competency-Based Simulations on E-Learners' Management Skills Enhancements

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Abstract

There is a growing interest in the assessment of tangible skills and competence. Specifically, there is an increase in the offerings of competency-based assessments, and some academic institutions are offering college credits for individuals who can demonstrate adequate level of competency on such assessments. An increased interest has been placed on competency-based computer simulations that can assist learners to gain tangible skills. While computer simulations and competency-based projects, in general and particularly in management, have demonstrated great value, there are still limited empirical results on their benefits to e-learners. Thus, we have developed a quasi-experimental research, using a survey instrument on pre- and post-tests, to collect the set of 12 management skills from e-learners attending courses that included both competency-based computer simulations and those that didn't. Our data included a total of 253 participants. Results show that all 12 management skills measures demonstrated very high reliability. Our results also indicate that all 12 skills of the competency-based computer simulations had higher increase than those that didn't. Analyses on the mean increases indicated an overall statistically significant difference for six of the 12 management skills enhancements between the experimental and control groups. Our findings demonstrate that overall computer simulations and competency-based projects do provide added value in the context of e-learning when it comes to management skills.

Keywords: competency-based projects in e-learning, simulations in e-learning, managerial skills enhancements, management skills in e-learning, self-reported skills.

Introduction

Recently, Competency-Based Learning (CBL) has been debated in higher education and professional development training, including in for-credit professional re-certification courses. According to the United States (U.S.) Department of Education, CBL enables learn-

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ers to "master academic content regardless of time, place, or pace of learning" (U.S. Department of Education, 2013). Such programs include "online and traditional courses, dual enrollment and early high schools, project based and community based learning, and credit recovery (i.e. Diploma Plus)" (U.S. Department of Education, 2013). Moreover, this strategy employs various teaching methodologies, while providing learners with the credits for the learning opportunities gained via lifelong experiences or other means by demonstrating adequate skill levels (i.e. competence) (Hyman, 2012). Learners can access preferred learning methodology that provides them with academic experience to develop and enhance specific skills needed to support their working careers. For example, the ability to make good decisions when faced with complex situations, the ability to research information in order to identify a solution, the ability to set goals and work towards achieving these goals, as well as the ability to communicate well are all skills needed in a number of organizations. Subsequently, learners can assume positions with little training on the job, and greater confidence (Gravill, Compeau, & Marcolin, 2006). CBL strategy can deliver greater flexibility, efficiency, and lower costs to learners, while at the same time, cultivating greater employability. The aim of CBL is to create various paths to college education, while taking advantage of innovative information system technologies not as part of traditional in-class education but rather as an online skills enhancement tool by itself. Such tools are not reserved only for adults. For example, Generation Z have been using popular CBL to develop their own Science, Technology, Engineering, and Math (STEM) skills including Websites such as Khan Academy (www.khanacademy.org), Reading Plus (www.readingplus.com), or the Stanford's Educational Program for Gifted Youth (EPGY) (epgy.stanford.edu) to name a few. Moreover, over the past several years there has been a growing use of free and open tools such as YouTube, iTunes U, online courses, Web 2.0, Massively Open Online Courses (MOOCs), digital books, and digital notes. While a significant number of research studies has been done on the benefits of computer simulations as a skill development tool, the majority of such studies have focused on using the tools as part of face-to-face courses or to augment traditional learning modalities. However, there is a very limited number of research studies that have been conducted on the measurements of skill enhancements in fully online courses and programs, as opposed to measuring the benefits of such computer simulations as well as competency-based projects to augment in-class courses (Levy, 2005). Additionally, there are still limited empirical results on the use of computer simulations and competency-based projects being used as part of fully online learning courses. Thus, in this paper we have developed a quasi-experimental research using such instrument on pre- and post-tests to collect the set of 12 management skills from learners attending fully-online courses, including competency-based computer simulations and those that didn't. Therefore, the main research question guiding our study was:

RQ: What is the effect of *computer simulations and competency-based projects* on *management skills enhancement* in online learning courses?

Literature Review

E-Learning and Life-Long Learning

The significant growth of e-learning systems has been well documented in literature as over the past two decades (Geri, 2012; Levy, Ramim, & Hackney, 2013). While e-learning systems have been extensively used for academic content delivery, they have been also adopted and integrated into business use, especially when it comes to corporate training and ensuring knowledge continuity in the organization (Koohang & Paliszkiewicz, 2013). As the 21st century is characterized as the 'knowledge economy', one of the most significant organizational assets is the knowledge of employees (Koohang, Paliszkiewicz, Nord, & Ramim, 2014). As such, the demand to corporate and organizational knowledge delivery increases, while e-learning has been in the forefront of life-long learning tools available for employees when it comes to human resources (HR) training, professional certifications, annual credit attainment, and alike (Gafni & Geri, 2010).

Nowadays, e-learning plays a significant role in an employee's knowledge acquisition and an efficient way for organizations to ensure their workforce is up to par with the latest developments that pertains to their work. Accordingly, one of the major roles of e-learning when it comes to knowledge acquisition is the assisting in skill enhancement, that can immediately be translated to better employee efficiency (Levy, 2005). Moreover, over the years employees are promoted to become managers in various organizations, while having very limited management skills (Rubin & Dierdorff, 2009). Acquiring management skills is not an easy task; however, it appears that e-learning content delivery can provide an efficient and cost effective way of doing so. Moreover, literature suggests that computer simulations do have positive impact on employee skills (Noy, 2014; Noy, Raban, & Ravid, 2006). However, there appear to be very limited research related to the role of online simulations and more specifically, the use of competency-based simulations in e-learner's management skills enhancements. As such, this study attempts to fill the gap by trying to assess the benefits of competency-based simulations that are delivered via e-learning systems. More precisely, it attempts to see if these competency-based simulations delivered to e-learners during their academic courses exert significant enhancement to their management skills.

Skills and Competencies

Skills have been the cornerstone of all mankind development (Brown, Green, & Lauder, 2001). According to Rasmussen (1983), skills are critical for human functioning as a foundational block for good performance in any task provided. Brown et al. (2001) emphasized the centrality of skills for human development by indicating that "it is widely argued that global economy competitiveness rest on the knowledge and skills of the workforce" (p. 1). Additionally, Brown et al. (2001) outlined the Human Capital Theory and its role in the economy prosperity of nations. They indicated that over the past 230 years human capital has been treated homogenously with more or less the same rate of productivity. Moreover, the need to increase organizational productivity has been tied directly to the increase of volume of machinery and employees that operate such machines. However, Brown et al. (2001) criticized such approaches by indicating that as globalization increases and the shift to knowledge economy is in full-force, there must also be a re-focusing of the theories to account the significant differences between employee skills as the single most important factor contributing to organizational productivity and ultimately success. Therefore, over the past several decades, companies are demanding incoming employees to be competent on the job, especially the educated workforce coming with academic degrees (Piccoli, Ahmad, & Ives, 2001). As such, hiring managers expect that academic programs will prepare their graduates with the right skills set that can be applied upon hiring (Lee & Mirchandani, 2010; Torkzadeh & Lee, 2003). For example, in the medical and health professions, a significant part of academic courses is devoted to skill enhancements (Berendonk, Stalmeijer, & Schuwirth, 2013). Moreover, the emphasis in medical programs is to develop, as well as enhance, the "skills and qualities doctors need to have to care for patients" (Morcke, Dornan, & Eika, 2012, p. 856). According to Boyatzis and Kolb (1991), a skill refers to a "combination of ability, knowledge and experience that enables a person to do something well" (p. 280). Thus, when medical and health professionals (i.e., surgeons, physicians, nurses, therapists, etc.) graduate from their academic degree program, they are required to demonstrate the skills that they have learned during their academic experience. That high-level of demonstrated skills (i.e., competency) is expected for certification and licenses (Bronsburg, 2011; Morcke et al., 2012). Beaudoin, Kurtz, and Eden (2009) introduced a definition based on prior literature that claimed competencies to be "a specialized system of abilities, proficiencies, or dispositions to learn or do something successfully, or to reach a specific goal, prerequisites for meaningful activities and which are influenced through experience and learning" (p. 277). This competency achievement philosophy is consistent with the models of the U.S. Department of Labor (2015), that developed subject specific competency models.

In some academic fields, such as medicine and engineering, the focus is almost exclusively on academic knowledge transfer for the purpose of skills development (i.e., "what we *need* students to *demonstrate* they know"). In other academic fields such as management, including information systems, a significant number of academic institutions appear to focus on academic knowledge transfer, for the purpose of content delivery and learning outcomes (i.e., "what we *want* students to know"), and less on skill development that is so crucial for employability (Compeau & Higgins, 1995; Kayworth & Leidner, 2000). Having said that, computer simulations and competency-based projects have a significant role in helping learners hone such skills. In general, while their use is not widespread as in other fields, computer simulations and competency-based projects have demonstrated great value in management education (Keys & Wolfe, 1990; Noy, 2014; Noy et al., 2006). Furthermore, research studies have demonstrated that computer simulations and competency-based projects can indeed assist in providing students with achieving fundamental skills that are needed upon graduation (Keh et al., 2008; Koh et al., 2010). In order to demonstrate the linkage between skills and competencies, Figure 1 highlights the relationship between the two (i.e., skill level & competency level), while providing a theoretical framework for this study.

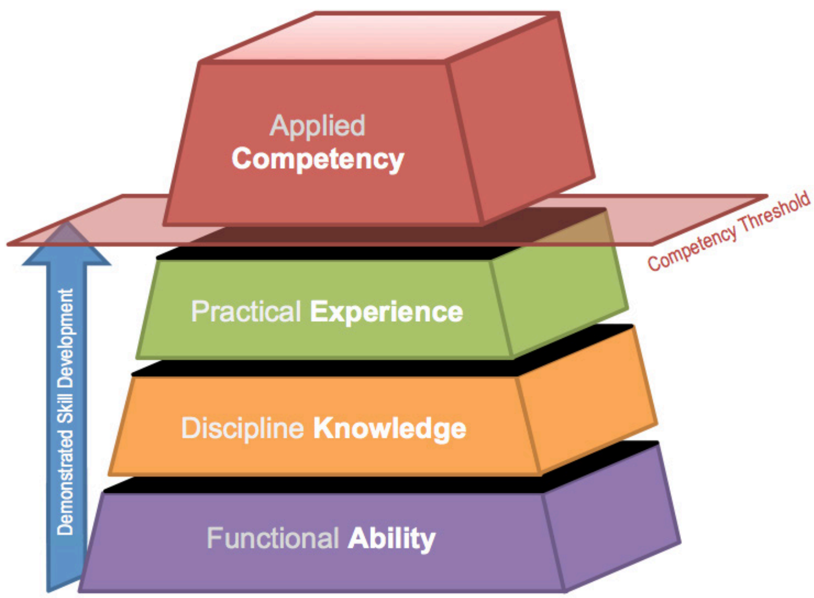

Figure 1. The Competency Pyramid: Relationship Between Skill Development and Competency Level

Methodology

Instrument

Self-reported instruments to measure skills have been criticized over the years for their internal validity (Carlton & Levy, 2015). However, some scholars indicate that there is still validity in using such measures when it comes to complex multivariate procedural-type skills (Gravill et al., 2006; Jacobs & Roodenburg, 2014). Thus, this quantitative study used a survey-based instrument to collect the skills from participants using a self-reported approach. This study built on the instrument used by the seminal work of Boyatzis and Kolb (1991, 1995), who developed a self-reported instrument to measure 12 management skills that pertain to businesses and are expected from a student graduating from management programs. Specifically, the core use of their measures was to compare the enhancements of skills over an academic experience, be it a course or a full program, where students are engaged in skill enhancements activities. Such skills are critical for those graduating from academic institutions, as these individuals are the future workforces including future managers. Given that management skills are challenging to measure, scholars in the field agree that self-reported skill level assessments are acceptable and indeed one of the ways to know what an individual feels about their own competence level when it comes to procedural-type skills (Gravill et al., 2006). As such, we have developed a study to collect the set of 12 management skills using a 36-item instrument (three items per skill) from online courses that included computer simulations compared with a control group of those that didn't experience the simulations, but were in other sections of the same management courses. The instrument scale ranged from 1='no skill or ability' to 7= 'I'm an expert in doing this'.

Experimental Design and Simulations

This study was designed as a quasi-experiment, given the fact the control over the assignment of participants was by the university's registration system (Levy & Ellis, 2011). The control group included one course in Project Management in the undergraduate level and one course in Management Information Systems at the graduate Masters of Business Administration (MBA), distributed about equally. The experimental group included two courses in Project Management in the undergraduate level and two courses in Management Information Systems at the graduate MBA, distributed about equally. The same professor taught all courses fully-online, however, given adjustment in accreditation and/or course objective requirements, computer simulations were introduced. The control group included the content covered in a regular e-learning fashion: weekly discussion board assignments, quizzes on chapter readings, current event papers, as well as a final exam. The experimental groups included online simulation via WileyPLUS (https://www.wileyplus.com/) of an SAP® Enterprise Resource Planning (ERP) project for the graduate MBA students and the use of Microsoft Project™ 2010 for the undergraduate students. Graduate students were asked to conduct several ERP modules within WileyPLUS to understand business processes, while undergraduate students were ask to use Microsoft Project™ to develop a project documentation report with Work-Based Structure (WBS), budget planning, resource allocation, as well as the project's Gant chart.

Data Collection

We developed a Web-based instrument to assess the 12 management skills using the 36 survey items along with some demographics information to ensure the groups were relatively similar. The instrument was fully anonymous and informed participants that there is no right or wrong answer, while they should do their best to provide a self estimation of their actual skill level that corresponds to their combined ability, knowledge, and experience for each of the given item asked. A definition of skill was provided to the participants at the top of the survey. Each group of students was asked to take the survey at the start of the term, and then asked to take it again at the end of the 16-week term (The Fall and Winter terms where 16 weeks long, but the Summer term was 14 weeks long). Data was collected during the 2012-2013 academic year (summer included).

Results

A total of 253 surveys have been collected over the four groups (pre-test control group, pre-test experimental group, post-test control group, & post-test experimental group). Table 1 provides the gender distribution of the learners who participated in all four groups. We have attempted to ensure that those who have taken the pre-test also will complete the post-test, however, given the nature of the quasi-experiment and real-life settings, a few students either dropped or elected not to further participate in the post-test survey, which explains the drop in the post-test sample size.

Table 1: Gender Distribution of the Learners

Test	Gender	Control Group Frequency	Control Group Percentage (%)	Experimental Group Frequency	Experimental Group Percentage (%)
Pre-Test	Female	21	42.0%	37	44.0%
	Male	29	58.0%	47	56.0%
		50		84	
Post-Test	Female	21	42.9%	31	44.3%
	Male	28	57.1%	39	55.7%
		49		70	

As part of the data analysis, we have verified the reliability of the 12 management skills using Cronbach's Alpha (Cronbach, 1951). Alpha levels of 0.7 and above have been reported to indicate strong reliability for the constructs (Boudreau, Gefen, & Straub, 2001; Straub, 1989). Table 2 provides the outcome of this analysis, which suggests that all 12 skills demonstrated very high reliability ranging from Cronbach's Alpha of 0.835 to 0.955.

Table 2: Cronbach's Alpha Reliability Analysis for the 12 Management Skills Measures

Management Skills	No. of Items	Cronbach's Alpha
Help Skills (HLS)	3	0.835
Adapting Skills (ADS)	3	0.898
Planning Skills (PLS)	3	0.870
Information Gathering Skills (IGS)	3	0.853
Information Analysis Skills (IAS)	3	0.899
Quantitative Skills (QNS)	3	0.916
Technology Skills (TCS)	3	0.952
Goal-Setting Skills (GSS)	3	0.955
Action Skills (ACS)	3	0.886
Initiative Skills (INS)	3	0.919
Leadership Skills (LSS)	3	0.952
Relationship Skills (RES)	3	0.920

Prior to investigating the skill increase, an Analysis of Variance (ANOVA) for the 12 management skills was conducted to check if the pre-test of both groups is similar (Terrell, 2012). Our findings indicate that 10 out of the 12 skills were not significantly different on the pre-tests between the experimental and control groups (p ranged from 0.167 to 0.836), aside from the LSS and RES, which were slightly lower p-values (p_{LSS}=0.018 & p_{RES}=0.053) for the pre-test of the control group compared to the pre-test of the experimental group. Figure 2 provides the star-graph view for the 12 management skills on the pre- and post-test for the control group.

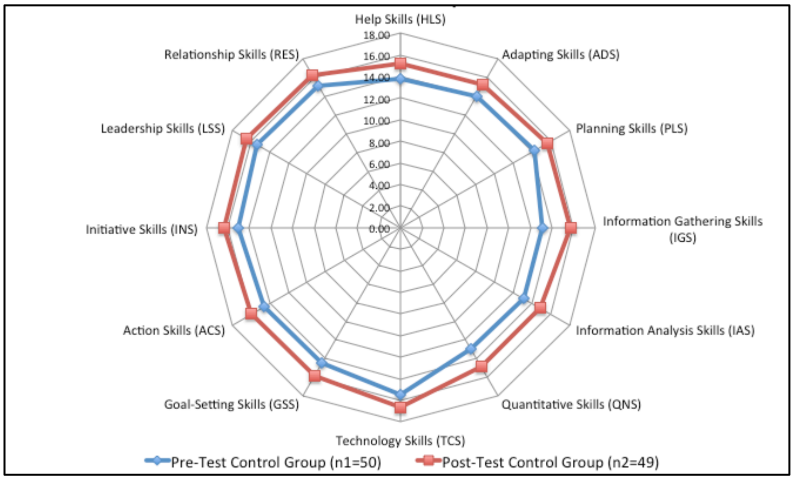

Figure 2. The 12 Management Skills for Pre- and Post-Tests Control Group (n_1=50, n_2=49)

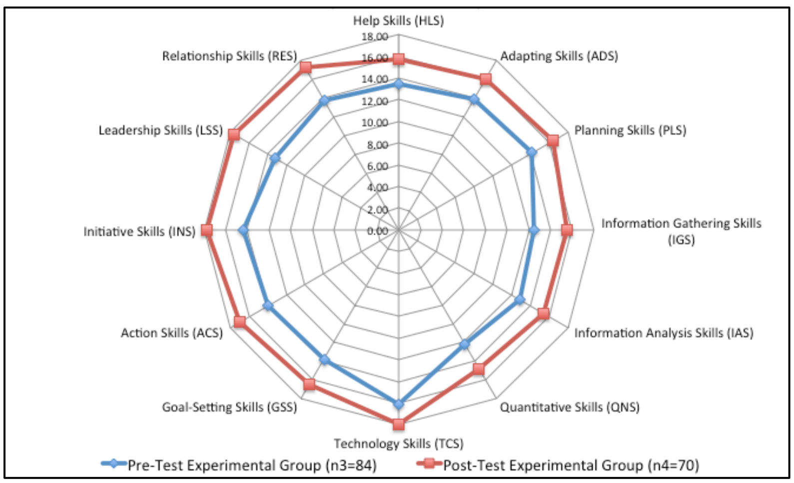

Figure 3. The 12 Management Skills for Pre- and Post-Tests Experimental Group (n_3=84, n_4=70)

In addressing the main RQ, we have conducted a t-test on the mean increases of the overall total management skills enhancement differences between the experimental group enhancements (Δ_{EG}) and control group enhancements (Δ_{CG}). The results indicate that although the overall management skills mean total for the pre-test control group was slightly higher than the mean total for the pre-test of the experimental group (171.52 vs. 164.29), the experimental group demonstrated a significant (p<0.001) enhancement of the total management skills in the post-test compared to the control group (189.05 vs. 197.85). Figure 3 provides the star-graph view for the 12 management skills on the pre- and post-tests for the experimental group (See Table 3). Figure 4 provides the star-graph view for the mean *increases* (i.e. Δ_{skill}) in the 12 management skills for the experimental and control groups.

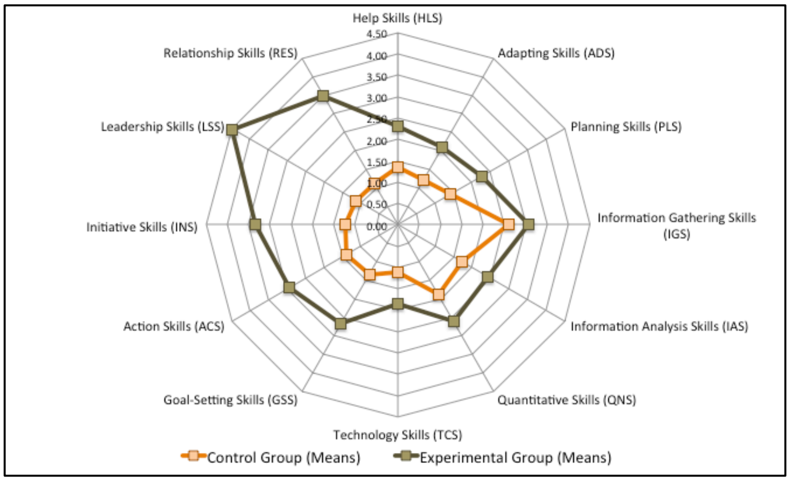

Figure 4. The 12 Management Skills Mean Enhancements for Control vs. Experimental Groups

Table 3 provides an overview of the whole study results including the means and standard deviations (SD) scores for the pre-test of the control and experimental groups, the post-test of the control and experimental groups, the mean *increases* (i.e. Δ_{skill}) of the two groups, along with the ANOVA results for the mean increases and significance levels of the 12 skills based on the aggregated scores, as well as the t-test of the overall total management skills enhancement differences between the two groups.

Table 3: ANOVA Results for the 12 Management Skills Enhancement Differences for Control vs. Experimental Groups and t-test of Overall Total Management Skills Enhancement Differences

Management Skills	Pre-Test Control Group (n1=50) Means	SD	Pre-Test Experimental Group (n2=84) Means	SD	Post-Test Control Group (n3=49) Means	SD	Post-Test Experimental Group (n4=70) Means	SD	Skills Enhancement Control Group (Means)	Skills Enhancement Experimental Group	ANOVA F	Sig.	
Help Skills (HLS)	13.82	3.28	13.47	3.90	15.16	2.51	15.77	3.70	1.34	2.30	8.91	0.041	*
Adapting Skills (ADS)	14.02	3.64	13.90	3.45	15.25	3.10	16.00	3.37	1.23	2.10	4.26	0.108	
Planning Skills (PLS)	14.30	3.90	14.20	3.43	15.72	2.96	16.46	2.76	1.42	2.26	13.65	0.021	*
Information Gathering Skills (IGS)	13.10	3.73	12.47	3.48	15.70	3.33	15.54	3.50	2.60	3.07	2.47	0.191	
Information Analysis Skills (IAS)	13.12	4.07	12.94	3.18	14.86	3.29	15.38	3.43	1.74	2.45	1.04	0.366	
Quantitative Skills (QNS)	12.96	4.44	12.16	3.62	14.84	3.36	14.77	3.42	1.88	2.61	4.41	0.104	
Technology Skills (TCS)	15.50	4.08	16.08	4.41	16.61	3.90	17.92	3.43	1.11	1.84	6.11	0.069	
Goal-Setting Skills (GSS)	14.50	3.73	13.78	3.83	15.84	3.40	16.46	3.50	1.34	2.69	19.28	0.012	*
Action Skills (ACS)	14.56	3.84	13.98	3.76	15.96	2.97	16.92	2.69	1.40	2.94	11.04	0.027	*
Initiative Skills (INS)	15.06	3.91	14.35	3.67	16.28	3.32	17.69	2.56	1.22	3.35	59.42	0.002	**
Leadership Skills (LSS)	15.38	4.40	13.14	4.79	16.51	3.28	17.62	2.93	1.13	4.47	302.45	0.000	***
Relationship Skills (RES)	15.20	3.70	13.82	3.30	16.32	3.01	17.31	2.93	1.12	3.49	30.45	0.005	**
											t	Sig. (2-tailed)	
Total Management Skills -->	171.52		164.29		189.05		197.85		17.53	33.56	10.52	0.000	***

* - p< 0.05, ** - p< 0.01, *** - p< 0.001

Discussions

While it is evident from the results that all 12 management skills were enhanced via the courses that incorporated computer simulation and competency-based projects, the amount of increase vary slightly among the skills set, which is consistent with prior literature (Keh et al., 2008; Koh et al., 2010). For example, it was observed that the most significant for the degree of increases were (in order of p-values) on leadership skills (LSS), initiative skills (INS), relationship skills (RES), goal-setting skills (GSS), planning sills (PLS), actions skills (ACS), and help skills (HLS). Marginal degree of significance for the increase was observed for technology skills (TCS), while non-significance for the degree of increases were observed for quantitative skills (QNS), adaptive skills (ADS), Information gathering skills (IGS), and information analysis skills (IAS). The most interesting finding that we encountered was that while technology skills, information gathering skills, and information analysis skills were originally anticipated to have the most significant increases, the simulation and competency project used might not have placed emphasis on these skills. This is somewhat paradoxical given that the treatment was the use of online computer simulations. It is speculated that given the type of participants and generation Z participants, the data indicated otherwise. Additional research is needed to uncover these specific issues, including investigation of the specific sub-types of such skills. For example, technology skills may need to be focused more on specific technologies or areas such as Information Technology (IT) skills, Cybersecurity skills, research and analysis skills, and so on.

Study Limitations

This quasi-experiment exhibits several limitations. The first limitation of this study includes the fact that the data collection was conducted at only two institutions. Moreover, the second limitation of this study includes the use of a single professor and narrow type of courses (Project Management & MIS); although the focus of the work was on the simulation, use of additional diverse professors may provide different results.

Recommendation for Future Research

Additional experimentations are needed to uncover the benefits of computer simulations and competency-based projects in skill enhancements within academic courses. Moreover, future work can explore further skills beyond those measured here, where it can also be focused on the specific academic program and profession category under study. Moreover, future work may further study why learners felt that the simulations helped skill development using qualitative investigation techniques. Also, there is a potential to introduce new simulations and competency-based projects, to address those specific skills that were observed to have smaller degree of skill enhancements, something that may also require additional investigation as well. Also, there is merit to understanding the interactions between learners-to-learners and learners-to-instructor in building skills towards the highest competency levels.

Conclusions

This research investigated the role of computer simulations and competency-based projects on a set of 12 management skills during online courses. This study included a 2x2 quasi-experimental design with a control group and an experimental group (not randomly assigned), that comprised of both a pre-test and a post-test assessment of the 12 management skills. Overall, six courses – three undergraduate and three MBA courses – were included. A comparison between the two pre-test groups (experimental vs. control) showed no significant differences on 10 of the 12 skills, which indicates that the base-comparison is adequate, given that we had no say on the allocation of participants into the groups. Our experimental comparison indicated that, while both groups experienced significant increases in a majority of the skills, the experimental group that included computer simulations and competency-based projects demonstrated an overall significant ($p<0.001$) enhancement in the 12 management skills combined, whereas, individually, seven skills demonstrated a significant mean increases, where the rest demonstrated not significant, yet still positive increases by the experimental group over the control group. Such results indicate that overall, there is a credible value for the use of computer simulations and competency-based projects as an important component of e-learning content delivery when the focus is to increase skills in general, and managerial skills in particular.

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ICT Use: Educational Technology and Library and Information Science Students' Perspectives – An Exploratory Study

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Abstract

This study seeks to explore what factors influence students' ICT use and web technology competence. The objectives of this study are the following: (a) To what extent do certain elements of Rogers' (2003) Diffusion of Innovations Theory (DOI) explain students' ICT use, (b) To what extent do personality characteristics derived from the Big Five approach explain students' ICT use, and (c) To what extent does motivation explain students' ICT use. The research was conducted in Israel during the second semester of the academic year 2013-14, and included two groups of participants: a group of Educational Technology students (ET) and a group of Library and Information Science students (LIS). Findings add another dimension to the importance of Rogers' DOI theory in the fields of Educational Technology and Library and Information Science. Further, findings confirm that personality characteristics as well as motivation affect ICT use. If instructors would like to enhance students' ICT use, they should be aware of individual differences between students, and they should present to students the advantages and usefulness of ICT, thus increasing their motivation to use ICT, in the hopes that they will become innovators or early adopters.

Keywords: ICT use, Educational Technology students, Library and Information Science students, Exploratory study

Introduction

Modern economies depend on ICT (Information and Communication Technology) use and development (Hine, 2011). According to the International Telecommunications Union (2014), by the end of 2014 there will be almost 3 billion Internet users, two thirds of them from the developing world. It seems that technologies are widely used in everyday life, as well as in workplace and academic settings. Therefore, it is very important that students be familiar with and master ICT in order to understand their learning environments, as well as their professional lives. The current research focuses on two kinds of popula-

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tions: Educational Technology (ET) students and Library and Information Science (LIS) students. These two populations were specifically chosen, as ICT plays a major part in both their training and future work environments.

This study seeks to explore what factors influence students' ICT use and web technology competence. The research may contribute to an understanding of the variables that influence their ICT use and may lead to further inquiry in this field. The current study uses Rogers' (2003) Diffusion of Innovations Theory, as well as the Big Five model (Costa & McCrae, 1992), and motivation theory (Deci & Ryan, 1987) as theoretical bases from which we can predict factors that may influence students' ICT use.

The remainder of the article is organized as follows. The next section introduces the theoretical foundations and hypotheses developed for the proposed study. Research methods are provided next, followed by findings and discussion. The last section provides theoretical and practical contributions, along with a discussion of some limitations of the findings.

Literature Review

Diffusion of Innovations Theory

Rogers' (2003) Diffusion of Innovations Theory (DOI) is a widely used theoretical framework in the area of technology diffusion and adoption. The theory suggests that within a population group, innovations are not adopted at the same time by all individuals, as some people are more willing to try new ideas and technologies than others. The adoption of innovations depends on personal factors such as the following: gender, age, innovativeness, and ethnicity; social ones (e.g., education and income status); and on technological factors such as perceived usefulness and perceived benefits (Leung & Wei, 1999). Rogers proposes that innovation, communication channels, time, and social system are the main components of DOI theory. Rogers suggests (2003) that the innovation decision process is similar to an information seeking process, where the person would like to reduce the uncertainty about the advantages and disadvantages of the innovation. This process is built of five stages: knowledge, persuasion, decision, implementation, and confirmation. In the knowledge stage the person learns about the innovation and seeks information about it. In the second stage (persuasion), the individual forms an attitude after s/he knows about the innovation. According to Rogers (2003), the knowledge stage is more cognitive oriented, while the persuasion stage is more affective oriented. In the third stage, the decision, the person decides whether to adopt or reject the innovation. In the fourth stage, implementation, the innovation is put into practice and in the last stage the individual looks for support for his or her decision.

Rogers (2003) suggests that the following attributes help decrease uncertainty about the innovation: (1) relative advantage, (2) compatibility, (3) complexity, (4) trialability, and (5) observability. Relative advantage is the extent to which people believe that the innovation is better than the traditional method. Compatibility refers to the extent to which people believe that the innovation is compatible with the traditional idea. Complexity addresses the extent to which people find the innovation difficult to use and understand. Trialability is the extent to which people believe that there are chances for the innovation to be experienced before deciding whether to adopt it or not, and observability addresses the extent to which results of the innovation are visible to others. The current study will focus on two-of these five attributes: relative advantage and complexity.

Rogers (2003) also presented classification categories of adopters: innovators, early adopters, early majority, late majority, and laggards. The Diffusion of Innovations Theory has been used as a theoretical framework to analyze the adoption of information technologies in both the education and library science environments. Various researchers have proposed that Rogers' theory is the most appropriate for exploring the adoption of technology in higher education (Borrego, Froyd, & Hall, 2010; Medlin, 2001; Parisot, 1997). A study that was carried out in Israel examined reasons for students' poor use of Web 2.0 technology (Goldstein et al., 2012). Bowers, Ragas, & Neely (2009) used Rogers' theory to investigate the value of Second Life as an educational tool among post-secondary instructors. Sahin (2006) suggested that Rogers' (2003) use of relative advantage, compatibility, and complexity attributes are related to the attitudes of individuals towards instructional computer use by college instructors. In addition, Tšoenyo and Wole (2012) proposed that relative advantage, complexity, and observability were the most relevant attributes to faculty attitudes towards ICT.

Addressing the library arena, Neo and Calvert (2012) found that compatibility and complexity were the most important factors to explain *Facebook* adoption in public libraries. Dorner and Revell (2012) used five attributes of Rogers' Diffusion of Innovations Theory as the basis for librarians' interviews while trying to explore their perceptions of promoting institutional repositories as an information resource for their clients. Rutherford (2008) classified librarians who used social software in libraries as falling into Rogers' (2003) categories of innovator and early adopter, while White (2001) examined diffusion of an innovation (Rogers, 1983) within digital reference services.

In light of the above, the first research hypotheses will be:

H1: Intensity of ICT use will be positively associated with students' perceptions of relative advantage.

H2: Intensity of ICT use will be negatively associated with students' perceptions of complexity.

The Big Five

The "Big Five" model of personality is one of the most famous measures of personality structure in recent years (Golbeck, Robles, & Turner, 2011), and it is considered a comprehensive model that includes five major factors representing personality traits: neuroticism, extraversion, agreeableness, openness to experience, and conscientiousness (Costa & McCrae, 1992). Various researchers have examined the model, finding validity and reliability across gender, age, and cultural lines (McCrae & John, 1992). Each factor in the model is bipolar and contains different aspects.

According to Wang, Jackson, Zhang, and Su (2012), neuroticism is in contrast to emotional stability and is characterized by anxiety, sadness, irritability, moodiness, hostility, and nervous tension. Extraversion is associated with activity, energy, assertiveness, sociability, talkativeness, expressiveness, and positive emotions. Agreeableness consists of altruism, warmth, trust, modesty, cooperativeness, and tender-mindedness. Openness to experience addresses the complexity and depth of the person's mental and experiential life, and consists of curiosity, creativity, and preference for novelty. Conscientiousness refers to impulse control that contributes to task- and goal-directed behavior and is associated with discipline, reliability, responsibility, and organization.

Other research has analyzed the association between the Big Five model and technology use. Some studies explored the association between the Big Five model and technology use. In the context of Computer Based Assessment (CBA), Terzis, Moridis, and Economides (2012) propose that neuroticism has a significant negative effect on perceived usefulness and on goal expectancy. Agreeableness is related to social influence and perceived ease of use, while conscientiousness is associated with perceived ease of use. Extroversion and openness are connected with perceived importance.

Various studies examined the connection between the Big Five model and Internet use (Amichai-Hamburger, 2002; Amichai-Hamburger & Ben-Artzi, 2003; Amichai-Hamburger, Wainapel, &

Fox, 2002) showing that extraversion and neuroticism were significantly related to Internet use. Witt, Massman, and Jackson (2011) examined the influence of the Big Five on videogame playing, overall computer use, and communication technology use. Mark and Ganzach (2014) suggest that global Internet use is positively related to extraversion, neuroticism, and conscientiousness. Other studies focused on the relationship between the Big Five model and the use of social networks sites, showing that all five factors were related to the use of social networks sites (Ross et al., 2009; Selfhout et al., 2010; Wehrli, 2008; Zywica & Danowski, 2008). Several studies proposed that extraversion was the most dominant factor concerning the use of social networks sites (Aharony, 2013; Gosling, Augustine, Vazire, Holtzman, & Gaddis, 2011; Wilson, Fornasier, & White, 2010, 2012; Zywica & Danowski, 2008). In a recent study (Deng, Liu, Li, & Hu, 2013), researchers found that extroversion impacts perceived satisfaction, supplementary entertainment, as well as playfulness and SNS continuance intention.

The current study will focus on three characteristics: extroversion, openness to experience, and neuroticism. Assuming that extroversion, openness to experience, and neuroticism may predict students' ICT use, the underlying assumptions of this study are:

H3: Extroversion and openness to experience will be positively associated with ICT use.

H4: Neuroticism will be negatively associated with ICT use.

Motivation

Another variable that may influence students' attitudes towards ICT is their motivation. Motivation is considered a key determinant of general behavior (Deci & Ryan, 1987), IT acceptance behavior (Davis, Bagozzi, & Warshaw, 1992; Moon & Kim, 2001; Teo, Lim, & Lai., 1999; Venkatesh & Speier, 1999), and work-related behavior (George & Brief, 1996; Lu, 1999). Ryan and Deci (2000) have introduced Self-Determination Theory (SDT) and suggested that when individuals' needs are satisfied, they will present optimal motivation and well-being. Alternatively, when these needs are hindered, people will have low motivation and well-being. Pritchard and Ashwood (2008) propose that "motivation is the process used to allocate energy to maximize the satisfaction of needs" (p. 6). The reasons for selecting specific behaviors are different from one individual to another, and a person's motivation is related to his/her attitudes, needs and goals.

Based on the literature review, H5 is developed:

H5: The higher the motivation students have, the greater their ICT use.

In light of the above, the objectives of this study are the following: (a) To what extent do certain elements of Rogers's (2003) Diffusion of Innovations Theory explain students' ICT use, (b) To what extent do personality characteristics derived from the Big Five approach explain students' ICT use, and (c) To what extent does motivation explain students' ICT use.

Methodology

Data Collection

The research was conducted in Israel during the second semester of the academic year 2013-14, and included two groups of participants: a group of Educational Technology students (ET) and a group of Library and Information Science students (LIS). The researchers obtained permission to investigate different graduate courses in two Israeli institutions. They gained access to two classes from the ET program at an Israeli college of education (Mobile technologies, and Social Networks) and two LIS classes at an Israeli university in the department of Library and Information Science (Information retrieval, and Introduction to Information Science). The researchers handed out 120 questionnaires to the students and explained the study's purpose. Of these 110 responses were received back from these groups (91.6%), 50 responses were from college students and 60 from university students.

The sample was made up of 28 (26%) men and 80 (73%) women. The average age was 38; the youngest was 23 and the oldest was 60. In terms of education, 57 (52%) were in their first year, 38 (36%) in their second year, and 12 (11%) in the third year of their graduate program.

Measures

The survey covered five topics that were covered in five questionnaires: personal details, ICT use, attitudes to ICT, personality, and motivation (see Appendix). The personal details questionnaire had four parameters: age, gender, education, and institution.

The ICT use questionnaire consisted of 14 statements rated on a five-point Likert scale (1=strongest disagreement; 5=strongest agreement). This questionnaire was previously used by the MOFET research group to measure students' ICT use in colleges of education (Shonfeld & Goldstein, 2014). The value for the Cronbach's Alpha of this questionnaire was .82.

The attitude to ICT questionnaire was based on Rogers' Theory, and modified for this study. It was previously used by Tsoenyo and Wole (2012). It consists of nine statements rated on a five-point Likert scale (1=strongest disagreement; 5=strongest agreement). The questionnaire encompasses two factors. The first is 'relative advanced' (meaning positive attitudes towards ICT because of the advancement to the user). This section consists of items 1, 2, 3, 5, 9. The second is complexity (meaning adverse attitudes to ICT because of difficulties using it). This section is composed of items 4, 6, 7, 8. The values of Cronbach's Alpha were .72 for both factors.

The personality questionnaire was based on the Big Five questionnaire (John, Donahue, & Kentle, 1991) and was modified for this study. It has 24 statements rated on a five-point Likert scale (1=strongest disagreement; 5=strongest agreement). The questionnaire includes three factors: extraversion (items 1, 4, 7, 10, 13, 16, 19, 22), neuroticism (items 2, 5, 8, 11, 14, 17, 20, 23), and openness to experience (items 3, 6, 9, 12, 15, 18, 21, 24). The values of Cronbach's Alpha were .82, .87, and .72 respectively.

The motivation questionnaire included 6 statements rated on a 5 point Likert scale (1=strongest disagreement; 5=strongest agreement). Cronbach's Alpha was .92. The questionnaire developed for this study is based on a section of a questionnaire used by research at MOFET institute (Shonfeld & Goldstein, 2014). It was used for a previous study in 2007-2011 (Goldstein et al., 2012).

Findings

The aim of this study was to examine students' ICT use in the fields of Educational Technology and Library and Information Science in higher education institutions. Descriptive statistics from the questionnaire results indicate that these populations' use of ICT environments are at the level of M (Mean) = 3.31 and SD (Standard Deviation) = 0.68, where the mean was measured on a scale of 1-5.

In order to examine whether there are differences between the ET students and LIS students, a one-way MANOVA was performed. The MANOVA revealed a significant difference between the two groups, $F(1.106.) = 18.39$, $p < .0.01$ $\eta^2 = .15$. Findings reveal that ET students use ICT more often: $M = 3.61$, $SD = .59$, than LIS students: $M = 3.08$, $SD = .68$. A similar analysis was performed to compare men with women, but no significant difference was found. In order to examine the relationship between attitudes, personality characteristics, motivation, and the dependent variable (ICT use), researchers performed Pearson correlations, which are presented in Table1.

Table 1. Pearson correlations between ICT use and research variables (*n* = 110)

Measures	ICT Use	Extraver-sion	Neuroti-cism	Open-ness	Ad-vanced	Com-plexity	Motiva-tion
ICT Use							
Extraversion	.29**						
Neuroticism	-.15	-.38***					
Openness	.25*	.42***	-.17				
Advanced	.35***	.34***	-.32***	.30**			
Complexity	-.40***	-.36***	.22	-.45***	-.58***		
Motivation	.25**	.15	-.21*	.26**	.32***	-.32***	

* $p < 0.5$. ** $p < .01$. *** $p < .001$

Table 1 presents significant correlations between almost all research variables except neuroticism and the dependent variable (ICT use). Most of the correlations are positive; hence, the higher the level of extroversion, openness, motivation, and advanced, the greater the ICT use. Further, significant negative correlation was found between complexity and ICT use. In other words, the less students perceive ICT use as complex, the higher their ICT use will be.

Regarding correlations between research variables, significant positive correlations were found between extraversion and openness to experience, and advanced. Therefore, the more extroverted students are, the higher their openness to experience and their attitudes towards ICT use. Significant, negative correlations were found between extraversion and neuroticism and complexity. Therefore, the less extroverted students are, the higher their level of neuroticism and their complexity attitudes. Significant negative correlations were found between neuroticism and advanced and motivation. The more neurotic students are, the less their advanced attitude towards ICT and motivation to use ICT. Significant positive correlations were found between openness and advanced and motivation, In other words, the more open to experience students are, the higher their attitude and motivation towards ICT use. A significant negative correlation was found between openness and complexity, meaning that the less students are open to experience, the higher their level of complexity towards ICT use. A significant positive correlation was found between advanced and motivation; hence, the higher students' attitudes towards ICT use, the greater their motivation to use ICT. In addition, a significant negative correlation was found between complexity and motivation, meaning that the more students perceive ICT use as complex, the lower their motivation to use it.

Pearson correlations were conducted between demographic variables (age and year of study) and ICT use. A significant positive correlation was found only between year of study and ICT use, $r = .23$, $p < .05$. In other words, the higher students' year of study, the greater their ICT use.

Researchers also conducted a hierarchical regression analysis, in which the dependent variable was ICT use. The regression explained 32% of ICT use. The predictors were entered as five steps: (1) personal details (group and education); (2) personality characteristics (openness to experience, extraversion, and neuroticism); (3) attitudes towards ICT (advanced and complexity); (4) motivation; and (5) an interaction between the research variables. In the regressions analysis, the entry of the first four steps was forced, while that of the interaction was entered according to its contribution to the explained variance. Table 2 presents the standardized and unstandardized coefficients of the hierarchical regression of respondents' ICT use.

Table 2. Hierarchical regression coefficients of respondents' ICT use (*n* =110)

Step	Predictors	B	β	R^2	ΔR^2
1.	Institution	-.50	-.34***	.17***	.17**
	Education	.17	.17*		
2.	Extraversion	.08	.08	.21***	.04*
	Neuroticism	-.03	-.04		
	Openness	.18	.16*		
3.	Advanced	.22	.19*	.30***	.09**
	Complexity	-.18	-.17*		
4.	Motivation	.06	.06	.30***	.00
5.	Extraversion x Advanced	-.14	-.17*	.32***	.02*

*p < .05. **p < .01. ***p < .001.

