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FROM AN ARTIFICIAL NEURAL NETWORK TO TEACHING

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ABSTRACT

Aim/Purpose	Using Artificial Intelligence with Deep Learning (DL) techniques, which mimic the action of the brain, to improve a student's grammar learning process. Finding the subject of a sentence using DL, and learning, by way of this computer field, to analyze human learning processes and mistakes. In addition, showing Artificial Intelligence learning processes, with and without a general overview of the problem that it is under examination. Applying the idea of the general perspective that the network gets on the sentences and deriving recommendations from this for teaching processes.
Background	We looked for common patterns of computer errors and human grammar mistakes. Also deducing the neural network's learning process, deriving conclusions, and applying concepts from this process to the process of human learning.
Methodology	We used DL technologies and research methods. After analysis, we built models from three types of complex neuronal networks – LSTM, Bi-LSTM, and GRU – with sequence-to-sequence architecture. After this, we combined the sequence-to-sequence architecture model with the attention mechanism that gives a general overview of the input that the network receives.

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Contribution	The cost of computer applications is cheaper than that of manual human effort, and the availability of a computer program is much greater than that of humans to perform the same task. Thus, using computer applications, we can get many desired examples of mistakes without having to pay humans to perform the same task. Understanding the mistakes of the machine can help us to understand the human mistakes, because the human brain is the model of the artificial neural network. This way, we can facilitate the student learning process by teaching students not to make mistakes that we have seen made by the artificial neural network. We hope that with the method we have developed, it will be easier for teachers to discover common mistakes in students' work before starting to teach them. In addition, we show that a "general explanation" of the issue under study can help the teaching and learning process.
Findings	We performed the test case on the Hebrew language. From the mistakes we received from the computerized neuronal networks model we built, we were able to classify common human errors. That is, we were able to find a correspondence between machine mistakes and student mistakes.
Recommendations for Practitioners	Use an artificial neural network to discover mistakes, and teach students not to make those mistakes. We recommend that before the teacher begins teaching a new topic, he or she gives a general explanation of the problems this topic deals with, and how to solve them.
Recommendations for Researchers	To use machines that simulate the learning processes of the human brain, and study if we can thus learn about human learning processes.
Impact on Society	When the computer makes the same mistakes as a human would, it is very easy to learn from those mistakes and improve the study process. The fact that machine and humans make similar mistakes is a valuable insight, especially in the field of education, Since we can generate and analyze computer system errors instead of doing a survey of humans (who make mistakes similar to those of the machine); the teaching process becomes cheaper and more efficient.
Future Research	We plan to create an automatic grammar-mistakes maker (for instance, by giving the artificial neural network only a tiny data-set to learn from) and ask the students to correct the errors made. In this way, the students will practice on the material in a focused manner. We plan to apply these techniques to other education subfields and, also, to non-educational fields. As far as we know, this is the first study to go in this direction – instead of looking at organisms and building machines, to look at machines and learn about organisms.
Keywords	deep-learning, text-mining, Hebrew, subject-tagger

INTRODUCTION

The world of Machine Learning (ML) is very large. ML is used in many areas such as: health, economics, web search engines, image processing, robotics, etc. It is customary to divide ML algorithms into several types: (1) "Supervised learning" (2020) – each example comes with a classification label. The purpose of the algorithm is to predict the classification of new examples that it did not encounter in the learning process. Artificial neural network training relies on such algorithms. (2) "Unsupervised learning" (2020) – the purpose of the algorithms is to find a simple representation or template for understanding the data collection. Common methods of this type are clustering and low-dimensional spreading such as principal factor analysis. (3) Reinforcement learning (Kaelbling et al., 1996) – the learning algorithm receives partial feedback on its performance (only after completion of the assignment) and must conclude which of its decisions led to success/failure. The motivation of this

research is how (if we can) to exploit the mistakes of a ML in favor of humans, i.e., to analyze the ML mistakes and teach humans not to make the same mistakes.