The first step introduced the education and group variables that contributed significantly by adding 17% to the explained variance of ICT use. The beta coefficient of the education variable is positive; hence, the higher the students' year of education, the higher their ICT use.

The second step introduced the personality characteristics (openness, extraversion, and neuroticism) of which only openness contributed significantly by adding 4% to the explained variance of ICT use. The beta coefficient of openness is positive. In other words, the more open to experience students are, the higher their ICT use.

The third step introduced the attitudes (advanced and complexity), of which only advanced contributed significantly by adding 9% to the explained variance of ICT use. The beta coefficient of advanced is positive; hence, the higher students' attitudes towards ICT, the higher their ICT use. The fourth step introduced the motivation variable, which did not contribute to the explained variance of ICT use.

As the fifth step, researchers added the interaction between Advanced X Extraversion that added 2% to the explained variance of ICT use. The interaction Advanced X Extraversion is presented in Figure 1.

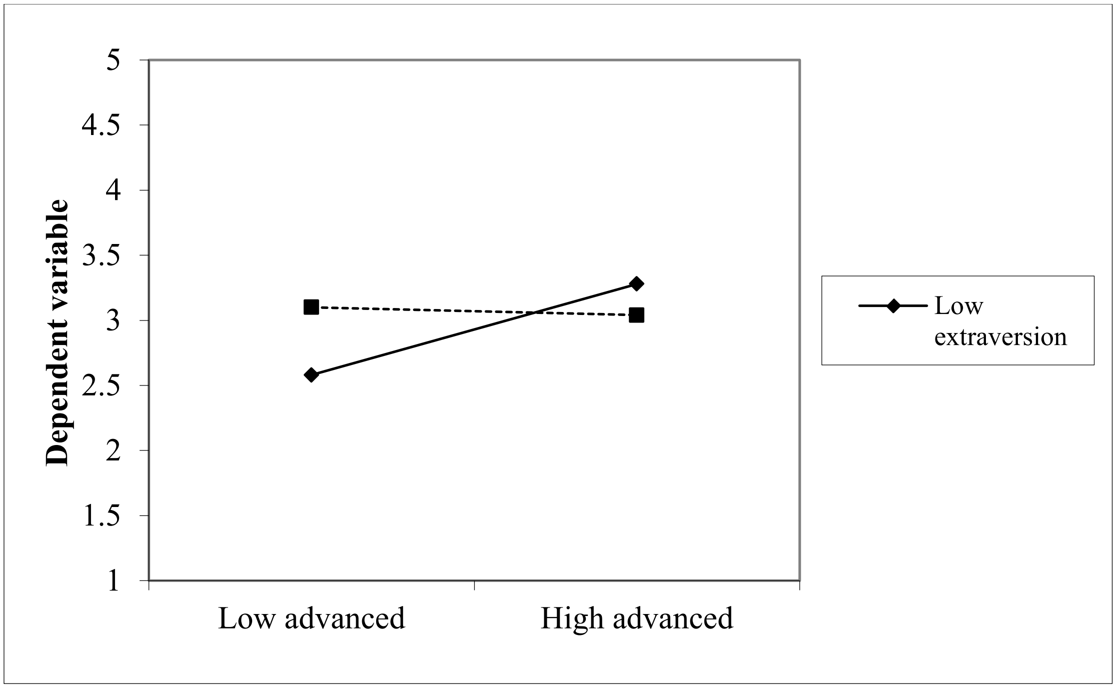

Figure 1. Interaction of advanced X extraversion

A correlation was found between the extraversion and advanced variables. However, this correlation is higher among students who are less extroverted. β =. 34, $p < 0.05$, than among those who are more extroverted, β =.03, $p > 0.05$. It seems that especially among students who are less extroverted, the more they perceive ICT use as advanced, the more they use ICT.

Discussion

Based on the premises of Rogers' Diffusion of Innovations theory, the Big Five model, and motivation theory, the present research explored the extent to which Rogers' attributes of innovations, personality characteristics, and motivation explain students' ICT use. By addressing these questions, this article makes a number of theoretical and practical contributions:

- The findings of this study add another dimension to the importance of Rogers' DOI theory in the fields of Educational Technology and Library and Information Science.
- Findings confirm that personality characteristics as well as motivation effect ICT use.
- If instructors would like to enhance students' ICT use, they should be aware of individual differences between students and handle them accordingly. Further, they should present to students the advantages and usefulness of ICT, thus increasing their motivation to use ICT, in the hopes that they will become innovators or early adopters.

Before dealing with research hypotheses, we would like to discuss the study population. Researchers assumed that because ET and LIS students deal a lot with technology, both in their learning environments and later in their professional life, participants would be classified as innovators who wish to experience new ideas and be gatekeepers in their organizations, or at least as early adopters who tend to spread the information about the innovation, decreasing others' uncertainty about it (Rogers, 2003). However, findings indicate that most students can be classified as early majority to whom the innovation decision takes more time than it takes for the innovators or the early adopters, or as late majority who will wait till most of their acquaintances adopt the innovation (Rogers, 2003). Instructors in the academic environments should be aware of this finding, and try to apply Rogers' theory in order to shift students towards the direction of innovators and early adopters. Hence, according to Rogers' theory (2003), they should begin in the knowledge stage, using cognitive reasons, to show students the importance, advantages and benefits of ICT use. In the next stage, they should try to persuade them to change their attitudes towards ICT, hoping that students will arrive at Rogers' third stage of decision, where they will use ICT more consistently becoming innovators and early adopters.

Addressing the research hypotheses, researchers divided them into three categories. The first refers to Rogers' theory (H1, H2), the second (H3, H4) to the Big Five Model, and the final one to motivation (H5).

Referring to the first category, it seems that both hypotheses were accepted (H1, H2). H1 showed that the more students use ICT, the higher their perceptions about its relative advantage. In other words, the more they use ICT, the more they believe it can enhance their ability and improve their efficiency. This finding echoes previous studies showing that relative advantage is associated with individuals' attitudes towards ICT use (Sahin, 2006; Tšoenyo & Wole, 2012).

Findings addressing H2 show that the more students perceive ICT use as complex, difficult, or complicated, the less they use it. This finding is logical, and is in accord with earlier studies that showed ICT use is related to complexity (Neo & Calvert, 2012; Sahin, 2006; Tšoenyo & Wole, 2012).

Referring to Rogers' theory (2003), it was surprising to find out that ET and LIS students are not innovators or early adopters, as was supposed. However, H1 and H2 confirmed his theory about the importance of relative advantage and complexity as attributes that impact students' ICT use.

Findings concerning the second category (H3, H4) reveal that only one hypothesis, H3, was accepted, showing that extroversion and openness to experience were positively correlated with ICT use. The findings indicate that the more extroverted and open to experience students are, the higher their ICT use. This finding was not unanticipated, as past studies have already shown that extroversion is strongly associated with Internet use (Amichai-Hamburger, 2002; Amichai-Hamburger & Ben-Artzi, 2003; Amichai-Hamburger et al., Wainapel, & Fox, 2002; Mark & Ganzach, 2014), and with social networks use (Aharony, 2013; Gosling et al., 2011; Wilson et al., 2010; Zywica & Danowski, 2008). Considering openness to experience, Ross et al. (2009) found that heavy users of social networking sites have higher levels of openness to experience. Furthermore, Aharony (2014b) found that the more open to experience information professionals and educational technology experts were, the higher their behavioral intention to use cloud computing.

H4 was rejected, indicating that neuroticism was not negatively associated with ICT use. This finding stands in contrast to previous studies (Amichai-Hamburger, 2002; Amichai-Hamburger & Ben-Artzi, 2003; Amichai-Hamburger, Wainapel, & Fox, 2002, Mark & Ganzach, 2014), which suggested neuroticism was significantly related to Internet use. This difference can be due to the fact that the current study focused on ICT (Information and Communication Technology) in general and not only on Internet use, as was examined previously.

H3 and H4 highlight the importance of personality differences that may affect students' ICT use. Academic instructors should be aware of these differences, understanding that not all students may adapt smoothly and naturally to technological innovations. In other words, they should make an effort to reach these populations, and try to encourage them to use ICT more constantly.

The last category, relating to motivation H5, was accepted—suggesting that the more motivation students have, the greater their ICT use. This finding strengthens the assumption that motivation is a key factor in an individual's general behavior (Deci & Ryan, 1987), IT acceptance (Aharony, 2014a; Davis et al., 1992; Moon & Kim, 2001; Teo et al., 1999; Venkatesh & Speier 1999), and work-related behavior (George & Brief, 1996; Lu, 1999). The current finding enhances the importance of the motivation variable, suggesting that if instructors in both academic disciplines would like to expand their students' ICT use and would like them to be innovators or early adopters, they should motivate students to use ICT, presenting the benefits, usefulness, and advantages.

Also, interesting correlations were found between the research variables. Relative advancement was positively associated with extroversion, openness to experience, and motivation. In other words, those students who perceive ICT's benefits and advantages were more extroverted, more open to experience, and more motivated to use ICT. In addition, one interaction that was performed in the study showed that, especially among students who are less extroverted, the more they perceive ICT use as advanced, the more they use it. On the other hand, complexity was negatively associated with these variables, meaning that those students who perceive ICT as complicated, were less extroverted, less open to experience and less motivated to use ICT.

Conclusions

These findings provide a more comprehensive picture, emphasizing the importance of combining elements derived from Rogers' theory and variables from the Big Five Model when trying to understand factors that may impact individuals considering adopting new technologies. In addition, these findings indicate again the fact that instructors in academic settings should be aware of individual differences, trying to make the ICT environment friendlier and less complex, thus increasing students' motivation to use ICT, and perhaps changing their predominant status from early majority and late majority to innovators and early adopters.

Further, another intriguing finding is that the higher the year of education, the higher students' ICT use. We see that these students, who have already started their studies in technology-oriented programs, use more ICT as they progress in their program. We may infer that there is an effect of the program on the intensity of their ICT use.

Limitation and Future Research

Despite its findings and implications, this study contains some limitations. First, the research was conducted on two technological programs. We may assume that results might be different with students from other departments and from other institutions. Second, the research was carried out only in Israel; therefore, it would be interesting to perform the same research in other countries. Third, in a future study, we would like to have a larger sample. Fourth, many different items have been put together on the questionnaire. In a further study we would like to concentrate on fewer items, in order to focus the research. Fifth, in order to have a comprehensive, in-depth understanding of ICT use, a future study should use also qualitative methods.

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Appendix

Personal Details

1. Male / Female
2. Age
3. Education: M.A. degree: 1st year, 2nd year, 3rd year

ICT Questionnaire

Please read the following statements and mark with X the column which describes your accordance with the following statements (1= strongly disagree; 5= strongly agree).

I use these platforms for my professional and personal needs	1	2	3	4	5
1. Word processing					
2. Presentations (such as Power Point)					
3. Electronic spreadsheet					
4. Collaborative platforms such as Google Docs					
5. Social networks sites					
6. Smart phones or tablets applications					
7. Wikis					
8. Blogs					
9. Communication systems based on the Internet (such as Skype)					
10. Media sites (such as YouTube)					
11. Simulations, software, electronic games					
12. An a-synchronic teaching and learning system					
13. Learning management system (such as Moodle)					
14. MOOCs					

Attitude Questionnaire

Please read the following statements and circle the number that best describes your attitudes towards ICT. Please mark with X the column which describes your accordance with the following statements (1= strongly disagree; 5= strongly agree).

When you think of ICT…	1	2	3	4	5
1. It can improve my efficiency when I use it.					
2. Mistakes with ICT transactions are easier to correct than manual ones.					

3. There are enough advantages of ICT for me to consider using them.					
4. Mistakes are more likely to occur with ICT usage than with manual operations.					
5. ICTs help me to better manage my time.					
6. ICTs are complicated to learn.					
7. ICTs are difficult to understand and use.					
8. ICTs are confusing					
9. It is easy to use ICTs even if one has not used them before					

The Big Five Questionnaire

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement (1 =strongly disagree; 5 = strongly agree).

I see Myself as Someone Who...	**1. Disagree strongly**	**2. Disagree a little**	**3. Neither agree nor disagree**	**4. Agree a little**	**5. Agree strongly**
1.Is talkative					
2.Is depressed, blue					
3.Is original, comes up with new ideas					
4. Is reserved					
5.Is relaxed, handles stress well					
6.Is curious about many different things					
7.Is full of energy					
8.Can be tense					
9.Is ingenious, a deep thinker					
10.Generates a lot of enthusiasm					
11.Worries a lot					
12.Has an active imagination					

13.Tends to be quiet					
14.Is emotionally stable, not easily upset					
15.Is inventive					
16.Has an assertive personality					
17.Can be moody					
18.Values artistic, aesthetic experiences					
19.Is sometimes shy, inhibited					
20.Prefers work that is routine					
21.Is outgoing, sociable					
22.Likes to reflect, play with ideas					
23.Has few artistic interests					
24.Is sophisticated in art, music, or literature					

Motivation Questionnaire

Please read the following statements and circle the number that best describes your attitudes towards ICT adoption. Please mark with X the column which describes your accordance with the following statements (1= strongly disagree; 5= strongly agree).

	1	2	3	4	5
1. I am interested to study subjects that are related to ICT.					
2. I am ready to devote a lot of time and practice, in order to master ICT.					
3. The subject of ICT interests me very much.					
4. I am ready to make many efforts to master ICT.					
5. Understanding ICT is very important for me.					
6. I would like to succeed and understand ICT.					

Biographies

Prof. Noa Aharony received her Ph.D. in 2003 from the School of Education at Bar-Ilan University (Israel). She is the head of the Information Science Department at Bar-Ilan University (Israel). Her research interests are in education for library and information science, information literacy, technological innovations and the LIS community, and Web 2.0. Prof. Aharony is a member of the editorial boards of Journal of Librarianship and Information Science, and Online Information Review. Prof. Aharony has published in refereed LIS and education journals.

Dr. Miri Shonfeld is head of the TEC Center at MOFET Institute. She was the head of ICT and the coordinator of the graduate program of Technology in Education at Kibbutzim College of Education, Technology and the Arts. She specializes in the fields of ICT, collaborative learning, multicultural education, not only in research but in organizing activities as well, in Israel and in international organizations. She received her Ph.D. in computer science from NSU, Florida, USA.

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Teachers as Designers of Technology-Enhanced Outdoor Inquiry

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Abstract

Implementing inquiry in the outdoors introduces many challenges for teachers, some of which can be dealt with using mobile technologies. For productive use of these technologies, teachers should be provided with the opportunity to develop relevant knowledge and practices. In a professional development (PD) program in this design-based research, 24 teachers were involved in adaptation of a learning environment supporting inquiry in the outdoors that included the use of mobile technologies. They first experienced the learning environment as learners, then adapted it for their own use, and finally, enacted the adapted environment with peers. We examined the scope and character of teacher involvement in adaptation, and the consequent professional growth, by analyzing observations, questionnaires, interviews and the adapted learning-environments. Findings indicate that all teachers demonstrated change processes, including changes in knowledge and practice, but the coherence of the learning environments decreased when substantial adaptations were made. Some teachers demonstrated professional growth, as reflected by their implementation of ideas learned in the PD program in their daily practice, long after the PD program had ended. This study demonstrates how the Teachers as Designers approach can support teacher learning and illustrates productive use of scaffolds for teacher growth and professional development.

Keywords: Teachers as Designers (TaD), mobile learning, teacher professional development (PD), TPACK, outdoor inquiry

Introduction

Teachers have always engaged in the design of curriculum materials as part of their profession (Laurillard, 2012). In-depth familiarity with their students allows teachers to create new activities or adapt existing ones to improve implementation of curriculum materials (Gerard, Spitulnik, & Linn, 2010). This often creates a sense of ownership of the curriculum materials, supporting the implementation effort (Cviko, McKen-

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An earlier, shorter version of this paper was presented at the Chais conference 2015, in Raanana, Israel, and included in Y. Eshet-Alkalai, I. Blau, A. Caspi, N. Geri, Y. Kalman, & V. Silber-Varod (Eds.), *Proceedings of the 10th Chais Conference for the Study of Innovation and Learning Technologies 2015: Learning in the Technological Era*. Raanana: The Open University of Israel.

ney, & Voogt, 2014). The rapid developments in informational communication technologies in general, and online educational resources in particular, alongside the encouragement to integrate technology in their teaching and learning, motivate today's teachers to take part in the effort to design technology-enhanced learning (TEL) activities for their students.

Supporting inquiry learning, and especially outdoor inquiry learning, is particularly challenging for teachers. Inquiry teaching in the outdoors is an approach to improve student understanding of scientific principles related to the natural world and the nature of science (Osborne, 2014), while also increasing social and affective outcomes (Tal, Lavie Alon, & Morag, 2014). However, supporting both inquiry and outdoor learning introduces significant pedagogical challenges for teachers. For instance, the unique type of guidance required for deepening the inquiry process (Crawford, 2000), especially when it is conducted in the field, as well as the need to teach in an unfamiliar environment (Tal, 2001). These often discourage teachers from outdoor teaching (Tal, 2001).

Teachers have a key role in supporting inquiry learning (Crawford, 2014). This role is even more significant when inquiry is conducted in the outdoors, in which the teacher must bridge between what students learn in the field and what they learn in class (Tal et al., 2014). However, despite the advantages of guiding their own students in the field, many teachers prefer to appoint external professional instructors to guide students in outdoor activities (Tal & Argaman, 2005; Tal, Bamberger, & Morag, 2005). In such a manner, a disconnect may form between the material taught in the classroom and that learned outdoors, and the teacher's advantage of familiarity with the students and their learning characteristics is lost. It seems that specifically in these complex learning environments the role of the teacher as a curriculum designer could be essential. Furthermore, teachers, much more than external guides, can design activities that streamline the learning between the different settings using mobile technologies (Kali, Sagy, Kuflik, Mogilevsky, & Maayan-Fanar, 2015).

In this study, we have examined how teachers may be supported in teaching inquiry in the outdoors via a technology-enhanced learning environment. Using an approach of "teachers as designers of technology-enhanced learning" (TaD of TEL) (Kali, McKenney, & Sagy, 2015), we sought to provide teachers with opportunities to develop their knowledge and expertise in outdoor inquiry teaching. During the professional development (PD) program, teachers used a TEL environment that was developed for the study, which includes a website and mobile applications for supporting outdoor inquiry. After experiencing the use of this learning environment for their own learning, the teachers learned how to adapt it to create a new learning environment tailored for their students. Finally, they implemented the adapted environment with their peers, who used the environment as learners. The study examined how the unique design of the PD program contributed to teachers' professional development and growth in the context of teaching inquiry in the outdoors. We examined the professional changes teachers went through during the PD program and afterwards, to address the following research questions:

1. In what ways was teachers' involvement in the PD program expressed in their design processes and products?
2. How were the teacher professional development and growth processes expressed following the program?

Theoretical Background

The theoretical grounding for this study integrates research that deals with (a) the *Teachers as Designers of Technology-Enhanced Learning* (TaD of TEL) approach, (b) *outdoor inquiry learning* and the challenges it presents for teachers, and (c) the potential of *mobile learning* incorporated within TEL environments to address such challenges.

Teachers as Designers of Technology-Enhanced Learning

Literature dealing with the professional development of teachers indicates a number of properties that make PD programs successful (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003; Penuel, Fishman, Yamaguchi, & Gallagher, 2007):

- focusing on teachers' pedagogical skills and content knowledge,
- providing opportunities for active learning,
- making connections to classroom practices,
- modeling practice,
- encouraging collaboration between teachers,
- providing a coherent structure of the activities in the program.

One way to employ these properties is to involve teachers in designing or adapting curriculum materials. Studies have shown that alongside the professional development, which is expressed, for example, by adoption of new pedagogical approaches (Dori & Herscovitz, 2005; Tal, Dori, & Keiny, 2001), involvement in curriculum design can promote teachers' sense of ownership of the curriculum materials (Cviko et al., 2014) as well as improve their implementation (Davis & Varma, 2008; Dori & Herscovitz, 2005; Gerard et al., 2010; Shamir-Inbal, Dayan, & Kali, 2009; Voogt et al., 2015; Voogt et al., 2011).

Involving teachers in the development of curriculum materials as a means for their professional development is not a new approach. However, the rapid advancements in technology in the past decade has brought more and more teachers to use, adapt, and design their own technology-enhanced materials in their teaching. As a result, the study of TaD of TEL has become a field of research. Challenges include better understanding of how to support teachers to participate in design endeavors, and revealing the factors that motivate them to do so (Kali, McKenney et al., 2015).

Studies from the last decade have characterized the type of knowledge required for teacher-designers of TEL, entitled TPACK – Technological Pedagogical and Content Knowledge (Mishra & Koehler, 2006). These studies are based on and expand the insights of Shulman (1986), who argued that teachers' knowledge sources include both content knowledge (CK), related to the subject matter taught, and pedagogical knowledge (PK), related to teaching methods. Professional teaching, according to Shulman, involves rich understanding and knowledge sources of both types, as well as a unique type of knowledge that merges them – pedagogical content knowledge (PCK). This knowledge assists teachers in choosing pedagogical strategies that are specifically suited for teaching certain contents, in predicting the difficulties that students may encounter while learning these contents, and in finding ways to assist student to cope with such challenges. Mishra and Koehler (2006) have expanded this theory, adding a third knowledge source – technological knowledge (TK). This type of knowledge source is required for teachers who integrate technology within their teaching and includes acquaintance with diverse technological tools and skills for using them. When technological knowledge is merged with pedagogical-content knowledge, a new type of knowledge is formed – technological pedagogical and content knowledge (TPACK), which indicates a teacher's skill to make appropriate use of technology for supporting various combinations of pedagogical strategies, content, and context. Similar to PCK, which is a unique type of knowledge, a teacher who holds both technological knowledge and pedagogical-content knowledge will not necessarily know how to integrate the two.

Studies that have explored processes of teacher learning have shown that the involvement of teachers in the design or adaptation of technology-enhanced curriculum materials, when appropriately supported, can advance the development of TPACK (Koehler & Mishra, 2005; Voogt et al., 2011). Support for this process may be embodied in learning environments in the form of scaffolds that assist teachers not only to better understand the contents but also to develop the ways of thinking and action in the field (Reiser & Tabak, 2014). Svihla, Reeve, Sagy, and Kali (2015) characterize a "fingerprint pattern" of supports that can assist teachers to develop TEL design skills and knowledge. These include (a) modeling design practices, (b) encouraging dialogue between teachers while they develop their artifacts, and (c) providing opportunities for teachers to develop real world activities for students (rather than imagined scenarios). These can be reached by employing a "studio approach" in which teachers are guided during their design process and constantly provide and receive formative feedback (Crowther, 2013; Kali & Ronen-Fuhrmann, 2011).

In this study, we chose to focus on teachers who adapt a technology-enhanced learning environment for supporting outdoor inquiry. "Outdoor inquiry" is a pedagogical approach for encouraging students to engage in investigations that include data collection outside the classroom. It is sometimes referred to as field investigation (e.g., Tal & Abramovitch, 2012) or field study (e.g., Wee, Shepardson, Fast, & Harbor, 2007); however, it should be distinguished from the term "field study" in its methodological meaning. Outdoor inquiry is a mandatory requirement in the curricula for biology and environmental sciences in Israel. Nonetheless, as elaborated below, the implementation of this pedagogical approach introduces many challenges for teachers, which technology in general and mobile technology in particular (e.g., smartphones and tablets) may help to address.

Challenges in Outdoor Inquiry Teaching

Inquiry learning constitutes a key component in teaching science all over the world. The reason for this lies in the potential of the inquiry process for advancing students' understanding of scientific ideas and the ways they are developed (nature of science), as well as core ideas and concepts that cut across scientific disciplines (NRC, 2012; Osborne, 2014). To support achieving these goals, the NRC K-12 framework (NRC, 2012) suggested that students would participate in scientific practices that express the nature of scientific inquiry. These practices require both procedural and epistemic knowledge concerning the way in which scientific knowledge is constructed. For example, one of the most important practices in science is the ability to present an evidence-based theory. This aspect of scientific inquiry relies on the skill to compare and choose between alternative theories and may be expressed while engaging in evidence-based argumentation (Osborne, 2014). Scientific inquiry may occur in a range of settings – in the classroom, in the laboratory, or outside the school. Each of these settings entails advantages and disadvantages for learners, but when scientific principles that are related to the natural world are at hand, there is a major advantage for learning outside the classroom. Outdoor instruction has the potential to promote cognitive aspects of learning, due to the natural context in which the content is explored. Additionally outdoor instruction can promote social interactions that may empower learning and promote affective outcomes such as positive changes in students' attitudes towards the environment (Morag & Tal, 2012; Tal et al., 2014).

Nonetheless, teachers who facilitate inquiry processes encounter many difficulties. Such challenges can stem from insufficient scientific knowledge or understanding of the nature of the inquiry process (Crawford, 2014; Zion, Cohen, & Amir, 2007). Challenges can also arise when teachers are missing the pedagogical knowledge and experience required for facilitating inquiry. These include shifting between a range of roles or adapting curriculum materials for the specific needs of their students (Crawford, 2000, 2014). Failure in coping with these challenges can lead to superficial processes that fail to achieve the goals of inquiry to deepen students' scientific ideas and their understanding of the nature of science. The result is that often such teaching leads students to conduct experiments that are technically correct but does not encourage them to develop critical thinking (Osborne, 2014).

Facilitating inquiry in the outdoors requires teachers to cope with these challenges in a setting with high unpredictability, leading teachers to feel insecure (Dillon et al., 2006; Tal, 2001). A review of the literature on field trips has shown that the pedagogy that teachers implement is crucial for the success of the field trip. Specifically, the ways by which teachers bridge classroom content with the outdoor environment is a critical factor (Lavie Alon & Tal, 2015; Tal et al., 2014). Part of this bridging can be accomplished by designing preparation and summarizing activities for the field trip (Orion, 1993; Orion & Hofstein, 1994). Unfortunately, the practical and theoretical knowledge that has accumulated in the past years regarding best practices in facilitating field trips is seldom implemented (Morag & Tal, 2012). In this study, we decided to take advantage of what technology can offer to address some of the challenges inherent to outdoor inquiry teaching.

The Use of Mobile Technologies for Outdoor Inquiry Learning

With today's technology, scaffolds can be developed with a range of tools that can support learners to develop scientific practices as well as epistemic knowledge (Reiser & Tabak, 2014). These tools, which include also mobile technologies, can be used for organizing information, constructing knowledge, and supporting collaboration processes (Kali & Linn, 2007). The use of mobile technologies for learning—"mobile learning" – has been defined as a type of learning that combines interactions among people, the usage of technology, and the occurrence in a range of settings, including indoor and outdoor environments (Sharples, Taylor, & Vavoula, 2007). By providing learners with just-in-time and just-in-place information required for their inquiry and by providing them with infrastructures for organizing collected data, mobile technology can support learning in various settings (Cahill et al., 2011; Land & Zimmerman, 2015; Vavoula, Sharples, Rudman, Meek, & Lonsdale, 2009). In addition, mobile technologies, when properly designed, can enable personalization of learning and student-oriented pedagogies (Anastopoulou et al., 2012; Looi et al., 2011). For example, Looi et al. (2011) showed that student-led inquiry with mobile technologies in field trips to zoos contributed to students' understanding of scientific ideas and improved their achievements; Land and Zimmerman (2015) showed how the integration of i-Pads in family visits to a botanic park advanced discourse between learners while exploring trees in their surroundings. Another important advantage of integrating mobile learning in outdoor inquiry programs is the potential of streamlining learning between the various learning settings, such as home, classroom, and field (Kali, Sagy et al., 2015).

In order to exploit the potential of technological tools to support educational processes, learning environments can be designed to embed appropriate pedagogical approaches (Salomon & Ben-Zvi, 2006). For instance, the major difference between web 1.0 and web 2.0 technologies is the shift from information consumption to a more participatory role of the user, which includes contribution of content and ideas to the web, as well as their negotiation with peers (Cormode & Krishnamurthy, 2008). This technological shift corresponds to a shift in modern education, from a focus on individual knowledge acquisition to a more participatory and active view of the learning process (Kali, Tabak et al., 2015).

An important aspect of technology-enhanced learning environments in science is coherence (Fortus & Krajcik, 2012; Kali, Linn, & Roseman, 2008). Coherence refers to the linkage of ideas, the depth to which they are taught, and the continuity of contents within various parts of the curriculum. However, teachers who are experienced in inquiry teaching do not necessarily have the TPACK required for integrating the technology in a coherent manner. This applies all the more so for teachers who lack appropriate knowledge and experience in guiding inquiry. Therefore, to enable science teachers to take advantage of technology for outdoor inquiry teaching, it is not sufficient to provide them with the technological tools. Science teachers should be provided with the opportunity and appropriate guidance to develop the knowledge and the skills required in order to design technology-enhanced activities that can assist them to guide students in inquiry learning in the outdoor environment.

As part of the current study, we have developed a teacher PD program that involves teachers in the design of a TEL environment for supporting outdoor inquiry. In view of the recommendations of the research dealing with TaD of TEL environments, the PD program was designed to enable teachers to a) experience technology-supported outdoor inquiry *as learners*, b) adapt the learning environment for their own potential use, and c) practice the role of mentoring outdoor inquiry using the adapted learning environment. To track teachers' professional development and growth processes, we used Clarke and Hollingsworth's (2002) Interconnected Model of Professional Growth. This model allows for examination of the individual processes that teachers undergo as part of their professional development as well as the identification of long term professional growth processes.

Methodology

The current study is a first iteration in a design-based research (DBR). This methodological approach involves multiple cycles of design-enactment-analysis, which lead to refinement of the design as well as to advancement of theoretical aspects of the learning afforded by the designed environment (Barab & Squire, 2004). We chose to combine quantitative and qualitative research methods according to the "mixed method" approach, as is often conducted in DBR. In this approach, each of the research methods unfolds a different aspect of the topic explored, allowing revelation of a wider picture of the phenomenon (Ercikan & Roth, 2006; Johnson & Onwuegbuzie, 2009).

We used Sandoval's (2014) technique for mapping conjectures in DBR, which enabled us to articulate *high level conjectures* from which we have started the study and stem from our synthesis of the research literature. These conjectures were embodied into our design of the learning environment that we used for the PD program and served as the basis for our *design conjectures.* Design conjectures describe the way we envisioned that processes, which Sandoval entitles "intermediate processes", will take place as a result of teachers' interaction within the designed learning environment. Finally, we articulated *theoretical conjectures* regarding how the intermediate processes will lead to the intervention outcomes that we anticipated and sought to further explore through this study.

The mapping of the conjectures for the current study is depicted in Figure 1. Based on the theoretical background described above, we assumed that the professional growth of teachers as implementers of outdoor inquiry would involve their experience in learning, adaptation, and mentoring activities that streamline learning between the field, classroom, and home. We assumed that such professional growth would develop through teachers' participation in activities that:

a) use technology for streamlining learning across the different learning settings – home, classroom, and outdoors (Kali, Sagy et al., 2015),
b) support their shifting between diverse roles as learners, curriculum adaptors and mentors of outdoor inquiry (Svihla et al., 2015), and
c) utilize a design studio approach (Crowther, 2013).

Our *design conjectures* were that active participation in the PD program would lead to change processes in teachers, as expressed in Clarke and Hollingsworth's (2002) professional growth model: in the personal domain (individual knowledge, beliefs and attitudes), in the domain of practice (teaching in class or any other practical experience), and in the domain of consequence (salient outcomes that result from pedagogical experimenting). Our *theoretical conjecture* was that these mediating change processes would lead to professional growth that would be expressed in continued professional development of teachers and continued changes in the long term, including changes in practice. In other words, as expressed in the conjecture map (Figure 1), we assumed that following the PD program, teachers would continue to implement outdoor inquiry using technology. Ultimately, we seek that teachers will design activities for preparing and summarizing the field activity, streamline learning between settings, and provide scaffolds that will help students conduct more in depth, critical inquiry.

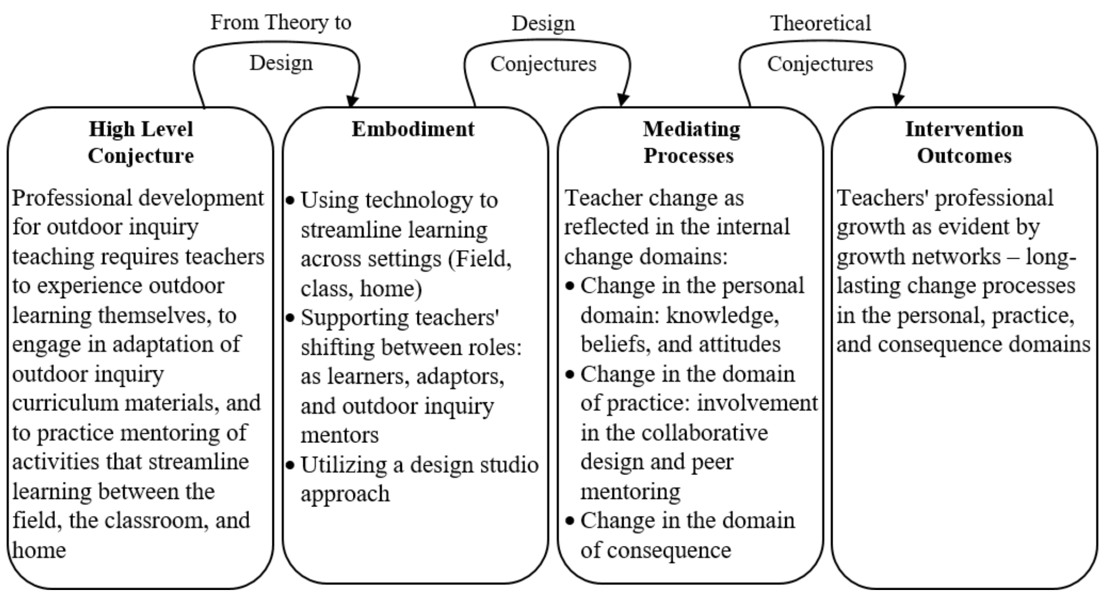

Figure 1: Conjecture mapping of the current study. Adapted from Sandoval (2014)

Context and Design

The teacher PD program included three face-to-face meetings and one online meeting (with a total of 14 hours), which were conducted over a period of nine weeks, facilitated by the authors of this paper. We developed an interactive website (using Google Sites) which included all the instructions for the activities and collaborative spaces for teachers' work (Figure 2). The website was adjusted for use by mobile phones in the field. The activities were designed with the aim of supporting teachers as designers of TEL. For this purpose, activities were designed around the three roles that teachers played in the PD program – learners, adaptors, and mentors – and for supporting learning using the studio approach (Crowther, 2013) in a range of social structures – individual, small group, and the entire group (Bielaczyc, 2006). For each of the teacher roles we developed a number of pages in the website. In addition, scaffolds were integrated to support teachers' design process using the "fingerprint pattern" of supports (Svihla et al., 2015). Throughout the PD program plenary discussions were integrated, dealing with the PD content as well as with reflection on the learning processes.

In the first stage, "*teachers as learners*", teachers had an opportunity to use a section of the website designed to support them as learners of the contents—ecological processes that they explored in an ecological garden. This included a set of inquiry activities that were organized in three parts – a preparation activity, an outdoor activity in the ecological garden, and a summary activity (Orion, 1993). The outdoor activity was supported with an "outdoor learning module" (see Figure 2) of the website that teachers accessed using their smartphones.

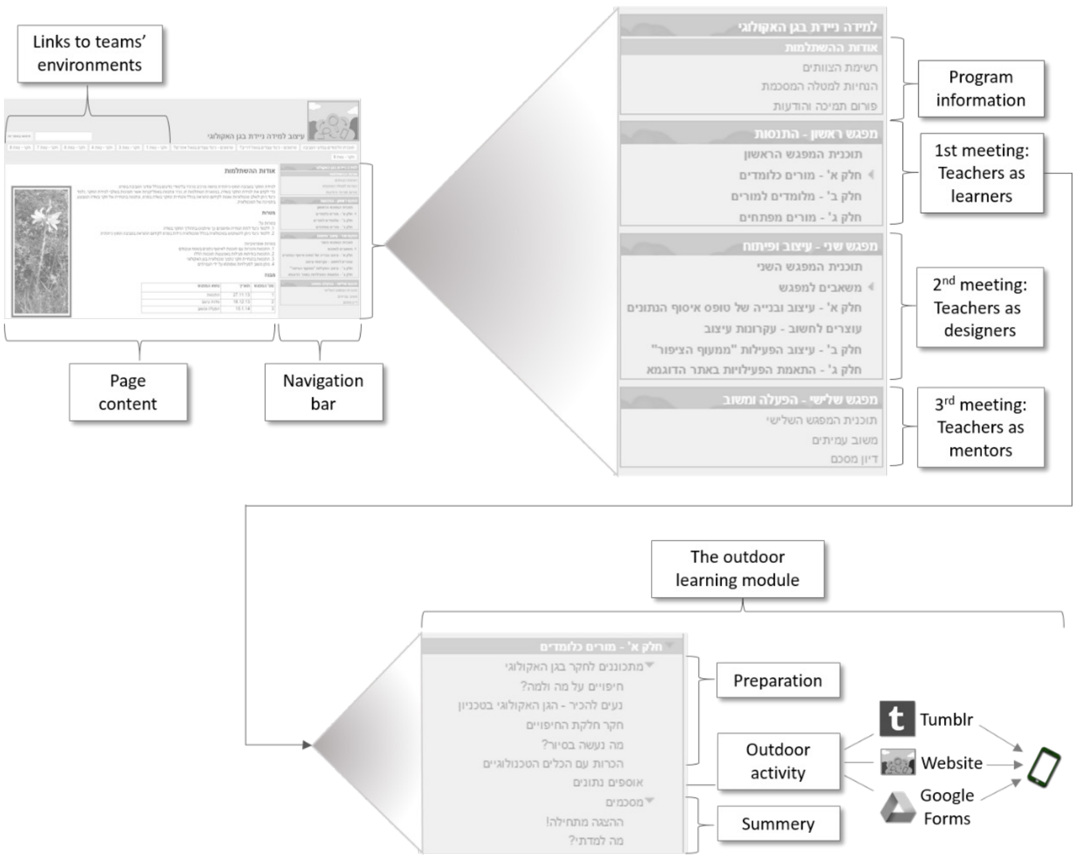

Figure 2: Description of the components of the PD-program learning environment

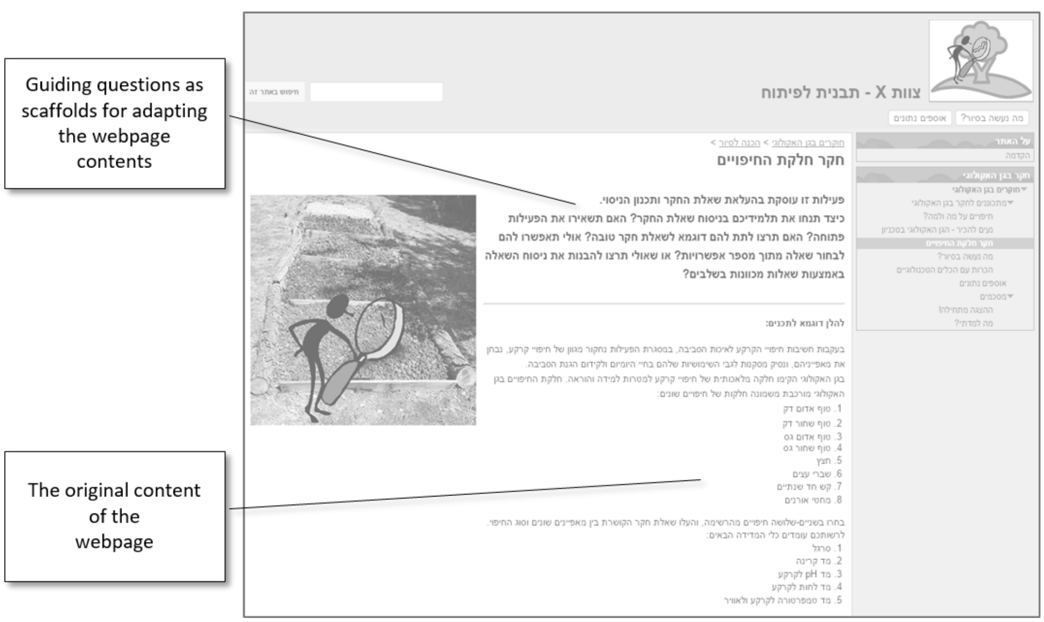

Figure 3: Components of a webpage for teachers' editing

To support the inquiry process, the activity was divided into stages (sub-pages in the website). Each of the stages included activities that guided a specific inquiry process, constructed according to design principles for inquiry learning (Kali, 2008; Kali & Linn, 2007) and in a manner that would promote critical thinking and advance scientific practices (Osborne, 2014). For example, the “investigating different types of mulch” page of the website, shown in Figure 3, shows an activity that included a description of the types of mulch with which measurements were designed to take place as part of the inquiry process. This page also included guiding questions to provide teachers with scaffolds for their formulation of an inquiry question: “What is your inquiry question? Why is it important to study the question that you have asked? What factors would you like to study in order to answer this inquiry question? How is it possible to measure these factors? What will you be able to learn from the findings? How would it be possible to implement the conclusions for advancing environmental protection?” In addition, the outdoor learning module included online forms to help teachers collect data in the ecological garden using their smartphones. We used Tumblr, a social networking platform, for taking photos and automatically incorporating them within teachers’ workspaces on the website. These applications were chosen following a pilot study that examined their usability, and have been shown to enable the streamlining of learning between settings that we sought to support (Levy, Tal, & Kali, 2013).

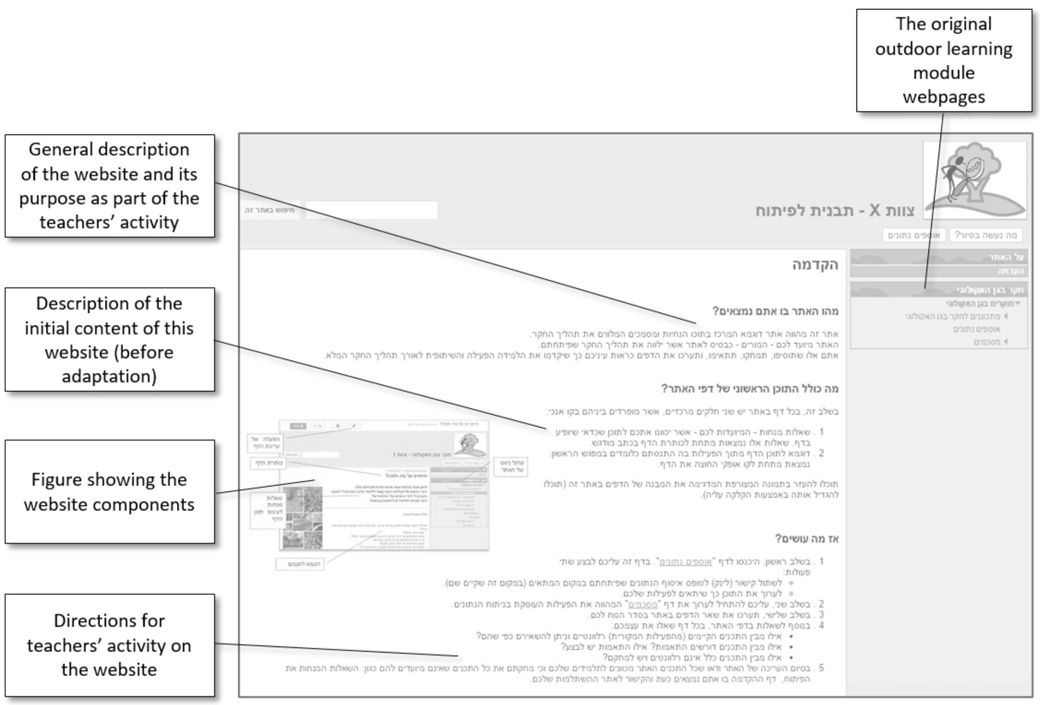

Figure 4: The introduction webpage of a team learning environment

In the second stage, “*Tad of TEL*”, teachers worked in collaborative teams to design their own learning environments. The meetings were conducted in a design studio format (Crowther, 2013), with us (the authors) as facilitators. Each team of teachers was provided with a copy of the outdoor learning module from the PD learning environment and a set of scaffolding activities for adapting this module for their own use and for developing appropriate preparation and summarizing activities (Figure 4). For example, on the “investigating different types of mulch” webpage shown in Figure 3, in addition to the activity of the original outdoor learning module at the bottom of the page, the top of the page was intended for teachers’ role as designers. Thus, it included the purpose and rationale for the design of the original activity, as well as scaffolds for the adaptation process: “This activity deals with asking the inquiry question and planning the experiment or observation. How would you guide your students to draft the inquiry question? Would you leave the activity open-ended? Would you want to give the students an example of a good inquiry question? Perhaps you would want to enable your students to choose a question out of a number of options? Or maybe you would like to assist students with guiding questions that would help them articulate their inquiry question?" Teachers in each team adapted their module according to the inquiry topic they chose to teach. For further support in the design process, the teachers were exposed to four design principles for designing their learning environment and were guided to work in collaborative documents within the website to summarize the ideas that were raised during the design process. During the online meeting, teachers received assistance and technical guidance for using Google Apps' tools for editing their learning environments (the guidance was conducted using JoinMe—a platform that enables screen-sharing in synchronous online meetings).

The PD program, if analyzed in terms of TPACK (Mishra & Koehler, 2006), dealt with the application of three types of knowledge – content, pedagogy, and technology – and with each of their integrated combinations. At the first stage, the teachers were engaged in conceptual development of goals with respect to the content they wanted to teach (content-pedagogy). Then, teachers were exposed to some design principles for inquiry activities in the outdoor environment (pedagogy). Afterwards, they engaged in planning the activities for their students to participate in (content-pedagogy). Finally, teachers learned how to use Google Apps to make the adaptations in the technological learning environment (technology) to support the content goals and the pedagogical characteristics of the activities (content – pedagogy – technology).

The third, and last stage of the program, "*teachers as mentors*", involved teachers in peer mentoring of inquiry in the outdoors using the teams' adapted learning environments. Teachers gave and received feedback from their peers regarding the activities they developed (embedded in the learning environments) and the mentoring that they provided (in the outdoors).

Following the PD meetings, teachers were provided with additional feedback concerning their adapted learning environments from one of the PD mentors and were requested to (a) refine their learning environments according to the feedback and (b) analyze the activities that they created according to the design principles that they learned.

Participants

In this study, 25 teachers who had participated in a PD program for leading environmental science teachers took part. All of them had at least nine years of experience in teaching, including teaching of inquiry in the outdoors. During the PD program activities, the teachers worked in seven teams of three to four members. (Please note that all the names used in this paper are pseudonyms.)

Data Collection and Analysis

Data was collected from:

- observations that were conducted during the PD meetings for examining the participation of teachers in the design of the learning environment,
- analyses of the teachers' activity in editing their team's adapted learning environments,
- open-ended questionnaires that were conveyed before and after the PD program, and
- semi-structured interviews that were conducted after the end of the PD program.

The way we used these sources to answer the research questions is summarized in Table 1.

Table 1: A summary of the data sources and how they were used to answer the research questions

Research question	Data source	Purpose	Data analysis
1. In what ways was teachers' involvement in the PD program expressed in their design processes and products?	*Observations* - taking field notes and summarizing insights from the program meetings	Examining the participation of teachers in the design of the learning environment	Qualitative evaluation of teachers participation in the program activities
	Automatic documentation of teacher activity (number and content of edits) in the team's adapted learning environments	Examining the way teachers participated in the development of the team's adapted learning environments	Quantitative analysis – counting the number of editing events using Google's 'recent site activity'
			Qualitative analysis to evaluate the level of adaptation and the coherence of the adapted learning environments
2. How were the teacher professional development and growth processes expressed following the program?	*Open-ended questionnaires (views regarding technology integration)* - before and after the PD program	Comparison of teacher views regarding the integration of technology in their teaching before and after the PD program	Qualitative analysis to identify emergent themes and quantitative analysis to evaluate the frequencies of the themes
	Open-ended questionnaires (views regarding PD program) - after the PD program has ended	Examination of teacher views towards the PD program	
	Semi-structured interviews – one to two months after the PD program has ended	Revealing teachers' views about the PD program and what they thought about future integration of technology in their teaching	Qualitative analysis of teachers' answers using Clarke and Hollingsworth's Interconnected Model of Professional growth (2002)
	Semi-structured interviews –six to nine months after the PD program has ended	Revealing long term effects of the PD program	

Analysis of teachers' activity in editing their team's learning environment

As stated previously, each team received a copy of the outdoor-inquiry learning module. Each team adapted the module in accordance with the inquiry topic teachers chose to develop. We analyzed each of the seven adapted learning environments in a quantitative and qualitative manner, as we explain below. The purpose of these analyses was to assess the *way teachers participated in adapting the learning environments.*

The quantitative assessment was conducted for the editing events of the teachers in the teams' adapted learning environments as documented in the "recent site activity" on Google sites. The automatic documentation includes both minor editing actions (such as language editing) as well as significant editing activities (such as changing and adding contents, links, images, and questions). For each teacher, editing events of both types were analyzed. Because this assessment is not sufficient and cannot provide comparable results, we carried out a qualitative assessment of the adaptations using a rubric we developed. The rubric enabled us to assess the essence of the adaptations in comparison to the original outdoor learning module that teachers adapted, and to scrutinize the coherence of the adapted learning environment. This rating was made for the three parts of the adapted learning environment according to the three-stage model for integrating field trips (Orion, 1993) in the curriculum: (a) the preparation activity, (b) the outdoor activity in the ecological garden, and (c) the summary activity. This was carried out in two steps that are detailed below.

Firstly, *the score of the adaptation* was rated on a 0-3 scale according to the rubric (Table 2). Each of the three parts of the adapted learning environment was scored on this scale. The total (maximum of 9, with 3 points for each part) specified the level of the adaptation: low – 0-3, medium – 4-6, and high – 7-9.

Table 2: Rubric for assessing the adaptation in the three parts of the outdoor learning module

Adaptation score (for each of the 3 parts of the module)*	Description	Example adaptations made by teachers
3	*Addition* of an activity with a new pedagogical approach that did not exist in the original outdoor learning module or *removal* of a complete activity, compared to the module	Activity added by the teachers for eliciting their students' ideas (including misconceptions), as part of the preparation for the inquiry. This activity did not exist in the original module: "For each of the statements below, please indicate your degree of agreement between 1 to 5 regarding the ecological system and the human intervention in the forest".
2	*Addition* to an existing activity or *change* of an existing activity in the module *without a change* in the pedagogical approach	Scaffolds added to the guidelines for student data processing and representation process: "Create a graph that describes the relationship between the distance from the pine tree and the density of plants" instead of a general guideline that appeared in the module: "Edit and process the data, find averages for repeated measurements, and plot graphs that describe your results".
1	*Minimal adaptation* of the new content: minor changes that are not substantial for the activity structure	Change of a title according to the new inquiry topic: "Spice bed inquiry" instead of "investigating different types of mulch".
No adaptation (0)	No change	

* The level of adaptation for the whole module was calculated as the sum of the scores for each of the three parts (preparation activity, outdoor activity, summary activity) with a maximum score of 9 (3 points X each part)

Secondly, *the intra-unit coherence*, as described by Fortus & Krajcik (2012), was examined in each of the adapted learning environments. The coherence was assessed in two ways (Table 3): (a) internal coherence for each of the three parts of the environment (only environments with adaptations at a minimum score of 2 were included) with a maximum score of 9, and (b) coherence of the complete learning environment (for environments that included adaptations at a medium or high level) with a maximum score of 3.

Table 3: Rubric for assessing coherence of adapted learning environments

Assessment criteria	Description
Internal coherence for each part of the learning environment	Completeness and continuity of each part with regard to: • Choosing appropriate technology to support the pedagogy • Clarity of the instructions • Relationship between title and content • Continuity between activities
Coherence of the learning environment as a whole	Examination of the continuity of the activities within the learning environment level with regards to: • Uniformity of the terminology throughout the learning environment • The relationship and the streamlining of knowledge between the activities in the different inquiry stages

Questionnaires

The questionnaires included open-ended questions related to:

a) the way in which teachers incorporate technology (before the PD program)
b) important ideas teachers claimed to have learned in the program (after the PD program)
c) features in the program that they feel that have contributed to their learning (after the PD program)
d) teachers' willingness to integrate mobile technology in their teaching and the reasons for this (before and after the PD program)

Overall, 21 of the teachers responded to the questionnaire at the beginning of the PD program and 19 responded at the end of the program. Teachers' answers were analyzed according to Chi's (1997) "quantifying qualitative analyses of verbal data" approach. By coding the verbal data and seeking patterns, this approach allows for a quantitative analysis of the subjective themes that emerge from the qualitative analysis. According to this approach, we chose to analyze all the answers to the questionnaires. Each answer constituted one unit of analysis. First, categories that emerged inductively from the answers were defined. Then, similar criteria were merged and another analysis cycle was conducted according to this encoding. Afterwards, two more researchers conducted the analysis according to the encoding to establish inter-rater reliability. Each disagreement in the analysis was discussed until reaching an agreement of at least 95% among the researchers on the coded items. Finally, a summary of the number of statements was made for each criterion.

Interviews

Two rounds of semi-structured interviews were conducted. In the first round, nine of the teachers were interviewed, one to two months after the PD program has ended. These interviews lasted for about 45 minutes on average. Teachers were chosen for the interviews to represent two profiles that emerged from the data: (1) involved, motivated teachers who expressed satisfaction with the PD program, and (2) teachers who were not involved in the development or did not feel that they got much benefit from the PD program. During the interviews, the teachers were asked:

- what new things they had learned from the PD program
- how they thought the technology could be integrated for advancing outdoor inquiry teaching
- whether and how the way in which they would integrate the technology in their future teaching would change

In the second round of interviews, seven teachers participated – six out of those who were interviewed in the first round and one additional teacher. The interviews were conducted six to nine months after the PD program has ended. The teachers who were interviewed in the second round were those who expressed (in the post questionnaire or in the first interviews) willingness to continue to integrate the technology in their teaching. In this interview, the teachers were asked whether and how they incorporated the technology in their teaching following the PD program.

The interviews transcripts and the teachers' answers to the questionnaires were analyzed according to the Interconnected Model of Professional Growth (Clarke & Hollingsworth, 2002). The model differentiates between four domains in the teacher environment in which change may occur: one is an external domain – an external source of information or stimulus (such as teacher PD program) – and three are internal domains:

a) *the personal domain* – knowledge, attitudes and beliefs
b) *the domain of practice* – all forms of professional experimentation (such as an experimentation with a new teaching strategy)
c) *the domain of consequence* – salient outcomes (as perceived by the teacher) following professional experimentation

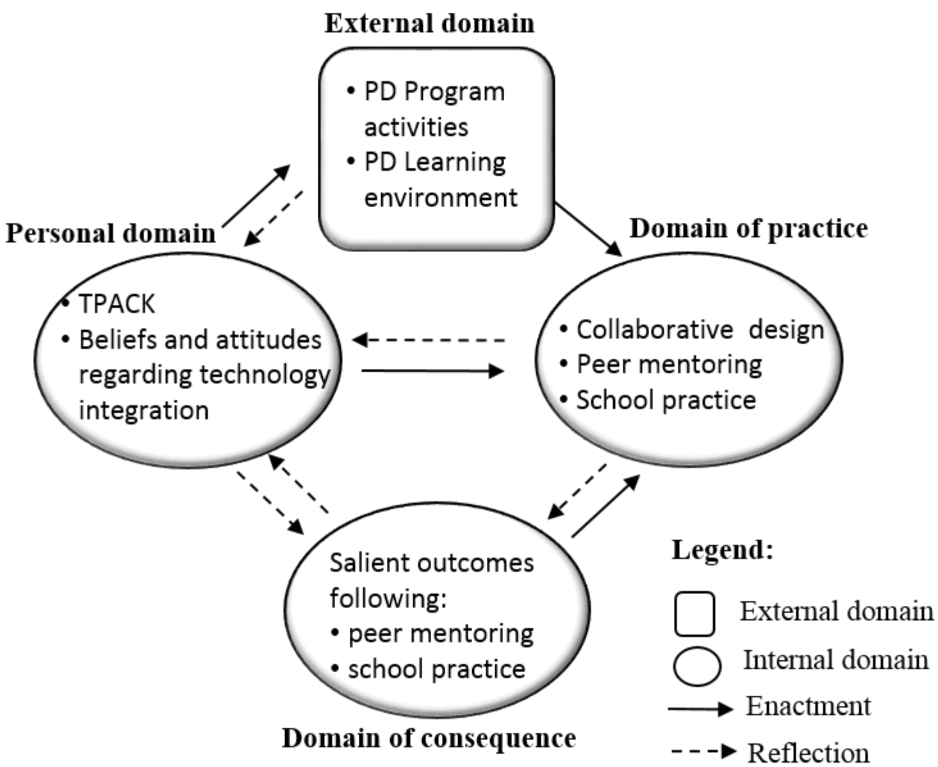

Figure 5: The Interconnected Model of Professional Growth as used in the data analysis. Adapted from Clarke & Hollingsworth (2002)

The change processes of the teacher includes "change sequences". Each change sequence consists of changes that have occurred in at least two domains and one "mediation process", which includes "enactment" or "reflection" on the change. Long-lasting change sequences constitute "growth networks" and reflect a process of professional growth. We identified the changes that the teachers went through in the internal change domains and characterized the change sequences by indicating the mediating processes which led to the changes. The model and the way we used it within the current analysis are illustrated in Figure 5.

Findings

Teachers' Involvement in the Design as Part of the PD Program

The observations indicate that all the teachers participated in the design activities during the PD meetings. These activities, which we interpreted as belonging to the domain of practice (professional experimentation) included:

a) conceptual design of the intended activities for the learning environment (such as articulating the activity outline features: goals and a general description of the activity)
b) adaptations to the online learning environments including the development (from scratch) of online forms for learner data collection in the ecological garden

In addition, the analysis and the rating of the adapted learning environments using the rubric described above (Table 2) enabled us to identify differences in the level of adaptation between the different teams:

- in one learning environment (team A) adaptation that was scored as 2 was made only in one part (the outdoor activity) and therefore the whole adapted learning environment was rated at a low level (2 out of 9)
- in two learning environments the adaptations of the three parts summed up as 6, and therefore, were rated at a medium level (6 out of 9)
- in four learning environments, the adaptations of the three parts summed up between 7 to 9, and were rated at a high level (between 7 to 9 out of 9)

Unlike the adaptations that were documented in the adapted learning environments of the teams, which constitute a product of an entire team, the documentation of the editing events of these environments describes the personal scope of work of each teacher. An analysis of the editing events of the 24 teachers reveals that the degree of teacher involvement in conducting the adaptations greatly varied:

- high involvement - 29% of the teachers (more than 20 editing events)
- medium involvement - 8% of the teachers (6-19 editing events)
- low involvement - 17% of teachers (1-5 editing events)
- no involvement at all - 46% of the teachers

In addition, unsurprisingly, the level of the adaptation of the adapted learning environments was congruent with the number of personal editing events. Teachers whose number of editing events was high (within their team learning environment) demonstrated a high or medium level of adaptation (six environments out of seven). In other words, these environments included new pedagogical approaches that did not exist in the original activities of the outdoor learning module or changes of existing activities. Accordingly, in environments in which the volume of editing events of teachers was low, the level of adaptation of the environment was low.

The rating of the internal coherence of each part of the adapted learning environments showed that in all of them there was some impairment of coherence: five environments were rated, using the rubric for assessing coherence (Table 3), between 1 to 5 (out of 9), and two environments were rated as 7 and 8. An analysis of the causes for the decreased internal coherence (Figure 6) showed that in all environments there were insufficient technical instructions for learners regarding how they should carry out the activities (e.g., lack of instructions for filling in the data collection form). Four of the environments displayed a mismatch between technology and pedagogy (e.g., there were no collaborative documents for student work even though students were expected to work collaboratively). Problems in the internal sequence arose when the order of activities did not make sense or when activities included instructions that were not in line with the place they were supposed be conducted (e.g., directions for conducting observations in the field as part of the summary activity that is supposed to take place at home / in school). Contradictions in contents stemmed from a difference between the questions appearing on the website and those appearing in the work documents.

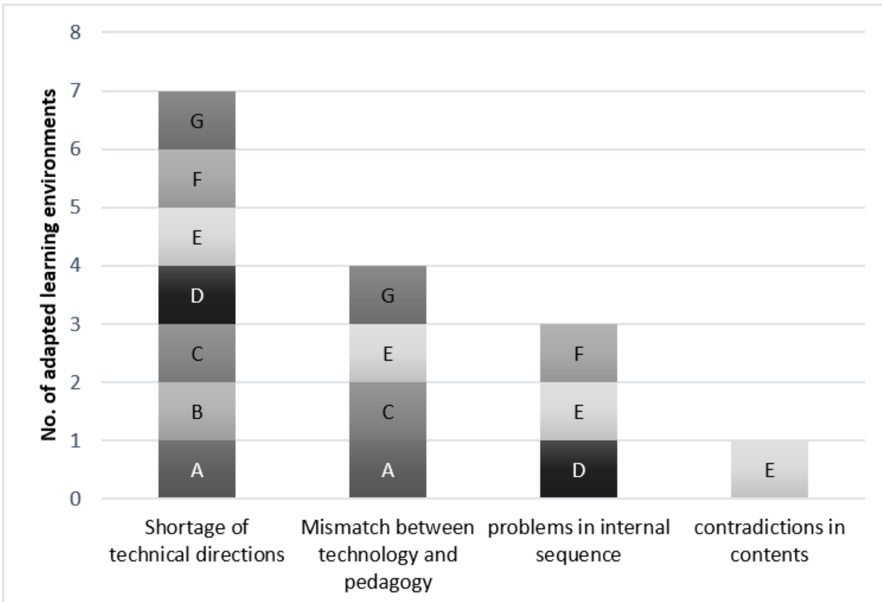

Figure 6: Causes for the decrease in internal coherence of the three parts of the learning environment.
The letters represent the seven adapted learning environments

Six of the seven adapted learning environments were examined according to the "coherence of the learning environment as a whole" criterion (in the environment of team A, only one of the three parts was adapted, therefore this environment was not examined according to this criterion). This examination showed that in five out of the six environments, adaptations decreased the coherence of the environment:

- in one environment (F) the coherence was maintained (rated at 3 out of 3);
- in another environment (B) the coherence was rated at a medium level (2) due to lack of consistency in terminology;
- in the four remaining environments the coherence was rated at a low level (1) due to poor sequencing of activities, such as a wrong order or a cluster of unconnected activities. For example, in team E's learning environment, an activity guiding the students on how to work while being in the field was incorporated in the middle of the preparation part (designed to be conducted at home).

Teachers' Professional Growth Following the PD Program

The change processes that teachers underwent

As detailed below, all of the findings reveal that the teachers went through change processes at different levels according to Clarke and Hollingsworth's model (2002). Some went through changes in three domains – personal, practice, and consequence – and some in only two domains – personal and practice. To examine the change processes, we analyzed the questionnaires and the interviews with the aim of identifying the knowledge bases (included in TPACK) that the teachers use, their beliefs and attitudes toward the integration of technology in teaching, and the characteristics of their practice before and after the PD program.

A range of evidences of changes that teachers went through in the PD process was found in the first round of interviews (9 teachers). These were classified into the three change domains: the personal domain (knowledge, beliefs, and attitudes), the domain of practice (as professional experimentations during and after the PD program), and the domain of consequence. As can be seen in Table 4, all of the teachers went through change processes during the PD program in at least two of the three domains shown in Clarke and Hollingsworth's model (2002) – in the personal and in the practice domains. Three of the teachers reported changes in the domain of consequence as well. The following sections show the findings on which Table 4 is based upon.

Table 4: Types of internal change processes teachers went through

Pseudonym	Changes in the personal domain				Changes in the domain of practice			Changes in the domain of consequence
	Knowledge*			Beliefs and attitudes	During the program	In planning	At school	
	TK	TPK	TPACK					
Sama	2	4	1	6	5	1	17	8
Adi	2	12	1	4	3	0	6	5
Nura	2	12	1	11	1	2	2	9
Avivit	2	8	1	1	2	2	1	0
Malka	2	6	1	5	4	2	1	0
Nihal	4	6	0	8	4	2	0	0
Alon	2	16	1	5	2	2	0	0
Michael	4	18	0	2	1	0	0	0
Madi	1	8	0	7	1	0	0	0

* TK – technological knowledge, TPK – technological pedagogic knowledge, TPACK – technological, pedagogic and content knowledge. The numbers represent the number of different statements (different changes) for each category as expressed in the transcripts of the interviews.

Changes in the personal domain. Changes in the personal domain occurred in knowledge, beliefs, and attitudes. Changes in knowledge were reflected by an elaboration of the various knowledge bases included in the TPACK framework, as expressed in teachers' answers to the questionnaires and interviews.

Teachers' answers to the questionnaires show that they went through a change in their views of mobile technology as a tool for promoting teaching (TPK). Most of the teachers provided explanations for their willingness or decline to integrate technology in their teaching. These explanations were classified into two aspects: learning-related and technical-related explanations. Learning-related explanations emphasized the advancement of student learning (increase in innovation, interest and motivation, connection to the student's world, multiple teaching methods, and better demonstration). Technical aspects, on the other hand, included explanations that focused on availability of mobile devices, fear of discipline problems, and prohibiting use of smartphones at school, etc. The findings show a positive change in teachers' views, expressed as an increase in the percentage of learning-related explanations (and a decrease in technical-related explanations) in the second round of questionnaires (Table 5). Additionally, more learning-related explanations for integration of technology that were not mentioned in the first round of questionnaires (before the PD program) were mentioned in the second round (after the PD program had ended). We interpret this change as an indication of teachers' development of their TPK.

Table 5: Reasons for willingness/decline to integrate mobile technology in teaching as depicted in the pre and post questionnaires

Type of reasons	Before the PD program (n=20)	After the PD program (n=19)
Technical-related	45% of teachers	5% of teachers
Student learning-related	35% of teachers	63% of teachers

Of the 25 statements in teachers' answers to the post questionnaire, our analysis indicates that:

- 44% expressed pedagogical-technological knowledge (TPK)
- 41% expressed technological knowledge (TK)
- 15% expressed pedagogical knowledge (PK)

For example, teachers stated that they learned how the integration of collaborative documents allowed for tracking of the learning process, sharing between students and collaborative learning (TPK). They also got familiar with different programs and applications that they could incorporate in their teaching and acquired skills in editing Google forms (TK). Some teachers stated that they had learned about inquiry activities and the importance of collaborative learning (PK).

The nine teachers who were interviewed also referred to the advantages of the tools that they learned during the PD program for teaching, in general, and for teaching inquiry outdoors in particular. We interpreted these references as a development of TPK. For example, Alon explained how he perceives the potential of technology for promoting outdoor learning as follows:

> [The students] share…, they work, they're with me, they don't just sit down and listen to me, they explore by themselves, they respond by themselves, they take notes by themselves, put up the data, add, take photos… they're more active. And that makes a big difference when working outdoors (Alon, interview1).

In addition, the teachers indicated, in the interviews, that they learned how to make changes in the technological environments that they experimented with (TK). Some, such as Adi, also showed pedagogical knowledge (PK) that they had acquired:

> …I learned to emphasize and break down the tasks into small, structured stages so that students would be able to take this and work in the field. They will not even need me there to guide them (Adi, interview1).

In contrast, three of the teachers (Alon, Michael and Madi) felt that their skills in editing websites were still limited after the PD program, and argued that the reason for this was the little experience they got in the PD meetings (in one case, due to missing of a meeting).

The TPACK of six of the interviewed teachers was reflected in their description of activities they developed or plan to develop. These included explanations for the rationale for using the technological tools. For example, Avivit described how collaborative documents within an inquiry project could support learning:

> I now want the students to put all of the data that they collected into the [collaborative] worksheet. This way I can see everything summarized, tidied… if they [the students] conduct collaborative activities, I don't need to keep checking my email … I can comment [on the collaborative document] and return it to them, which is really excellent (Avivit, interview1).

The changes in the attitudes and beliefs were reflected by self-efficacy and intentions for future integration of technology in teachers' practices. Analysis of the questionnaires showed an increase in willingness to integrate mobile technology in teaching from 85% of teachers at the beginning of the PD program (16 of the 20 responses) to 95% of teachers at the end of the PD program (18 of the 19 responses). In addition, all of the interviewees stated their intentions to integrate technology in their teaching in the future. Six of the teachers stated that their self-efficacy and confidence for integrating technology had increased. Nura, for example, stated:

> I have learned… now I have more confidence to use it [technology]. I was familiar with [some of the technological tools] before, but haven't really used them. I was scared. But not anymore. Not like I was before the PD meetings (Nura, interview1).

Changes in the domain of practice. Changes in the domain of practice were expressed by:

a) experiencing design and development during the PD program, in the classroom and at home,
b) detailed descriptions of future activity, and
c) descriptions of integration of the technological tools in school practice.

While 95% (18 of the 19 responses) of the teachers incorporated the use of technology in their teaching prior to the PD program (as depicted from the pre-program questionnaire), their use of technology was primarily to assist students to *consume information* within the classroom, mostly using web 1.0 technologies. The devices they used included smart-boards, desktop computers connected to the internet, and a projector. Three teachers also stated the use of smartphones. Prior to the PD program, the teachers considered technology to be a tool primarily for visualization and for introducing or summarizing contents they taught (13 teachers). They did so by developing PowerPoint presentations and by projecting animations and videos they found on the Web (such as demonstration of experiments in YouTube) and having their students search for information as part of the inquiry process (10 teachers). Only two of the teachers stated that they used technology for communication with the students. This picture changed dramatically following the PD program. The interviews show that after the PD program teachers viewed students as *collaborative knowledge builders* and used much more web 2.0 technologies to support their students' learning. Adi, for example, described how Google documents enabled her to provide feedback to her students:

> I asked each student to prepare [a Google document], and share it with me… I have one group in which students document all their work there [in a Google document]. They send me the link and I make my comments there. They also prepare tables [collaborative spreadsheets]… I can go in and have a look at their tables anytime (Adi, interview1).

Changes in the domain of consequence. Changes in the domain of consequence, according to Clarke and Hollingsworth's model (2002), are reflected in the practice outcomes that are perceived as salient to the teachers. Evidence for such changes came up in interviews and were related to teachers' enactment of the adapted learning environment with peers (teachers as mentors) or in cases in which teachers enacted the technological tools that they developed with their students. This evidence included:

a) teachers' insights concerning the quality of the activities that were developed (such as components that they felt that require additional refinement),
b) teachers' notions regarding pedagogical characteristics of their students' learning (such as collaborative learning supported by the activities they developed), and
c) teachers' notion of their students' emotional responses (such as enthusiasm).

The teachers' change sequences. The analysis of teachers' change sequences, as reflected from the interviews, indicates a range of sequences, the salient ones being:

a) reflective processes stemming from the participation in the PD program (the external domain) and affecting the personal domain (32% of all sequences identified),
b) reflective processes stemming from the professional experimentation (the domain of practice) and affecting the personal domain (24%), and
c) enactment processes stemming from a change in the personal domain and affecting the domain of practice (20%).

Examples of the analysis of the sequences are introduced in Table 6.

Table 6: Examples of the analysis of statements from interviews according to Clarke and Hollingsworth's (2002) notion of change sequences

The change sequence (from one domain to another, with "enactment" or "reflection" as connecting process)	**description of the process**	**Example**
Reflection From the external domain (E) to the personal domain (PE) E ⇢ PE	Development of knowledge and change in beliefs and attitudes following the PD program	Changes in TK and in TPK: "A teacher at school told me 'Wow, all the Google tools are so great, and you can use them this way, and that way'. Now, it's not that I freed up time for it and said: 'Okay, now I shall go into it, and I shall learn the Google tools'... I didn't learn these tools at my own initiative. It was the PD program… one of the things in the program was the exposure to options that exist in the internet that I wasn't aware of" (Malka, interview1).
Reflection From the domain of practice (PR) to the personal domain (PE) PR ⇢ PE	Development of knowledge and change in beliefs and attitudes following the experiences during and after the PD program	A change in the sense of self-efficacy following the PD program and its experiences: "This is the first time that I have used Google Drive [as an editor], to create forms. In the past, people would have sent me such forms [to fill in details]. But until now, it looked like something that is way beyond my skills. Now I think that it's easy for me to do it (Nihal, interview1).
Enactment From the personal domain (PE) to the domain of practice (PR) PE → PR	Application of new knowledge in practice and change in attitudes and beliefs that affect practice	Application of TPK in teaching in the classroom: "After the second meeting [of the PD program] I said to my students: 'Alright, you write the results for me on Google Docs'… I knew Google Docs before that. I used it in the past. But I had never enacted it with students" (Adi, interview1).

□ - external domain, ○ - internal domain, → - enactment, - - -▶ - reflection.

Professional growth processes

The change sequences that five of the interviewees underwent could be interpreted as growth networks (viewed by Clarke and Hollingsworth (2002) as change sequences that persist in the long term). These teachers described how the PD program made them expand their knowledge through the experiences they went through and reported on changes that continued into their school practice too. An example of a professional growth network described in Figure 7 came up in the interview with Sama. Sama described how following her engagement in the PD program she learned to edit Google documents and Google sites (change in the personal domain) and created a website for her students that consisted of collaborative slides (change in practice). These slides allowed her to track students and identify collaborative learning through discussions that they held as part of the process (change in the domain of consequence) and also to provide them with formative feedback (change in practice). This experience provided her with concrete examples and led her to recognize the advantages of technology in advancing collaborative learning (change in the personal domain).

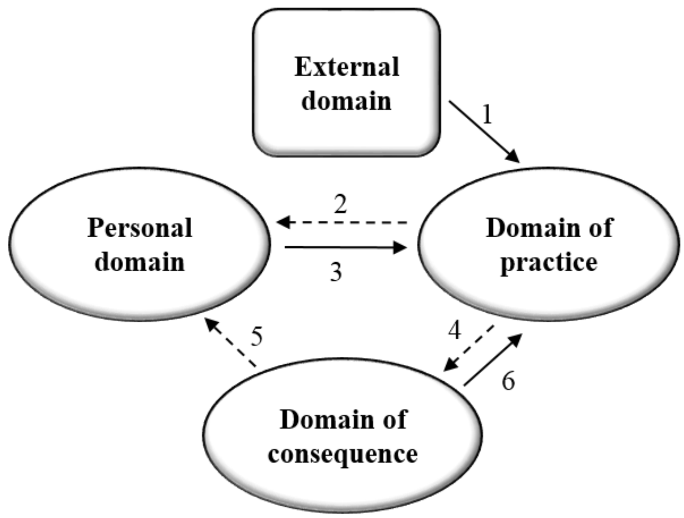

Figure 7: Sama's growth network

The second round of interviews enabled us to examine whether the growth networks that had been identified in the first round of interviews were sustained when checked about half a year later. The analysis indicated that five teachers (out of the seven interviewees in this round) who described future activities in the first interview (see Table 4) did continue to incorporate the technology in their teaching. For example, Sama created a collaborative document with a table in which students were required to fill in their row, with a picture of an organism of their choice, and a description of the organism's adaptation to a scarce water habitat (such as a cactus or a camel in the desert). Malka created collaborative presentations in which each student created a number of slides describing a different habitat. Adi used collaborative documents as a tool for preparation for an oral test on the group's outdoor inquiry project. Each student was requested to answer questions, individually in his/her own collaborative document, and provide feedback on the answers of another student in his group using the document. At the last stage, each group opened one collaborative document, in which the group members drafted together one answer for each of the questions.

Discussion and Conclusions

The literature describes a variety of challenges teachers face when teaching inquiry in the outdoors (e.g., Osborne, 2014; Tal & Argaman, 2005) and demonstrates ways in which technology may support outdoor inquiry (e.g., Land & Zimmerman, 2015). In this study, we implemented the Teachers-as-Designers approach by involving teachers in the design and development of technology-enhanced outdoor inquiry learning environments. The model of the PD program included three main stages: *Teachers as learners*, *teachers as designers,* and *teachers as mentors*. We examined how the unique design of the PD program contributed to the teachers' professional growth. Our findings show that this model proved to be effective as a way to support teacher professional growth, allowing the teachers to implement what they learned in their daily practice.

We assumed, as shown in our conjecture map, that a PD program that would integrate the current state of theoretical and practical knowledge regarding *TaD*, *Mobile learning*, and *outdoor inquiry* would lead to professional change processes among teachers and eventually to their professional growth. Specifically, we used mobile and non-mobile technology to streamline the learning between the various physical settings (as in Kali, Sagy et al., 2015) according to the model of outdoor inquiry learning (Orion, 1993, Tal et. al, 2014) and implemented the TaD approach (Svihla et al., 2015) with studio pedagogies (Crowther, 2013). The analysis of the data, inspired by the Interconnected Model of Professional Growth (Clarke & Hollingsworth, 2002), enabled us to identify the professional change and growth processes following the PD program. This analysis affirmed the design conjecture. The findings showed that the PD program supported all of the teachers to undergo professional change processes that included changes in different degrees and diverse development trajectories. All the teachers showed change processes in the personal domain and in the domain of practice, and some in the domain of consequence as well. In the personal domain, the PD program exposed the teachers to technological tools and enabled them to develop TK and TPK that would further assist them in coping with challenges in outdoor inquiry teaching. As described in previous studies that dealt with involving teachers in the design of technology-enhanced curriculum materials (e.g., Koehler & Mishra, 2005), some of the teachers also developed knowledge at the TPACK level (the highest level in the TPACK framework). In addition to the development of knowledge, the participation in the PD program resulted in changes in teachers' beliefs and attitudes, which was manifested in increased willingness to incorporate technology in their teaching and in their self-confidence to do so in practice.

The participation in the design process led also to changes in teachers' domain of practice. Some of the teachers demonstrated changes in their practice even months after the PD program has ended, as was evident in interviews, by their description of the way they integrated technology in their daily practice at school following the PD program. It seems that the teachers' experiences within the PD program as designers of TEL environments were significant for their professional growth. This was interpreted from the emphases that teachers gave in the interviews to the experience they had in designing and enacting their own learning environments (such as the statements cited in Table 6).

Some of the teachers also described changes in the domain of consequence following their integration of TEL materials that they had developed. These changes were reflected in teachers' insights concerning the quality of the adapted learning environments and the attention they gave to affective aspects of the students, which were revealed as a result of the new practice. These changes also contributed to teachers' willingness and motivation to continue to integrate the technology (as demonstrated in the description of Sama's professional growth).

In the design of the PD program, we applied recommendations from research literature regarding successful PD components (Loucks-Horsley et al., 2003; Penuel et al., 2007) and showed how teachers can be supported in designing technology-enhanced outdoor inquiry. The scaffolds that we designed implement the "fingerprint pattern of supports" described by Svihla et al. (2015) to support these processes in the following manner:

- *modeling of practice* – the teachers first experience, as learners, the use of the outdoor learning module which was designed by us as a model for their further adaptation,
- *support for discourse* – was implemented using the various activities for collaborative design, and
- *design for real world use* – was implemented by having teachers make the adaptations of their learning environments for their own students.

The analysis of the development processes that the teachers had undergone, as reflected in the interviews, shows that the changes in the practice domain were most dominant, as reflected by the high percentage of change processes in this domain. Our findings show that the process of adaptation of a learning environment had provided teachers with a meaningful experience in pedagogical design. As emphasized by Salomon & Ben-Zvi (2006), such an experience can provide teachers with much more than programs that focus on familiarization with technological tools.

The findings of this study also support the theoretical conjecture that we suggested in our conjecture map: teachers who went through a range of change processes in the three internal domains (personal, practice, and consequence) demonstrated the highest level of professional growth with long term effects. These findings differ from earlier notions regarding the need for continuous support in order for long term effects to occur (Dori & Herscovitz, 2005). Teachers in the current study continued to integrate technology in other contexts, long after the PD program was over. They did so using the approaches they learned in the program although this was a relatively short (14 hour) intervention, which did not include additional follow-up support.

In addition to findings that confirm our conjectures, there were other findings that we will take into considerations in future changes to the design of the PD program. Firstly, not all of the teachers were involved in conducting high-level adaptations. Secondly, the analysis of the adapted learning environments of the teams showed that the coherence of the learning environments had decreased in comparison with the original outdoor learning module that we offered. Such learning environments, when used by students, may inhibit their development of sound scientific knowledge (Fortus & Krajcik, 2012; Kali et al., 2008). Therefore, it seems that future research will need to develop and explore improved means to support teachers in adapting learning environments while maintaining a high level of coherence. Specifically, more research is needed to find ways to assist teachers in better exploiting the opportunities provided by the mobile technology to bridge between physical settings. Davis and Varma (2008) state that there is a risk of impaired coherence of curriculum materials when teachers make adaptations. In our case too, the reason for impaired coherence may be due to the fact that the teachers had received a copy of a whole inquiry module for adaptation. Thus, in the next iteration, we will enable greater freedom to the teachers in the design of the learning environment by providing a more open-ended learning environment (but with some scaffolding structure). In addition, as suggested by Davis and Varma (2008), we intend to add guided activities in which teachers will analyze the outdoor learning module that they have used as learners, before the adaptation stage. By doing so we hope to increase teachers' awareness of the importance of streamlining knowledge throughout the learning process and to improve the quality and coherence of the adapted learning environments. We also expect that this will allow for greater involvement of teachers in the design process, and consequently, will deepen their development and growth processes.

In conclusion, we have shown how the "TaD of TEL" approach can be implemented to support teachers' design of technology-enhanced outdoor inquiry activities. The three-stage model that we have developed – *teachers as learners*, *teachers as designers,* and *teachers as mentors* – proved to support teachers' professional growth and adoption of advanced means for using technology, which can address some of the challenges inherent to outdoor inquiry teaching. We suggest using this model for additional PD contexts in which integration of technology has a potential to advance teaching and learning. Since teachers' involvement in design and development of technology-enhanced learning materials is crucial for the success of their implementation, we see great promise in our model as a way to promote productive use of technology by teachers, as well as long-term teacher professional growth.

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Biographies

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Yael Kali is an associate professor of technology-enhanced learning at the Technologies in Education Graduate Program, Faculty of Education, University of Haifa, and the director of the the Learning In a NetworKed Society (LINKS) Israeli Center of Research Excellence (I-CORE). Using a design-based research approach, Kali explores technology-enhanced learning and teaching at various levels, from junior high school to higher education. Together with her students of the TEL Design group she studies the role of design, and design principles for supporting Computer Supported Collaborative Learning (CSCL), and for teacher professional development, in a Teachers as Designers (TaD) approach. Kali currently serves as an Associate Editor for the journal Instructional Science.

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OER Usage by Instructional Designers and Training Managers in Corporations

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Abstract

Since the development of Open Educational Resources (OERs), different models regarding the usage of these resources in education have appeared in the literature. Wiley's 4-Rs model is considered to be one of the leading models. Research based on Wiley's model shows that using materials without making changes is the most common use. Compared to the extensive literature regarding OER usage in education, the literature barely deals with OER usage by instructional designers or training managers in corporations. The purpose of this research is to examine the OER usage of these two stakeholders, distinguishing between Little and Big OER repositories, in which Little OER repositories such as YouTube and Wikipedia aren't necessarily designed to fulfill educational purposes. Findings show that these stakeholders almost use only Little repositories and that their usage level is higher than what is documented in the literature: they mostly Revise–modify the form of the resource, and Remix–combine different resources to create new ones. These differences can be explained by the fact that materials from Little OER repositories are raw materials, requiring further editing and adjustment. Significant differences between instructional designers' and training managers' usage of OERs were found regarding the Reuse level of resources from internal repositories and the Google Images repository, and the frequency of this Reuse.

Keywords: OER, Open Educational Resources, instructional designers, training managers, corporate

Introduction

The term, Open Educational Resource (OER), was first coined in 2002 by the UNESCO committee (World Forum of UNESCO Chairs, 2002)) and was defined by Hylén (2006, p. 1) as "Digitized materials offered freely and openly for educators, students, and self-learners to use and reuse for teaching, learning, and research". Following Hylén's definition, it can be assumed that instructional designers in the training world might have interest in these resources since they already use new technologies and incorporate learning objects into their designs (Duncan, 2009).

OERs can usually be found in varied repositories. The literature suggests a

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distinction between these repositories based on different theoretical frameworks, e.g., distribution and sharing models (Shmueli, Reisman, & Sperling, 2010): Big repositories and Little repositories (Weller, 2010). A Big OER repository is defined as an institutional repository for teaching and learning objectives and is usually of high quality. It is presented in a unified style and forms part of a time-limited, focused project, has a portal, and is associated with research and data. A Little OER repository is defined as an individually produced, low cost resource that can be produced by anybody, not just educators, and may not have explicit educational objectives. It is usually perceived to have low production quality and is shared through a range of third party sites and services. Reference to Little OER repositories, such as Wikipedia, posts and blogs on Wordpress, Slideshare, Wikispaces, and images on Flicker, which do not contain the classic learning objects, can be found in the literature (Hylén, 2006; Keegan & Bell, 2011; Rolfe, Williams, & Windle, 2012; Weller, 2010).

Types of OER usage are varied. In his 4-Rs model, Wiley (Hilton, Wiley, Stein, & Johnson, 2010) differentiates four levels of reuse: using the content without changes (Reuse); sharing copies of the content with others (Redistribute); adapting, modifying, translating, or changing the form of the content (Revise); and combining different OERs to create a new source (Remix). The literature suggests that the last two levels represent a minor part of the possible utilization of OERs (Hilton, Wiley, & Lutz, 2012; Rolfe et al., 2012). Through the reuse of OERs, teaching and learning processes can be enhanced (Friesen, 2009; Hylén, 2006).

OER repositories might be relevant for corporate instructional designers who are required to supply training solutions of considerable content and domains. There is no doubt that organizations have different training needs, thus the requirement for particular content; however, instructional design in organizations often revolves around a standard set of topics. Varied resources are available for instructional designers, such as internal manpower, internal organizational repositories, external repositories, and repositories which are not necessarily meant for learning purposes. These last two might be open Big or Little repositories and, thus, are accessible to instructional designers and training managers. In addition, it seems that there are different work characteristics for instructional designers working in corporate organizations in comparison to instructional designers in the academic and educational domains. Therefore, this research aims to examine which OER repositories are used by the instructional designers working in corporate organizations and whether their usage characteristics are different from those described in the literature. This research broadens the little knowledge that exists regarding the use of OERs by instructional designers and training managers in corporations, especially in Israel, and provides insight into the way they are used.

Background

The impact of open learning resources in higher education was discussed during UNSCO's education forum in 2002. Out of that forum came the term OERs (Johnstone, 2005). Around this principal, a movement was developed, and at its heart lies the simple and powerful idea that the world's knowledge is a public good and that technology in general and the World Wide Web in particular, provide an extraordinary opportunity for everyone to share, use, and reuse that knowledge (Smith & Casserly, 2006). Since the time the term originated, there have been several attempts to clarify the definition of OERs. Hylén (2006) defines OER as digital materials offered freely and openly to reuse for education and research. Hylén also adds that OERs contain educational content, software tools, and application resources. A more detailed definition of OERs was suggested by the William and Flora Hewlett foundation, which is considered part of the OER movement leadership: "Teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or repurposing by others. OERs include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge" (D'Antoni, 2009, p. 3).

The meaningful advantage of these resources being free for use turns out to have profound implications; for example, in an updated study of eight US colleges that had adopted the use of OERs, Hilton, Robinson, Wiley, and Ackerman (2014) found a significant cost reduction for their students worth thousands of dollars. Beyond that, the money savings did not come at the expense of the quality of materials nor the students' academic achievements. A study from 2013 compared the academic achievements of students who used OERs to the achievements of students who used learning books, and found no difference (Hilton, Gaudet, Clark, Robinson, & Wiley, 2013).