The goal of this study is to examine the learning process of computational tools built according to the human brain model and to learn from their mistakes. There are a number of ML algorithms; one of the common mathematical models in this field is the Artificial Neural Network (ANN, 2020) model. ANN, as used in ML, is a computational mathematical model based on the structure of the human brain or on the cognitive processes that take place in a natural neural network. The network consists of a number of "neurons" arranged in layers, with each neuron being able to interact with a number of other neurons in the system. Each neuron is capable of simple computational operations and, in turn, transmits the information, i.e., number, it deduced to other neurons. In this way, as data advances through the ANN layers, the system transforms the raw data into valuable, usable information. In order to "teach" the network how to avoid mistakes, we can use a feedback mechanism, known as a back-propagation algorithm. This mechanism enables the network to adjust the connections back through the network. By applying this algorithm, the network can go back and "double-check" to make sure that all the biases are correct and that all the connections are weighted correctly. As a result, the system learns to make more accurate decisions. One of the primary properties of the neural networks is their ability to emulate the brain's pattern-recognition skills. Neural networks are used for a wide array of tasks such as predicting the outcome of investment decisions, finding patterns in handwriting, and even facial scanning to identify a person.

Use of ANN has become very widespread. The ANN model has great potential to provide important information to researchers in various domains, such as the academic, industrial, medical, and communications domains. Currently, computerized corpora are the basis of many textual projects; as a result, ANN is of prime importance in this field.

As far as we know, to this day, researchers in the AI field have not taken the approach of using ANN's results to try to draw (technical) conclusions about humans. AI and DL researchers have focused on, and are still focusing on, the opposite direction only: studying how to enable the computer model to imitate the organism (humans). However, currently, researchers still can't explain why the ANN model comes to one conclusion or another (even if the network's conclusion is correct) even though, in recent years, researchers have begun to work intensively to try to explain why the ANN model made the decision it did. Additionally, when researchers currently try to solve problems using an ANN model, every once in a while they run into problems that an organism manages to solve and AI does not. To cope with this phenomenon, researchers try to improve the existing models, but today, even after great advances in the AI field, AI is still not close enough to human capabilities. However, this does not mean that it is not worthwhile to investigate the opposite direction – from the machine to the organism. This work is preliminary, and we are now performing the first experiments, as far as we know, in this direction.

We will examine the learning processes of a number of such models and try to draw conclusions about human learning processes, because the ANN model is based on the human brain. For example, if ANN makes some mistakes on a specific task, we might expect human students to make the same or similar mistakes. In this way, we can be better prepared for the teaching process. Beyond that, it is possible that by analyzing how ANN deals with a particular task we can estimate what decision a person would make when dealing with the same or a similar task.

One way to research this is to analyze ML errors. ML makes mistakes, and also humans make mistakes. If we analyze the mistakes that ML makes, maybe we can learn what mistakes humans will make. Then, we can teach humans not to "repeat" the mistakes that ML made. By doing so, we can improve the quality of human learning. While taking a human survey of a learning process, and choosing the right people to participate in it, is expensive and sometimes not easy, using a computer to model the learning process is much cheaper and simpler. To our knowledge, we are the first to investigate this area.

In this work, we will deal with the syntactical analysis of Hebrew language texts, especially Hebrew sentences. The task being taught is identifying the grammatical subject of a sentence. Our goal is to compare ANN mistakes in performance of this task to human mistakes, in order to identify and assess common human grammar mistakes and to analyze the ways humans can perform this task.

Semitic languages are quite dissimilar from Indo-European languages. Hebrew texts are processed differently than the English language because (1) texts written in Indo-European languages are written from left-to-right, while those written in Hebrew are written from right-to-left (Wintner, 2004); (2) in comparison to Indo-European languages such as English, German, and French, little Natural Language Processing (NLP) research has been done on the Hebrew language to date; (3) Hebrew is a morphologically rich language, e.g., words can have many prefix forms ("and when in …", "and when …", "and …", "when …", "in …"). One of the results of this complex morphology is ambiguous words (HaCohen-Kerner, Kass & Peretz, 2010); (4) Hebrew texts contain many acronyms and abbreviations (HaCohen-Kerner et al., 2004). HaCohen-Kerner et al. (2004) show that there are 40,000 abbreviations in Hebrew, compared to 17,000 in English. A study made in 2013 (HaCohen-Kerner et al., 2013) shows that the manual disambiguation of an acronym is a very time-consuming process, and it is a very difficult task even for a professional; (5) Hebrew is an ancient language; people have been speaking that language since the beginning of the 2nd millennium BCE. In Hebrew, there are written texts from two thousand years ago and more, most of them rabbinical (religious) texts (Mughaz, 2003; Mughaz et al., 2019a, 2019b).