Generally, OERs can be found in various dedicated repositories. The literature suggests several theoretical frameworks to distinguish between these repositories. Shmueli et al. (2010) categorize types of online learning material repositories based on distribution and sharing models; Cohen, Kalimi, and Nachmias's (2013) distinction is of local and global repositories. Hylén (2006) provides a different angle to the characterization of repositories by placing them on two axes: scale of operation (small/large), and provider of materials (institution/community). Although the terminology is similar, Weller (2010) presents a slightly different approach to the classification of repositories. He groups the repositories in terms of Big repositories and Little repositories. A Big OER repository is usually defined as an institutional repository for teaching and learning objectives and is usually of high quality. It is presented in a unified style and forms part of a time-limited, focused project, has a portal, and is associated with research and data. A Little OER repository is defined as an individually produced, low cost resource that can be produced by anybody, not just educators, and may not have explicit educational objectives. It is usually perceived to have low production quality and is shared through a range of third party sites and. Indeed, the literature refers to Little OER repositories as not containing the classic learning objects such as Wikipedia, posts and blogs on Wordpress, Slideshare, Wikispaces, and images on Flicker (Hylén, 2006; Keegan & Bell, 2011; Rolfe et al, 2012; Weller, 2010). Despite this categorization, one should notice that Weller's terminology might be misleading. The repository size in terms of number of objects and number of users reflects the opposite picture. In their research, Zervas, Alifragkis, and Sampson (2014) analyzed the functionality of 49 Big OER repositories and presented data regarding the number of objects and users for each repository. They found that the biggest repositories contain no more than several hundreds of thousands of objects, and they located only two repositories with more than one hundred thousand users (e.g., Curriki and Merlot). This contrasts Little repositories such as Wikipedia, which contains more than 26 million articles in more than 250 languages and serves more than 500 million readers each month (Mesgari, Okoli, Mehdi, Nielsen, & Lanamäki, 2015).

Detailed examination of OER repositories, whether they are Big or Little, reveals a variety of objects that are used as OERs. In their 2009 review, Wiley and Gurrell display the development of several OER projects such as Internet Archive, Wikipedia, Connexions, and MIT OpenCourseWare; each contains a wide variety of objects. Wikipedia includes encyclopedic items that are mainly text based; Internet Archive is an online library containing websites, moving images, texts, audio, and recently added educational resources (Murphy, Hashim, & O'Connor, 2007); Connexions is an Internet repository containing educational content focusing on books, organized in modules that include tools for editing and reorganizing content (Burrus, 2014); MIT OpenCourseWare is a repository containing the academic content of entire courses from all the MIT university faculties, where some of the courses even include full video lectures (d'Oliveira, Carson, James, & Lazarus, 2010). Thus, it seems that the types of OERs are varied – from small learning objects to full courses.

A significant aspect of the definition of OERs is the extent of openness, which is the way they can be used. Obviously, OERs are used as a knowledge source for the learner, but a more advanced OER use is the Reuse: usage which exceeds a simple reading or reviewing of the learning object. Hylén (2006) states that Reuse of OERs means that the end-user should be able not only to use or read the resource but also to adapt it and build a new OER upon it. By the Reuse of OERs, teaching and learning processes can be made efficient, and their quality can be improved via adaptation to local needs, improvement, renovation, adding or removing layers, and combining several resources (Friesen, 2009; Hylén, 2006). However, there is always the concern that information overload might cause confusion, create a mismatch, or waste time during the data search due to a lack of consistent classification schemes. There is additional concern for the quality of the data because of the absence of appropriate evaluation tools (Nash, 2005).

Hilton et al. (2010) expanded the definition of the Reuse types. In their research, they present Wiley's 4-Rs model, in which four levels of Reuse are differentiated. The model defines the possible openness levels of OERs, but in a broader sense the model can be used to define the usage types of OERs:

1. Reuse – the most basic usage type, using the content unaltered and verbatim.
2. Redistribute - sharing copies of the content with others.
3. Revise - adapting, modifying, translating, or changing the form of the content.
4. Remix – the highest level of reuse, combining different OERs to create a new source.

The literature suggests that the last two levels represent a minor part of the utilization of OERs. Hilton, Wiley, and Lutz (2012) examined OER repositories of digital books in order to map the usage types of the repository's users. They concluded that Reuse is the most popular usage type, and that the Revise and Remix usage types, although they seem to be appealing for use, represent only 7.5% of overall usage. This finding is in line with what is known from the literature regarding the Reuse of OERs from other repositories. For example, the Rolfe et al. (2012) research, in which the usage types of medical OERs in a specific repository were examined, found that 99% of users didn't implement any changes to the content, but simply reused it. Hilton et al. (2012) found that the easier it is to make changes to an OER, the more changes people will make. Nevertheless it is important to mention that this research was conducted on a repository that enabled the option to track changes made on its objects. A major limitation of the research was the dark reuse of content – cases in which the users Revise or Remix objects outside of the system without the researchers knowing.

In the corporate world, a requirement for instructional design turns up when someone in the corporation, usually a manager, identifies a performance gap that requires a training treatment. According to the needs and the target audience, the instructional designer decides what the required solution is and develops manuals, scripts, video tutorial, computer based solutions, or tests (Gordon & Zemke, 2000). A substantial part of learning solutions might combine technological elements; therefore, instructional designers might have interest in OERs since they already use new technologies in their projects and incorporate learning objects from the web in their designs (Duncan, 2009). Additionally, given the global economic condition, organizations are increasingly forced to reduce manpower while simultaneously being required to increase the productivity of their remaining employees. In such an environment the instructional designers' role becomes more significant, and they are required to increase the quality of instructional programs using ever more efficient methodologies (Roytek, 2010). Therefore, instructional designers might find OER repositories useful since they contain high quality learning objects likely to be relevant for them, answering the organization's demand for efficiency. There is no doubt that considerable differences can be found between organizations in regard to their training needs and vocational training, and thus in their different content needs. However, in the learning development world, in most organizations, there are a few common fundamental topics that can be found. Different and varied resources are available for instructional designers who develop training materials such as: internal manpower, internal organizational repositories, external repositories, and repositories which are not necessarily meant for learning purposes. The latter might be OER repositories – Big or Little – thus accessible for instructional designers. In addition, it seems that different OER usage can be found when comparing instructional designers working in corporations to instructional designers in the academic and educational domains due to the dissimilar nature of their work. Actually, publication regarding OER usage in the corporate world is scarce, as it seems that the literature has mostly focused on the academic and educational domains. Even when the literature deals with OER issues in the corporate world, it is mostly from the point of view of how the corporation is using the repository knowledge, and not its training division. For example, Orri-Badia (2015) describes a case in which the L'Oréal Company chose to train 160 employees to improve their presentation skills via a Massive Open Online Course (MOOC) and another example is an OER that was established for the food industry (Geith, Vignare, Bourquin, & Thiagarajan, 2010). Therefore, this research aims to examine which OER repositories are used by the instructional designers working in corporations, and whether their usage characteristics are different from those outlined by the literature.

The Study

The current study explores the corporate training development domain, focusing on two main stakeholders – instructional designers (content developers of face-to-face and online training) and training managers – in order to examine the types of repositories they use and their usage levels. The claim was that different organizations have their own unique characteristics, thus their learning and training needs are unique. Therefore, it was hypothesized that only a few external institutional repositories (Big) are used for content development in corporations, mainly due to compatibility issues and irrelevancy of other corporate content. Furthermore, it was theorized that instructional designers who use external repositories are required to make adjustments to learning objects obtained from these repositories, hence deriving the following research hypotheses:

- Instructional designers and training managers use the Little OERs.
- Since Little repositories do not contain structured learning items, instructional designers and training managers mainly utilize the Revise and Remix levels of use, which the literature indicates as less than 10% of common use.

Accordingly, the research questions are:

- Which OER repositories are used by the instructional designers of corporations? Do they use Little OERs?
- If instructional designers of corporates do use Little OERs, what is the level of use in accordance with Wiley's 4-Rs model?
- Are there any differences regarding the usage level of instructional designers and training managers?

Methodology

The research tool was a questionnaire, which was distributed to instructional designers and training managers in corporations through the following: Google Docs, by e-mail; relevant forums related to corporate training in LinkedIn; as well as Facebook groups of instructional designers and training managers. The full questionnaire in Hebrew can be found at the following link: **http://tinyurl.com/qe4hkbz**, while the translated questionnaire in English can be found in the Appendix.

The questionnaire was designed according to the research questions, and the usage scale was based mainly on the 4-Rs model (Hilton et al., 2010). It was mostly focused on the usage levels of the items located in different kinds of repositories and their usage frequency, which was measured by a Likert scale.

The questionnaire was composed of four major parts:

- General data – demographic data of the participant such as age, gender, role, and nature of his/her job with an emphasis on learning material types developed by him/her.
- Internal repositories – participants were asked to report whether their place of work has an internal repository, and their usage type.
- External repositories – participants were asked to report which external repositories they use, and their usage type.
- Sharing – participants were asked to report whether they share the learning objects that they develop.

Regarding the external repositories, it should be noted that this part had two segments: in the first segment, participants were asked to name the Big repositories that they use and describe their usage level. In the second segment, participants received a list of popular Little repositories from diverse disciplines and were asked to report whether they use them, and if so, to also describe their usage level. In addition, participants had the option to list other Little repositories that they use and describe their usage type. The main reason for focusing on popular Little repositories was to obtain a sufficient amount of data for statistical analysis. The chosen repositories were:

- YouTube – a popular website used for sharing videos and movies, containing millions of videos and movies.
- TED – a popular website containing short videos of lectures and movies from varied domains and topics.
- Google Images – a search engine containing millions of pictures.
- Flicker – a website used for sharing pictures, containing millions of pictures.
- Wikipedia – an encyclopedia website, containing free content and millions of informative articles.

The questionnaire was sent to the targeted population of the study by e-mail and through posts in relevant Facebook and LinkedIn forums. The mails and posts included an explanation of the study aims and a request for participation. The questionnaire included further explanation and guidelines regarding how to fill it out and was voluntarily completed online by Israeli participants in the month of June, 2014.

According to the analysis of the completed questionnaires, the population of this study consisted of 50 participants from the field of training, from 29 corporate organizations across Israel of which there were 16 men and 34 women. 62% of the participants were instructional designers and 38% of them were training managers. The average age of the participants was 34.5, and their average number of years of experience in the industry was 6.9. The participating organizations included companies from varied domains such as finance, food industry, and technology.

Findings

Characteristics of Learning Resources Developed in Corporations

The study examined the types of learning resources which were developed by the participants, their topics, and the development frequency of each resource. A list of common and popular corporate training topics was shown to the participants. The participants were asked which topics they developed as learning content. The options were sales, service, technical topics, regulations, and other (the participants were able to report what kind of other contents they developed for learning purposes). The results show that the developed learning items deal with service, sales, technical topics, and regulations (Figure 1).

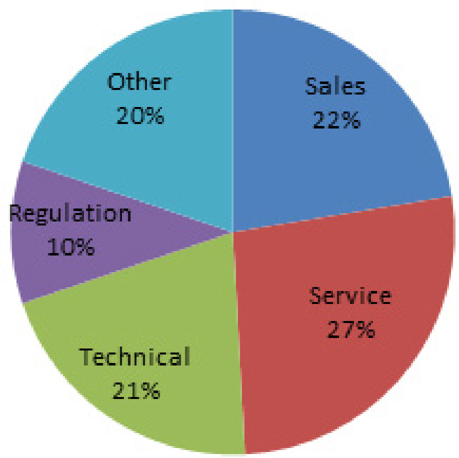

Figure 1. Segmentation of learning resource topics

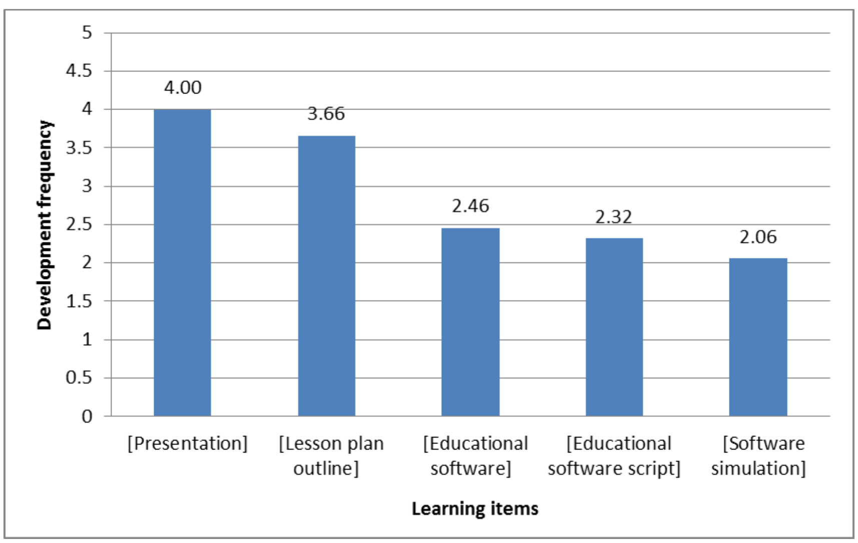

Figure 2. Types of learning objects and development frequency

Figure 1 presents the major topics of learning resources developed in corporate organizations. Service (27%), Sales (22%), and Technical (21%) were found to be the major topics of learning resources developed in corporate organizations, with a balanced division. Regulation was only

10% of developed learning resources. The category of Other did not result in a clear trend toward a specific topic. In addition, participants were presented with common corporate learning items such as presentations and software simulation and were asked to report the development frequency of these items on a 1-5 Likert scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = mostly).

As shown in Figure 2, the learning item that had the highest development frequency was Presentation (4.00 on average), followed by Lesson plan (3.66 on average). Educational software (2.46 on average), Educational software script (2.32 on average), and Software simulation (2.06 on average) were far behind.

The Usage of Internal Repositories

Part of the questionnaire examined whether there were internal repositories in the participants' working environments and whether the participants use them. In addition, types and usage levels of participants' learning items were explored. The findings show that 92% of organizations have an internal repository and that 87% of the participants frequently use these internal repositories. In order to examine the types of learning items that are available in the internal repositories, and the search frequency of these items, the common corporate learning items were presented to the participants and they were asked to rate their search frequency on a 1-5 Likert scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = mostly).

Figure 3 shows that in accordance with the development frequency of the different types of learning items, the most searched item was Presentation (3.59 on average), followed by Lesson plan outline (3.21 on average). Educational software (2.76 on average), Educational software script (1.81 on average), and Software simulation (1.69 on average) were, again, far behind.

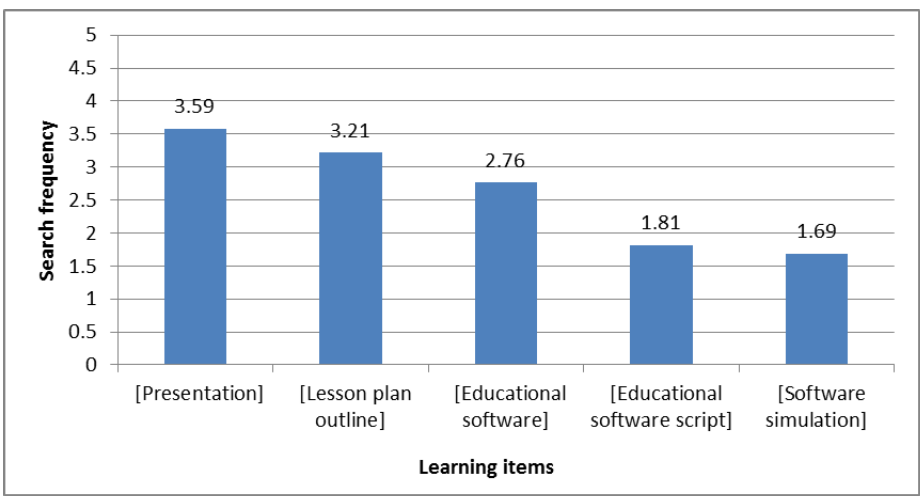

Figure 3. Types of learning items retrieved from internal repositories, and their search frequency

The participant usage level of learning items available in the internal repositories was examined, as well. Different levels of learning item usage were presented to the participants, and they were asked to rate their usage frequency for each level. The different levels were based on Wiley's 4-Rs model; however, in this current study only three out of the four Reuse levels were examined. The fourth level of Reuse, Redistribute – distributing free learning materials – was not examined, since it does not have relevance to the role of instructional designers. Table 1 outlines the congruence between the model's definitions and the options that were given to the participants in the questionnaire.

Table 1. The congruence between Wiley's 4-Rs model and the answer options on the questionnaire

The 4 Rs	Reuse	Revise	Remix
Definition	The most basic usage level, using the content unaltered and verbatim	Adapting, modifying, translating, or changing the form of the content	The highest level of Reuse, combining different OERs to create a new source
Description in the questionnaire	Using the learning item for informational purposes only/using the learning item in its original form, just as it appears in the repository	Creating changes and adjustments in the learning item according to my needs	Creating changes and combining different learning items according to my needs

The participants were asked to report on the frequency of their Reuse for each level. The usage levels and the frequency of Reuse were rated on a 1-5 Likert scale (1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = mostly), as well. The findings are presented in Figure 4. As the Figure shows, the most popular usage levels are "creating changes and adjustments in the learning item according to my needs" (3.67 on average) and "creating changes and combining different learning items according to my needs" (3.64 on average). This means that Revise and Remix are the most frequent answers, respectively. They are followed by "using the learning item for information purposes only" (3.53 on average), and far behind with "using the learning item in its original form, just as it appears in the repository" (2.36 on average), which correspond to the first two levels of Reuse.

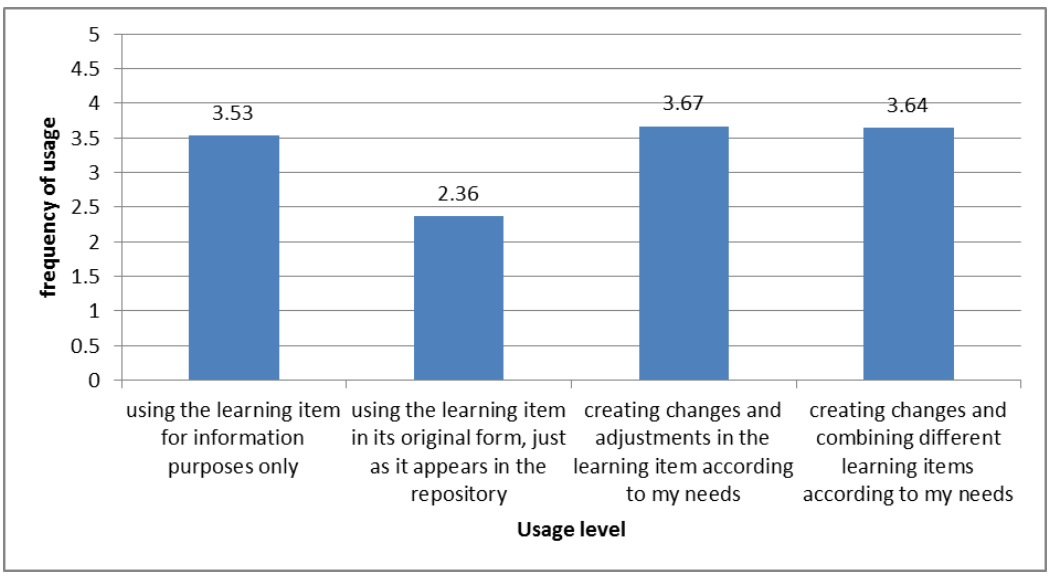

Figure 4. The frequency of usage level

The Usage of External Big Repositories

49% of the participants answered positively to the question, "Do you use online repositories containing learning items when you are working on training development?" Subsequently, the participants were asked to report the repositories that they use and on what level. It is noted that although the questionnaire gave clear and specific guidance to the participants, asking them to only list repositories containing items which are clearly dedicated to learning such as presentations, lesson plan outlines, and educational software, and not to list learning items such as Google Images, forums, or newsletters, most of the participants still reported only Little repositories such as Wikipedia and YouTube. The small number of participants who did report using the relevant repositories (Big repositories) referred to pre-paid repositories, which did not fit the OER definition. Therefore, the results presented in this section could not be subjected to statistical analysis.

The Usage of External Little Repositories

The popular Little repositories – YouTube, Google Images, Wikipedia, Flicker, and TED – were presented to the participants, and they were asked whether they use these repositories and at what level. In addition, participants were able to report their usage of other Little repositories. As shown in Table 2, YouTube is the most popular repository among participants of the current study; 47 participants (96%) referred to this repository and reported that they use it when they develop learning materials. Google Images was also found to be a popular repository for developing learning materials, used by 44 participants (90%). Wikipedia was found to be a slightly less popular repository, with 34 participants (69%), and similarly, the TED repository was reported as used by 27 participants (55%). The Flicker repository was hardly used by participants for the purposes of learning development, and, in fact, the usage of this repository was so negligible that a statistical analysis was not computed. Only 10 participants reported that they use other repositories for learning development; 5 participants reported that they use pre-paid ShutterStock, which makes it irrelevant to the current study. Other repositories that were mentioned by individuals were Safaribooks (online professional literature), short medical videos and movies found online, internet articles, webinars, and Slideshare.

Table 2. Usage of external Little repositories

	Repository Content	**Usage Popularity***	**Reuse** Uses the item just as it is	**Revise** Creates changes and adjustments to item	**Remix** Creates changes and combines different learning items
YouTube	Videos and Movies	47 (96%)	51%	**26%**	**23%**
Google Images	Pictures	44 (90%)	11%	**62%**	**27%**
Wikipedia	Text	34 (69%)	15%	**32%**	**53%**
TED	Videos and Movies	27 (55%)	67%	**15%**	**18%**
Flicker	Pictures	5 (11%)	-	-	-

* Usage Popularity column presents the number of participants using the repository and their percentage.

The participant usage level of these repositories can be seen in the last two columns of Table 2. Regarding Google Images, Revise and Remix were found to be 89% of all usage levels, and Re-use represented only 11%. With the YouTube videos repository, Revise and Remix uses were found to be 49% of all usage types. Wikipedia also had high rates of Revise and Remix uses (85% of usage), and Remix was especially prominent and represented 53% of all usage. When comparing the TED video repository to YouTube, there was a similar trend. It seems that Reuse was the most popular level of use as it represented 67% of all usage, while Remix was 18% of all usage, and Revise was only 15%. As mentioned previously, statistical analysis was not conducted on the Flicker repository due to the low level of participant usage; as was the case for other repositories with low levels of participant usage.

Sharing of Adapted OERs

The participants were asked to report whether they share the adapted learning resources that they retrieve from repositories and modify for their needs, and if yes, how the sharing process is carried out; 26 participants (58%) answered positively. As for the sharing processes (Figure 5), e-mail was the most common sharing tool (54%). Another popular sharing process was to upload the learning resource to the organization's internal repository (33%). Together, other types of sharing processes accounted for 13%; and interestingly, a small portion of participants chose to "give back" the resource to the repository (3%).

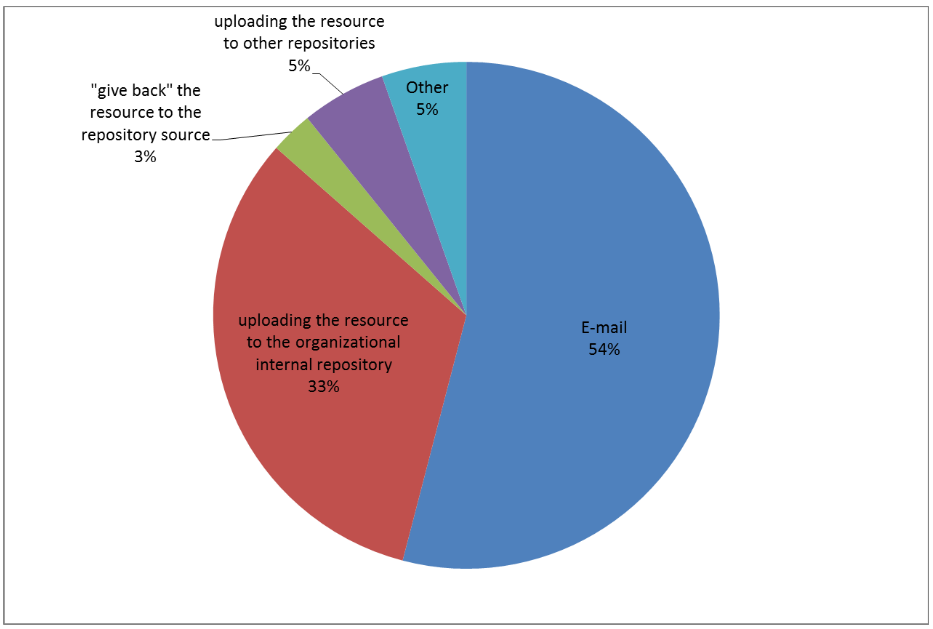

Figure 5. Sharing practices of changed learning objects

The Differences between Instructional Designers and Training Managers Regarding OER Reuse Level

In the current study, no significant differences were found between instructional designers and training managers regarding their usage levels, except for two cases. The first significant difference was found regarding the Reuse level of resources from the internal repositories and the frequency of this Reuse [$t(42) = -2.375$, $p < 0.05$]. Thus, training mangers create more changes in learning resources to fit their needs than instructional designers do. The average change frequency for instructional designers ($M = 3.33$, $SD = 1.41$) is lower than the average for training managers ($M = 4.2$, $SD = 0.9$). The second significant difference was found regarding the Reuse level of the Google Images repository [$t(47) = -1.171$, $p < 0.05$]. Instructional designers usually Reuse the learning items as they are, with no changes (M = 2.73, SD = 1.09), while training managers tend to make changes to learning objects in order to fit them to their needs (M = 3.06, SD = 0.69).

Discussion and Conclusions

Characteristics of Developed OERs in Corporations

Corporate training and learning development are mainly focused on topics such as sales, service, and technical subjects, which constitute 70% of their learning development content. This finding is not surprising, since many organizations deal with these domains, train their employees, and manage departments, which are tasks that are all targeted to these objectives. Similarly to other studies conducted in higher education (Cohen et al., 2013), the current study found that presentations and lesson plan outlines (classical learning items) were commonly used in corporate learning development. A significant gap was found between these learning items and those considered more advanced, such as educational software, tutorials, courseware, interactive videos, and simulations. This finding indicates the preferences of the instructional designers, and thus the organizations' preferences to use standard learning means rather than other learning means.

The Usage of Internal Repositories

Most of the organizations in this study have internal repositories containing learning resources, and the majority of participants use them. This finding suggests that corporations attribute importance to employee development through learning. Naturally, the operation of learning resource repositories involves an investment of numerous organizational resources, both financial and managerial. These resources might include technological infrastructure such as servers, storage, and licensed information management software. The maintenance of these infrastructures requires additional workforce employment and training, which adds to the organization's financial costs. Furthermore, resources of time and management are also required to manage these repositories, constantly checking that materials are beneficial, of good quality, indexed correctly, and updated.

Instructional designers and training managers use learning materials from internal repositories in various ways and at a similar frequency. However, a preference to Revise and Remix learning materials rather than Reuse them was identified. This finding is significantly different than the findings of former studies (Hilton et al., 2012), although it is important to emphasize that the majority of literature deals with general OER usage and did not focus on internal repositories. Still, this finding indicates the preferences of corporate instructional designers; and although internal repositories might contain items that can be useful just as they are, corporate instructional designers often choose to alter them.

The Usage of Big External Repositories

A significant portion of participants reported that they use Big external repositories. However, when asked to specify which Big external repositories they use, the majority of participants gave names of Little repositories, in spite of the fact that the questionnaire explicitly requested not to mention Little repositories when answering this particular question. Other participants mentioned repositories that were not free for use, and thus are not defined as OERs and not included in the analysis. Lacking the ability to indicate a Big OER repository may suggest that such repositories are not common among corporations. Actually, this lack might indicate characteristics of the corporations' learning development. Commercial secrets are considered to be a type of knowledge, which might contain potential competitive advantage for the organization (Liebeskind, 1996), thus it is reasonable to assume that a commercial organization will try to avoid sharing its information as much as possible. This might indicate the differences between OER initiatives as part of the open access movement in education, which are supporting the sharing and distribution of information, and the commercial organizations' perception, which gives preference to the use of internal repositories, without the sharing of information.

The Usage of Little External Repositories

Corporate instructional designers and training managers are using Little external repositories. The current study reveals that the majority of the examined Little repositories – YouTube, Google Images, Wikipedia, TED – are indeed used extensively for the purpose of learning development (compared to the lack of Big repositories). This finding supports the first hypothesis, that instructional designers use Little repositories, sometimes extensively.

While the literature suggests high rates of Reuse and low rates of Revise and Remix usage (Hilton et al., 2012), the current study found high rates of Revise and Remix use of pictures, videos, and Wikipedia. This finding supports the second hypothesis that Revise and Remix use is more frequent among instructional designers than the literature reports. These differences may derive from the availability of Big repositories in different fields for educators while it seems that there is a lack of such repositories for instructional designers in the corporate world. Thus, they are required to use Little repositories, which often necessitate changes and adjustment. However, these findings might also imply differences in learning material development approaches in education compared to the corporate world. It is possible that instructional designers change, adjust, and customize learning materials to fit their trainers. This assumption may be supported by the findings that show that Revise and Remix are significantly higher when using learning resources from internal repositories, as well.

Little repositories of pictures were found useful for learning development in the current study. Google Images is significantly more popular in relation to Flicker, and the usage of its resources was characterized by the Revise and Remix levels of use. Actually, in the current study, only a few participants reported Reuse of the Google Images repository, while most Revise and Remix the images (89%). However, this can be explained by the fact that the repository contains only pictures. Naturally, a picture is not a stand-alone learning material but it may be integrated into an item such as a presentation or educational software. In addition, a picture which is integrated into a learning resource usually requires adjustment, such as resizing or changing the brightness. Adjustments can be made relatively easily with free and available editing tools, resulting in a higher level of Reuse.

Little repositories of videos were found to be useful, as well. The current study shows that YouTube is a significant repository, specifically when compared to TED. Actually, most of the participants reported using YouTube (96%), while half of them reported using TED (55%). A high level of Reuse was found in these video-based repositories. Half of the participants Reuse videos from YouTube and the other half (49%) Revises and Remixes the videos. In regard to TED videos, slightly different findings were found; more than half Reuse TED videos (67%) and only one third (33%) of the participants Revise and Remix TED videos. Similar to the picture repository usage, video repository usage may be explained by the fact that a video usually will not stand alone, but will be part of a learning resource such as a presentation or educational software. Like a picture, a video is considered to be raw material that requires editing and adjustment to produce the final learning resource. Nevertheless, Revise and Remix usage rates are substantially lower for videos (89% vs. 49% and 33%). This gap can be explained by the fact that video editing is more complex than picture editing. It requires the use of complicated editing tools that are not as standard or available as picture editing tools.

The usage level of Wikipedia (a Little repository) was found to be similar to that of Google Images: the Reuse is almost negligible (15%) while Revise and Remix represent most of the usage

(85%). A specific article in Wikipedia, as a repository, does not fulfill the instructional designers' needs during the learning resource creation process. Learning resources are composed of several information pieces from several articles, meaning that the information retrieved from Wikipedia is edited, adjusted, and even combined with additional objects.

Research Limitations and Future Research

The main limitation of the current research is connected to the fact that the participants were introduced to five specific Little external repositories, and they were asked to report whether they use these repositories and at what level. These repositories were chosen due to their popularity. However, such an approach might affect the free choice of the participants, although participants were given the option to add additional repositories on their own. Another limitation is related to the targeted population, which was only partially homogenous. The study focused on two stakeholders – instructional designers and training managers – assuming they have quite similar work conditions in the development of learning materials. Differences between these two stakeholders regarding their learning material usage levels might have created a diversion in the results; although the statistical analyses reveal that the differences, if existent, have a minor effect on the results. This limitation might be a basis for further research, investigating the possibility of other differences between the two groups. Furthermore, this research focused only on Israeli organizations, and thus, in future work it will be interesting to address cultural differences. Additionally, the differences that were found between instructional designers and training managers regarding OER Reuse level were based on a rather small sample size; subsequently, further research addressing this issue should include a bigger sample size.

In future research, further and deeper exploration of the differences between corporate instructional designers, and instructional designers from the academic and educational domains will be considered, along with the attempt to understand the influence of different environments on their approaches and level of Reuse. However, it seems that the key to understanding the differences in usage levels among instructional designers lies in a better understanding of the Little repositories. In many ways, during the process of developing learning materials, corporate instructional designers have no choice but to use the Little repositories, due to (as the current study suggests) the lack of Big repositories that can fit their needs. Little repositories do not contain structured learning resources, but they do have different objects which almost always require changes, adjustments, and even combinations of several objects. Thus, it will be interesting to investigate in a complementary study whether instructional designers from educational institutions will use Little repositories at the same high level of Reuse as corporate instructional designers do. Furthermore, the finding that videos from Little OERs were reused mainly without any changes, most likely due to the difficulty of altering videos, may lead to follow up research which asks about the user's technical skills and explores whether the Reuse level has a correlation to technical skills, e.g., editing images or videos.

In summary, although the literature refers to the usage of non-institutional Little repositories for the purposes of learning, it does not describe the usage level of these repositories (Keegan & Bell, 2011; Rolfe et al, 2012; Weller, 2010). This current study describes the usage levels of these repositories in corporations and suggests that instructional designers consider the Little repositories as significant to their work. The findings of this study give a specific glimpse into OER usage by instructional designers and training managers in corporations, and in the broadest sense, these findings contribute to the existing body of knowledge which is mostly focused on the educational and academic point of view.

The term OER can be used to describe repositories more flexibly, thereby broadening the term and making it more encompassing. Consequently, further research regarding Little repositories and their influence on developing learning resources is needed, whether in the corporate training world or in the higher education domain.

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Appendix

Knowledge repository usage by the training community

General

- Age**:**
- Gender: Male/Female
- What is your primary role definition?
  Instructional designer/training manager/other (please specify)
- Company name (optional):
- Years of experience in the training field:
- Which training topics do you deal with? (you may choose more than one)
  Sales/Service/Technical/Regulation/Other (please specify)

- How frequently do you develop the learning items described in the table below?

	Never	Rarely	Sometimes	Often	Mostly
Presentations					
Lesson plan outlines					
Educational software					
Educational software script					
Software simulation					
Other 1					
Other 2					
Other 3					

- If you chose Other 1/Other 2/Other 3 – please specify

Internal repositories

- Is there an internal repository of learning items at your workplace?
  (An "internal repository" is a repository that belongs to a corporation and can only be accessed by employees. The question is referring to a repository that includes learning items such as presentations, lesson plan outlines, etc.)
  Yes/No
- If yes, do you use it?
  Yes/No

- If yes, what learning items do you look for, and how frequently?

	Never	Rarely	Sometimes	Often	Mostly
Presentations					
Lesson plan outlines					
Educational software					
Educational software script					
Software simulation					
Other 1					
Other 2					
Other 3					

- If you chose Other 1/Other 2/Other 3 – please specify
- During training development, in which way do you use the internal repository learning items, and how frequently?

	Never	Rarely	Sometimes	Often	Mostly
Use the learning item for informational purposes only					
Use the learning item in its original form, just as it appears in the repository					
Make changes and adjustments to the learning item according to my needs					
Make changes and combine different learning items according to my needs					

External repositories

- During training development, do you use repositories existing on the internet, containing learning items?
  Please note!
  "Learning items" refers to items significantly targeted for learning needs, such as presentations, lesson plan outlines, etc. Please don't mention repositories where learning is not the main objective such as Google images, forums, or newsletters.
  Yes/No
- If yes, please specify (up to 5 repositories)
  Repository 1=
  Repository 2=
  Repository 3=
  Repository 4=
  Repository 5=

- In which way do you use the repository learning items you mentioned above?

	Use the item just as it is	Make changes and adjustments to the item	Make changes and combine different learning items
Repository 1			
Repository 2			
Repository 3			
Repository 4			
Repository 5			

- In the table below, there are repositories of different types containing all kinds of items (which don't necessarily contain learning items). Please choose the way you use the repository items during training development.

	Use the learning item for informational purposes only	Use the learning item in its original form, just as it appears in the repository	Make changes and adjustments to the learning item according to my needs	Make changes and combine different learning items according to my needs
YouTube				
Google Images				
Flicker				
Wikipedia				
Ted				
Other 1				
Other 2				
Other 3				

- If you chose Other 1/Other 2/Other 3 – please specify
- If needed, please elaborate regarding the way you use the repositories mentioned in the table above, or any other remark you may have.

Sharing changes

- In cases where you make changes to a learning item, do you share these changes? Yes/No
- If yes, how do you share the changes? (you may choose more than one)
    - By mail
    - By uploading to an internal repository of the corporation
    - By uploading to the repository where the item was found, which is not an internal repository

- By uploading to a repository, which is not the repository where the item was found and not an internal repository
- Other (please specify)

Remarks

- In case you would like to add a comment or remark regarding the questions and/or the answers, please use the text box below.

Biographies

Eli Merkel is a Graduate student in Tel-Aviv University's School of Education, the Math, science, and technology education department. Eli holds a B.Sc. in Electrical Engineering. His thesis deals with benefits derived from integrating technology into the learning process in corporations, under the supervision of Dr. Anat Cohen. The thesis is based on his work as an instructional designer in a corporate.

Dr. Anat Cohen (PhD) is a senior academic staff member (on tenure track) at Tel Aviv University at School of Education; Head of the Learning and Technology program in The Department of Education in Mathematics, Science and Technology; A research and pedagogical coordinator of Web-Supported Academic Instruction at Tel-Aviv University. Dr Cohen's dissertation analysed the cost-effectiveness of Web-based Education, based on theoretical and computational models and empirical data using web-mining techniques. She has vast experience in research and teaching in the field of learning and cyber technologies after 14 years of development of online learning materials, training of academic staff, characterization of learning-management features fit to the University's needs, as well as research activities focusing on research areas such as social networks and privacy perception on the cyber space, internet implementation in higher education, innovative pedagogical practices using ICT, open educational resources (Learning object repositories and MOOCs), learning analytics and educational data mining. .

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Does 1:1 Computing in a Junior High-School Change the Pedagogical Perspectives of Teachers and their Educational Discourse?

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Abstract

Transforming a school from traditional teaching and learning to a one-to-one (1:1) classroom, in which a teacher and students have personal digital devices, inevitably requires changes in the way the teacher addresses her role. This study examined the implications of integrating 1:1 computing on teachers' pedagogical perceptions and the classroom's educational discourse. A change in pedagogical perceptions during three years of teaching within this model was investigated. The research analyzed data from 14 teachers teaching in a junior high school in the north of Israel collected over the course of three years through interviews and lesson observations. The findings show that the 1:1 computing allows teachers to improve their teaching skills; however, it fails to change their fundamental attitudes in regard to teaching and learning processes. It was further found that the use of a laptop by each student does not significantly improve the classroom's learning discourse. The computer is perceived as an individual or group learning technology rather than as a tool for conducting learning discourse. An analysis of the data collected shows a great contribution to collaboration among teachers in preparing technology-enhanced lessons. The findings are discussed in terms of Bruner's (Olson & Bruner, 1996) "folk psychology" and "folk pedagogy" of teachers and "the new learning ecology" framework in 1:1 classroom (Lee, Spires, Wiebe, Hollebrands, & Young, 2015). One of the main recommendations of this research is to reflect on findings from the teaching staff and the school community emphasizing 1:1 technology as a tool for significant pedagogical change. It seems that the use of personal technology per se is not enough for pedagogical changes to take place; the change must begin with teachers' perceptions and attitudes.

Keywords: one-to-one computing, 1:1, laptop integration in school, teachers' pedagogical perceptions, teacher "folk psychology" and "folk pedagogy", "the new learning ecology" framework, educational discourse in the classroom.

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Introduction

Technology-enhanced learning environments are becoming more prevalent in the classroom, and digital tools have been used as intellectual partners for active participation in construction of knowledge (Jonassen, 2008; Salomon & Perkins, 2005). Researchers, practitioners, and policy-makers are engaged in debate about the effectiveness of learning and future promise of one-to-one (1:1) computing in K–12 (Bebell, Clarkson, & Burraston, 2014). The definition of one-to-one computing (Penuel, 2006), indicated 3 criteria: providing a laptop for every student in class, connecting the laptops to the internet, and focus on using laptops to complete academic tasks. With the emergence of new technological devices, the definition expanded to any portable device, such as smartphone, tablet, and netbook (Bebell et al., 2014; Lee, Spires, Wiebe, Hollebrands, & Young, 2015; Shamir-Inbal & Blau, 2014). The devices used in the 1:1 project explored in this study were laptops.

Some evidence suggests that 1:1 computing can impact students' achievement, discipline, attendance, and attitudes towards learning, as well as differentiate teaching and learning practices (Bebell et al., 2014; Harris & Al-Bataineh, 2015; Rosen & Beck-Hill, 2012). The qualitative analysis of K-12 students' reflections over time, presented in blog postings about the impact of 1:1 computing in their schools (Zheng, Arada, Niiya, & Warschauer, 2014), revealed seven main themes: (1) more efficient and productive learning, (2) tools for better writing, (3) access to information, (4) engagement with new media, (5) remaining relevant in a technological world, (6) share and learn from peers, and (7) individualized and differentiated instruction.

However, as Cuban (2001) noted, from the pedagogical perspective, technology integration often mimics its analog counterpart rather than facilitates transformative change in teaching and learning. Despite a broadly accepted premise that 1:1 computing can change teaching methods, findings show only peripheral change in teachers' attitudes and educational practices (Bebell & O'Dwyer, 2010; Penuel, 2006; Wilson, 2014). This study examined the implications of integrating a 1:1 computing with laptops in a large junior high school (7^{th}-9^{th} grades) on teachers' pedagogical perceptions and the educational discourse in classroom.

Types of Pedagogical Change and 1:1 Computing

The pedagogical change in a technology-enhanced classroom may occur as a first order change or a second order change. A first order change is a behavioral change within the limits of the existing pedagogical principles, while in a second order change boundaries are breached, pedagogical principles change, and, as a result, behavior changes as well (Watzlawich, Weakland, & Fisch, 1974). In a technology-enhanced classroom, a first order change can be manifested as the improvement of the prevalent teaching methods by using various demonstration tools and online information sources (Blau, 2011b). This use of technology does not change the pedagogical perceptions of the teacher, but rather serves her teaching method. The integration of technology in the processes of teaching and learning can also bring about a second order change, a paradigmatic change in the triad: teacher-student-content. Such a change is suggested by Scardamalia and Bereiter (1999) who seek to stop viewing the student as a consumer of content and the teacher as his supplier, but rather to see the two of them as partners in a learning community that is building new knowledge. According to this approach, the school needs to change from a supplier of services into a productive factory of knowledge construction, in which the input of students is acknowledged. As long as the integration of technology in the school is perceived as a technical issue, it will only achieve a first order pedagogical change. As soon as this integration is seen as an opportunity for changing pedagogical paradigm and the relationship between the teacher, students, and content, it can produce a second order change. This kind of change requires a change in the teacher's beliefs and in the entire school culture in which she operates (Ertmer & Ottenbreit-Leftwich, 2010).

First order change and second order change might reflect different models of teaching and learning. Bruner (Bruner, 1996; Olson & Bruner, 1996) argued that educational decisions are deeply affected by our intuitive theories about how people learn (or "folk pedagogy") and our beliefs regarding how minds work and learning takes place (or "folk psychology"). As other adults, teachers have "folk psychology" – beliefs regarding the mind of their students and the process of learning – and these conceptions are reflected in the way teachers speak about their teaching and in their behavior in classroom (Olson & Katz, 2011; Strauss, 2001). Bruner (Olson & Bruner, 1996) suggest four models of perceiving teachers-learning processes: (1) learning as an acquisition of "know-how" (i.e., procedural knowledge) and students as "doers"; (2) learning as an acquisition of propositional knowledge and a transfer of content from teacher to student, and learners as "knowers"; (3) learning as a development of inter-subjective interchange that explores child's own perspective about the world, and children are independent "thinkers"; (4) learning as a management of "objective" knowledge and students as "knowledgeable" and able to connect their perspectives to existing cultural and scientific conventions.