This article is organized as follows: we will give a review of previous works; we will introduce the data-set and its pre-processing; we will explain the experiments and the tools we used; we will analyze the results; we will show how the experiments we did can have a practical implications, and at the end we will make conclusions and future works.

RELATED WORKS

The fact that ML learn from examples that humans feed them has been widely researched and discussed. ML is a useful aid in many areas such as face recognition (Deng et al., 2019; Zangeneh et al., 2020), robotics (Levine et al., 2018; Vemula et al., 2018), text mining Luque et al., 2019; Mughaz et al., 2015, 2019a, 2019b), natural language processing (Eger et al. 2019; Kulkarni & Shivananda, 2019; Young et al., 2018), and machine translation (Bahdanau et al., 2014; Luong et al., 2015; Wu et al., 2016). However, none of these studies researched the opposite direction, i.e., taking examples of machine results/answers and learning from the error/behavior of the machine in order to teach humans to avoid making the same mistakes.

Following the general introduction of ANN, which appears in the introduction section, we then elaborate on the ANN sequential model. Sequence modeling is widely used in text analysis, for example, predicting the word/letter that comes next in a sequential input (Sutskever et al., 2011). This task is accomplished by computing the probability of occurrence of several words in a particular sequence. In sequence modeling, the current output is dependent not only on the current input but also on the previous input. Unlike other ML tasks, in sequence modeling, the input and output length are not fixed.

The basic and classic ANN is a feedforward net. A feedforward network (Schmidhuber, 2015) feeds information straight through the net, while Recurrent Neural Networks (RNN) (Mozer, 1988) cycle information through a loop, and the inputs are called recurrent. Given one input which is a series of data through time, e.g., a sentence, the Feedforward network has no interest in time or serial reference in time, e.g., words, and the only input it considers is the current example to which it is exposed. Thus, Feedforward networks have "amnesia" in regards to previous stages of the timeline (steps of series) they remember only the current moment. On the other hand, RNNs take as their input not just the current input example, also what they processed previously in the series or in the time.

RNNs can even apply to images, which can be decomposed into a series of patches and treated as a sequence. What distinguishes RNN networks from other neural networks is that they take time and sequence into account. Since recurrent networks possess a specific type of memory, and memory is also part of the human condition, the RNN has a partial enology to the human brain.

The main problem with RNNs occurs when the sequence is too long; the networks have trouble carrying information from earlier steps to later ones. So, when processing a big paragraph of text, RNN's may 'forget' important information from the beginning. This problem is known as the "vanishing or exploding gradient problem" (Bengio et al., 1994) when gradient values are used to update the weights of the RNN. The problem of vanishing gradient arises when the values shrink or expand along the time. If the values of the gradients becomes very small, they do not significantly contribute to learning. So, in RNN, layers with a small gradient update impede learning.

The RNN variation plus "Long Short-Term Memory" (LSTM) was first proposed in 1997 by two researchers from Germany, Ied Hochreiter and Jorn Schmidauber (Hochreiter & Schmidhuber, 1997). In their research, they show that LSTM units solve the RNN problem by preserving the error value over time and over layers. By maintaining the error value over time and over the RNN layers, the RNN can cause the learning process to continue over an extended period of time. The result was that LSTM has opened options for linking words that are far apart. Thus, in our research, we used LSTM.

The neuron network receives sentences/words as input and returns an output regarding the task it is coping with. Like all computational tools, neuronal networks cannot receive words as humans do; rather, they must receive the words numerically, i.e., vectors of numbers representing the words. The domain of converting words into representative vectors is called word embedding. There are several methods of embedding words, for example, one-hot encoding ("One-hot" 2020) or FT (Ramos, 2003); modern methods for embedding words include as word2vec (Mikolov, Chen et al., 2013; Mikolov, Sutskever et al., 2013) and glove (Pennington et al., 2014). The main idea of embedding words is that the words around a specific word define it; this is referred to as the Distributional Hypothesis. The Distributional Hypothesis is that if words are in a similar environment, then the semantic meaning of the words is similar (Harris, 1954). The main idea that "a word is characterized by the company it keeps" was proposed by Firth (1957). The Distributional Hypothesis is the basis for Statistical Semantics. Despite the fact that the Distributional Hypothesis originated in the study of Linguistics, it is now receiving attention in Cognitive Science (McDonald & Ramscar, 2001). The theoretical basis and source of the Distributional Hypothesis is discussed by Sahlgren (2008).