All models suggested by Bruner can be found in 1:1 classrooms. For instance, technology-enhanced activities in which the teacher is the "model to imitate" or "source of knowledge" and the students are engaged in drill and practice or "consume" knowledge, lies on the first or second model of Bruner's that perceives the processes of teaching as "demonstration" or "knowledge transfer" and learning as "modeling" or "knowledge acquisition". As opposed to this, in technology-enhanced inquiry by students, on-topic discussions among peers, or collaborative learning, students function as "owners of knowledge" in terms of the third model of Bruner. With appropriate guidance and facilitation, the teacher can use technology for helping students ground their subjective knowledge in the accepted conventions of science and culture, and thus, move them to the fourth model of teaching and learning proposed by Bruner.

The Role of Teacher and Educational Discourse in 1:1 Classroom

The pedagogical promise that lies in the integration of 1:1 computing is realized only under optimal conditions (Ilomaki, 2008). These conditions include appropriate school leadership and the creation of teachers' professional communities of practice, the purpose of which is to build up knowledge and skills of teachers, coordinate their lesson plans, expose colleagues to appropriate educational apps, and collaborate on designing digital learning materials (Bebell et al., 2014; Downes, & Bishop, 2015; Lindqvist, 2015). In order to feel a sense of ownership of the pedagogical change, a teacher must be an active partner in the formulation of the pedagogical vision of technology integration, and the processes of learning and professional development must focus on this change (Ertmer & Ottenbreit-Leftwich, 2010). The assumption that only by using 1:1 laptops or other digital devices students will become more knowledgeable or more highly skilled is not valid from a pedagogical point of view (Fullan, 2011; Shamir-Inbal & Blau, 2014). Personal technology may be an impetus for change on the condition that it is led by the pedagogy; thus, the teacher must be aware of her pedagogical attitudes and remain open to professional changes (Blau & Peled, 2012).

The integration of 1:1 computing influences the teacher's role in the classroom (Bebell et al., 2014; Bebell & Kay, 2010; Blau, Peled, & Nusan, 2014; Fleischer, 2012). Fleischer (2012) found that 1:1 technology enables teachers to work with more flexibility relative to the existing curricula. Teachers reported that the 1:1 computing enabled them to teach more, in more depth, and in a shorter period of time (Silvernail, Pinkham, Wintle, Walker, & Bartlett, 2011). The objectives of 1:1 initiatives underlie hidden or explicit expectation of changing the teaching methods (Rosen & Beck-Hill, 2012). For the most part, the attitude towards this change is described as the adoption of more student-centered teaching practices that promote higher-order thinking skills, "21st century skills" and "future competences" of students (Bebell et al., 2014; Shamir-Inbal & Blau, 2014).

On the other hand, these practices challenge teachers in terms of 1:1 classroom management (Blau et al., 2014; Tallvid, Lundin, Svensson, & Lindström, 2015). Some authors (Lee et al., 2015) even link 1:1 computing to "the new learning ecology", in which (1) technology enables immediate and constant access to information; (2) the teacher acts as content expert, facilitator, consultant, mentor, and improvisationist; (3) students are more self-directed, self-regulated, curious, and creative learners; and (4) the learning process is intense, personalized, and relevant to students.

One of the ways in which pedagogical change is manifested is educational discourse the teacher carries on in the classroom (Cazden, 1998). The prevalent pattern of educational discourse in classroom was first identified by Sinclair and Coulthard (1975) as IRF and later by Mehan (1979) as IRE sequences. The sequence is initiated by the teacher (represented by "I") asking a question mostly relating to already known information. Then the pupils are supposed to respond (represented by "R"), and the short sequence is closed by the teacher's feedback (represented by "F") or evaluation (represented by "E"). According to Cazden (1998), these patterns govern educational discourse in a teacher-centered classroom. She claimed that teachers do not use it for the sake of exploring ideas or building new knowledge, but mainly to maintain control. Recent findings in the 1:1 learning environment support this claim (Blau et al., 2014; Wilson, 2014). Wertsch (1998) recognized that this pattern of educational discourse is the most resistant to change across classrooms.

The IRE is still the most widespread discourse structure to be found in classrooms all over the world (Rogers, 2011), including 1:1 classrooms (Wilson, 2014). However, one should consider this triadic structure of educational discourse as a basis for different pedagogical goals (Molinari, Mameli & Gnisci, 2013). For example, 1:1 computing can facilitate online educational interaction of students with teachers and with more advanced peers, as a part of both in- and out-of-class learning activities (Shamir-Inbal & Blau, 2014). In terms of Social Constructivism (Vygotsky, 1978), we can assume that such interactions and educational discourse of students with the teacher and more advanced peers in 1:1 settings provides online scaffolding. Thus, through educational discourse, 1:1 classroom can advance students within their Zone of Proximal Development (ZPD) – beyond their current level or understanding and competence.

In sum, the literature reviewed above focuses on pedagogy, the role of teachers, and the educational discourse in 1:1 classrooms. The conceptual frameworks we used to discuss these issues are first and second order change, Bruner's models of teaching and learning, and "the new learning ecology". Previous studies showed that 1:1 technology can be a powerful pedagogical tool, but in many cases this model preserves teacher-centered instructional practices. Consequently, the educational potential of 1:1 computing remains only partially realized and does not produce deep pedagogical changes.

The Study's Objective

This study examined the implications of 1:1 computing on the pedagogical perspectives of teachers and educational discourse in classroom. This study was carried out with a qualitative research approach. The conceptual framework for analyzing pedagogical perspectives of teachers used in this study is the "four models" of Bruner (Olson & Bruner, 1996) reflecting the "folk psychology" and "folk pedagogy" of teachers, and "the new learning ecology" framework in 1:1 classroom (Lee et al., 2015). Educational discourse in 1:1 classroom will be addressed in terms of the IRE pattern and socio-constructivist claim of promoting students within their ZPD through interactions of students with the teacher and more advanced peers.

The following research questions attempted to expose the teachers' perspectives and their expression in teaching:

1. Whether and how teachers' pedagogical perspectives have changed during the three years of teaching in the program?

2. Whether and how 1:1 computing affected the educational discourse in the class?

3. Whether and how 1:1 computing affected collaboration among the teachers in the design of technology-enhanced lessons?

The Method

Participants

The participants in the study were eleven female teachers and three male teachers from a variety of disciplines, in a large regional junior high school (7^{th}-9^{th} grades) in the north of Israel, which had integrated 1:1 laptop initiative for teachers and students (the KATOM initiative – the acronym of "Classroom, Student, and Teacher" in Hebrew). All the teachers who taught in 1:1 classrooms for three years (2011, 2012, 2013) took part in the study. These teachers volunteered to teach in 1:1 classroom during the first wave of the integration. The age of the participants was normally distributed, the average was 44.1 years. The teachers were from the following disciplines: two teachers of math, science, Hebrew (native language), literature, English (SL), Bible studies, and one history teacher.

All teachers participated in the program received a standard initial training provided by the Israeli Ministry of Education (30 hours). The initial training focused on basic digital competences and the ways of incorporating technology in teaching in order to enhance learning. In addition, ongoing professional development was provided by the 1:1 laptop initiative and included weekly meetings of the participants with the instructor holding the M.A. degree in Educational Technology and Learning Systems. The ongoing professional development was based on three parallel segments derived from the Technological pedagogical and content knowledge (TPACK) model (Mishra & Koehler, 2006): (1) technological knowledge and proficiency (TK), which had the objective to create a first order change; this segment was based on weekly group work and personal support according to each teacher's needs; (2) subject related team work; for instance, the science teachers met weekly in order to connect their unique content knowledge to their technological knowledge (TCK); and (3) teaching with technology – experimenting and evaluating in their classes ways to enhance their teaching and student's learning with technology. This model (TPACK) leads to a second order change. A follow up in the subject-related teams and with the program's instructor enabled peer support and spread of pedagogical ideas and best practices.

Research Tools and Procedure

At the end of the first semester and the second semester of each school year, non-participant observations were carried out in double lessons of each teacher who taught in 1:1 classroom. The observation protocol included a description of the classroom, descriptions of events, and related commentary (for details see Lee et al., 2015). Immediately after the observation, a semi-structured interview was conducted with the teacher (see Appendix). The proximity of the interview to the observation allowed immediate reference to the lesson, in which personal laptops were used. A total of six hour-and-a-half observations and six hour-long interviews were carried out with each of the 14 teachers. The observations' notes were typed. The interviews were audio recorded and transcribed.

At the end of the third year of the initiative, a final meeting was conducted, at which each of the curricular teams reported on and demonstrated examples of the way in which they integrated 1:1 computing in teaching and learning. In addition to the curriculum team coordinator's report, each of the teachers on the team expressed his or her reflections on teaching in 1:1 classroom. This meeting also was audio recorded and transcribed.

Our data analysis consisted of scrutinizing our open-ended observations and resulting field notes as well as the data from the follow-up interview sessions. The analysis of the final meeting notes was also conducted as part of confirming and disconfirming emerging findings. We applied the method of thematic analysis by the classifications of generating initial codes, defining and naming themes, reviewing themes, and searching for themes (Vaismoradi, Turunen, & Bondas, 2013). It has been suggested that thematic analysis, as a flexible and useful research tool, provides a rich and detailed, yet complex, account of the data (Braun & Clarke, 2006).

Results and Discussion

1:1 Computing and Teachers' Pedagogical Perceptions

Already in the first year of implementation of the program, all the teachers recognized the possibility of 1:1 computing to change teaching practices. One of the teachers emphasized that the opportunity allowed her "*to step away from the teacher-centered approach to a situation in which students are provided with a variety of opportunities. For example, during the today's lesson my students conducted independent research, watched educational video, used simulation, and discuss their understanding with peers*" [T2]. This finding is consistent with Lee et al.'s (2015) study that links 1:1 computing to "the new learning ecology". The activities in the citation reflect three out of four elements of the new learning ecology framework: 1:1 computing enables immediate access to information; teacher acts as content expert, facilitator, and mentor; and the learning process is more intense, personalized, and relevant to students.

However, only a minority (three out of fourteen teachers) saw 1:1 computing as an opportunity for substantial pedagogical change. It appears, therefore, that only a fifth of the teachers in the initiative arrived at what could be interpreted as second order change (Watzlawick et al., 1974). In contrast, most of the teachers were satisfied with first order change. They identified the main objective of teaching in 1:1 classroom as reinforcement of existing teaching methods, diversification of demonstration tools, and exposure of students to various information sources. For instance, some of the teachers used laptops mostly for taking notes: "*The laptop replaces the traditional notepad - it can help students organizing learning materials and revising them before an exam. But it can't replace frontal instruction, the conveying of information by the teacher.*" [T6].

Furthermore, most of the teachers perceived frontal instruction as their main teaching method, and some explained that this teaching style arises from their need to control the class. This finding is consistent with the need for control documented in a previous study of 1:1 computing (Wilson, 2014). Moreover, some teachers noted that traditional instruction without technology allows them to carry on more meaningful discussions in the classroom and were dissatisfied with 1:1 computing, which did not allow them to hear their students' opinions and monitor students' progress. This argument was also presented by the participants of Wilson's study and can be attributed to the need to control students.

Comparative analysis between the observations and the interviews shows discrepancies between the pedagogical principles that our participants declared in the interviews and the teaching practices observed in their lessons. It was apparent from the interviews that most of the teachers recognize the potential of 1:1 computing for implementing the principles of constructivist learning. However, consistent with previous results (Blau et al., 2014), the teachers in our study were aware of these principles on a declarative level: this awareness was not manifested in their teaching. From the observations it was found that (1) in most of the lessons the laptops were used for the entire class demonstrations and for independent work by students, (2) few teachers initiated a process of collaborative learning in small groups, (3) most of the learning tasks had one correct answer that the students were meant to arrive at. In terms of Bruner's "folk pedagogy" (Bruner, 1996; Olson & Bruner, 1996), the finding suggests that these participants assume that teaching is a process of knowledge transmission, according to which the teacher is the "owner of knowledge" and his role is to transfer a defined "body of knowledge" to the students. This finding reinforces the previous conclusions that the use of computers improves existing teacher-centered instruction, but does not bring about essential pedagogical changes (Cuban, Kirkpatrick, & Peck, 2001; Ilomaki, 2008; Magen-Nagar, Rotem, Inbal Shamir, & Dayan, 2014; Wilson, 2014). Nevertheless, our findings differ from the argument of Bruner (Olson & Bruner, 1996), according to which beliefs about the nature of learning – "folk psychology" – are consistent with teaching methods – "folk pedagogy". We can explain this contradiction by the different population of our study – in-service teachers that receive ongoing pedagogical-technological professional development. It seems that professional development changes only "folk psychology", at least on its declarative level, but "folk pedagogy" in 1:1 classroom remains unchanged. This explanation is consistent with previous differentiation between teachers' folk psychology and pedagogy and their professional knowledge (Strauss, 2001). Future studies can explore this apparent gap between folk psychology and folk pedagogy of teachers on one hand, and professional knowledge of in-service teachers in the context of technological-pedagogical professional development on the other hand.

Only three out of fourteen teachers explicitly described the ways in which 1:1 computing enables them to put the constructivist approach into practice in the classroom and perceive themselves as facilitators of learning processes and mentors of their students. For example, one of these teachers emphasized the responsibility of teachers to differentiate the learning process in 1:1 classroom [T3]:*"Learning with laptops allows differentiation. It's possible to reach every student, and I think it is important to adapt the learning process in a heterogenic classroom to different academic levels of my students".* Another teacher argued that in 1:1 classroom teacher should pass to students more responsibility for the learning process and develop their self-regulation competences: *"The students assume responsibility for their own learning because in 1:1 classroom it depends on them whether they learn or not. If I let my students learn how to be independent, I think that they gain additional important skills. They know how to learn, to solve complex problems, to overcome challenges"* [T2]. These findings are consistent with the Lee et al.'s (2015) claim, according to which 1:1 computing promotes "the new learning ecology". These citations revealed the following three elements of the new learning ecology framework: teacher in 1:1 classroom acts as facilitator, consultant, and mentor; students are more self-directed and self-regulated learners; and the learning process is more personalized and relevant to students.

These three teachers expressed dissatisfaction with the prevalent pedagogical perceptions and did not find first order change to be sufficient in 1:1 classroom. In terms of Bruner's teaching-learning models (Bruner, 1996; Olson & Bruner, 1996), we can argue that these teachers view their students, according to the second and the third model, as independent "thinkers" and "knowledgeable". These teachers acknowledge the fact that knowledge is constantly developing, is found in everyone, and is therefore constructed and cannot be transferred, but rather grounded in the conventions of science and culture. Thus, the role of teacher in 1:1 classroom is not only to facilitate the construction of knowledge by students, but also to provide (digital and analog) scaffolds that will frame the ideas and intuitive understanding of their students in the existing scientific and cultural heritage (Barzilai & Blau, 2014). In other words, the role of teacher goes beyond the constructivism according to the third model of Bruner, towards the fourth model of teaching and learning, which deals with facilitating the construction of "objective knowledge" by students.

The Evolvement of Pedagogy over Time

Over time, digital competences of the teachers and their abilities to design technology-enhanced lessons have improved. This improvement was apparent in both the time needed to design these lessons and the quality of the lessons. A science teacher, who estimated during the first year that she spent more time in preparations, stated at the end of the third year that "*As time goes by, it becomes easier. At the start of the 1:1 initiative it would take about two hours and in most cases it wasn't as well planned as today's lesson. Now, if I know what I want to design and I am focused, the preparation takes from 30 minutes to an hour*" [T8]. The shortening of the lesson design time after three years of 1:1 initiative is highly significant, since previous studies that did not examine changes over time, presented the time required for digital design as a hindering factor in the integration of 1:1 computing (Carenzio, Triacca, & Rivoltella, 2014; Cuban et al., 2001; Guitert & Vazquez, 2013).

However, three years of teaching in 1:1 classroom did not change the pedagogical perspectives of the teachers and the way in which they use laptops in the classroom. This is an example of using the laptops at the end of the third year: *"The teachers and students write answers together. One of the students composes the answer and the teacher suggests what they should add in order to get an acceptable answer. The individual laptops of students are basically used as a whiteboard – for working with the whole class on editing "right answers"."* [L83].

Moreover, after three years of 1:1 initiative in the school, it did not bring additional teachers to make a second order pedagogical change (Watzlawick et al., 1974). In terms of Bruner's models (Bruner, 1996; Olson & Bruner, 1996), time did not bring about a shift from the teaching-learning process as "transfer of knowledge" from teacher to student, according to the second model, to the process of learning as active construction of knowledge by the students, as described by the third and fourth models. Those three teachers who defined themselves in the first year as "facilitators" of learning processes conserved this definition at the end of the third year as well, but surprisingly, not even one additional teacher joined them. Over time, the observations consistently showed that these three teachers expanded their repertoire of 1:1 computing in the way consistent with the principles of constructivist pedagogy –they used technology to enable inquiry learning of students, problem solving, and collaborative learning. The only exception was presented in the interview by one of these three teachers and it described the change over time from teacher-centered to student-centered teaching: *"Before the initiative, a large proportion of the time in classroom was spent on solving discipline problems and then, on frontal instruction, in which I was the source of knowledge. For example, I read them the poem, explained the words, analyzed it for them, and gave them some questions as homework. Today, as you could see, there's no need for that. Now they listen to the poem on the computer, they read it by themselves, they find the words that they don't understand in the online dictionary and read the poem's interpretation on the web. After analyzing it according to characteristics summarized on the class website, each student has his or her final product and we begin a discussion. Thus, their learning with laptops is self-directed and my role is mainly to monitor this process and facilitate the discussion at the end of the process, in order to insure that there are no misinterpretations"* [T10]. In terms of Lee et al. (2015), the activity in the citation presents all four components of "the new learning ecology" in 1:1 computing: technology enables immediate access to information; teacher acts as content expert, facilitator, and consultant; students are self-directed; and the learning process is personalized and relevant to students.

Similarly, the teachers' perceptions regarding the amount of content covered in 1:1 classroom did not change over the years either. The teachers, who claimed in the first year of the initiative that the amount of content covered was unimportant or that they sufficiently covered the material, repeated the claim in the third year as well. On the other hand, teachers, who in the first year complained of delays caused by the 1:1 computing, repeated the same complain after three years of the initiative. These findings are similar to the results of 1:1 initiative in Spain (Guitert & Vazquez, 2013). The participants' claims about the sense of advancing in the content provide additional testimony for the prevalence of Bruner's second model (Bruner, 1996; Olson & Bruner, 1996) in "folk psychology" of teachers. Consistent with the claim of Strauss (2001), interviews with the majority of our participants showed that subject-matter content is perceived as a body of information of a certain scope, which exists beyond the consciousness of the students, is transferred by the teacher during the lesson, and is acquired by the students. Unfortunately, our findings suggest that over time 1:1 computing does not change, but on the contrary, *reinforces* beliefs of teachers about the nature of learning. The absence of change over time in the pedagogical perceptions of the teachers who participated in the present study suggests that "folk psychology" of teachers is quite fixed and does not change substantially as a result of changes in the learning environment. Future research should examine this explanation with a larger and more diverse sampling of teachers.

Our findings in regard to the changes over time in 1:1 classroom support the claim that technological innovations do not guarantee changes in pedagogical perceptions of teachers (Cuban, 2001). Changing pedagogical perceptions requires professional development of teachers as a community of practice and explicit encouragement of the school leadership (Blau & Presser, 2013). Neither professional development of the teachers nor the school leadership and stakeholders from the 1:1 initiative had aims of changing pedagogical beliefs of the teachers, which, according to Ertmer and Ottenbreit-Leftwich (2010), is a necessary precondition for bringing about second order change.

Characteristics of the Educational Discourse

Regarding the educational discourse, our data showed the same differences between the three constructivist-minded teachers and the rest of the participants. Most of the lessons of the three teachers included a substantial element of independent or group learning, and both observations and interviews revealed that complex discourse occurred during the lessons between the students and the teacher and between peers. One of the teachers stated, *"... I believe that class should include basic data acquisition, group discussion, work in pairs and larger groups, a lot of research and discovery, as well as the traditional assignments and tests... I think that the laptops have changed the balance between the various teaching methods….. In 1:1 classroom there are much more discussions related to student learning outcomes, much more interactions, and on-demand scaffolding of student understanding."* [T3].

In the lessons of the majority of teachers, however, it appears that the use of laptops mostly encouraged independent learning of students and left less opportunity for educational discourse in the classroom. Moreover, among all the participants, 1:1 computing was not used at all for creating online educational discourse. It appears that 1:1 computing does not substantially change the patterns of communication between the teacher and the students, and among peers in the classroom. Our data is consistent with the recent data regarding communication in 1:1 classroom presented by Swallow (2015). It seems that the characteristics of the educational discourse are determined by the pedagogical perceptions and not by the technological tools available to teachers. In opinion of most of the teachers who took part in the study, the meaningful educational discourse occurs during face-to-face group discussion, and not online. The laptop is perceived as a tool for enhancing independent or group learning, but not as a tool associated with the educational discourse, neither in the class nor out-of-class. Thus, in terms of Social Constructivism (Vygotsky, 1978), one of the potential benefits of 1:1 computing for advancing the students within the Zone of Proximal Development through online learning-related interactions with the teacher and/or more advanced peers has remained unrealized. Surprisingly, this potential for scaffolding students' understanding by online discussions is not a part of "the new learning ecology" framework for 1:1 computing (Lee et al., 2015). We recommend exploring this issue in future studies in both, in-class and out-of-class online discussions, and including online interactions in the new learning ecology framework.

Collaboration among Teachers on Digital Learning Design

From the reports of the curricular teams has arisen the major importance of the collaboration on designing digital learning materials. Collaboration within a team can both improve the quality of the outcome (Blau & Caspi, 2009; Caspi & Blau, 2011) and save the time invested on preparing 1:1 lessons. As stated by a teacher from the science department, *"We work as a team, so we distribute the work load. We work together for approximately 30 minutes per day"* [T8].

Collaboration among teachers is a significant factor in improving the level of teaching and an integral part of teacher's professional development (Daly, Moolenaar, Bolivar, & Burke, 2010; Downes, & Bishop, 2015). Indeed, it appears that the teachers' ability to learn and collaboratively design digital learning materials adapted to specific needs of their students, is one of the most important conditions for the success of the 1:1 initiative (Lindqvist, 2015). That being said, it's clear that the level of functioning of the curricular team depends on the human factor, regardless of the requirements of the initiative leadership and educational decision-makers (Blau & Hameiri, 2012). The initiative created the necessity for adapting curriculum and to devote more time to collaborative design of digital learning materials (Downes, & Bishop, 2015). All the teachers referred to this necessity in positive terms. It appears that peer learning among teachers and exposure to appropriate sources of information, various models of technology-enhanced lessons, and different apps, can significantly contribute to the design of 1:1 lessons (Lindqvist, 2015). Moreover, the adoption of collaborative teamwork by teachers in the professional context could spread into the classrooms and encourage the teachers to promote collaborative learning among their students (Blau, 2011a). In future research, we recommend to explore the relationship between the professional collaboration among teachers and the collaborative learning of their students.

Conclusion and Implications

This study analyzed pedagogy, the role of teachers, and educational discourse in 1:1 classrooms in terms of first and second order change, Bruner's models of teaching and learning, and "the new learning ecology" framework. The study reinforces the claim that technology is a powerful educational tool, but technology per se does not produce deep pedagogical changes. One-to-one computing expands the educational repertoire, but preserves both student-centered and teacher-centered instructional practices. Moreover, the findings indicate a gap between the teachers' declared insights about optimal technology-enhanced learning and the translation of those insights into actual teaching practices.

The study has implications for the integration of 1:1 computing for enhancement of teaching and learning processes. The decision makers in education systems and schools that aspire to promote pedagogical changes need to clarify the pedagogical principles, or "folk pedagogy", of the teachers in the context of technology integration and teacher professional development. Based on the findings, we can recommend the encouragement of online discourse among students, both in-class and out-of-class, as a mean for the advancement of learning processes. In addition, we recommend educational decision-makers and designers of teacher professional development programs to emphasize the processes of collaboration among teachers in the design of technology-enhanced lessons. These processes require ongoing encouragement of educational leadership and appropriate teacher training.

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Appendix: Guiding questions for semi-structured interviews with teachers

1. In your opinion, what are the goals of one-to-one computing project on a school level?
2. What are your **personal goals** as a teacher in one-to-one computing classroom? Why did you decide to join the group of teachers that has volunteered to teach in one-to-one classes? What were your **expectations and concerns** before launching the program? Whether and how is the reality different from the expectations?
3. Describe the ways you **use** a laptop: 1-in everyday life; 2-for pedagogical purposes. On average, how much time do you invest into preparing technology-enhanced lesson?
4. Do you succeed in "transferring the content" you planned for the lesson in one-to-one classroom? How, if at all, your **role as a teacher** in one-to-one class is different from your role as a teacher in regular class?
5. Describe how, in your opinion, students should **learn with laptops** in one-to-one classroom. What is important to pay attention to? Please provide an example, when and what type of activity is not suitable for using the technology.
6. Some teachers argue that students "waste" too much time **searching for information** online. What do you think about this statement? Can you provide an example of a task that requires students to work with online information sources?
7. To what extent is the lesson I have just observed **typical** for "regular" one-to-one computing lesson in your class? To what extent is the atmosphere in the lesson observed typical for one-to-one classroom?
8. What was your goal in the lesson I have observed? What is your impression of the learning process that took place during the lesson? Can you provide an example of "typical" learning activity that involves technology?
9. Do you see the **change in a way students learn** compared to the regular class? What about the **change in the classroom atmosphere**? Do students enjoy technology-enhanced lessons? How about the **change in interaction between students** inside and outside the classroom?
10. To what extent, if at all, one-to-one classroom management is different from traditional **classroom management**? How, if at all, are you aware of sites that students visit during the lesson? (Perhaps during the lesson kind-hearted boys are looking for girls who have no money to buy clothes…).
11. Do you allow students to use **online communication** during the lesson? Explain why.
12. Are technology-enhanced lessons **available** for students and **visible** for parents and the school staff through the classroom website? Can you show an example?

Biographies

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Teacher-student Relationship and SNS-mediated Communication: Perceptions of both Role-players

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Abstract

Teacher-student relationships are vital for academic and social development of students, for teachers' professional and personal development, and for having a supportive learning environment. In the digital age, these relationships can extend beyond bricks and mortar and beyond school hours. Specifically, these relationships are extended today while teachers and students communicate via social networking sites (SNS). This paper characterizes differences between teachers (N=160) and students (N=587) who are *willing to connect* with their students/teachers via Facebook and those who do not wish to connect. The quantitative research reported here within is based on data collection of personal characteristics, attitudes towards Facebook, and perceptions of teacher-student relationship. Findings suggest differences in characteristics of the two groups (*willing to connect* vs. *not willing to connect*) within both populations (teachers and students). Also, in both populations, those who were *willing to connect*, compared to those who were *not willing to connect*, present more positive attitudes towards using Facebook for teaching/learning and are more opposed to a banning policy of student-teacher SNS-based communication. We also found that students who were *willing to connect* showed a greater degree of closeness with their teachers compared to those who were *not willing to connect*. This study may assist policymakers when setting up regulations regarding teacher-student communication via social networking sites.

Keywords: teacher-student relationship, social networking sites, SNS-mediated communication, Facebook

Introduction

The growing usage and popularity of social media applications has created new modes of communication and collaboration across the world and has

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An earlier, shorter version of this paper was presented at the Chais conference 2015, in Raanana, Israel, and included in Y. Eshet-Alkalai, I. Blau, A. Caspi, N. Geri, Y. Kalman, & V. Silber-Varod (Eds.), *Proceedings of the 10th Chais Conference for the Study of Innovation and Learning Technologies 2015: Learning in the Technological Era*. Raanana: The Open University of Israel.

caused transformation and vast implications on all aspects of our lives (cf. Mioduser, Nachmias & Forkosh-Baruch, 2008). Within the realm of social media, several fundamental issues arise, related to, e.g., self-exposure, intimacy, and self-expression (Amichai-Hamburger & Vinitzky, 2010; Livingstone, 2008; Lowenthal, 2009; Marwick & Boyd, 2010). The current knowledge era challenges society with a paradigm shift, setting demands for new tools and skills. Specifically, in the education field new pedagogical paradigms are encountered, e.g., new assumptions, concepts, and practices that shape our views of teachers' and students' roles, as well as the role of policy makers and educational systems at large. With regards to social media, teacher-student interactions should be carefully examined, as they dramatically affect communicating beyond boundaries of time and space.

Teachers, as well as educational systems at large, can benefit from these changes by facilitating contemporary educational paradigms (Abbott, 2005), allowing teachers to "[engage] in an authentic relationship with students where teachers know and respond with intelligence and compassion to students and their learning" (Rodgers & Raider-Roth, 2006). This pattern of teacher-student communication challenges traditional paradigms in which communication is limited and based on traditional hierarchical teacher-student relationship and roles.

However, some changes are difficult to adopt by educational policymakers as they dramatically challenge long-established norms and traditions. The emergence of social networking sites, one of the prominent building stones of the Web 2.0 era, is perhaps the most salient example of the need to address unfamiliar educational scenarios. Social networking sites (SNS) are websites that enable their users to construct a public or semi-public profile and to build a personal inner network of connections (Boyd & Ellison, 2007); SNS have become the most popular websites on the Internet and have been adopted by many teenagers worldwide (Boyd, 2008; Ellison & Boyd, 2013; Lenhart, Madden, Macgill, & Smith, 2007). SNS pedagogical usages have been extensively discussed from several points of view, e.g., the instruction point of view, learning possibilities, and challenges for formal and informal teaching and learning (e.g., Mazman & Usluel, 2010; Veletsianos, Kimmons, & French, 2013). However, there is still a lack of research regarding yet another angle related to the use of SNS in education, that is, the social and interpersonal aspects of SNS-mediated communication between students and teachers. This is the unique angle we discuss in this paper, based on studies examining the relationships between students and teachers who are closely familiar with the SNS world. Mainly, we focus our attention on middle and high school students and teachers, as this population has special characteristics when it comes to SNS use and perceptions (cf. Boyd, 2014). Furthermore, while many studies have explored Facebook educational affordances in higher-education, studies in the context of secondary schools are relatively limited (cf. Hew, 2011).

SNS challenge the traditional dichotomy between students and teachers, as well as help re-invent student-teacher out-of-class communication in many ways. Hence, SNS carry educational promises, such as allowing available, enriched, and contextual student-teacher communication, or facilitating multi-channel learning experiences. Notwithstanding, SNS may also generate some undesired consequences, from being a waste of time to extreme cases of cyber-bullying, making this issue highly controversial in the public opinion. The moral and educational concerns involving SNS-based student-teacher communication reinforce the need for balancing opportunities and risks within policy (Livingstone & Brake, 2009).

Some intriguing questions have been raised regarding student-teacher connections on SNS and their effect on student-teacher relationships in "real-life", and vice versa. Even the very term used in many SNS to describe connected users, "friends", may challenge traditional student-teacher hierarchy, as traditionally teachers are allowed some power over their students even when close relationship between the two are developed (Ang, 2005; Jaimeson & Thomas, 1974; Steinfield, Ellison, & Lampe, 2008; Vie, 2008). Albeit, closeness and friendship may be different in SNS compared to the real world (e.g., Subrahmanyam, Reich, Waechter, & Espinoza, 2008; Van House, 2007).

This should be viewed in the light of an ever-changing role of teachers in the information era, as a result of blurring, even breakdown, of time and space boundaries (MacFarlane, 2001; Scardamalia & Bereiter, 2006). This changes teaching paradigms, as well as the learning experience in its broader sense. However, although technology is a major factor in schools nowadays, teachers and students are still crucial players in this process (Elmore, 1996; Ertmer, 2005; Lambert, 2007). Teachers may change their role from “a sage on the stage” to “a guide on the side”, that is, from a formalized, well-established format of traditional teaching and learning to a contemporary educational paradigm focusing on connecting to students, mentoring and assisting them (Abbott, 2005; Wong et al., 2006). SNS-based communication plays a major role in this change, extending the scope and setting in which teachers and students communicate. This may affect, in turn, mutual perceptions and beliefs (Mazer, Murphy, & Simonds, 2009), thereby changing student-teacher relationships, followed by an even greater change in traditional hierarchical structures in schools.

For this reason, school authorities and policymakers have been pondering about their position regarding student-teacher SNS-based communication. Educational policymakers worldwide have adopted different educational approaches, often prohibiting teacher-student communication via SNS altogether. Public discussion on teacher-student communication via SNS reflects the complex nature of this issue, and overall demonstrates the difficulty in adapting novel tools in large-scale systems and organizations. However, most policies are not based on empirical evidence.

The purpose of this paper is to present the emergence of SNS into students’ and educators’ lives and its effect on teacher-student relationships. We propose a quantitative view of this phenomenon via two empirical studies examining students’ and teachers’ perceptions of student-teacher communication via SNS, focusing on Facebook. These studies, presented here side by side, are a continuation of two exploratory, qualitative studies, in which students and teachers were interviewed in-depth regarding their beliefs about and usage of Facebook as a means for student-teacher communication (Forkosh-Baruch & Hershkovitz, 2014).

Research Questions

Overall, we were interested in the differences (if there are any) between students and teachers who are *willing to connect* to each other via social networking sites and those who are not willing to do so. We will shortly call them the *willing-to-connect* and the *not-willing-to-connect* groups (an overall of four groups, as students and teachers are studied separately). These groups will be defined in the *Research Population* section here below. Therefore, the research questions are the following:

1. What are the differences in <u>personal characteristics</u> between the willing-to-connect and the not-willing-to-connect students/teachers?
2. What are the differences in <u>attitudes towards Facebook-use in education</u> between the willing-to-connect and the not-willing-to-connect students/teachers?
3. What are the differences in <u>teacher-student relationship</u> between the willing-to-connect and the not-willing-to-connect students/teachers?

Methodology

The chosen methodology included a well-planned widespread procedure for collecting data from online questionnaires. From May until July 2013, we virally distributed a hyperlink of an online research questionnaire via social networking sites (mostly Facebook and Twitter), as well as via professional and personal mailing lists (the former includes, for example, mailing lists of centers for domain-specific teacher training). Our target population was teachers in lower and higher secondary schools. The questionnaire was built using Google Forms (see Instruments, below).

A similar process was replicated the next year with the student questionnaire, from which data was collected between December 2013 and April 2014. We virally distributed a hyperlink of an online research questionnaire via social networking sites (mostly Facebook), as well as via schools' and teachers' mailing lists.

Research Variables

Teachers' Characteristics Included:

- Age
- Gender
- Marital status [single, married, divorced, widowed]
- Teaching seniority [years]
- Experience on Facebook [years]
- Number of friends on Facebook

Students' Characteristics Included:

- Age
- Gender
- Grade [7-12]
- Experience on Facebook
- Number of friends on Facebook

Attitudes towards Facebook-use in Education

All participants were asked the following two questions:

1. Do you think Facebook can be used for educational purposes? [Yes/No]
2. There are countries/authorities prohibiting any teacher-student connection via Facebook. What is your standpoint on this policy? [a 1-5 Likert scale (completely disagree, tend to disagree, does not have an opinion, tend to agree, completely agree)]

Teacher-Student Relationship

All participants filled-out a section that included a questionnaire about teacher-student relationship; this was adapted to our study based on the Teacher-Student Relationship Inventory (TSRI) (Ang, 2005), see details in *Instruments* section below.

Instruments

We used two newly-developed versions of the Teacher-Student Relationship Inventory (TSRI), originally developed to measure teacher-student relationships, as reported by teachers, using 14 items graded on a 5-point Likert scale (completely disagree, tend to disagree, sometimes disagree and sometimes agree, tend to agree, completely agree) (Ang, 2005). For the purpose of the studies reported here, the questionnaire was translated to Hebrew and was adapted to measure:

- Teacher-class relationship, that is, the questionnaire was filled out by a teacher about a whole class. For example, the item "I enjoy having this student in my class" was translated to: "I enjoy teaching this class." (The full questionnaire appears in Appendix A.) We will refer to this new version as TCRI (Teacher-Class Relationship Inventory);

- Student's perceptions of teacher-student relationship, that is, the questionnaire was filled by a student about one of their teachers. For example, the item "I enjoy having this student in my class" was translated to: "I think this teacher is enjoying having me in his/her class". (The full questionnaire appears in Appendix B.) We will refer to this new version as TSRI-S.

Both TCRI and TSRI-S were implemented as part of an online survey, using Google Forms. Within this form, teachers and students were asked about their current use of, and their connections with students/teachers (respectively), via Facebook. Following their answers, they were guided to choose a class or a teacher to which they will refer while replying TCRI or TSRI-S. For matter of simplicity, we will define the four groups of teachers (the student groups were defined similarly):

1. Teachers who have an active Facebook account and are connected to their current students. These are the *connected teachers*, and they were requested to fill in the questionnaire regarding a class they are currently teaching and to students from which they are currently connected on Facebook;
2. Teachers who have an active Facebook account, are not connected to their current students, but are interested in such a connection. These are the *interested-in-connection teachers*, and they were requested to fill in the questionnaire regarding a class they are currently teaching and to students to which they would like to be connected on Facebook;
3. Teachers who have an active Facebook account, are not connected to their current students, and are not interested in such a connection. These are the *not-willing-to-connect teachers*, and they were requested to fill in the questionnaire regarding an arbitrary class they currently teach.
4. Teachers who do not have an active Facebook account were also requested to fill in the questionnaire regarding an arbitrary class.

Eventually, we merged the first two groups – connected teachers and interested-in-connected teachers (groups 1 and 2 in the list above) – to form the *willing-to-connect* group to which we will refer from now on; pay attention that this group holds both teachers who are de-facto connected to their students and teachers who are not. This group will be compared to the *not-willing-to-connect* group (group 3 above). Very similarly, we define two groups of students: *willing-to-connect* and *not-willing-to-connect*. Group 4 (teachers and students who do not have Facebook accounts) were omitted from the current report.

Population

Altogether, 160 teachers and 587 students participated in this study (when omitting students and teachers who reported not having Facebook accounts). Teachers' age was 21-68 (M=47, SD=10.8), with 1-38 years of teaching seniority (M=19, SD=10.8), of whom 123 are females (77%) and 37 are males (23%). Students' age was 12-19 (M=14, SD=1.6), of whom 340 are female (58%) and 247 are males (42%). Participants were from all over Israel.

Distribution of the teachers and students to the *willing-to-connect* and *not-willing-to-connect* groups is presented in Table 1.

Table 1. Distribution on the population into the main two groups of analysis

Group	Teachers		Students	
	N	%	N	%
Willing-to-connect	109	68%	191	33%
Not-willing-to-connect	51	32%	396	67%
Total	160	100%	587	100%

Findings

Personal Characteristics

Teachers' personal characteristics

Using t-test, we compared means of the variables describing personal teacher characteristics, i.e., age, teaching seniority, experience on Facebook and number of Facebook-friends, between the two groups. Results show that on average, the *willing-to-connect* teachers are significantly younger than the *not-willing-to-connect* teachers; the average of the former is 44.8 (SD=11.0) and of the latter 49.6 (9.6), t(157)=2.6, at p<0.01, with a medium effect size (Cohen's d=0.42). As for teaching seniority, the mean over the *willing-to-connect* teachers (17.0, SD=10.9) is significantly smaller than the mean over the *not-willing-to-connect* teachers (21.6, SD=10.1), t(158)=2.5, at p<0.05, with a medium effect size (d=0.40).

In addition, findings show that on average, *willing-to-connect* teachers have significantly longer Facebook-usage experience than their *not-willing-to-connect* colleagues, while the mean of the former is 4.0 (SD=1.8), the mean of the latter is 3.3 (SD=1.5), with t(158)=2.3, at p<0.05, a medium effect size (d=0.37). The number of Facebook friends was not found to be significantly different between the two groups. Results are summarized in Table 2.

Differences in gender and marital status were tested using χ^2; no significant differences were found between the two groups in gender, $\chi^2(1)=1.3$, at p=0.26, nor in marital status, $\chi^2(3)=3.3$, at p=0.35.

Students' personal characteristics

Next, we compared means of the variables describing personal student characteristics, i.e., age, experience on Facebook and number of Facebook-friends, between the two groups (using t-test). Results show that on average, the *willing-to-connect* students are significantly older than the *not-willing-to-connect* students; the average age of the former is 14.5 (SD=1.8) and of the latter 13.7 (1.4), t(309.8)=5.4, at p<0.01 (As Levene's test for equal variances was significant, equal variances were not assumed), with a high effect size (Cohen's d=0.61).

Number of Facebook friends was found to be significantly different between the two groups. The *willing-to-connect* students had 609 Facebook-friends on average (SD=618), while the *not-willing-to-connect* students had only 505 (SD=411), with t(259.7)=2.1 (As Levene's test for equal variances was significant, equal variances were not assumed), at p<0.01, with a small effect size (d=0.26). No significant difference was found between the two groups in Facebook-usage experience. Results are summarized in Table 2.

Difference in gender between two groups was tested using χ^2 and was found significant; There are relatively more boys in the willing-to-connect group (49%, 94 of 191) than in the not-willing-to-connect group (39%, 153 of 396), with $\chi^2(1)=5.9$, at $p<0.05$.

Table 2. Mean (SD) for the variables describing personal characteristics of teachers and students

Variable	Teachers			Students		
	willing-to-connect	not-willing-to-connect	T	willing-to-connect	not-willing-to-connect	t
Age	44.8 (11.0) N=109	49.6 (9.6) N=50	2.6^{**} df=157	14.5 (1.8) N=191	13.7 (1.4) N=395	5.4^{**} df=309.8[1]
Teaching seniority [years]	17.0 (10.9) N=109	21.6 (10.1) N=51	2.5^{*} df=158			
Facebook-use experience (years)	4.0 (1.8) N=109	3.3 (1.5) N=51	2.3^{*} df=158	4.2 (1.5) N=189	4.0 (1.5) N=389	1.7 df=576
Number of Facebook-friends	273.5 (391.4) N=109	179.4 (362.9) N=51	1.4 df=158	609 (618) N=181	505 (411) N=373	2.1^{**} df=259.7[1]

* $p<0.05$, ** $p<0.01$

[1] Levene's test for equal variances was significant, hence equal variances were not assumed

Attitudes towards Using Facebook in Education

Teachers' attitudes towards using Facebook in education

The distribution of the nominal variables was compared using a χ^2 test. The two variables show significant difference between the two teacher groups. Among the *willing-to-connect* teachers, 94% (102 of 109) asserted that Facebook can be used for teaching, as opposed to only 62% (31 out of 51) among the *not-willing-to-connect* teachers, $\chi^2(1)=26.6$, $p<0.01$. As for teachers' attitude towards the banning regulation, 87% (95 of 107) of the *willing-to-connect* teachers disagreed or tended to disagree with this policy, as opposed to only 35% (18 out of 50) among the *not-willing-to-connect* teachers, $\chi^2(1)=47.1$, $p<0.01$. Only 3 teachers (3%) responded that they did not have an opinion about the banning policy (they were omitted in this analysis).

Summarizing the comparison of the *willing-to-connect* and the *not-willing-to-connect* teachers, we conclude that the former are younger, less experienced in teaching, and more experienced on Facebook than the latter. Additionally, the *willing-to-connect* teachers tend to believe that Facebook can be used for teaching/learning and that it should not be banned for teacher-student communication in much higher numbers than the *not-willing-to-connect* teachers.

Students' attitudes towards using Facebook in education

The distribution of the nominal variables was compared using a χ^2 test. The two variables show significant difference between the two student groups. Among the *willing-to-connect* students, 70% (133 of 191) asserted that Facebook can be used for learning, as opposed to only 47% (185 of 396) among the *not-willing-to-connect* students, $\chi^2(1)=27.3$, $p<0.01$. As for students' attitude towards the banning regulation, 66% (95 of 143) of the *willing-to-connect* students disagree or tend to disagree with this policy, as opposed to only 25% (70 of 285) among the *not-willing-to-connect* students, $\chi^2(1)=70.5$, $p<0.01$. More than a quarter of all students (159 of 587, 27%) responded that they did not have an opinion about the banning policy and were not counted in this analysis.

Additionally, gender was found to be significantly different between the two student groups. Of the *willing-to-connect* students, 49% were males (94 of 191), compared to 39% males in the *not-willing-to-connect* group (153 of 396), with $\chi^2(1)=5.9$, at $p<0.05$.

Summarizing the comparison of the *willing-to-connect* and the *not-willing-to-connect* students, we conclude that the former are older and have more Facebook-friends than the latter and that the former group has a higher rate of males than the latter. Additionally, the *willing-to-connect* students tend to believe that Facebook can be used for learning and that it should not be banned for teacher-student communication in higher numbers than the *not-willing-to-connect* students.

Perceptions of Teacher-Student Relationships

Teachers' perception of teacher-student relationship

The original TSRI was validated as having three axes: Satisfaction (items 1, 3, 5, 13, 14), Instrumental Help (items 2, 6, 9, 10, 12) and Conflict (4, 7, 8, 11). As we have translated and adapted it, we tested the new TCRI for inter-consistency, using Cronbach's α, based on these three axes. Results are promising, with $\alpha=0.83$ for satisfaction and instrumental help and $\alpha=0.67$ for conflict.

There were no significant differences in any of TCRI axes between the two groups of teachers (*willing-to-connect* and *not-willing-to-connect*). Findings are summarized in Table 3.

Students' Perception of Teacher-Student Relationship

As detailed above, we needed to check TSRI-S for inter-consistency, due to the translation and adaptation of the original TSRI. Cronbach's α values are very good, with $\alpha=0.88$ for satisfaction and conflict and $\alpha=0.86$ for instrumental help.

Comparing TSRI-S axes between the *wiling-to-connect* and the *not-willing-to-connect* students, we find significant differences in two axes. Satisfaction mean was higher in the *willing-to-connect* group (3.9, SD=1.0) than in the *not-willing-to-connect* group (3.7, SD=1.1), with $t(421.5)=3.0$, at $p<0.01$ (As Levene's test for equal variances was significant, equal variances were not assumed), with a medium effect size (0.3). Instrumental mean help was higher in the *willing-to-connect* group (3.1, SD=1.1) than in the *not-willing-to-connect* group (2.6, SD=1.1), with $t(585)=5.2$, at $p<0.01$, with a medium effect size (0.43). No significant difference was found between the two groups of students in the conflict axe. Findings are summarized in Table 3.

Table 3. Mean (SD) for the TCRI axes teachers and students

Variable	Teachers			Students		
	willing-to-connect (N=109)	not-willing-to-connect (N=51)	t	willing-to-connect (N=191)	not-willing-to-connect (N=396)	t
Satisfaction	4.4 (0.6)	4.4 (0.6)	0.3 (df=158)	3.9 (1.0)	3.7 (1.1)	3.0** (df=421.5)[1]
Instrumental Help	3.7 (0.8)	3.8 (0.7)	0.5 (df=158)	3.1 (1.1)	2.6 (1.1)	2.5** (df=585)
Conflict	1.5 (0.6)	1.4 (0.5)	1.1 (df=132.3)[1]	1.6 (0.9)	1.7 (1.0)	1.0

* $p<0.05$, ** $p<0.01$

[1] Levene's test for equal variances was significant, hence equal variances were not assumed

Discussion

In this research, we have studied the associations between teacher-student relationships and teachers' and students' beliefs about, and actual usage of, SNS-mediated communication, focusing on Facebook. Specifically, we have compared two sub-populations of teachers and students: Those who are *willing to connect* as Facebook-friends to the "other side" (whether they are actually connected to them or not) and those who are *not willing to connect*. As Facebook-friendship requires both sides' agreement to take place, this distinction is critical as it relies on the participants' motivation for such a connection. Therefore, and in order to evoke the participants to consider all the pros and cons of connections via Facebook, we have explicitly focused on Facebook-friendship, the strongest type of connection via this SNS. Of course, other types of teacher-student communication are feasible on Facebook, the most common of which is communication via Groups (Asterhan & Rosenberg, 2015). However, we believe that in order to explore the full range of relationships, Facebook-friendship is a better choice to explore, as it might break the traditional barriers between "academic" and "social" and between "work" and "after school". Some countries prohibit such a connection (as is the case in Israel, where the current study took place), in which case the willing to de-facto connect might indeed imply a greater motivation to strengthen the relationship between one another. Furthermore, as previous studies have shown, students do not perceive Facebook as a place for teaching/learning and prefer to keep it for their own place to socialize with their peers (Brandtzæg, Heim, & Kaare, 2010; Durrant, Frohlich, Sellen, & Uzzell, 2011; Halverson, 2014; Hershkovitz & Forkosh-Baruch, 2013; Livingstone, 2008), which makes these students who are willing to be Facebook-friends with their teachers interesting to examine. The importance of this study is also strengthened in the light of the fact that only a few studies in recent years have been exploring teacher-student SNS-mediated communication in elementary or secondary education, and there might be a big difference between teenagers and young adults with regards to the effects of SNS use on school-related measures (Koles & Nagy, 2012). Hew (2011), in his literature review of 539 articles discussing Facebook use in schools, did not find a single study about this population (all were referring to college and university population); however in recent years the study of secondary school populations has been emerging (e.g., Asterhan & Rosenberg, 2015; Blonder & Rap, in press; Greenhow, 2011; Halverson, 2014; Ranieri, Manca, & Fini, 2012).

When examining the personal characteristics of teachers and students who are willing to be Facebook-friends with each other (i.e., teachers with students and students with teachers), our findings suggest that both teachers and students on these groups have richer activity on Facebook – more friends for students, more Facebook-use experience for teachers – than those who are *not willing to connect*. Interestingly, the *willing-to-connect* teachers are younger than the *not-willing-to-connect* group, and the *willing-to-connect* students are older than those who are *not willing to connect*; that is, the *willing-to-connect* students and teachers are closer in age than the *not-willing-to-connect* ones. This is in line with previous studies which have found that as the age difference between teachers and students increases, students' and teachers' perceptions of the value of their relationship with one another decreases (Ang, Chon, Huan, Quek, & Yeo, 2008; Saft & Pianta, 2001; Yeo, Chong, Huan, & Quek, 2008). Therefore, it might be that teachers and students who are traditionally known to be in good relationships with each other are willing to use Facebook as yet another platform to strengthen their relationships.

An interesting difference between the *willing-to-connect* and the *not-willing-to-connect* student groups is in gender; among the former, there are relatively more boys than among the latter. As Barker (2009) found, male adolescents are more likely to use SNS-based communication for social compensation and social identity. Our findings might mirror Barker's notion of social compensation to the context of student-teacher relationship, as it is known that male students have more conflictual relationships with teachers than female students do, and that female teachers have closer relationships with female students than with male students (e.g., Quaglia, Gastaldi, Prino, Pasta, & Longobardi, 2013; Split, Koomen, & Jak, 2012). Therefore, male students might find themselves inferior to their female peers regarding the relationships with their teachers (who are mostly female), hence the possible need for online compensation.

As our findings suggest, there is a positive association between students' perceptions of student-teacher relationships in general and the willingness of the two sides to connect on Facebook. The group of *willing-to-connect* students is characterized with better teacher-student relationship in the axes of satisfaction and instrumental help than the *not-willing-to-connect* group. Therefore, from the students' perspective, Facebook-mediated communication might serve as yet another platform to support their relationships with teachers with whom they already have good relationships. This is in line with our previous, qualitative study, which showed that real-time relationships are mirrored on Facebook (Hershkovitz & Forkosh-Baruch, 2013), and in line with other studies about online/offline relationships (Callaghan & Bower, 2012; Ivcevic & Ambady, 2013; Sheldon, 2008). Therefore, SNS-mediated communication can support student-teacher relationships and, following on from that, might eventually contribute to the student's general well-being (cf. Pianta, 1999; Wentzel, 1998). Interestingly, these differences in student-teacher relationships between the *willing-to-connect* and the *not-willing-to-connect* groups were not observed in the teacher population. A possible explanation is that adolescents might feel the need for teachers to continually take part in their out-of-school life, while teachers do not necessarily feel so with regards to their students, as secondary school teachers might tend to keep emotions as intrusion in the classroom (cf. Hargreaves, 2000). This issue should be further studied in a future research.

Our findings also support previous studies indicating the critical role of teachers' educational beliefs in their technology integration practices, specifically Web 2.0-based platforms (Ertmer, 2005; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Sang, Valcke, van Braak, & Tondeur, 2010; Windschitl & Sahl, 2002). These findings might have implications on the study of student-teacher relationships in general. Indeed, SNS are complex Web 2.0-based platforms requiring teachers and students to utilize both ICT skills and social skills. There is a clear need to supply teachers with elaborate technological skills for using SNS, as expected by their students. Assisting teachers with the needed IT skills for using SNS may therefore prove to be as important to their teaching agenda as supporting their instructional strategies. As Davis (2003) emphasized, knowledge of student-teacher relationships is often embedded within knowledge of a particular underlying approach (for example, motivation studies, being mostly interested in teachers as effective instructors, define "good" student-teacher relationships as those that support motivation and learning in classrooms). Our study suggests that online social media through which these relationships are facilitated (e.g., SNS) may also be a critical component of teacher-student relationships. Hence, the need for proficiency in using this media is crucial for teachers.

Due to their major role of SNS-mediated teacher-student relationship to students' academic and emotional development, as well as to teachers' professional development, the solution of banning SNS-based communication, already taken by some policymakers, is potentially damaging to the education system. Notwithstanding, it is also difficult to enforce, as technology has a path of its own, and communication needs create an impossible situation, which causes some teachers to break the rules and engage in SNS interaction with their students anyway. A banning policy affects the very teachers and students who most need this type of communication and could benefit from it. Moreover, a banning policy may send a message to teachers and students about the degree of trust and support of the system to its teachers. The alternative solution is promoting and supporting an effective use of SNS, as pursued with 21st century skills in general, which Ministries of Education worldwide implement and promote via national programs. As SNS-mediated communication is voluntarily facilitated, such a policy will not harm the teachers and students who do not wish to use it. Students, educators, parents, and policymakers should be well aware of the risks and challenges with which they are faced by using SNS. We argue that teacher-student relationships in the SNS-era may have a bearing on additional aspects of the school milieu, e.g., teaching and learning, achievements, and parents' involvement in schools. Therefore, we strongly recommend further research into these aspects, providing policymakers with insight on these issues, which will support evidence-based decisions, and possibly change existing policies.

Conclusions

In this quantitative study, we explored differences in personal characteristics, attitudes, and teacher-student relationships between students (N=587) and teachers (N=160) who are *willing to connect* to each other via social networking sites (referred to as *willing-to-connect*) and those who are not willing to do so (referred to as *not-willing-to-connect*). We did this via self-reported, online questionnaires. Summarizing the results, we have found the following:

1. Personal Characteristics
    - *Willing-to-connect* teachers are younger, have less teaching experience and longer Facebook-usage experience than the *not-willing-to-connect* teachers.
    - *Willing-to-connect* students are older and have more Facebook-friends than the *not-willing-to-connect* students. Furthermore, there are relatively more boys in the *willing-to-connect* group than in the *not-willing-to-connect* group.
2. Attitudes towards Using Facebook in Education
    - Both *willing-to-connect* teachers and students tend to believe that Facebook can be used for teaching/learning and that it should not be banned for teacher-student communication in much higher rates than their *not-willing-to-connect* peers.
3. Perceptions of Teacher-Student Relationships
    - There were no significant differences in perceptions of teacher-student relationships between the *willing-to-connect* and the *not-willing-to-connect* teacher groups.
    - Perceptions of satisfaction and instrumental help regarding students' relationships with their teachers were higher for the *willing-to-connect* students compared to their *not-willing-to-connect* peers.

As with any study, this one is not without limitation. First of all, the way the research population was recruited, based on viral distribution of the research questionnaire, does not mean it is in any way representative of the whole Israeli teacher/student population. Furthermore, the fact that the participants were practically self-recruited (i.e., any person who was exposed to our viral distribution of the online questionnaire could have chosen not to take part in the research), and the fact that we used online questionnaires, might somehow bias the results.

The complex issue of teacher-student relationships in the SNS-era should be further studied. In particular, we urge further study of the implications of this phenomenon on additional aspects of the school milieu, including teaching and learning, achievements and parents' involvement in schools. This will allow broadening the body of knowledge regarding teacher-student relationships at large and will assist policymakers in taking evidence-based decisions.

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Appendix A: Teacher-Class Relationship Inventory (TCRI)

Item	Original Item (TSRI)	Adapted Item
1	I enjoy having this student in my class	I enjoy teaching this class
2	If the student has a problem at home, he/she is likely to ask for my help	If students from this class have a problem at home, they are likely to ask for my help
3	I would describe my relationship with the student as positive	I would describe my overall relationship with this class as generally positive
4	This student frustrates me more than most other students in my class	This class frustrates me more than most other classes I teach
5	If this student is absent, I will miss him/her	If I miss a lesson with this class, I will miss them
6	The student shares with me things about his/her personal life	Students from this class share with me things about their personal life
7	I cannot wait for this year to be over so that I will not need to teach this student next year	I cannot wait for this year to be over so that I will not need to teach this class anymore
8	If this student is absent, I feel relieved	If I miss a lesson with this class, I feel relieved
9	If this student needs help, he/she is likely to ask me for help	If students from this class need help, they are likely to ask me for help
10	The student turns to me for a listening ear or for sympathy	Students in this class turn to me for a listening ear or for sympathy
11	If this student is not in my class, I will be able to enjoy my class more	If I don't teach this class, I will be able to enjoy my teaching more
12	The student depends on me for advice or help	This class depends on me for advice or help
13	I am happy with my relationship with this student	I am happy with my relationship with this class
14	I like this student	I like this class

Appendix B: Teacher-Student Relationship Inventory, responded by Students (TSRI-S)

Item	Original Item (TSRI)	Adapted Item
1	I enjoy having this student in my class	I think this teacher is enjoying having me in his/her class
2	If the student has a problem at home, he/she is likely to ask for my help	If I encountered a problem at home, I would likely approach this teacher for help
3	I would describe my relationship with the student as positive	I would describe my relationship with this teacher as positive
4	This student frustrates me more than most other students in my class	I think this teacher is frustrated by me more than by most other students in class
5	If this student is absent, I will miss him/her	I think my teacher would miss me if I'm absent from class
6	The student shares with me things about his/her personal life	I share things about my personal life with this teacher
7	I cannot wait for this year to be over so that I will not need to teach this student next year	I think this teacher cannot wait for the moment he/she does not need to have me in his/her class any more
8	If this student is absent, I feel relieved	I think this teacher would feel relieved if I weren't in his class
9	If this student needs help, he/she is like-ly to ask me for help	If I need help, I am likely to ask this teacher for help
10	The student turns to me for a listening ear or for sympathy	I turn to this teacher for a listening ear or for sympathy
11	If this student is not in my class, I will be able to enjoy my class more	I think this teacher will enjoy the class more if I am not in it
12	The student depends on me for advice or help	I depend on this teacher for advice or help
13	I am happy with my relationship with this student	I am happy with my relationship with this teacher
14	I like this student	I like this teacher

Biographies

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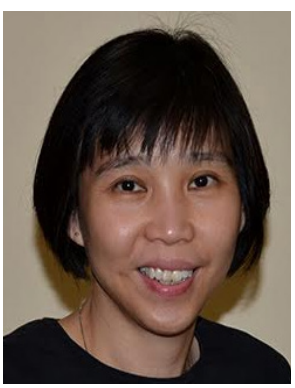

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Adoption of Online Network Tools by Minority Students: The Case of Students of Ethiopian Origin in Israel

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Abstract

Students of Ethiopian origin belong to one of the weakest sectors in the Jewish population of Israel. During their studies they have to deal with social alienation, cultural gaps, economic hardships, and racial stereotypes which reduce their chances to successfully complete their academic degree. In this respect, the present research asks whether online social media could provide those youngsters with tools and resources for their better social integration and adaptation to the academic life. For this purpose, the study was conducted in one of Israel's largest academic colleges while adopting a design-based research approach, which advanced gradually on a continuum between 'ambient' and 'designed' technology-enhanced learning communities. The interventions applied for this study aimed at examining how they may encourage students of Ethiopian origin to expand their activities in the online social learning groups. The findings indicate that the main pattern of students of Ethiopian origin online participation was peripheral and limited to viewing only. Nevertheless, the level of their online activity has been improved after a series of two interventions, which also led to a slight improvement in indicators of their social integration and in a change in their usage of online learning groups from social to academic uses.

Keywords: students of Ethiopian origin, immigrant' social integration, social media, online learning groups, peripheral participation, Israel

Introduction

The present study focuses on students of Ethiopian origin who belong to one of the weakest sectors in the Jewish population of Israel (Saguy & Chernyak-Hai, 2012). This immigrant community copes on a daily basis with the consequences of its being of different skin color to the majority group, which

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makes it a community of "permanent *Olim*" (immigrants in Hebrew) in Israeli society (Ben Ezer, 1992), making their integration more difficult (Elias & Kemp, 2010; Mizrachi & Herzog, 2012; Ringel, Ronnel, & Getahune, 2005). Even as they get access to academic studies, young people of Ethiopian origin are faced daily with exclusion and manifestations of racism, which lead to feelings of frustration, alienation, and social isolation (Ringel et al., 2005; Salamon, 2003; Walsh & Tuval-Mashiach, 2012).

In this context, the research literature has shown that computer-mediated communication may offer an alternative for immigrants to make contact with students from the majority society, since the Internet provides them with cultural and academic resources that are unavailable or inaccessible by other communication means (Bosch, 2009; Cheung, Chiu, & Lee, 2011; Elias, & Lemish, 2009; Jürgens, 2012). Moreover, immigrants' utilization of the Internet is aimed not only at information seeking and sharing, but also at building social ties with the majority society, which would not have been possible in an offline reality (Clafferty, 2011; Elias & Lemish, 2009; Steinfield, Ellison, & Lampe, 2008).

In addition, several studies on students from the majority society in higher education found positive contribution of social media to the learning process (e.g., Forkosh-Baruch & Hershkoviz, 2012; Kurtz, 2014). Moreover, in parallel with acquiring academic knowledge via online networks, these students searched for information about their peers and initiated new social relationships (Madge, Meek, Wellens & Hooley, 2009; Quan-Haase & Young, 2010).

Yet very little is known about the specific contribution of social media to the integration of immigrant students in the academic life. To fill this gap, the present study examined the Ethiopian students' uses of online social media and the connection between the online participation and social and academic integration. For this purpose, we examined the particular patterns of participation of students of Ethiopian origin in online learning groups, the changes that occurred in these patterns, as well as the change in various indicators for a better integration into the academic life, as a result of a series of minimal interventions designed to encourage them to take a more active part in online learning groups without undermining the spontaneous dynamics of participation.

Immigrants of Ethiopian Origin in Israel

The Jews of Ethiopian origin arrived in Israel within the framework of the *Law of Return* (Berhanu, 2005) in two major immigration waves, in 1984 and in 1991. Since their arrival in Israel, these immigrants have had to cope with the difficulties of integration in every sphere of life, due to the wide gap between traditional Ethiopian culture and modern Israeli culture. Their working skills were based in agriculture and handicrafts; most of the families had more than three children; and their general level of education was extremely low, as the majority had been living in small remote villages with no formal educational infrastructure (Goldblatt & Rosenblum, 2007; Ringel et al., 2005; Walsh & Tuval-Mashiach, 2012).

Upon arrival, virtually all of the Ethiopian immigrants were directed in bulk into *Absorption centers* located on the margins of peripheral cities, which isolated them from the majority society and fueled their dependence on the Israeli establishment (Flum & Cinamon, 2011; Goldblatt & Rosenblum, 2007; Rosenblum, Goldblatt, & Moin, 2008; Salamon, 2003; Walsh & Tuval-Mashiach, 2012). As of today, 62% of families of Ethiopian origin are still living in cities with a disproportionately large concentration of Ethiopian population (Israel's Central Bureau of Statistics, 2013). The majority (70%) live in a small number of peripheral settlements, usually classified as of lower-middle to low socio-economic status (Vurgan, 2011).

Due to the combination of their geographic concentration in the periphery and lack of skills suitable for Israel's labor market, first-generation immigrants had a tremendous difficulty with occupational integration (thus remaining constantly unemployed) or worked in blue-collar occupations that did not require vocational training (Flum & Cinamon, 2011). As a result, for more than 20 years Ethiopian immigrants remain Israel's poorest population with 41% of families below the poverty line, compared to 15% among the general population (Elias & Kemp, 2010; Myers-JDC-Brookdale Institute, 2012). Although today increasing numbers of young adults of Ethiopian origin are integrating in the Israeli labor market, there are still wide discrepancies in employment rates and wage level between them and the rest of the population (King, Fischman, & Wolde-Tsadick, 2012).

In addition, immigrants of Ethiopian origin encountered in Israel a great deal of prejudice and discrimination, as they were labeled 'Blacks' in predominantly white Israeli society (Flum & Cinamon, 2011; Saguy & Chernyak-Hai, 2012; Salamon, 2003; Walsh & Tuval-Mashiach., 2012). The racism against the Ethiopian immigrants is even more pronounced when Ethiopian youths come into contact with native Israeli youngsters during their studies and military service (Walsh & Tuval-Mashiach, 2012). A recent survey of Ethiopian-origin youth indicated that 73% of them had encountered racist comments about their origin and skin color; 37% reported racism in their schools; and 33% thought that youth outside their community avoid making Ethiopian friends because of their ethnic origin (Elem, 2012). In response, youth of Ethiopian origin have developed a new identity, which was completely strange to them prior to their arrival in Israel and which is based on Afro-American ethnic models (e.g., slang, names, hair and dressing style, and music) (Mendelson-Maoz, 2013; Shabtay, 2003 Walsh & Tuval-Mashiach, 2012).

Difficulties of Immigrants and Ethnic Minorities in Academic Studies

Research literature shows that in many multi-cultural societies ethnic minority and immigrant students are faced with great difficulties in their integration in academic studies. For instance, in the United States, 49% of high school graduates who are not immigrants continue their studies in colleges or in universities, compared to 37% of Hispanic high school graduates (Song & Elliott, 2011). Moreover, Afro-American students' scores are significantly lower compared to their white peers, despite the fact that these students work much harder than their counterparts in order to achieve their academic goals. This finding is explained by the fact that Afro-American students are forced to dedicate considerable effort and more time (compared to white students) to developing and applying adaptive skills, such as coping with racism, maintaining a positive self-image, and developing support networks (Green, Marti, & McClenny, 2008).

In Israel as well, ethnic minorities and immigrants experience fundamental difficulties in higher education (Almagor-Lotan & Koch-Davidovich, 2011; Mesch, 2012). A most prominent example of this is the Arab minority, which constitutes about 20% of Israel's population, but their participation in the higher education system is only 12% (Shaviv, Binstein, Stone, & Fudem, 2013). The percentage of first-degree graduates among the Arab minority is 9.6% of the total number of graduates, compared to 87% Jewish graduates (Israel's Central Bureau of Statistics, 2010). Arab students take longer to complete their first degree studies, with only 36.6% of those who enroll actually managing to complete the program on schedule, compared to 52.5% of Jewish students (Israel's Central Bureau of Statistics, 2011). Students of Ethiopian origin experience similar difficulties in their academic studies resulting in their low rate in the undergraduate and graduate programs (4.5% compared to 10.2% in the general population) (Israel's Central Bureau of Statistics, 2013). In addition, the dropout rate from universities is 19% among students of Ethiopian origin, compared to 11% in the rest of the population (Annual Israeli Report of the State Comptroller, 2012).

In order to help students of Ethiopian origin reduce these gaps and complete their academic studies successfully, preparatory tracks with dedicated assistance programs are available in most of

Israel's institutions of higher education. The purpose of these programs is to address gaps in academic literacy and general knowledge; indeed, about 90% of students of Ethiopian origin begin their academic studies having first completed a pre-academic preparatory track (Almagor-Lotan & Koch-Davidovich, 2011). Their benefits notwithstanding, such programs create a separation between students of Ethiopian origin and students from the majority population, which may undermine both the self-image of Ethiopian students (as they are labeled as 'struggling academically') and their chances of social integration into the community of majority students.

Internet and Immigrants

A key concept for examining the relationship between members of a minority group and their own community, as well as between the minorities and the majority society, is social capital. This notion refers to the characteristics of a social organization, such as networks, norms, and trust, which enable coordination and cooperation among individuals for their mutual benefit (Putnam, 1993). In this regard, Putnam (2001) distinguishes between two categories of social capital: *bonding* – social relations within a minority community, usually characterized as deep, emotional and intensive; and *bridging* – connecting with the majority society, usually characterized by loose relations of an instrumental nature.

The literature consistently points to the use of Internet by immigrants as a tool for cultivating a bonding social capital. The Internet helps immigrants to maintain contact with their family and friends in their country of origin, to build friendships with members of their ethnic community in the host country, and preserve their culture of origin (Chen, Choi & Kay, 2011; Elias & Lemish, 2009; Mesch, 2012; Peeters & D'Haenens, 2005; Windzio, 2012). Concurrently, among relatively young immigrants (mostly students and youth), there are indications of creating a bridging social capital: building new social relationships with young people from the majority group and acquiring familiarity with the norms and culture of the host country (Chen et al., 2011; Elias & Lamish, 2009; Ellison, Steinfield & Lampe, 2007; Steinfield et al., 2008). In this regard, a study by Elias & Lemish (2009) of immigrant youth from the Former Soviet Union in Israel shows that they perceived the Internet as a more reliable source of information than local socialization agents, such as teachers or fellow students. At the same time, the Internet also provided them with a wide variety of opportunities to learn about Israeli society in a less threatening environment than direct inter-personal communication.

Most of the previous studies, however, have been conducted before the advent of Web 2.0 tools and new digital technologies, such as smartphones, so that there is a scarcity of research on the utilization of social media by immigrants and ethnic minorities. This lack is especially evident in the context of immigrant youngsters' adaptation into the host society and, particularly, in integration into the academic life.

Patterns of Participation in Online Social Media

The two fundamental factors that motivate individuals to use social media are the needs for socialization and a sense of belonging (Özgüven & Mucan, 2013). In this context, the literature suggests that Facebook users who are socially active (upload images, write posts, comment on others' posts, share links to news updates, and so on) tend to have lower levels of loneliness, whereas passive users are characterized by higher levels of loneliness (Tobin, Vanman, Verreynne, & Saeri, 2015). Likewise, higher levels of interaction among Facebook users have been found to be positively correlated with increased social support and, consequently, a declining loneliness over time (Burke, 2011).

Furthermore, passive behavior on social media ("lurking") is correlated with lower levels of satisfaction and intimacy (Preece, Nonnecke, & Andrews, 2004; Rau, Gao, & Ding, 2008; Tobin et al., 2015). Lurkers are individuals who participate in social media, but initiate posts rarely, if at all, so their participation is mostly limited to viewing (Nonnecke & Preece, 2001; Rau et al., 2008; Tobin et al., 2015). A number of reasons were offered for lurkers' passivity, including lack of familiarity with the group's nature and activity, shyness, as well as personal, social, and educational insecurity (Nonnecke & Preece, 2001; Rafaeli, Ravid, & Soroka, 2004).

Although lurkers' contribution to group's activity is clearly smaller, they do take part in it. Their participation can be characterized according to Lave and Wenger's (1991) definition of "legitimate peripheral participation", which views certain minor activities that newcomers make within a community as first steps in becoming more experienced members and eventually old timers. Moreover, for certain groups, such as immigrants, peripheral participation is often the only possible mode of participation in online activity, due to language barriers and lack of familiarity with the host cultural norms (Elias & Lemish, 2009). And yet, since social interactions have been found to make group members feel good about themselves and experience the esteem and support of others, peripheral participants should be encouraged to "de-lurk" and take a more active part in online group activities (Hustad & Arntzen, 2013).

Students' Utilization of Online Social Media

In recent years, social media have been perceived not only as a place for leisure and recreational activity, but also as a place where spontaneous, non-formal learning can occur. This type of learning is dynamic and ongoing, as it takes place through discussion, debate, and information sharing processes (Burbules, 2006; Forkosh-Baruch & Hershkoviz, 2012; LINKS, 2012). Within the framework of a learning online group, students raise content-related questions and answer each other. In addition, as group activity increases, so does the students' commitment to learning (Forkosh-Baruch & Hershkovitz, 2012). This suggests that on top of the online network's traditional role as a virtual meeting place, it is becoming a platform that facilitates and benefits learning (Bosch, 2009; Meishar-Tal, Kurtz, & Pieterse, 2012).

Social media offer several learning-related benefits: they are open, free of charge, and not owned by the academic institute. These strengths allow social media to expropriate the centralized institutional control and management of scholarly information and move it into the communal cyberspace. Their main advantage over other discussion settings/environments is the fact that they invoke and encourage response and involvement and enable a dynamics of active participation. Such participation could make it easier for members to disagree with each other, thus making them more willing to make their attitudes and opinions regarding the learning content and not merely to consume information, which is often the case in formal learning environments (Bosch, 2009; Burbules, 2006; Meishar-Tal et al., 2012).

Despite the advantages of online social media as a place for meaningful interaction as well as a resource for non-formal learning, their contribution and utilization have not been studied in the context of immigrant students, who experience particular difficulties in integrating into academic studies. The purpose of the present study is, therefore, to examine the immigrant students' uses of online social media, focusing on students of Ethiopian origin in Israel. In addition, because immigrants may have significant difficulties participating in social media due to insecurity and cultural gaps, the present study incorporated a series of interventions designed to encourage more active participation by immigrant students in online learning groups. For this purpose, the following research questions were articulated:

1. What is the scope and nature of participation by students of Ethiopian origin in online learning groups, and how can a more active participation be encouraged through a minimal intervention that does not undermine the spontaneous nature of participation?

2. What are the uses of online social media by students of Ethiopian origin, and could such uses be modified by minimal intervention?
3. Does participation in online social media contribute to the indicators for a better integration of students of Ethiopian origin into the academic life and could such contribution be increased by minimal intervention?

Methodology

The methodology adopted for this study is based on combining two disciplines (communication and education) and incorporating research strategies that characterize social science (studying processes without intervention) with those that characterize learning sciences (examining processes through intervention). Along these lines, the study employs a design-based research approach, which has been especially adapted to this unique integration of the research paradigms of both disciplines.

Design-based research includes several cycles, called 'iterations', of design, enactment, and analysis of the learning with the designed environment, and refinement of the design for the next iteration (Barab & Squire, 2004; Kali, 2008). Through the characterization of the learning that takes place in each iteration, design-based research enables testing theoretical as well as design conjectures. In this manner, design-based research serves to develop both a theory regarding how people learn in specific contexts and means to support learning in this context (Sandoval, 2014).

As mentioned above, to date no research has been undertaken to examine how students from weakened populations in general, and students of Ethiopian origin in particular, use social media in an academic context. Therefore, in contrast to the design-based method commonly employed in learning sciences – where intervention is introduced already in the first iteration – the present study began by observation without intervention, describing the initial 'zero point' which would be used for later comparisons.

Design

The study was conducted in one of Israel's largest academic colleges, which offers undergraduate studies in a wide variety of disciplines, from behavioral sciences to economics and accounting. To carry out the study, we chose an annual course in computer skills, which is taught as part of the pre-academic preparatory program that the majority of Ethiopian-origin candidates attend in order to improve their chances of admission to first degree tracks. As one of the researchers is the lecturer in that course, various steps had been taken to address ethical issues, such as an explicit assurance, given both verbally and in writing, that participation or non-participation in the study would not affect the students' final scores; protecting participants' anonymity; allowing students to skip questionnaire items; allowing the deletion of posts and text messages exchanged within the online learning groups, which the students did not wish to share with the researcher; and allowing students to opt out of the study at any stage.

The research population comprised students who emigrated or whose parents emigrated from Ethiopia to Israel during the 1990s, along with students belonging to the 'majority group', comprising white Jewish students. Altogether 279 students participated in the different stages of the study, out of which 75 were of Ethiopian origin (55 women; 20 men), and 204 were members of the majority group (125 women; 78 men; 1 undefined). The average age of both groups was 24 years. Out of the Ethiopian-origin group, nine were born in Israel, while 48 had emigrated as children in the early 1990s (for details see Table 1 below). In addition, we analyzed messages written by the study participants on the Facebook and WhatsApp learning groups. All messages were analyzed, including 464 Facebook posts and 1,343 WhatsApp messages (see Table 2).

The study included three iterations, which were gradually expanded from describing a natural situation without intervention, through minimal intervention, to a slightly more significant intervention. The rationale for expanding the intervention in such small steps was that such steps would enable us to pinpoint the exact stage at which some change had occurred in the uses of online social media of students of Ethiopian origin, as compared to their situation prior to the intervention. In addition, because the contribution of online social media for integrating students of Ethiopian origin in higher education has not been studied before, finding the most effective intervention entailed a slow and careful progression in the implementation of expanded intervention. The present study therefore advanced gradually on a continuum between 'ambient' and 'designed' technology-enhanced learning communities (Kali et al., 2015). The following is a detailed description of the rationale for applying each of the iterations, the data collection methods, and the participants for which data were collected in each iteration.

Iteration 0: Spontaneous use of social media

In the first stage, called Iteration 0, a comprehensive survey was conducted in order to get as accurate as possible picture of the purposes and uses of social media in general, and of online learning groups in particular, by students of Ethiopian origin. We sampled students enrolled in various departments (Behavioral Sciences, Business Management, Economics and Administration, Nursing, and the pre-academic preparatory program) who were in various stages of studies towards a first degree, selecting only classes that were attended by students of Ethiopian origin. The time to fill in the survey questionnaire was about 15 minutes. The survey took place during the 2013-2014 academic year and included 37 students of Ethiopian origin and 136 students from the majority group (see Table 1).

Another source of data was the activity of pre-academic preparatory program students in the WhatsApp and Facebook online learning groups, used in conjunction as students were simultaneously active in both groups. The Facebook group was established for the entire range of courses taught in the program, whereas the WhatsApp group had been opened for the course in mathematics. At the end of the semester, one of the researchers asked permission to join these groups in order to analyze their contents. In total, 318 Facebook posts and 488 WhatsApp messages were analyzed (see Table 2).

Iteration 1: Online learning group participation and uses following minimal intervention

In the second stage of the study, Iteration 1, we introduced a minimal intervention which consisted of a talk initiated by one of the researchers (who is also a lecturer in the program) with the students regarding the educational value of establishing a learning group on an online social network in the context of the course that she taught. The lecturer told the students that in previous years, students have assessed such groups to be highly conducive to their learning processes. Through that talk, students were exposed to the existence and benefits of such a possibility. At the end of the course, the students permitted the researcher to join their Facebook group and analyze its posts. A total of 146 posts were analyzed (see Table 2).

It should be noted that students who took part in Iteration 1 had also been included in Iteration 0, which meant that we already had data about them and their patterns of participation in online social networks from the survey questionnaire. Consequently, we did not conduct another survey after this iteration, since the intervention had been minimal and we did not expect to find essential attitude shifts or changes in indicators of social integration compared to those reported in the survey taken in Iteration 0. The changes that we did expect to find were in the level of participation in the online learning groups, which were assessed using content analysis of their Facebook posts and WhatsApp messages.

Iteration 2: Online learning group participation and uses following a slightly more significant intervention

In the third stage, Iteration 2, we expanded our intervention by asking the students to establish a learning group on any social media network (this time as part of the course's requirements) and to allow the researcher to join the group from its inception, as part of the initial intervention. This iteration took place during the 2014-2015 academic year, involving a new group of students who had not participated in Iterations 0 and 1 (see Table 1). The students were free to choose among the various social media platforms, and they opted to establish a WhatsApp group. Similar to previous iterations, at the end of the intervention we analyzed the contents of all 855 messages written by members of the online learning group (see Table 2).

In addition, we conducted a survey aimed at pinpointing the uses of online learning groups that have been previously identified in Iteration 0, as well as an in-depth examination of various indicators that may predict better integration in the academic studies, such as the students' relationships with their peers, social support, sense of self-confidence, assessment of learning difficulties, and self-perceptions regarding academic aptitude (Bettencourt, Charlton, Eubanks, Kernahan & Fuller, 1999; Yu & Shen, 2012). This survey was conducted at the beginning and at the end of the iteration, in order to explore the possibility that some of the indicators had changed following the intervention.

Table 1: Participants in each of the iterations

	Iteration 0		Iteration1	Iteration 2
	General group (N=173)	Group 1*: Facebook (N=30) and WhatsApp (N=20) spontaneous learning groups (Total N= 50)	Group 2: Facebook learning group (N=29)	Group 3: WhatsApp learning group (N=28)
Students of Ethiopian origin	37 (25 women – 68%, 12 men – 32%)	12 (9 women – 75%, 3 men – 25%)	6 (4 women – 67%, 2 men – 33%)	20 (17 women – 85%, 3 men – 15%)
Majority group	136 (90 women – 66%, 45 men – 33%, 1 undefined – 1%)	38 (17 women – 45%, 21 men – 55%)	23 (11 women – 48%, 12 men – 52%)	8 (7 women – 88%, 1 man – 12%)

* Group 1 is included in the General group

Data Analysis

Research Question 1: Level of Participation of Students of Ethiopian Origin in the Online Learning Groups

The objective of Research Question 1 was to examine the scope of activity of students of Ethiopian origin and students of the majority group in online social networks and the changes in this activity following intervention. In analyzing students' activity, we made a distinction between *active* participation, which was expressed in writing posts/messages, replying to others' posts, and 'likes', versus *peripheral* participation, which was expressed in reading the responses of other students, with little or no writing. All the forms of online activity (which included posts, messages, replies to others' posts, and 'likes') were counted and typed into an Excel spreadsheet, using separate categories for the various iterations and attributing the analyzed contents to students of Ethiopian origin and students of the majority group. We then calculated the average number of posts and messages per student in each of the two groups in order to see whether and how the interventions introduced in the two iterations had affected the participation patterns of students of Ethiopian origins in online learning groups. In addition, we examined the number of students in each of the groups who had not taken any part in the online learning groups in order to ascertain (a) whether and, if so, which iterations had caused changes in the participation pattern of a greater number of students of Ethiopian origin and (b) whether such change was also found in comparison with students of the majority group. The data were analyzed using Excel software (version 2010), including frequencies and averages calculations.

Research Question 2: Utilization of Online Social Networks by Students of Ethiopian Origin

To examine the different uses of online social networks by students of Ethiopian origin as compared to students of the majority group, we used two complementing research tools: the survey and the content analysis of posts and messages in the online learning groups. In the survey conducted in Iteration 0, we examined the reasons given by students for using Facebook and WhatsApp, while dividing them into three categories: "Learning Uses", "Social Uses" and "Administrative Uses".

The Learning Uses category was examined through questions regarding web use for getting homework-related answers and for receiving study-related materials. The Social Uses category was examined through questions related to the students' utilization of social media for keeping in touch with classmates and for keeping up-to-date with social life in college. The Administrative Uses category was examined through questions regarding the use of social networks for keeping up-to-date with course- and program-related information and instructions, such as lessons locations changes, exercises date of submission. All statements were measured on a four-point Likert scale (1 = "strongly disagree" till 4 = "strongly agree"). The survey data were analyzed using SPSS software (version 20), including Independent-samples T Tests, Chi square tests (χ^2) and frequencies rate calculations.

Concurrently, we attempted to identify the various uses by students of online learning groups through quantifying the qualitative analysis of the verbal data (Chi, 1997) gathered from the Facebook and WhatsApp learning groups. Our analysis indicated that the three categories of use that emerged inductively from students' answers to the open ended questions in the survey (described above) also emerged from the content analysis of the posts and messages in the learning groups. These categories were characterized in this context as follows: Learning Uses (e.g., asking questions, blackboard capture photos, photos of written homework solutions, and notes taken in various classes), Social Uses (e.g., personal and group photos of students, jokes, congratulations), and Administrative Uses (e.g., inquiries and notices about cancelled classes, assignment submission deadlines, and end of semester dates). For each category we examined how many messages and posts were written by students of Ethiopian origin compared to students of the majority group. We then compared the incidence rates of the three categories in each iteration in order to see (a) whether and when a change occurred along the three iterations and (b) whether there was a difference in the activity within the various categories between the two sub-groups (i.e., majority students versus Ethiopian students) and, if so, which iteration had caused that difference. The data were analyzed according to Independent-samples T Tests procedure.

Table 2: Research methods in each of the iterations

Iteration	Type of intervention	Research group	Data corpus	Analysis
0	No intervention	General group (37 students of the minority group, 136 students of the majority group)	Survey	Statistical analysis
		Group 1 • 30 participants in the spontaneous learning group on Facebook (6 students of the minority group, 24 students of the majority group) • 20 participants in the spontaneous learning group on WhatsApp (6 students of the minority group, 14 students of the majority group)	• 318 Facebook posts: (0 minority group, 318 majority group) • 488 WhatsApp messages (65 minority group, 423 majority group)	Quantifying qualitative analyzes of verbal data (Chi, 1997)
1	Minimal intervention: Students were told about the potential contribution of participation in a learning group in social media	Group 2 • 29 participants in the online learning group on Facebook (6 students of the minority group, 23 students of the majority group)	• 146 Facebook posts (4 minority group, 142 majority group)	
2	More substantial intervention: Students were requested to open a social media learning group as part of the course requirements	Group 3 • 28 participants in the online learning group on WhatsApp (20 students of the minority group, 8 students of the majority group)	• 855 WhatsApp messages (355 minority group, 500 majority group) • Survey (pre/post)	Quantifying qualitative analyzes of verbal data (Chi, 1997) Statistical analysis

Research Question 3: Relation between Participation in Online Learning Groups and Integration of Ethiopian Students in Academic Life

Using the survey conducted at the beginning and the end of Iteration 2, we examined whether there was a change in various indicators of better integration of students of Ethiopian origin in the academic life following the intervention that was designed to promote more active participation in an online learning group. For this purpose, we measured indicators that included the sense of belonging that students felt towards their classmates such as “I feel part of the group”; “I feel alienated from other students in the group”; their satisfaction with their social situation in the preparatory program such as “I am pleased from my social status in the preparatory program”, “I feel lonely in the class most of the time” and their sense of self-efficacy such as “I am proud of my academic achievements”; “During studies I feel valuable” and more. Statements were measured on a four-point Likert scale (1 = “strongly disagree” to 4 = “strongly agree”). The surveys data were analyzed using Mann-Whitney test due to a large difference between the sizes of the groups (eight students from the majority group and 20 from Ethiopian origin) and the low number of students from the majority group who participated in the online learning group.

Findings

Research Question #1: Level of Participation of Students of Ethiopian Origin in the Online Learning Groups

The first research question examined the level of participation in online learning groups on social media by students of Ethiopian origin, as compared to students from the majority group and considered how a more active participation may be encouraged through minimal intervention.

As mentioned, Iteration #0 consisted of examining the students’ online activity in two learning groups, one on Facebook and one on WhatsApp. In the Facebook group, the initial non-intervention stage took place during one academic semester, whereas the WhatsApp group continued without intervention for a whole year. Analysis of the online activity of students of Ethiopian origin on the Facebook learning group (six out of the 11 students of Ethiopian origin in the class, see Table 1) shows that during the entire semester they had not initiated any posts, had not responded to any posts written by other students, and had not ‘liked’ any of the posts or replies by others. In contrast, students from the majority group (23 students who were all members of the Facebook group) initiated 28 posts, responded to others’ posts 132 times, and ‘liked’ 87 posts. In semesters of reading the posts and responses, however, there was no difference between students of Ethiopian origin and students from the majority group – every one of the group members had read all the messages.