The RNN/LSTM/GRU network receives an input of vectors (each vector represents a word) and sequentially transmits the information contained in the vectors up to the end of the network. The information coming to the end of the network from the first vectors is less than the information coming from the last vectors. In many cases, there are vectors (words) at the beginning of the sentence that are very important for the last vectors (end of the sentence); however, in the serial transitions the information contained within them fades by the end of the sentence. For this purpose, (among other things) the attention mechanism (Bahdanau et al., 2014; Luong et al., 2015) is built. The attention mechanism takes all the vectors (all the sentence) as input and decides which of the representative's vectors (among the words in the sentence) is most important. In fact, in addition to the serial view of the vectors (the words in the sentence, the attention mechanism takes an overall view of all the vectors (sentence). This mechanism works well and improves performance.

Syntactic parsing is the task of building a syntactic parse tree of a sentence. This syntactic tree represents the structure of the sentence. The subject of a sentence is one of the properties that sentence syntactic parsing tries to uncover. Sentiment analysis is one type of task for which sentence parsing has been useful. Gómez-Rodríguez et al. (2019) empirically examined how important the quality of the syntactic analysis is for sentiment analysis, specifically polarity classification on English sentences as the target language. They evaluate their experiments using four well-known dependency parsers.

They concluded that better syntactically-labeled sentences do not necessarily lead to a significantly better accuracy in this task.

Jaf and Calder (2019) present a multi-lingual dependency parser using DL. The DL technique deals with common problems with parsing, for example, long-distance head attachment. One of the advanced DL techniques is transfer learning. Transfer learning exploits extensive knowledge of the resourced language and uses it for a limited-resourced language. Their study yielded interesting results of the effect of transfer learning on resource-limited languages, which always performed at the same, or a higher level than the best-known parsers.

Liebeskind and Liebeskind (2020) were interested in the task of classifying Hebrew historical texts according to their period of composition. Following the promising results of DL for various tasks in natural language processing (NLP), they used three DL models to deal with this problem, convolutional neural networks (CNN), LSTM, and GRU. The results of their experiments were that the GRU model reached an accuracy of 84.9%, a recall of 77.47%, and an F1 of 78.29%, and was better that the other models.

Our case study was performed on the Hebrew language. The number of studies performed on the Hebrew language is not large. Mughaz et al. (2018) classify short Hebrew texts according to the opinion of the writer. The corpus they used consists of short product reviews which were parsed into individual sentences. They applied the SVM algorithm on a combination of both unigrams and bigrams. Then they applied feature selection according to weights of the features by removing the features ranked less than 0.1. They tested the pruned features on SVM with a linear kernel and Bayesian Logistic Regression which yielded a success rate of 92.6% and 92.4%, respectively. Liebeskind (2019), and Liebeskind and Liebeskind (2019) extracted a Hebrew data-set of short user political comments. The aim was to predict the most emoji most closely corresponding to the text. They showed that word2vec Word Embedding is not optimal for this task; moreover, they showed that for the emoji prediction for political domain in Hebrew, the use of character n-grams representations exceeded all the other representation. Liebeskind et al. (2017) examined nine ML technics for classifying writer sentiment for a Hebrew Facebook corpus of 5.3 million messages. The Facebook messages were of incumbent politicians. They examined two different sentiment classification tasks, general attitude and attitude towards the content of the post. They combined two classes of features, Facebook-based and text-based features. They found that the n-grams character model text representation exceeded other representations. Their results showed that the Logistic Regression method exceeded the other eight ML models in terms of F-measures and accuracy.

Other studies that are related to document classification and address the challenges of Hebrew involve the classification of Hebrew-Aramaic documents according to style (Koppel et al., 2006; Mughaz, 2003); authorship verification, including forgeries and pseudonyms (Koppel et al., 2003, 2004) and classification of texts according to their ethnic origin and their historical period (HaCohen-Kerner, Beck, Yehudai & Mughaz, 2006; HaCohen-Kerner, Mughaz et al., 2008; HaCohen-Kerner, Beck, Yehudai, Rosenstein & Mughaz, 2010).

HaCohen-Kerner et al. (2011) used six ML techniques for identifying citations. To achieve this task, they used four feature types – n-gram, stop word-based, quantitative, and orthographic – and tested them separately and together. The best results were by combination of the four feature sets. Their study could identify if a sentence included a citation; it did not identify the citation itself.

Mughaz et al. (2015) extracted time-related key-phrases from rabbinical texts. They found that many of the sentences that hold time-related key-phrases also contain rabbinic names. They presented and applied a semi-automatic method that facilitates the extraction of time-related key-phrases. In other works of Mughaz et al. (2014a, 2014b, 2017, 2019a, 2019b) and HaCohen-Kerner & Mughaz (2010) they improved upon the previous method and used time-related phrases and references in order to date texts. The dating they suggested could help identify ancient anonymous texts and could even help identify edited texts.

In this study, we will use RNN in order to identify the subject of sentences. We will randomly select sentences that the RNN tagged incorrectly. Then, we will give the incorrectly tagged sentences to students, and we will examine how well the students succeeded in the subject-tagging task.

We do not know any other work on this approach, for the English language and certainly not for the Hebrew language.

DATA-SET

In this work, we have performed experiments on ANNs whose purpose is to learn to identify a subject in a sentence. The data set on which we did the experiments came from SVLM Hebrew Wikipedia Corpus (SVLM Corpus, 2020). This corpus was used by Silber-Varod et al. (2017) as part of a project of phoneme prevalence testing in the Hebrew language. The sentences originally came from Hebrew Wikipedia. The input of the training and testing set contained 35,000 sentences. We divided the data set into two parts, 75% for the training process and 25% for the testing.

PREPARING THE DATA

For the training step, we tagged the sentences by Dependencies Hebrew Parser (Goldberg, 2011). To test the results of our ANN, we used the same tagger and compared the results of our ANN with Goldberg's tagger results.

PRE-PROCESSING WORD EMBEDDING

We ran Mikolov's word2vec algorithm by applying the gensim tool (Gensim, n.d.) with the following hyper-parameters:

- **min_count** = 1: Minimum words appearance to build for vector, i.e., we build vectors for all the words.
- **window** = 5: For each word, take the five words before and after it.
- **iter** = 100: The number of iterations for the word2vec algorithm in order to build the word vectors.
- **embedding_dim** = 300: The vector size (per word).

PREPARING THE SENTENCES FOR THE NETWORK

To each sentence of the 35,000 sentences, we appended the subject of the sentence. Sentences are constructed from a series of words, with the subject also appearing at the end of each sentence. The input that the network receives is in the form of vectors of numbers. With the word2vec algorithm, we built a vector representation for each word, which means that each statement is a matrix. It follows that the input that the network receives is a representative matrix of the sentence with a special vector representing the subject; this vector appears at the end of the matrix. In the learning phase, the network learns to associate each sentence with its subject, and during the test phase, the network receives a sentence (without it "seeing" its subject) and predicts the sentence subject.

EXPERIMENT

RNNS EXPERIMENTS

We ran the data set mentioned in the previous section on three types of RNN, i.e., LSTM, BiLSTM, and GRU with and without the attention mechanism. The RNNs were written using Keras, which listed in the following URL https://keras.io, using Python deep-learning library.

Attention mechanism

The RNN views each word in a sequential order; however, the RNN lacks a view of the entire sentence at once. In order to overcome this drawback, we added the attention mechanism, as we mentioned above. In general, this mechanism works well and improves performance (Bahdanau et al., 2014; Luong et al., 2015). The basic idea of the attention mechanism is similar to that of the human approach. When individuals look for something in a text, they pay attention to certain details concerning their search target, while other details in the sentence are ignored. The same thing is done by attention mechanism: it "sees" the whole sentence and decides which words to give more weight and to which to give less (see Figure 1). In Figure 1, there is input of n-words (u_{t-n},…,u_{t-1}, u_t); Bidirectional RNN layer (hidden layers) and attention layer. The words are input to the Bidirectional RNN layer. Each hidden state of the Bidirectional RNN layer is related to a word of the input layer. The attention layer receives the calculated data from the Bidirectional RNN hidden states and then it decides to which words it must "pay more attention".