A slightly different activity pattern was found in the WhatsApp learning group, which was monitored (retroactively) for the entire academic year. All the six students of Ethiopian origin in the class who took this course (six) were members of this online learning group, as well as 12 (out of 14) students from the majority group (see Table 1). During the entire academic year, students of Ethiopian origin wrote 65 messages (an average of nine messages per student), compared to 423 messages written by students from the majority group (an average of 26 messages per student). In addition, only half of the students of Ethiopian origin (three out of six) were active in the group, in contrast to the majority group, in which all members of the online learning group had written messages.

In Iteration #1 we examined the online activity in the Facebook learning group whose members included six students of Ethiopian origin (out of 11 Ethiopian students in the class and 23 (out of

26) students from the majority group (see Table 1). The learning group's activity was monitored for one academic semester. As described above, this iteration consisted of a minimal intervention in which the researcher told the students about the academic benefits of joining an online learning group. Our analysis shows that students of Ethiopian origin were scarcely active in the group during entire semester; students of Ethiopian origin initiated only one post, wrote three responses, and 'liked' three posts. Thus, this iteration had not helped in changing their online participation patterns. In contrast, students from the majority group initiated 30 posts, responded 19 times, and 'liked' 60 posts. Nevertheless, as in Iteration #0, all the posts and responses had been read by all members of the group, regardless of ethnic origin.

Finally, in Iteration #2, when students were asked to open an online learning group as part of the course's requirements, they chose to open it on WhatsApp. This group included 20 students of Ethiopian origin (out of 21 students in the class) and eight students (out of 14) from the majority group (see Table 1) and was monitored for one academic semester. An analysis of the group's activity shows that students of Ethiopian origin wrote 357 messages (an average of 18 messages per student per semester), compared to 497 messages written by students from the majority group (an average of 62 messages per student per semester). Hence, the findings from Iteration #2 also indicate an improvement in Ethiopian student's' participation level as compared to Iteration #0, in which the average number of messages written by students of Ethiopian origin was only nine during the entire academic year (see Table 3).

Table 3: Average number of posts and messages per student in the three iterations

	Iteration 0		Iteration 1	Iteration 2
	WhatsApp	Facebook	Facebook	WhatsApp
Students of Ethiopian origin	8.9*	0**	0.7**	18.2**
Majority group	26.3*	7	2.1**	61.9**

* Average number of posts and mobile messages per student per academic year
** Average number of posts and mobile messages per student per semester

In addition, an improvement was found in online activity among students of Ethiopian origin in the course of the intervention, which was tested for one month near the beginning of the Iteration #2 and for another month towards its end. Among students of Ethiopian origin, the average number of messages per student increased from the beginning of the iteration (1.5 messages on average) to the period just before the end (1.8 messages on average) ($t_{(128)} = 2.226$, sig<0.05). In contrast, among students from the majority group no change was found in the average number of messages per student in the course of the intervention.

Furthermore, the findings from Iteration #2 indicate that six out of the 20 online group members of Ethiopian origin did not initiate any messages, whereas all the students from the majority group initiated messages. In addition, five students of Ethiopian origin did not respond to any messages, whereas all of the eight students from the majority group responded to messages posted in the group. Nevertheless, these findings suggest an overall improvement in the participation level of students of Ethiopian origin in online learning groups, since in this iteration, 75 per cent of the students of Ethiopian origin in the class participated in the online activity, whereas in previous iterations, their participation rate had ranged between 0-44 per cent.

Finally, we should emphasize that because the study was in the research participants' natural environment we had no control over the proportion of students of Ethiopian origin and students from the majority group enrolled in different classes selected for the study as well as those who participated in the online learning groups. Moreover, because our interventions were deliberately kept to a minimum, students were given a freedom to make their own choices of different communication platforms (Facebook or WhatsApp). Hence, our analysis yielded two important trends (that were not anticipated in the research design) bearing further implications for the findings presented above.

First, despite an increase in the number of students of Ethiopian origin and a decrease in the number of students from the majority group attending the same class, in Iteration #2, the majority of the messages (500) were written by students from the majority group in comparison with 355 messages written by the Ethiopian students (see Table 2). This finding is surprising, since being the majority in the online learning group (20 compared to eight), the activity level of students of Ethiopian origin would have supposed to be higher than that of students from the majority group. And second, activity in the Facebook learning group was much more limited in scope compared to the activity in the WhatsApp learning group, both among students of Ethiopian origin and among students from the majority group (see Tables 2 and 3).

Research Question #2: Utilization of Online Social Networks by Students of Ethiopian Origin

The second research question examined the utilization of online social networks by students of Ethiopian origin, and how (if at all) such uses may change following minimal intervention.

First, it is important to note here that the survey findings collected in Iteration #0 regarding the students' experience of using online social networks and their access to the technological platforms of Facebook and WhatsApp revealed only minor differences between students of Ethiopian origin and students from the majority group, suggesting that there was no substantial digital divide between the two groups.

Thus, the average number of years of using online social networks among students of Ethiopian origin was 3.3 years, which is slightly lower than among students from the majority group (4 years) ($t_{(170)} = 3.794$, sig<0.001). Among students of Ethiopian origin, 92 per cent owned a smartphone, compared to 100 per cent among students from the majority group ($X^2_{(1)} = 11.222$, sig<0.001). Among students of Ethiopian origin, 86.5 per cent had an active Facebook account, compared to 99.3 per cent among students from the majority group ($X^2_{(1)} = 13.959$, sig<0.001). Similarly, 89.2 per cent of students of Ethiopian origin had an active WhatsApp account, compared to 100 per cent of students from the majority group ($X^2_{(1)} = 15.051$, sig<0.001). Along with these slight differences, there was no significant difference between students of Ethiopian origin and students from the majority group in their frequency of social media usage, as well as in the number of Facebook and WhatsApp groups in which they participated.

On the other hand, the survey findings also suggest that a significantly smaller number of students of Ethiopian origin believed that the online social media contributed to their learning process (52 per cent), compared to students from the majority group (78 per cent), $\chi^2_{(1)} = 7.765$, $p<0.05$. Differences were also found between students of Ethiopian origin and the majority students regarding specific uses, according to academic, social, and administrative purposes. Thus, students of Ethiopian origin used the online social networks less than students from the majority group for getting help in doing their homework: 2.6 compared to 2.97, respectively ($t_{(166)} = 2.26$, $p<0.05$); as well as for studying with their classmates: 2.6 compared to 3.0, respectively ($t_{(166)} = 3.086$, sig<0.05). In addition, students of Ethiopian origin used social media less than their majority group counterparts for staying in touch with their classmates and keeping up-to-date in their social life: 2.3 compared to 2.7, respectively ($t_{(165)} = 3.085$, sig<0.05). Finally, differences (albeit statistically insignificant) were also found in the administrative uses, such as keeping up-to-date with course requirements and deadlines: 2.6 among students of Ethiopian origin compared to 2.9 among students from the majority group (see Figure 1).

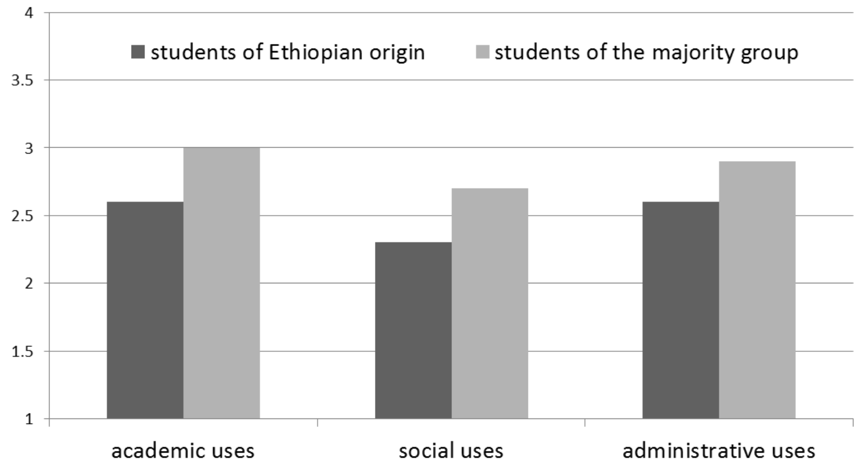

Figure 1: Academic, social and administrative uses - iteration #0

Later on, during Iteration #2 we examined the actual uses of the WhatsApp learning group, also by categorizing them according to the academic, social, and administrative uses, which were tested for one month near the beginning of the iteration and for another month towards the end of the iteration. The analysis suggests that there was a marked shift from using the online learning group for social purposes to an increased use for academic and administrative purposes. Thus, 61 per cent of all the 'social' messages by students of Ethiopian origin had been written at the beginning of the iteration and 39 per cent at the end. Likewise, 42 per cent of the administrative messages were written at the beginning of the iteration versus 58 per cent at the end; and 100 per cent of all messages for the learning purposes were written at the end ($X^2_{(2)} = 9.03$, sig<0.01) (see Figure 2).

A quite similar pattern characterized the changes in the majority students toward a more intensive usage of the group for academic purposes and less for the social purposes. Thus, out of the total number of social messages, 64.5 per cent had been written at the beginning of the iteration and 35.5 per cent at the end; and 9.1 per cent of academic messages were written at the beginning of the iteration while 90.9 per cent - by the end. It appears, therefore, that the nature of the WhatsApp learning group had changed in the course of the iteration, with all the students eventually learning to use the group not just for social purposes (such as posting jokes, funny photos, and video clips), but for the academic purposes as well. On the other hand, there was a decrease in the majority students' online group usage for the administrative purposes, since 63 per cent of administrative messages were written at the beginning of the iteration, compared to 37 per cent at the end ($X^2_{(2)} = 13.34$, sig<0.001).

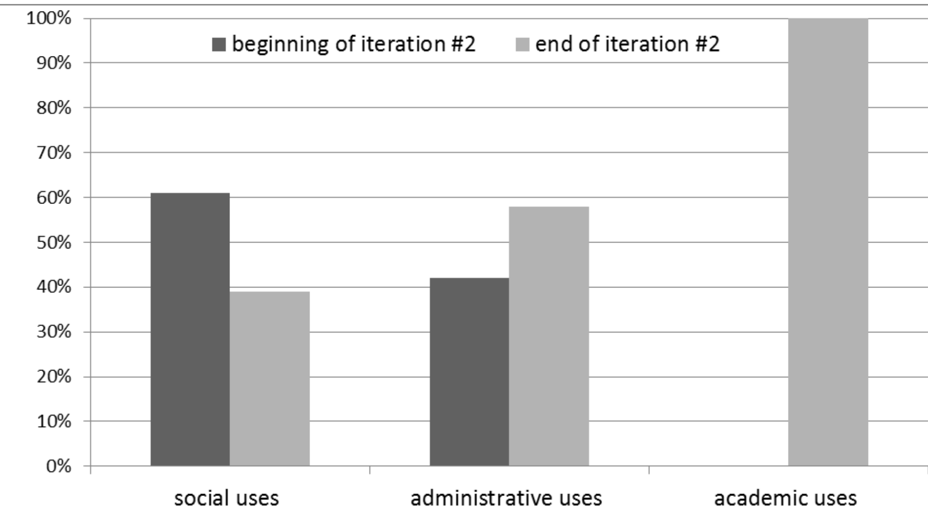

Figure 2: Uses of the WhatsApp learning group according to academic, social and administrative uses among students of Ethiopian origin

Research Question #3: Relation between Ethiopian Students' Participation in Online Learning Groups and their Integration in Academic Life

The third research question examined whether and how participation in online learning groups may improve the integration of Ethiopian students in academic life. Measured indicators included the sense of belonging that students felt towards their classmates, their satisfaction with their social situation during the studies, and their sense of self-efficacy. The findings from the Mann-Whitney test on students' answers to the two identical surveys (conducted at the beginning and at the end of Iteration #2) suggest that there was an improvement, albeit statistically insignificant, in some of the indicators of the Ethiopian students' social integration. In particular, by the end of the iteration, students of Ethiopian origin felt that they were more integrated socially than they did in the beginning (from 3.1 to 3.4), whereas among students from the majority group there was no change at all (from 3.3 to 3.3). Moreover, there was a small increase among students of Ethiopian origin in their sense of belonging with students from the majority group (from 3.0 at the beginning to 3.2 at the end), whereas among students from the majority group, there was a decrease in the sense of belonging with students of Ethiopian origin (from 3.4 at the beginning to 3.2 at the end) These light changes can be explained by the fact that the intervention conducted at this stage was so minor that apparently, it was not sufficient to bring about a significant improvement in the quality of online communication between the majority students and their immigrant counterparts.

In parallel, there was a decrease in the indicators measuring self-efficacy among students in both groups. Students of Ethiopian origin felt less confident in their academic aptitude (3.2 at the beginning of the iteration; 2.4 at the end); as did students from the majority group (from 3.3 to 2.8). Nevertheless, there was an overall increase among all the students in semesters of their self-assessment of academic success. That increase was found to be significant among students of Ethiopian origin (from 1.8 at the beginning to 2.3 at the end) ($U_{(32)} = 195.50$, $p<0.05$), but not among students from the majority group (1.9 at the beginning, 2.3 at the end).

Discussion and Conclusions

The objective of the present study was to examine the potential of online social networks for improving the integration of students of Ethiopian origin in academic life. This was achieved through a research design in which gradual intervention was introduced in minute steps, designed to encourage a more active student participation in online learning groups.

First and foremost, the study findings suggest that without an intervention the participation pattern of students of Ethiopian origin in the online learning groups was peripheral and limited to viewing only (i.e., 'lurking'). This is in contrast to students from the majority group, who were already active participants in the spontaneous learning groups. This finding is not surprising in light of the fact that youth of Ethiopian origin feel alienated from the host society and suffer from social isolation (Elias & Kemp, 2010; Ringel et al., 2005).

Following two minimal interventions the activity pattern of students of Ethiopian origin had changed to some extent, and as the level of intervention increased, so did their level of activity in the online learning groups. The more significant change occurred in the course of Iteration #2, when students of Ethiopian origin began to initiate messages and respond to messages of their peers. It should be noted, however, that despite the interventions, the Ethiopian students' level of online activity was still significantly lower than that of the students from the majority group.

In this context, the study also suggests that the participation pattern of students of Ethiopian origin was not affected by the numerical ratio between them and students from the majority group in the class. When students of Ethiopian origin were a minority, there was a little interaction within the online learning group between them and students from the majority group – a finding that might point to the difficulties in their social integration. When the ratio was reversed, however, and students of Ethiopian origin became a majority in the class, their participation pattern remained peripheral. This finding suggests that the increase in the numerical representation of group members sharing the same cultural background is not sufficient in itself for encouraging students of Ethiopian origin to take a more active part in the online learning activity; instead, planned interventions must be introduced in order to instill the confidence necessary for active participation.

Moreover, the study reveals discrepancies between students of Ethiopian origin and students from the majority group in adoption of the online social networks for academic purposes, such as studying with classmates, homework assistance, and learning from summaries uploaded to the group. Similarly, the analysis of their online activity showed that without intervention most of the uses (albeit very few) have been for social purposes, such as funny pictures and video clips. But when the level of intervention increased, there was a marked increase both in the level of activity and in the academic and administrative uses of the online learning group, along with a decrease in social uses. This finding suggests that social media can be harnessed to the academic needs of students from disadvantaged backgrounds, even without developing and intervening with significant structured activities. This is consistent with the findings of previous studies that examined the learning support afforded by online social networks to students from the majority group (Bansal & Dhananja, 2014, Kurtz, 2014).

In addition, the findings apparently indicate differences in all students' online activity on different technological platforms (Facebooks versus WhatsApp). Although such differences have not been taken into consideration in the research design, the fact that students were free to choose a different platform in each of the iterations has enabled us to distinguish between patterns of participation on the Facebook and WhatsApp learning groups. While both of the platforms selected by students for creating learning groups have certain common features (such as the ability to deliver group messages, upload pictures, animation, and video clips), each has distinct and unique characteristics that affect its uses (Schejter & Tirosh, 2014). In addition, WhatsApp being a mobile phone application makes it more accessible and easier for students to use it away from home (Bansal & Dhananja, 2014; Lauricella & Kay, 2013). Indeed, the research findings suggest that activity in the WhatsApp group was greater in scope and its uses more diverse, although it consisted mostly of short messages accompanied by visual aids (screen shots, photos of assignment solutions, etc.). In contrast, activity in the Facebook learning group was more limited in scope, but the learning opportunities it offered were more comprehensive, as the students uploaded files with class notes, summaries written in preparation for exams, course syllabi, etc.

In parallel with changes that occurred in the scope of online participation and in the utilization of online earning groups by students of Ethiopian origin as the level of interventions increased, there was also an improvement in the indicators of their social integration. That is to say, during Iteration #2 (following which the Ethiopian students' level of activity in the online learning group had increased), their level of satisfaction from their social situation increased, and their sense of belonging with their classmates was enhanced. Concurrently with the increase in social integration indicators, however, there was a decrease in their self-confidence regarding their academic aptitudes. In our view, however, this finding is not necessarily negative. The research literature shows that learners often experience various difficulties that are regarded as "desirable difficulties" (Bjork & Linn, 2005) and even localized failures that are defined as "productive failures" (Kapur, 2014). Under certain circumstances, such difficulties and failures could serve as a springboard for the development of further abilities and skills. We intend to examine such circumstances in a further study.

The results of the present study are therefore encouraging, as they suggest that even a minimal intervention, in which students of Ethiopian origin had been required to open an online learning group, has brought about an increase in their active participation, as well as an enhanced utilization of online network tools for academic purposes, and ultimately, a sense of better integration in academic life. We regard this improvement as a first step towards promoting the Ethiopian students' more substantial social involvement and better adaptation to academic life and to Israeli society as a whole. Our findings, however, indicate that access to social media and the skills for using them are in themselves insufficient for creating bridging social capital (Putnam, 2001), because students from disadvantaged background are also faced with social and cultural barriers which apparently prevent their active online participation. Intervention is thus needed in order to encourage a more active and productive intercultural communication in online learning groups, which in turn would facilitate the building of more meaningful social relationships.

Finally, it is important to emphasize the advantages of the methodological design adopted in the present study, integrating methodological approaches that are typical to social sciences with those of education and learning sciences. The shift from studying a phenomenon without intervention (i.e., studying learning in "ambient" technology-enhanced learning environments) into "designed" learning environments, through the use of minute interventionary steps, has enabled us to identify the exact minimal intervention required for affecting the desired changes. A further study should investigate more substantial interventions whilst designing and developing structured activities and moving into designed technology-enhanced learning environments. Such environments would enable us to consider how a more meaningful interaction between students of Ethiopian origin and students from the majority group may be encouraged, in order to continue to improve their social integration within the majority group, and to enhance the self-confidence in their academic aptitude.

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"Will a Black Hole Eventually Swallow the Earth?" Fifth Graders' Interest in Questions from a Textbook, an Open Educational Resource, and Other Students' Questions

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Abstract

Can questions sent to Open-Educational-Resource (OER) websites such as Ask-An-Expert serve as indicators for students' interest in science? This issue was examined using an online questionnaire which included an equal number of questions about the topics "space" and "nutrition" randomly selected from three different sources: a 5th-grade science textbook, the "Ask-An-Expert" website, and questions collected from other students in the same age group. A sample of 113 5th-graders from two elementary schools were asked to rate their interest level in finding out the answer to these questions without knowledge of their source. Significant differences in students' interest level were found between questions: textbook questions were ranked lowest for both subjects, and questions from the open-resource were ranked high. This finding suggests that questions sent to an open-resource could be used as an indicator of students' interest in science. In addition, the high correlation of interests expressed by students from the two schools may point to a potential generalization of the findings. This study contributes by highlighting OER as a new and promising indicator of student interest, which may help bring "student voices" into mainstream science teaching to increase student interest in science.

Keywords: Ask-A-Scientist, elementary school, Interest, Open Educational Resource, Science curriculum, Students' questions, Student voice.

Introduction

The notion of "student voice", which refers to learning based on student choices and interests ("Student voice," 2013), was introduced in the late 20th century in Dewey's work (1902, 1916). He saw interest as a crucial factor in learning. Today, however researchers are still drawing attention to the lack of a "student voice" in teaching and learning (Cook-Sather, 2006).

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To promote the "student voice" in science education, Hagay and Baram-Tsabari (2011) suggested the implementation of a "shadow curriculum" - a strategy for identifying students' interests based on their questions and incorporating them into the formal curriculum in a planned manner. While the strategy supports students' intrinsic motivations, it requires considerable work from the teacher to collect and research student questions (Hagay & Baram-Tsabari, 2015). Creating an online repertoire of interesting Q&A and their curricular relevance ("an online shadow curriculum") may help remedy this problem, and pave the way for better inclusion of students' interests in mainstream teaching.

Clearly, creating a unique repertoire for every teacher is impossible. Thus, the online shadow curriculum would only be applicable if students share similar interests in science questions. Initial indications of the generalizability of students' science interests across countries and religions were presented in Hagay et al. (2013). They found that students from Portugal, Turkey, England, and Israel, show interest in similar science questions.

It is important to note that the questions examined in the above-mentioned study were originally raised by students. However, since students' questions asked openly in class are quite rare (Dillon, 1988), there is a need for another source of interesting questions. One possible source might be questions sent to a free-choice environment, such as a TV shows and an Ask-a-scientist websites, in which "people usually ask questions to obtain information that they are lacking, rather than posing rhetorical questions, suggestive questions, or questions asked to please someone" (Baram-Tsabari, 2015 p.150).

Thus in order to produce an applicable "online shadow curriculum", this study was designed to examine the validity of using questions sent to an Open-Educational-Resource (OER) as indicators of student interest. Specifically, it focused on the Ask-An-Expert website, which is a section of an informal science institute's website.

We also compared students' interest in science questions at three distance levels from the "student voice": Students' interest level in (1) questions collected from other students in the same age group, (2) questions sent by motivated surfers of the OER, and (3) questions taken from the 5th-grade science textbook, which covers the science curriculum.

Following is a theoretical background of the concept "student voice" and the field of OERs, drawing potential connections between the two and setting the scene for the research goals.

Literature Review and Conceptual Framework

"Student Voice" and Interest in Science Learning

"Student voice" refers to the values, opinions, beliefs, and perspectives of individual students and groups of students in school. It also refers to learning that is based on student choices and interests ("Student voice," 2013). Recent studies have indicated the potential of incorporating students' voice into decision making on different aspects of school life (e.g., Davie & Galloway, 1996; Hennessy, 1999). According to Jenkins (2006, p. 51), "Involving students in decisions about their education can be regarded as a means of introducing them to the complexities and limitations of the democratic process and thus as something of a preparation for their future role as citizens".

Beyond the experience with the democratic process, the "student voice" may also be effective in improving teaching, the curriculum, and teacher-student relationships (Mitra, 2004). "Students have unique knowledge and perspective…By talking with and listening to students, we can learn more about how classroom and school processes can be made powerful, and how improvement can be fostered…" (Levin, 2000, p. 158).

However, according to Cook-Sather (2006, p. 359) "…despite its increasing and emphatic use, none such clear and definite conception exists for 'student voice'." More specifically, in science education Jenkins (2006) identified a variety of meanings using this term. For some, the student voice refers to "students view about the form, content and purpose of their school science education", while for others, it refers to exploring "students' attitudes towards a variety of science-related issues and whether or not they wish to pursue a career in science or technology" (Jenkins, 2006, p. 50).

Moreover, there is a mix between pedagogical and content implications. Over the last decade, many studies have examined the effect of "student voice" on learning mostly from pedagogical perspectives and have interpreted the "student voice" in a student-centered context (e.g., Mitra, 2003; Toshalis & Nakkula, 2012). While the idea of student-centered pedagogy has been widely accepted (Kain, 2003), the content aspect of the "student voice" has been less well examined or related to pedagogy. Counter examples are fairly rare; for example, in Grace (1999) first and second graders chose the learning subject and the learning process. Murray and Reiss (2005) examined student reviews of the science curriculum in England. The survey included questions on the science curriculum content (e.g., "Is it right to include controversial issues such as genetic engineering or cloning in the science syllabus?") and questions on pedagogy in science education (e.g., "Which three of these methods of teaching and learning do you find the most useful and effective in helping understand your school science?").

Listening to the "student voice" with regard to content may contribute to increasing students' interest level (Hagay & Baram-Tsabari, 2011). Interest is a critical cognitive motivational variable that facilitates learning in different content areas and in all age groups (Renninger & Hidi, 2011). It also has a strong influence on students' cognitive functioning (Ainley, Hidi, & Berndorff, 2002) and learning outcomes (Swarat, Ortony, & Revelle, 2012). Specifically, within the elective field of advanced science education, students' interest level has been found to explain and predict their career choice (e.g., Tai, Liu, Maltese, & Fan, 2006; Xie & Reider, 2014).

How should interest be measured?

Renninger and Hidi (2011) reviewed a number of acceptable methods for measuring interest. One is self-report measures, which require participants to rate their interest level on given items using a questionnaire or survey. This method is very popular in studies on interest evaluation (Frenzel et al., 2009, as cited in Renninger & Hidi, 2011). However, the items in this method are chosen by the researcher and therefore are limited in their scope and relevance.

Another possible indicator of student interest is student questions (e.g., Baram-Tsabari & Yarden, 2005; Chin & Osborne, 2008; Hagay & Baram-Tsabari, 2011; Jidesjö, Oscarsson, Karlsson, & Strömdahl, 2009). When students raise questions, they express scientific concepts in their own words using their prior knowledge (Baram-Tsabari & Yarden, 2007). One of the advantages of this approach over questionnaires is students' ability to express their interests, rather than respond to a list suggested by a researcher.

In this study, we employed the two approaches to measure student interest. The first was students' questions, which were viewed and used as expressions of "student voice". The second was self-reporting questionnaires, which were used to evaluate students' interest in science questions.

Open Educational Resources

Open Educational Resources (OER) are "digitized materials offered freely and openly for educators, students and self-learners to use and re-use for teaching, learning and research" (Hylén, 2006, p. 49). For example, course materials, textbooks, streaming videos, multimedia applications, and any other material designed for usage in teaching and learning are included in the definition of OER (Kanwar, Uvalić-Trumbić, & Butcher, 2011).

Weller (2010, p. 2) differentiated between two types of OERs: "Big OERs…are usually of high quality, contain explicit teaching aims, presented in a uniform style and form part of a time-limited, focused project with portal and associated research and data. Little OERs are the individually produced, low cost resources. They are produced by anyone, not just educators, may not have explicit educational aims, have low production quality and are shared through a range of third party sites and services."

There has been extensive research on the contribution of OERs to education over the last decade. Some studies have dealt with models for using OERs (e.g. Hilton, Wiley, & Johnson, 2010; Wiley, 2009). These have specifically focused on teachers using OERs (e.g., Cohen, Kalimi, & Nachmias, 2013) and on their training needs (e.g., Clements & Pawlowski, 2012). Other studies have examined the characters of OER users and providers and have looked at what prompts individuals to share their digital resources (e.g. Hylén, 2006).

One form of OERs that has attracted quite a bit of research attention is question and answer (Q&A) websites. According to Harper, Raban, Rafaeli, and Konstan (2008, p. 866) Q&A websites are "places where users ask questions and others answer them". They identified three types of commonly used Q&A sites:

1. Digital reference services, such as the New York Public Library's "Ask Librarians online" (http://www.nypl.org/ask-nypl/about). This type of website can be classified as a Big OER in which trained information specialists answer user questions.

2. Community Q&A sites, such as Yahoo! Answers (https://answers.yahoo.com/), which is the most frequently visited community Q&A website in the United States (Harper et al., 2008). This type of website can be classified as a Little OER in which everyday users answer other users' questions.

3. Ask-An-Expert services, such as "Ask-Our-Experts" website (http://davidson.weizmann.ac.il/en/online/askexpert), which is part of the Davidson Institute of Science Education website. The consideration of this site as an OER is further supported by a license from the Israeli Ministry of Education ensuring the site is a suitable content provider for secondary school science teachers (Israeli Ministry of Education, 2015). This type of website falls into the category of Big OERs in which scientists answer users' questions.

This latter type of Q&A, which is examined in this study, tends to be topic-oriented (Harper et al., 2008). Thus, in an educational context, it could serve as a free-choice learning environment for a specific discipline and provide data on individual needs and interests in a natural setting (Baram-Tsabari, Sethi, Bry, & Yarden, 2006). This approach is unique in that it can tap OERs not as a learning resource but as an interest identification resource and, thus, can act as an indicator of students' interests, which could help incorporate the "student voice" into mainstream science teaching.

Research Goal and Questions

This study examined the differences in 5th graders' interests in questions from three sources, each of which represents a different distance level from the "student voice": (1) Questions asked by 5thgraders from other schools (which represent other students' questions), (2) OER questions (which represent other people's questions), and (3) Science textbook questions (which represent the science curriculum).

Specifically, we explored the following:

1. What are the differences in students' interest level in questions from these three resources?
2. To what extent will there be commonalities between students' interests in these two different schools?

Methodology

Participants

The study involved 113 (56 females, 57 males) 5th graders (10-11 years old) from two public elementary schools (two classes in each) in the northern part of Israel. The schools were chosen for their accessibility and their agreement to take part in this research.

These schools are characterized by an average socio-economic level, according to the latest socio-economic report of the local authorities (Israel Ministry of Finance, 2008).

According to a national assessment conducted by the Israeli Ministry of Education & RAMA (http://cms.education.gov.il/EducationCMS/Applications/IMS/HomePage.htm) in 2012 and 2013, the two schools are characterized by a below-average level of student attitude toward science compared to public schools with the same socio-economic level. (A copy of the questionnaire [in Hebrew] can be found at http://meyda.education.gov.il/files/Rama/25-mad-012-5A-SOF-net.pdf) In addition, the two schools are characterized by an above-average level of academic achievement, with school B ranked 5 points higher (on a scale of 100) than school A (Table 1).

Table 1: Participating schools' statistics in relation to science education

	School A (n = 66)	School B (n = 47)	National average
Average academic achievements on a national science and technology test	**61**	**66**	**55**
Students' self-reports about competence in science. Measured by agreement with the statement: "Usually I do well in science and technology".	**74%**	**85%**	**72%**
Students' self-reports about enjoyment in learning science. Measured by agreement with the statement: "I enjoy learning science and technology".	**60%**	**34%**	**72%**
Students' self-reports concerning the value and importance of learning science. Measured by agreement with the statement: "It is important for me to study science and technology".	**81%**	**81%**	**84%**

The data are based on the report of Israeli Ministry of Education & RAMA - The National Authority for Measurement and Evaluation in Education (2012; 2013).
Agreement with the statements was measured on a Likert scale with 1 (highly disagree) to 5 (highly agree).
The numbers represent the percentage of students who marked the two higher values (4 or 5).
"Science and technology" refers to science classes.

Research Tool: Questionnaire

To assess students' interests, a questionnaire was developed. The online questionnaire was administered in both schools during one of the final science lessons of the school year after completing the curriculum. It required about 15 minutes to complete. For ethical reasons, the questionnaires were anonymous, and students were asked only to state their gender.

The questionnaire was composed of 42 questions. Students were asked to rank their interest in getting the answer to each question on a 1 (very interested) to 5 (not interested at all) Likert scale (Figure 1).

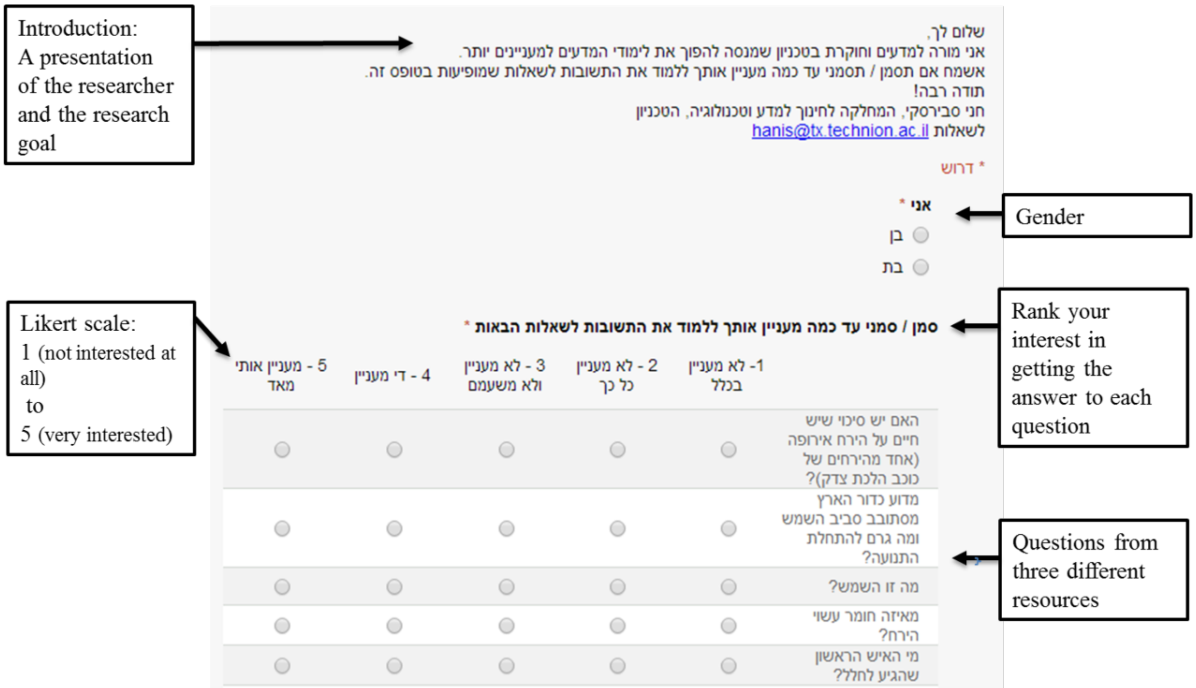

Figure 1: The online questionnaire

Twenty-one of the questions were on the topic of "space" and the other 21 concerned "nutrition". These topics are two out of the three on the 5th-grade science curriculum and are also included in the "Ask-Our-Experts" website (unlike the third topic, "natural resources", which is not).

The 21 questions on each topic were randomly selected from three sources (seven questions from each):

1. Textbook: The "Science and Technology" textbook for the 5th grade (Center for Science and Technology, 2008) is commonly used in elementary schools including the two participating schools. The textbook was approved by the Israeli Ministry of Education in 2008. It is based on the Science, Technology, and Society (STS) approach, which combines several scientific fields and emphasizes the relevance of the science content to students' everyday life. The textbook covers three topics: "space", "nutrition" and "natural resources", according to 5th-grade science curriculum. There are about 60 questions for each topic presented throughout the chapter.

2. Open-Educational-Resource: The "Ask-Our-Experts" section, "Davidson online", the website of The Davidson Institute Of Science Education - the educational wing of the Weizmann Institute of Science (http://davidson.weizmann.ac.il/online/askexpert). The section was first established in 2005 and has almost 3000 Q&As. The Q&As are classified by scientific field, such as Medicine, Chemistry, Physics, Earth Science and Technology. Questions are answered by graduate students in the sciences.

3. Students' Questions: A total of 310 questions addressing the topic "nutrition", and 341 questions addressing the topic "space" were anonymously collected from 5th grade stu-

dents from two additional schools. The questions were collected in 2013 using written prompts in a similar process to the collection process described in Swirski and Baram-Tsabari (2014, p. 157).

Questionnaire Development Process

The questionnaire development process had four stages (Figure 2).

Stage 1: Filtering procedure. Omitting textbook questions that depended on external content (e.g., text and figures) and selecting open-resource questions compatible with the students' age. Repetitive questions were left in, thus increasing the likelihood they would be chosen in the random sampling. All anonymously collected questions from 5th grade students in two additional schools were used.

Stage 2: Inter-coder reliability for filtering of questions. In order to establish inter-coder reliability, the textbook questions and the open-resource questions were also filtered by an elementary school science teacher and yielded substantial agreement (80%).

Stage 3: Selection. All the questions from each source were numbered separately. Seven questions from each source for each topic were randomly selected using the Excel RAND() function.

Stage 4: Randomly ordering the questions.

The Cronbach alphas indicated high reliability (internal consistency) for all 14 questions from the same source ($\alpha_{textbook}$=0.926, $\alpha_{open\text{-}resource}$=0.91 and $\alpha_{student\text{-}questions}$=0.906).

Question Source / Question topic	5th grade Textbook	Open Educational Resource	5th grade Students
Nutrition (number of questions)	Original number: 72 After filtering: 37	Original number: 82 After filtering: 45	310
Space (number of questions)	Original number: 50 After filtering: 40	Original number: 155 After filtering: 85	341

Inter-coder reliability for filtering of questions: above 80% agreement for all samples

Randomly selecting seven questions from each source for each topic

Randomly ordering the questions

Figure 2: The questionnaire development process

Data Analysis

To assess students' interest level in questions from the three resources, we defined six new independent variables. Each variable represents the average interest level of seven questions on the same topic **and** from the same source (Table 2). For example, all the questions from the textbook about "space" were defined as one variable, the questions from the textbook about "nutrition" defined as a second variable, etc. In addition, "gender" (F/M) and "school" (A/B) were defined as discrete variables.

Table 2: Variable construction. Each variable included questions from the same source on the same topic

Question source / Question topic	5th grade Textbook	Open Educational Resource	5th grade Students
Nutrition (question numbers)	24, 26, 27, 28, 33, 39, 41	25, 30, 31, 34, 35, 36, 37	22, 23, 29, 32, 38, 40, 42
Space (question numbers)	6, 7, 10, 11, 16, 18, 19	1, 2, 9, 12, 13, 15, 21	3, 4, 5, 8, 14, 17, 20

The data were analyzed using SPSS. Between the two schools, significance was tested using T-tests for independent samples (after finding significance using Levene's Test for equality of variances). Between the three resources significance was tested using T-tests for dependent samples (after determining significant Pearson correlations). Significance was defined as $p < 0.05/3$ since the comparison was between two out of three groups (FDR correction).

Findings

Overall, the average interest level in all the questions was 3.38 ±1.35 (on a 1-5 scale). The average interest level in all the questions on the topic of "space" was 3.48 ±0.41, higher by 0.2 than the topic of "nutrition", which was 3.28 ±0.23 (not a significant difference).

No significant differences for gender were found in students' interest level (Table 3).

Table 3: Students' interest level on all the questions, between genders and schools

		Average	Standard Deviation	Significance
Total average students' interest level		3.38	0.34	
Gender	Male (n=56)	3.42	0.94	n.s.
	Female (n=57)	3.34	0.8	
School	A (n=66)	3.7	0.76	Significance at p<0.05
	B (n=47)	2.93	0.81	

The most popular question for the topic of "space" was "Will a black hole eventually swallow the Earth?" (4.21), originally asked by a student, and the least popular question was "What objects are in the solar system and how are they similar/different from each other?" originating from the textbook (2.82).

In the topic of "nutrition", the most popular question was "Is it possible to fry an egg on the sidewalk if it's hot enough?"(3.59) taken from the open resource, and the least popular question was " Is there such a thing as unhealthy food?" (2.86), originally asked by a student.

Table 4: Fifth-grade students' average interest level in 21 questions on the topic "space", ordered by their popularity

Question (Question number)	Source	Average	Standard Deviation
Will a black hole eventually swallow the Earth? (8)	Students	4.25	1.29
Will the Sun disappear some day? (17)	Students	4.20	1.17
What space research technologies will be available in a hundred years? (18)	Textbook	3.99	1.18
What is the moon made of? (4)	Students	3.94	1.21
How different would the world be if the Earth had no moon? (9)	Open resource	3.87	1.20
Why there is no oxygen on other planets? (15)	Open resource	3.81	1.29
What do you see on the moon? (16)	Textbook	3.80	1.23
Could there be life on Europa (one of the moons of Jupiter)? (1)	Open resource	3.65	1.17
Way does the Earth rotate around the Sun and what caused it to start? (2)	Open resource	3.57	1.27
How long does it take to reach space from Earth? (20)	Students	3.56	1.30
What is the Sun? (3)	Students	3.27	1.32
What is the largest planet? (12)	Open resource	3.27	1.33
Are there other planets aside from the Earth in the universe? (13)	Open resource	3.25	1.40
What is the length of the year on Venus, Mars, Earth and Mercury? (7)	Textbook	3.20	1.27
Are the stars that we see in the sky reflecting light or emitting light? (21)	Open resource	3.20	1.38
Why is Mars called "the red planet"? (14)	Students	3.17	1.32
What was Michael Collins' job on Apollo 11? (6)	Textbook	3.12	1.28
What is the structure of the solar system? (10)	Textbook	3.12	1.33
Who was the first person to reach space? (5)	Students	3.11	1.45
Is there a relationship between the distance of a planet from the sun and the length of its year? (19)	Textbook	3.04	1.37
What objects are in the solar system and how they are similar/different from each other? (11)	Textbook	2.82	1.33

*The shaded area indicates below average students' interest level.

Table 5: Fifth-grade students' average interest level in 21 questions on the topic "nutrition", ordered by their popularity

Question (Question number)	Source	Average	Standard Deviation
Is it possible to fry an egg on the sidewalk if it's hot enough? (25)	Open resource	3.59	1.30
What kind of food is digested the fastest? (42)	Students	3.59	1.41
In the desert there are lizards that do not drink at all. Where do they get the water they need to live? (33)	Textbook	3.58	1.37
Why are we thirsty after we eat something sweet? (34)	Open resource	3.57	1.29
What will happen if I only eat meat all week? (32)	Students	3.55	1.36
Why do potatoes and apples turn brown after you cut them? (37)	Open resource	3.46	1.35
Does eating at night cause obesity more than eating during the day? (35)	Open resource	3.44	1.39
Why do we and all living things need water? (41)	Textbook	3.44	1.37
Why do we look for water and not for oxygen on planets – is water really necessary for life? (30)	Students	3.43	1.31
What would happen if the food we eat didn't dissolve in water? (28)	Textbook	3.28	1.28
Why does food spoil and how does it happen? (36)	Open resource	3.27	1.42
How much do we need to drink every day? (40)	Students	3.20	1.36
Does sugar damage our stomach? (23)	Students	3.19	1.32
What would happen if the esophagus was made of cartilage rings like the trachea? (24)	Textbook	3.19	1.27
Does all the food we eat and don't vomit stay in the body? (38)	Students	3.18	1.32
Where in the digestive system is the food absorbed? (27)	Textbook	3.05	1.37
How do we digest our food? (22)	Students	3.04	1.26
What characteristics of water in liquid form are important for life? (26)	Textbook	3.04	1.21
Is the color of wine related to the color of grapes? (31)	Open resource	3.00	1.38
What are the food groups? (39)	Textbook	2.91	1.26
Is there such a thing as unhealthy food? (29)	Students	2.86	1.34

*The shaded area indicates below average students' interest level.

Tables 4 and 5 present the average and standard deviation (SD) of interest levels for each of the 42 questions, ranked according to their popularity. The original question structure was preserved while translating from Hebrew to English in order to present the original questions as accurately as possible. This results in less than perfect English grammar, to mimic the original Hebrew question.

Differences in Interest Level across the Three Sources

A significant difference ($p<0.016$) in students' average interest level was found the between textbook questions, open-resource questions, and student questions.

On the topic of "space" (Figure 3a), the interest level in the textbook questions was significantly lower than the two other resources. The interest level in students' questions was significantly higher than the open-resource questions. On the topic of "nutrition" (Figure 3b), the interest level in open-resource questions was significantly higher than the two other resources.