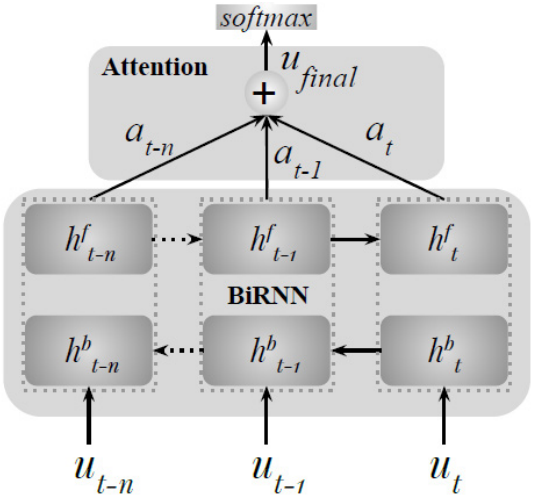

Figure 1. Attention mechanism (Bothe et al., 2018)

In the context of our work, the attention mechanism gives RNNs a look at the whole sentence, which would not be the case without it. This mechanism helps the network decide which words to give greater weight to, as Bahdanau et al. (2014) showed. Figures 2, 3 and 4 show the learning process of the RNNs, i.e., the convergence of LSTM, BiLSTM, and GRU networks, with and without attention mechanism. In Figure 2, we can see the loss-function of the LSTM network with and without attention mechanism; the same is for Figures 3 and 4. The X axis shows the number of iterations of the learning process; the Y axis shows the percentage of network errors.