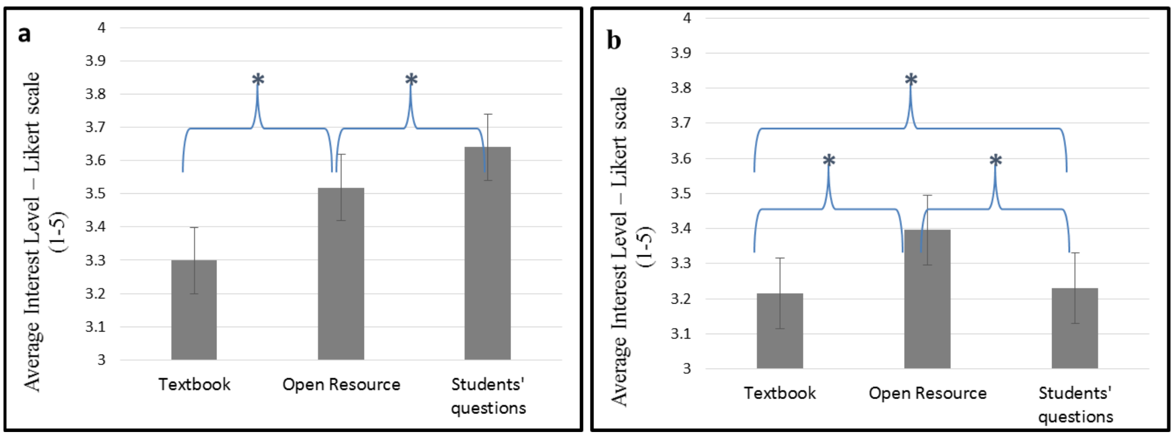

Figure 3. Students' average interest level on questions from different sources for the "space" (a) and "nutrition" (b) topics

* indicates significance at $p<0.05/3$

Differences in Interest Level between Schools

There was a significant difference ($p<0.05$) in students' average interest level between the schools (Table 1). The average interest level on almost all the questions in school A (which is characterized by a lower achievement level) was higher than in school B.

Despite the differences in overall interest level, a high correlation between schools ($r = 0.84$) was found with regard to the questions students found interesting (Figure 4). It is interesting to note that the correlation between schools on the topic of space ($r = 0.93$) was much higher than the nutrition topic ($r = 0.68$), as seen in Figure 4a and 4b.

The inverse correlation between achievement and interest at the school level mirrors findings from PISA 2006 which indicated "a tendency for students in low-performing countries to show relatively high levels of interest in science, with students in high-achieving countries showing relatively lower levels of interest" (Bybee & McCrae, 2011, p. 17).

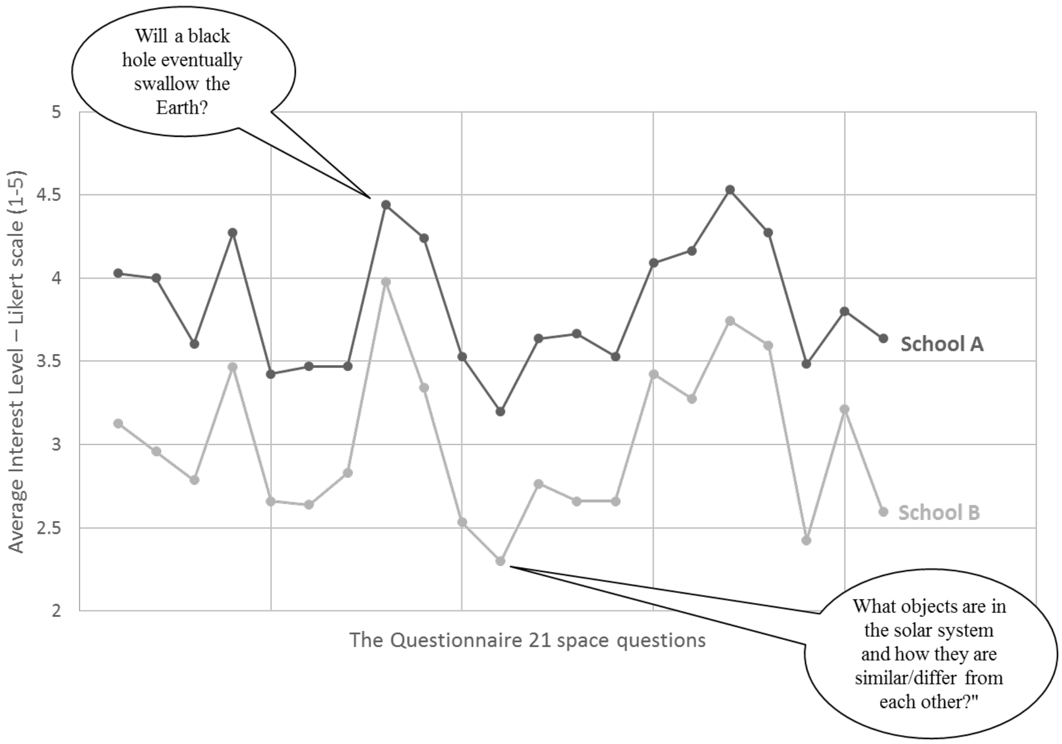

Figure 4a. Comparison of students' average interest level on the space topic in the two schools (r=0.93)

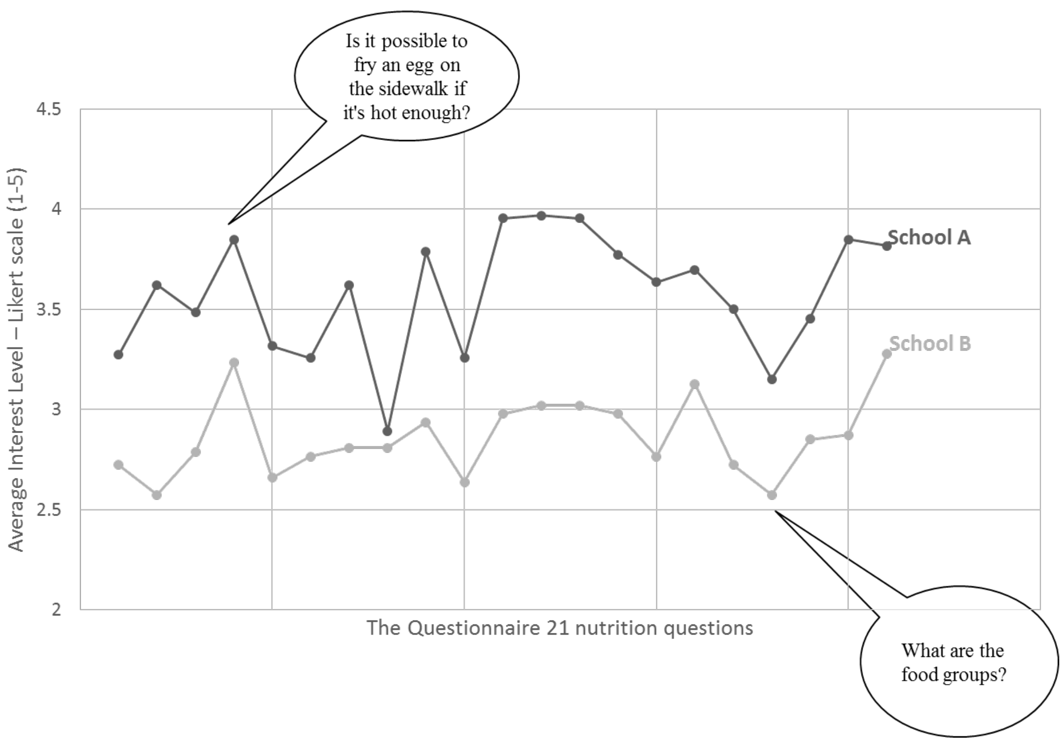

Figure 4b. Comparison of students' average interest level on the nutrition topic in two schools (r=0.68)

Research Limitations

This study has several limitations. The main limitation was the small sample of questions used from each database. The questionnaire had only 14 questions from each source, which is less than 5% of the 868 collected questions. Therefore, the results could have been different if other questions had been included in the questionnaire or if other topics had been used.

Another limitation of this study was the small number of participants and the lack of diversity among participants. The two schools were from the same area and the same sector. Moreover, all the participants were from the same grade level. Thus, generalization is limited. Future studies with a larger and more diverse sample could lead to greater generalizability of the findings. Furthermore, generalization is limited to similar Q&A sites and not to all kinds of OER.

Furthermore, although the questions were randomly ordered, the questionnaire was administrated in one version alone; thus the order might have influenced the results due to fatigue.

Discussion

Could questions sent to an Ask-An-Expert OERs serve as indicators for students' interest in science? This question was examined as part of a broader study aimed at utilizing Web 2.0 technologies to incorporate the "student voice" into mainstream science teaching. The findings indicate the relative popularity in many of the questions sent by a motivated few to these OERs.

The high correlation between students' interest levels in specific questions from two different schools tends to support generalization. This finding is consistent with previous studies that found similarities across student questions. For example, Sperduti, Crivellaro, Rossi, and Bondioli (2012), who collected questions on the topic of the brain from 508 Italian students, reported that questions such as "what else the brain do?" and "how does the brain work?" were frequently asked by the students. Moreover, Baram-Tsabari and Yarden (2005), who examined more than 1600 questions sent to a series of television programs also found repetitive questions, such as "who invented the computer?" which was tabulated 26 times, and patterns of questions, such as "which is the biggest/fastest/strongest/smallest animal" which occurred 46 times.

These frequently asked questions support the potential of an "online shadow curriculum" by using Q&A databases as bridges between curricular requirements and students' interests. This online repertoire of interesting Q&As and their curricular relevance may remedy the problem identified by teachers: incorporating students interests into their teaching requires much work in collecting and researching students' questions (Hagay & Baram-Tsabari, 2015).

Although the findings described here point to the validity of using questions sent to open learning resources as indicators of students' interests, it is still important to ask: Do the questions asked in this paper really reflect the "student voice"?

From a theoretical point of view, the answer might be "no", as Cook-Sather (2006, p. 363) claims: "…'Student voice' as a term asks us to connect the sound of students speaking not only with those students experiencing meaningful, acknowledged presence but also with their having the power to influence analyses of, decisions about, and practices in schools." However, from a practitioner's point of view, the answer might be "yes", since the findings point that science questions that were sent by motivated individuals to Ask-An-Expert website are interesting to a broader students' audience. This might contribute to bringing the "student voice" into science class in practice by using OERs, not only as an educational resource but also as a tool for reflecting and addressing the interests of wider student audiences.

This ambiguity points to a potential contribution of this research: Many studies have addressed the changes that need to be made in education in the digital era. For example, some are exploring new models for teaching, such as the flipped class, some have suggested new disciplines, such as programming, and yet others point to skills that should be included in the curriculum, such as digital literacy. This study documents yet another affordance of Web 2.0 technologies in education: technology as a means of identifying student interests to promote the "student voice" in science education.

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Biographies

Hani Swirski completed her BSc and MEd at the Technion - Israel Institute of Technology at the Faculty of Education in Science and Technology in Physics education. From 2005 to 2013, she worked at an elementary school in the northern part of Israel, teaching science. During the last two years, she trained teachers to use ICT tools in teaching while maximizing their pedagogical value. Now she is a PhD student in the Faculty of Education in Science and Technology under the supervision of Prof. Ayelet Baram-Tsabari. Her research focuses on integrating student voice into the science curriculum using online learning environment, which is based on students' questions.

Ayelet Baram-Tsabari is an Assistant Professor at the Technion - Israel Institute of Technology, and head of the Biology Education and Science Communication research groups at the Faculty of Education in Science and Technology. She is a member of the Learning in a Networked Society (LINKS) Israeli center of Research Excellence (I-CORE).

Her main research interests are in bridging science education and science communication scholarship, including identifying peoples' interests in science and building on these authentic interests to teach and communicate science in more meaningful and personally relevant ways.

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5-7 Year Old Children's Conceptions of Behaving Artifacts and the Influence of Constructing Their Behavior on the Development of Theory of Mind (ToM) and Theory of Artificial Mind (ToAM)

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Abstract

Nowadays, we are surrounded by artifacts that are capable of adaptive behavior, such as electric pots, boiler timers, automatic doors, and robots. The literature concerning human beings' conceptions of "traditional" artifacts is vast, however, little is known about our conceptions of behaving artifacts, nor of the influence of the interaction with such artifacts on cognitive development, especially among children. Since these artifacts are provided with an artificial "mind," it is of interest to assess whether and how children develop a Theory of Artificial Mind (ToAM) which is distinct from their Theory of Mind (ToM). The study examined a new theoretical scheme named ToAM (Theory of Artificial Mind) by means of qualitative and quantitative methodology among twenty four 5-7 year old children from central Israel. It also examined the effects of interacting with behaving artifacts (constructing versus observing the robot's behavior) using the "RoboGan" interface on children's development of ToAM and their ToM and looked for conceptions that evolve among children while interacting with behaving artifacts which are indicative of the acquisition of ToAM. In the quantitative analysis it was found that the interaction with behaving artifacts, whether as observers or constructors and for both age groups, brought into awareness children's ToM as well as influenced their ability to understand that robots can behave independently and based on external and environmental conditions. In the qualitative analysis it was found that participating in the intervention influenced the children's ToAM for both constructors and for the younger observer. Engaging in building the robot's behavior influenced the children's ability to explain several of the robots' behaviors, their understanding of the robot's script-based behavior and rule-based behavior and the children's metacognitive development. The theoretical and practical importance of the study is discussed.

Editor: Janice Whatley

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Keywords: Theory of Mind (ToM), Theory of Artificial Mind (ToAM), Cognitive Development, Behaving artifacts, Robots.

Introduction

In the last decades a new kind of artifact has penetrated our world. We are increasingly surrounded by artifacts that are capable of adaptive behavior, such as electric pots, boiler timers, automatic doors and robots. As a consequent, the traditional and intuitive distinction between the alive and not-alive, animate and inanimate, human-operated and autonomous has become blurred.

Although this new area of the artificial world, the human-mind-made world, is part of our everyday environment, little is known about the genesis and development of the technological stance required to perform within this environment. Thus, the study addressed a domain that up to now has been minimally researched – children's Theory of Artificial Mind (ToAM). The paper focus on children's ToAM, a new theoretical construct, and its characteristics, resemblance to, and differences from children's Theory of Mind (ToM). In general, Theory of mind refers to the ability to understand that others have beliefs, desires, and intentions that are different from one's own, (Davidson, 1984; Dennett, 1987). We examined whether constructing the artificial minds of behaving artifacts influences the development of children's ToAM and their ToM. We focused on children between the ages of 5 and 7 since significant development of cognitive, affective and social systems has been found to emerge between these ages (Sammeroff & Haith, 1996).

Three main questions were addressed in the current study:

(1) Is ToAM a theoretical scheme distinct from ToM?

(2) What are the effects of interacting with behaving artifacts on children's development of ToAM and ToM?

(3) Which conceptions that evolve among 5- and 7-year-old children while interacting with behaving artifacts are indicative of the acquisition of ToAM?

Structure of the Paper

We will first present the literature in the area of humans' conceptions of human and behaving artifacts, Theory of Mind, and the use or robotic kits in education. We will then present the gaps in the literature that stem from the literature review. Following, we will present the methodology and results followed by a discussion of the results. Finally, we present the importance and Significance of the Current study, its' limitations and Future Research.

Background

The literature concerning human beings' conceptions of "traditional" artifacts is vast; however, little is known about our conceptions of behaving artifacts or of the influence of the interaction with such artifacts on cognitive development, especially among children. Since these artifacts are provided with an artificial "mind," it is of interest to assess whether and how children develop a Theory of Artificial Mind (ToAM) which is distinct from their Theory of Mind (ToM). As already mentioned, Theoy of Mind (ToM) refers to the ability to conceive mental states, knowing that other people know, want, feel, or believe things which are different from our own (Premack & Woodruff, 1978). Most of the studies that focused on the pre-school child examined ToM by means of first-order (such as the False belief task) (Wimmer & Perner, 1983) and second-order tasks (i.e., understanding what another person thinks a third person knows - the "ice-cream" and the "birthday puppy" stories) (Perner & Wimmer, 1985; Sullivan, Zaitchik & Tager-Flusberg, 1994). In the current study, we examined whether "building" an artificial mind enhances the development of the above concepts and causes children to adopt the intentional stance and treat a robot as if it had beliefs and desires and as if it acted rationally on these beliefs and desires (Dennett, 1978, 1987).

Much research has been conducted regarding children's conceptions of natural kinds and human made artifacts (e.g., Bloom, 1996; Matan & Carey, 2001; Ross, Gelman & Rosengren, 2005). In contrast, research on children's conceptions of behaving artifacts and artificial mind is sparse.

The use of robot construction kits (RCK) in education (such as the LEGO/Logo system) were found to simulate learning concepts and methods in scientific fields such as mathematics, physics, computer science, and mechanics: children learned ideas such as control, feedback, communication principles, and principles of acceleration, deceleration and kinematics (Resnick, 1998; 2006; Resnick, Berg, & Eisenberg, 2000; Resnick, Martin, Sargent & Silverman, 1996; Resnick & Ocko, 1991), decentralized systems, emergent phenomena and aspects of engineering, design, artistic expression, programming and scientific inquiry (Druin, 2000), scientific research skills (Datteri, Zecca, Laudisa & Castiglioni, 2012), cognitive and academic skills such as deductive reasoning, reading comprehension and geometrical problem-solving (Caci, D'amico, & Chiazzese, 2012), literacy and numeracy skills as well as interpersonal skills (McDonald & Howell, 2012), sequencing ability (Kazakoff, Sullivan, & Bers, 2013), and computational, programming and robotics abilities (Bers, Flannery, Kazakoff, & Sullivan, 2014).

Studies by the group of Mioduser and his colleagues examined various aspects of children's conceptions of behaving artifacts: Levy and Mioduser (2008) examined which frameworks are used by 5- to 6-year-old children when reasoning about a robot. Mioduser and Levy (2010) examined young children's ability to construct and explain adaptive behaviors of a robot. Mioduser and Kuperman (2012) found that in 5- to 6-year-old's explanations of programmable adaptive artifacts as a function of the complexity the level of involvement in constructing the robot's behavior affected children's explanations

Gaps in the Literature

The theoretical review indicates that knowledge is constructed throughout interaction with robots that serve as "objects to think with" (Papert, 1980) as well as that interacting with technological devices, including robots, has an influence on children's cognitive development. To the best of our knowledge, no studies have examined children's ToAM or its development as a consequence of the construction of the robots' behaviors. In the current study we would like to enlarge the body of research existing in this area and examine the nature and essence of the differences between 5- and 7-year-old children in their conceptions, ToM and ToAM characteristics and their development following interaction with adaptive robots including constructing their behavior.

Methodology

Research Design

A mixed methods approach (Johnson & Onwuegbuzie, 2004) combined with a microgenetic approach (Siegler & Chen, 1998) was used in the current study.

Research Population

Participants were 24 children: (a) twelve 5-year-old children, 8 boys and 4 girls, attending public kindergartens in central Israel (socioeconomic status defined as mid-high), whose ages spanned 4 years 10 months to 6 years, with a mean age of 5 years 6 months and a standard deviation of 4.5 months, and (b) twelve 7-year-old children, 5 boys and 7 girls, attending public elementary schools in central Israel (socioeconomic status defined as mid-high) whose ages spanned 6 years 1 month to 7 years 3 months, with a mean age of 6 years 6 months and a standard deviation of 5 months (see Table 1). The battery of tests and tasks was administered to all the children. The children's parents signed consent forms approving their child's participation in the study. Following the parents' approval, children were selected and divided randomly for the mode of interaction (observation and construction). The conduct of the study was approved by the chief scientist of the Israeli Ministry of Education.

Table 1: The research population

Age group	**Age range**	**Mean** (years, months)	**Stdv** (in months)
5-year-olds N=12 (Male=8; Female=4)	4y10m-6y	5y6m	4.5m
7-year-olds N=12 (Male=5; Female=7)	6y1m-7y3m	6y6m	5m

The research population for the qualitative analysis

Two 5-year-olds (a boy aged 5 years and 3 months and a girl aged 4 years 11 months and 22 days at the beginning of the study) and two 7-year-olds (two boys aged 6 years and 4 months at the beginning of the study) from the total research population were randomly chosen for the qualitative analysis. In each age group there was one constructor and one observer.

Research Instruments

Two main research instruments were used in the proposed study: (1) A robotic environment, and (2) Data collection tools.

The "RoboGan" computerized interface

A robotic learning environment which was developed for young children, the "RoboGan" (Mioduser, Levy, & Talis, 2009) was used in the study. This environment includes a computer interface (Figure 1), a physical robot (made with the LEGO® system) and modifiable "landscapes" for the robot's navigation (Figure 2). The environment is an iconic interface for defining the control rules in a simple and intuitive fashion (Mioduser et al., 2009, Talis, Levy, & Mioduser, 1998). The right panel in Figure 1 presents the progression of the modes of constructing the robot's behavior, moving through level of difficulty from remote control behavior (top, easy task) to two interrelated rules (bottom, advanced task). The central section is devoted to the "Desktop" in which children construct behavior procedures, which change according to the stages. In each of the right panel's modes, the options for carrying out the assignment are related to the task so that the construction of the behavior of the robot is intuitive. The learning of the options is accomplished while performing the tasks. For example, in Figure 1 (high complexity task), children construct a rule for the robot's behavior. The construction of the behavior rule requires reference to two input modes (light, darkness). The child is required to drag icons that represent the expected behavior in conditions of light and darkness, thus constructing a rule for the robot's behavior. Upon constructing the rule, it is downloaded to the robot using the "download" icon (circled).

Figure 1. The computer interface

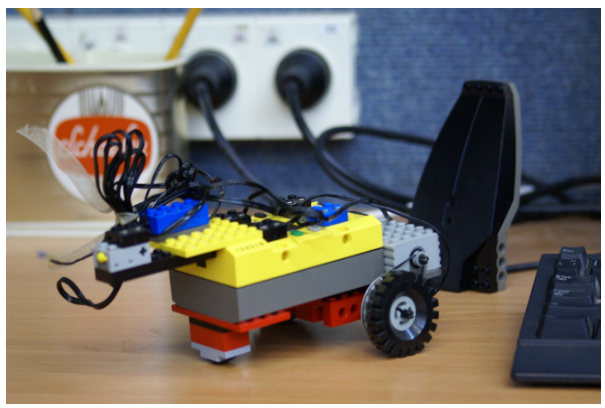


Figure 2. The robot made of LEGO

Data collection tools

Three sets of data collection tools were used in the study: (1) intelligence (IQ) test, (2) Pre-Post tests and (3) Process tasks.

Intelligence (IQ) test

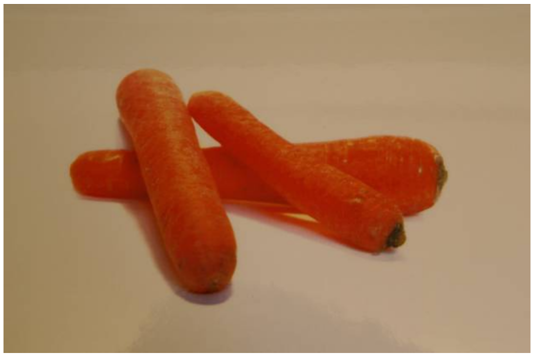
The Hebrew version (Peyser, Shimborsky, Wolf, & Hazany, 1996) of the Kaufman Assessment Battery for Children (K-ABC) (Kaufman & Kaufman, 1983) was used in order to characterize the research population as homogeneous in relation to intelligence. This battery is a standardized test that assesses intelligence and achievement in children aged 2.5 to 12.5 years. This tool was chosen because both age groups in the proposed study are within the age range for which this battery is designed. The test consists of 18 subtests—10 mental processing subtests and 8 achievement subtests. Out of the 18 subtests, children were administered three subtests: (1) riddles (achievement scale), (2) matrix analogies (simultaneous processing scale), and (3) word order (sequential processing scale). These subtests were chosen because (1) they all appear in the English short version, (2) each belongs to one of the three possible categories (appearing in parentheses), (3) they are suitable for administration to subjects in both age groups, and (4) these tasks have high split-task inner reliability.

Pre- and Post-tests

Children were administered pre- and post-tests that relate to the 2 dependent variables: assessment of ToM and assessment of ToAM.

(A) Assessment of the development of ToM: Two main types of tasks were used:

(1) Tasks that assess classic aspects of ToM (understanding of first and second order beliefs). For example, in a first order Diverse desires task the child is presented with a doll and two pictures: of a carrot and a cookie.



The child is told, "Here's Dana. It is 10:00am break time and it's time to eat a snack. Dana wants to eat. She has two snacks she can choose from."

The child is asked the "desire" question, "Which snack do you like best: a cookie or a carrot?" If the child chooses the cookie (carrot) he is told: "This is an excellent choice. But in fact, Dana likes carrots (cookies). She does not like cookies (carrots)."

The child is asked the target question, "So it is time to eat. Dana can choose only one snack. Which snack will Dana choose? A cookie? A carrot?"

In addition, the child is asked to give an explanation for his answer. To perform this task correctly the child must answer that Dana will choose the snack that he did not chose and his explanation should refer to Dana's desires.

(2) New tasks that assess aspects of the human mind that relate to behavior control and adaptivity and were not part of previous ToM studies.

For example, in the Diverse desires decision making task, the child is presented with a doll and two pictures: of an ice-cream and a cookie.

The child is told, "Here's Tom. Tom eats ice-cream during the day and a cookie at night. It's time for dessert. Eyal can eat only one dessert." The child is then asked the target question, "Which dessert will Eyal choose? - ice-cream or cookie?"

In addition, the child is asked to give an explanation for his answer.

To perform this task correctly the child must answer that Eyal will choose his dessert based on the time of day.

(B) Assessment of the development of ToAM: Two main batteries of tasks were used:

(1) Adaptation of the classic ToM tasks to assess ToAM:

For example, in the "No will" task, the child is presented with a doll and a robot.

The child is told the following, "Roey has a robot. The robot can move forward or backwards. Roey operated the robot to move forward. When he put the robot on the floor the robot moved backwards." Then, the child is asked the "no will" question, "What do you think happened?" or "Can this happen? If so – why? and if not – why not?". In addition, the child is asked to give an explanation for his answer.

To perform this task correctly the child must present an answer that indicates to us that he understands that the robot's behavior is dependent on its programming and that the robot does not have a will, such as "Roey didn't operate the robot well" or "The robot was programmed to go backwards."

(2) Tasks that were developed for the study in order to assess aspects of the artificial mind that relate to behavior control and adaptivity:

For example, in the "No will – decision making task", the child is presented with a robot and a container filled with red and blue balloons.

The child is told, "When a child celebrates his or her birthday during the day RED balloons are used. When the birthday celebration is at night BLUE balloons are used. There is a pile of balloons in the container. The robot is located next to the container." The child is asked the target question, "Which balloon will the robot pull out?" In addition, the child is asked to give an explanation for his answer.

To perform this task correctly, the child must say that if the robot was programmed to make a decision it will first check the light outside (using light sensors) and thus will be able to pull out the correct balloons.

Each battery of tasks contained 10 tasks (5 ToM and 5 ToAM tasks) in two versions (A and B). The entire battery was administered twice: in the pre-test and post-test sessions of the study in a counterbalanced order.

Process tasks

In order to assess the influence of constructing the robot's behavior on the development of ToM and ToAM, Nine tasks and three boards were developed and constructed. The tasks were divided into four levels of complexity (1-4; 1 – low level of complexity; 4 – high level of complexity) based on the cognitive demands made on the participants in order for them to accomplish the task:

(1) The script learning tasks require basic thinking. The outcome of the participants' or the experimenter's actions is immediate and no advance planning is needed.

(2) The script programming tasks require temporal and sequential thinking. Advance planning is needed and the outcome of the actions is apparent only after the programming is completed. The children (or experimenter) teach the robot a specific set of fixed actions for performing an expected and finite behavior. For example, we used the "going to the basketball yard" task (see Figure 3), in which the robot is placed in a neighborhood with one school, a play-ground and a basketball yard.

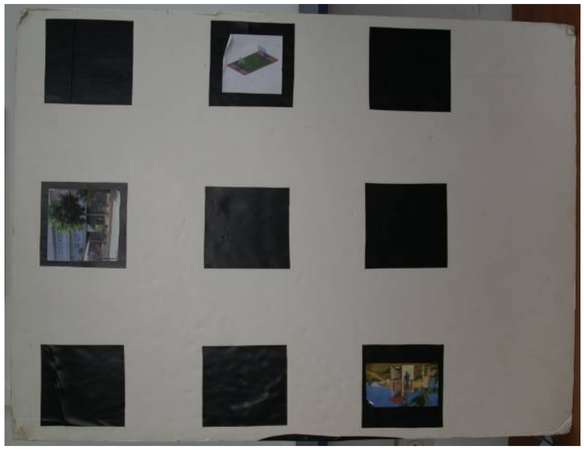


Figure 3. "Going to the basketball yard" board

The children are instructed to program (or observe) the robot to go to the basketball yard.

(3) The half-rule tasks require a-temporal and general associative thinking between environmental conditions and the robot's actions (if-then rules). However, participants referred only to one output for one input (if – output A).

(4) The full-rule tasks also require a-temporal and general associative thinking between environmental conditions and the robot's actions; however participants referred to the two values of the rule - two outputs in correspondence with the two input values of the conditions (if-else – output A, output B).

For example, we used the "politeness task" (see Figure 4). In this task the robot is placed upon a white surface with black areas.

Figure 4. "The politeness task" board

The children are instructed to program (or observe) the robot to move freely on the white surface while being polite – without touching the black areas.

Children in the construction group constructed the robot's behavior according to the task and children in the observation group saw the robot's behavior which had been constructed by the experimenter. Children in the observation group were not exposed to the interface nor did they at any time see the experimenter constructing the robot's behavior.

Procedure

Children were administered the Kaufman Assessment Battery for Children (K-ABC) assessing their intelligence, a battery of pre- and post-tests that assess the development of first- and second-order ToM and ToAM (that were developed for the study), and process tasks administered during the intervention that assess the concepts which are indicative of the acquisition of ToAM. Children were selected and divided randomly into one of two groups: observation or construction of the robot's behavior. Data was collected in nine to ten 20-30-minute sessions. All sessions were recorded and videotaped and later analyzed.

Qualitative Data Collected During the Pre- and Post-Tests and Manipulation Process

Based on the data collected during the pre- and post-tests and observations, criteria were constructed by two independent judges. Reliability was assessed on one fourth of the data and was based on an agreement of 89.78% between the judges.

Data Analyses

Three types of analysis were conducted in the current study:

(1) The Kaufman Intelligence test: Two-way ANOVA was conducted to examine differences between groups on performance.

(2) Analysis of the raw data of all tasks that were collected in the theory of mind and theory of artificial mind pre- and post-tests. This analysis includes the mean accuracy of children's answers in each task separately, followed by the analysis of children's explanations.

(3) Analyses as a function of the research questions: this analysis included analysis of the mean of the correct responses and of the frequency of children's explanations in all tasks in order to answer research question 2 and Qualitative analysis – in order to answer the third research question. In the latter we analyzed four case studies. Within the construction and observation groups, we looked for concepts that evolve during the intervention that support the acquisition of ToAM, looking for age differences in the concepts that evolve and looking for the influence of the type of involvement on the concepts that evolve.

Analyses #2 and #3 served in order to answer research question 1.

Results and Discussion

The purpose of the current study was to examine the existence of a new scheme named ToAM and to examine the effects of constructing the robots' behavior on children's development of ToM and ToAM. We focused on children between the ages 5 and 7 since significant development of cognitive, affective, and social systems were found to emerge between these ages.

The main results of the current study can be summarized as follows:

Intelligence was not found to be a confounding variable in the current study.

Analysis of the Raw Data

In the *ToM analysis by task* we found that, in general, the intervention influenced children's understanding of first-order decision making based on beliefs and desires which are dependent on environmental conditions. In the second-order tasks we found two levels of basic second-order understanding while only one level of decision making second-order understanding. Lastly, we found that for all children it was easier to grasp decision making than beliefs and desires.

In the *ToAM analysis by task* we found that only in the second-order tasks, but not in the first-order tasks, the intervention may have influenced constructors more than observers. In the second-order tasks we assume one level of second-order understanding.

We found that even though ToM and ToAM share several characteristics (both include first-order and second-order understanding, rule-based understanding, and decision making and adaptive behavior understanding) most of their characteristics differ in the following ways: (1) in their essence, (2) in the content of first- and second-order understanding, and (3) in children's ability to grasp several of the ToM or ToAM concepts.

The essence of ToM and ToAM

While ToM first-order understanding consists of understanding that another individual holds beliefs and desires which are different than our own and that another person can make decisions based on desires and beliefs that are different than our own, ToAM first-order understanding consists of understanding that the robot has no will, rather, its operation depends on either direct operation or programming, that robots behave according to environmental conditions and make decisions accordingly (rule understanding), and that robots behave according to either direct operation or human programming that are dependent on environmental conditions.

The content of first- and second-order understanding

While ToM second-order understanding (SOU) consists of understanding what character 'A' thinks character 'B' knows, and understanding that character 'A' thinks that character 'B' makes decisions based on environmental conditions and behaves accordingly, ToAM second-order understanding refers to understanding a scenario in which robots 'A' and 'B' operate according to a program and that the operation of robot 'B's depends on the output of robot 'A', and understanding what robot 'B' would do following a change in the behavior of robot 'A', both of which are dependent on programming.

Children's ability to grasp several of the ToM or ToAM concepts

While in ToM understanding of rules includes only complex rules, ToAM includes understanding of half and full rules. In addition, ToAM, but not ToM, includes understanding of scripts. We also found that hypothetical decision making in robots (i.e., "can the robot help finding a dog?") is harder for children to grasp in contrast to concrete behavior of a robot (i.e., "which balls/balloons will the robot pull?") and with decision making in humans that is based on beliefs (i.e., "Where would Ronen look for the dog?"). These findings supports the dichotomy between abstract-concrete concepts (e.g., Altarriba, Bauer, & Benvenuto, 1999; Paivio, Yuille, & Madigan, 1968). Thus, it might be that ToM and ToAM are two separable schemes that develop independently.

Analysis of the Research Questions

In order to answer the first research question, *Is ToAM a theoretical scheme distinct from ToM?*, we will first present the main results of questions 2 and 3.

Research question 2

Research question 2: What are the effects of interacting with behaving artifacts on children's development of ToM and ToAM?

ANOVA (repeated measures) was calculated for 2 (pre-post) X 2 (age) X 2 (condition) to examine differences within the pre- and post-tests and between the age and condition groups for all tasks.

Concerning **ToM**, we found that, in general, the interaction with behaving artifacts, whether as observers or constructors and for both 5- and 7-year-old children, brought into awareness children's ability to understand that other people hold different beliefs and desires than their own, and that the human mind's ability to make decisions is based on beliefs and desires which are dependent on environmental conditions [$F(1,20)=5.992$, $p<.05$].

Concerning **ToAM**, we found that, in general, the interaction with behaving artifacts, whether as observers or constructors and for both 5- and 7-year-old children, influenced the children's ability to understand that robots can behave independently and based on external and environmental conditions, as well as the relationship between the behaviors of two robots [$F(1,20)=13.867$, $p=.001$].

These findings are in line with previous findings that indicated the construction of knowledge via interaction with robots that serve as "objects to think with" (e.g. Caci et al., 2012; Granott, 1991; 1993; 2002, Papert, 1980).

Research question 3

Research question 3: Which conceptions that evolve among 5- and 7-year-old children while interacting with behaving artifacts are indicative of the acquisition of ToAM?

The qualitative analysis of the intervention sessions among four children indicated differences and similarities between the 5- and 7-year-old children and between children who constructed and observed the robot's behavior in four major areas: (1) conceptions that evolve among 5- and 7-year-old children while interacting with behaving artifacts are indicative of the acquisition of ToAM, (2) immunity to functional fixedness, (3) Meta cognition, and (4) development in children's language in their conceptions of the artificial mind.

Conceptions that evolve among 5- and 7-year-old children while interacting with behaving artifacts are indicative of the acquisition of ToAM

We found various conceptions that evolve among 5- and 7-year-old children while interacting with behaving artifacts which are indicative of the acquisition of ToAM. For example, we found that the engagement in building the robot's behavior in both 5-year-old and 7-year-old constructors enhanced a full technological model of the mind (i.e., "*"The tower is connected to the computer. The computer passes it [the information] to the robot").* We also found that Engaging in building the robot's behavior influenced the children's ability to explain several of the robot's behaviors, their understanding of script-based and rule-based behavior (i.e., *"The robot will behave the same... because it received an input from the tower... what I told it… to go backwards in strong light").* These findings too, support Papert's constructionism theory (1980).

Immunity to functional fixedness

Among the constructors, we found that both 5- and 7- year-old children evidenced immunity to functional fixedness (which refers to a situation when subjects are hindered in reaching a solution to a problem by their knowledge of an object's conventional function (Duncker, 1945), in relation to their conceptions of the artificial mind, while among the observers, only the younger observer showed such flexibility. We assume that engaging in the construction of artifacts contributed to the older child's immunity to cognitive fixedness. It might be that while constructing the robot's behavior and building its mind even older children become epistemologists which can enhance their construction of general knowledge (Papert, 1980, 1986) and the robot's ability to make choices based on environmental changes and traits (or decision making), and its ability of adaptive behavior**.** We suggest that older children who were found to be less flexible in their thinking and learning compared to younger children in previous studies (German & Defeyter, 2000; Defeyter & German, 2003), become flexible in their thinking, similar to the younger children, when engaged in an activity that involves programming.

Meta Cognition

We found evidence for Meta Cognition among both constructors that reflected on their own learning and thinking, even at the early age of 5: *"In the second level every time I pressed on a row the robot moved. In the third level it didn't move. It was more difficult for me to do* [the third level] *because I didn't know what to do. I showed you what I planned to do and it helped me because I already knew what to do… Eventually I succeeded because I thought"*. We found that only the constructors reached higher-order thinking and were capable of thinking about their own thinking, an indicator of their metacognitive abilities. In other words, engaging in constructing the robot's behavior influenced children's metacognitive abilities. Our findings support previous findings relating to the effect of learning computer and robotic programming on children's metacognitive abilities (Casteldine & Chalmers, 2011; Clements & Gullo, 1984; La Paglia, Caci, La Barbera, & Cardaci, 2010). We indeed believe that "*by programming the behavior of a robot, the student has to get inside the mind of the RCK, and think about thinking!*" (Lau, Kiat-Tan, Erwin & Petrovic, 1999, p. 28), and we also assume that the children's ability to reflect on their thinking can provide them with confidence to solve problems in authentic situations (Kramarski, Mevarech & Arami, 2002), and might contribute to reflecting on their learning in curricular settings as well.

Development in children's language in their conceptions of the artificial mind

We found that during the intervention children used both technological language and a combination of technological-psychological language. We found evidence of a correlation between the level of difficulty of a task and the language used by the children: as the task became harder, the language became a "bridging" one (see also Levy & Mioduser, 2008), combining both technological and psychological concepts. We also found that observers tended to use such combining language more than constructors. Based on previous studies (Levy & Mioduser, 2008; Mioduser & Kuperman, 2012; Mioduser & Levy, 2010), we assume that the children's use of such bridging-anthropomorphic language was either because it helped the children in solving the more difficult tasks or because it was more convenient or functional for them, and not because they attributed human-like characteristics to the robot.

Research question 1

Research question 1: Is ToAM a theoretical scheme distinct from ToM?

Results of both qualitative and qualitative analyses indicated the existence of a theoretical scheme –ToAM– in 5- and 7-year-old children.

We found that ToAM is comprised of the following:

First- and second order understanding (in artifacts).

(1) A model of the artificial mind with the following continuum: (a) a ToM-like model completely based on children's model of the human mind; (b) a ToM-based ToAM-technological model referring to the artificial mind but using elements borrowed from their model of the human mind; (c) a partial ToAM-technological model referring to the existence of the artificial mind (i.e., reference to the input and output of the robot), but not to the content or processing of the artificial mind; (d) a fully technological ToAM model.

(2) The type of ToAM model children hold. When they evidenced a ToM-based ToAM model (TbTa), a partial ToAM model (PToAM), or a fully technological ToAM model (FT ToAM), we distinguished between two types of models: (1) an “obeying” technological model (OMM – Obeying Model of the Mind) referring to the robot as having an obeying-dependent mind that obeys external sources, and (2) an “adaptive” of the artificial mind (AMM) technological model referring to the robot as having a mind that makes decisions based on environmental conditions.

(3) Understanding of script-based behavior.

(4) Understanding of half-rule and full-rule based behavior.

Importance and Significance of the Current study

The current study supplied significant insights both theoretically and practically.

Theoretically, the findings broadened the existing knowledge at different levels. In relation to the literature concerning ToM, our study enlarged the existing data in several directions. The current study is the first attempt to refer to children’s perception of aspects of the human mind’s ability to make decisions within the framework of ToM studies. As a result of expanding the classic ToM tasks to include aspects of decision making, we were able to characterize two levels of ToM decision making: one that refers to beliefs and the second that refers to desires. Finally, our study indicated that interacting with behaving artifacts influences children’s conceptions of the human mind.

In relation to the literature concerning ToAM, although we know much about the development of the theory of the human mind, the domain of children’s conceptions of the artificial mind is at an early stage. Our findings indicated a new theoretical scheme we defined as ToAM. Our study unveiled the characteristics and components of this new scheme. We also found that interacting with behaving artifacts influenced the development of ToAM. Additional research is needed in order to establish these theoretical ideas in relation to both ToM and ToAM.

In relation to the concepts evolving that support the acquisition of ToAM while interacting with behaving artifacts, the current study supplies important insights at several main levels: (a) the identification of intriguing aspects of children’s thinking about behaving and adaptive artifacts, (b) the nature of suitable tools, tasks, and “objects to think with” allowing children to enact, construct, and reflect on their understandings of the world of behaving artifacts, and (c) the language used while interacting with behaving artifacts. Our study also enlarged existing data in relation to the ages of 5-7 years as important in development, young children’s immunity to functional fixedness, and the influence of constructing artificial behavior on the development of ToAM and on metacognitive abilities.

Our study also indicated the importance of combining quantitative and qualitative analysis. We have learned from the current study that only by combining quantitative and qualitative research methods were we able to receive a complete and coherent picture of children’s ToM, ToAM, the influence of constructing adaptive behavior on these constructs, and the concepts that evolve while interacting with behaving artifacts that support the acquisition of ToAM.

Practically, this theoretical knowledge has clear implications for education, supporting the development and implementation of learning environments in the area of intelligent machines and control already in **pre-school**. These environments should enable young children to **enact and construct** artificial behavior by themselves, which will enable them to reflect on their understanding of the world of behaving artifacts and the artificial mind and, as a consequence, on the world of the human mind. This, in turn, will support their acquisition of metacognitive knowledge relating to their engagement in the construction of behaving artifacts including decision-making skills, acquisition of programming capabilities, robotics knowledge, construction of artificial behavior and problem-solving skills on the one hand, as well as supporting their acquisition of metacognitive regulation abilities such as self-reflection. These, in turn might contribute to their understanding of the human mind, as well as enabling them to regulate and reflect on their curricular leaning.

Limitations of the Current study

The current study has several limitations. Participants were 5- and 7-year-old children from kindergarten and primary schools in central Israel, and thus the sample was not representative of the entire population of children in Israel of the target ages. In addition, the children were from high socio-economic backgrounds and might have encountered behaving artifacts previous to their participation in the study. Also, the number of participants was not large and might have influenced some of the non-significant differences obtained in the quantitative analyses of the study. Bearing these limitations in mind, the results and conclusions obtained in the current study can be generalized only to similar populations.

In addition, participants were selected randomly out of each class and were divided randomly to the two conditions (observers and constructors), and thus, the sampling was a non-probability sampling but rather was a convenience sampling.

Future Research

With respect to the limitations and the preliminary results of the current study, future research should include a larger population size and expand the study to diverse socio-economic backgrounds including more rural populations that might have less exposure to smart machines from an early age.

A large-scale study (in terms of population characteristics, sampling methods, scope of construction tasks and developmental aspects of both ToM and ToAM) will provide robust data on the trends unveiled so far, which will enlarge the body of research in relation to children's conceptions of the artificial mind.

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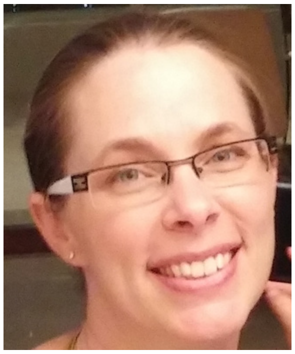
Biographies



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