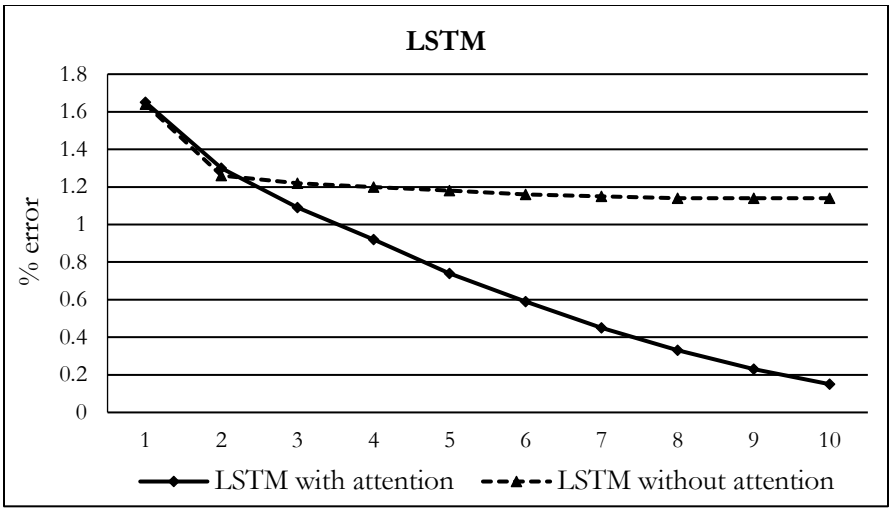

Figure 2. LSTM network with and without attention mechanism

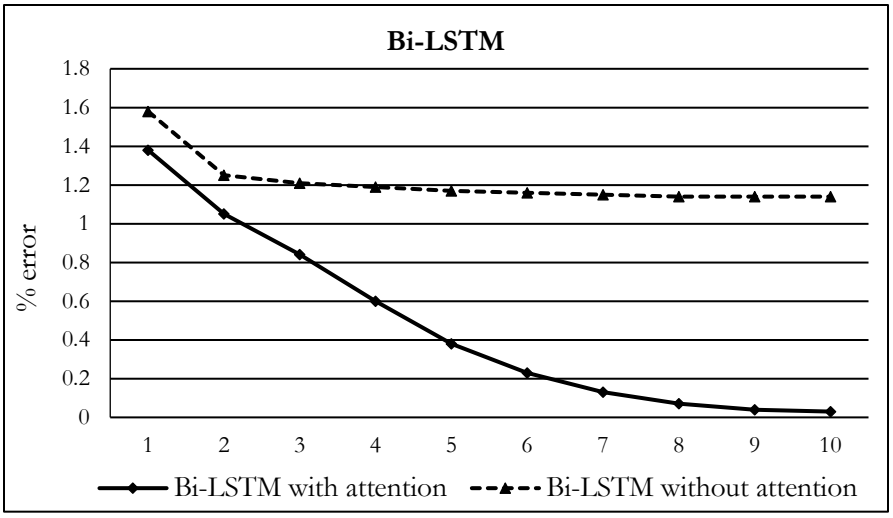

Figure 3. Bi-LSTM network with and without attention mechanism

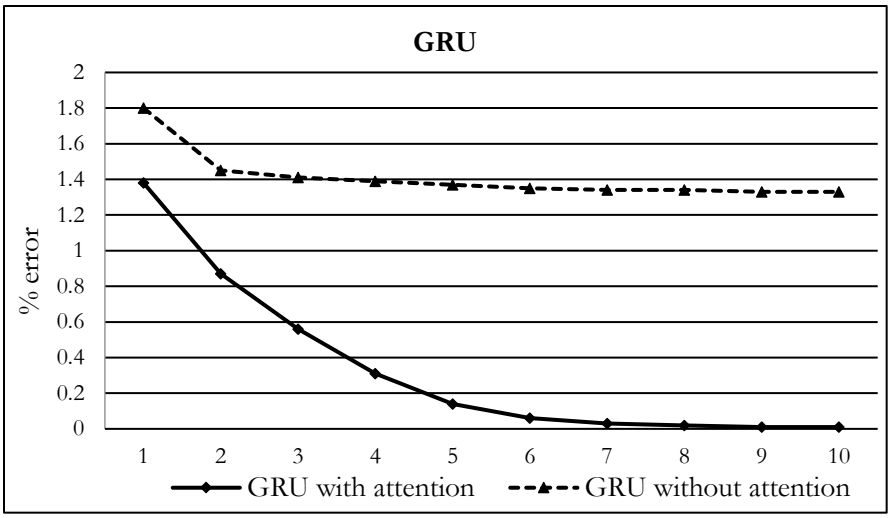

Figure 4. GRU network with and without attention mechanism

We see that in LSTM, BiLSTM, and GRU without attention mechanism there is very similar behavior: a big improvement in the first two iterations, and then small linear improvement up to the tenth iteration.

With the attention mechanism, one sees a beautiful convergence of all three RNNs, unlike without the attention mechanism. The networks with attention mechanism provide better results than without the attention mechanism (as Bahdanau et al., 2014, and Luong et al., 2015, stated) on all the iterations; there is one case where without the mechanism the result is better (the second iteration on the LSTM network). Figures 2, 3 and 4 show important information; the results of the networks with the attention mechanism show both that their results are better, and also that the rate of convergence of learning is much faster than without the attention mechanism.

Here is an example of how a general overview can help. Suppose there is a person who is interested in a particular topic. This person wants to read a paragraph or two about it; however, the text at his disposal is in his second language. If, before he starts reading, he would receive an overview of the subject, he would know what to expect from the text, and then it would be easier for him to read the text. Another example: Suppose there is a newcomer to a language; their first step is to learn the language. During their first period, it takes them a long time to learn the language. While they are learning the language, their mind is busy translating the information they receive; only after that their brain deals with understanding what they read. When they have enough vocabulary, their learning curve grows. Over time, their knowledge has increased, so they have less to learn, and their learning curve is smaller. A similar thing happens in the ANN learning process.

EXAMINING THE SUBJECT-IDENTIFICATION RESULTS

Now we will present randomly selected sentences (which were identified incorrectly) of the output of the ANN. From the examination that we did, we saw that in a significant part of the ANN's errors, the network identifies the central/important word in the sentence as the subject. These words are an important element of the central message of the sentence, but syntactically they are not the subject of the sentence. Another mistake that the ANN makes is the identification of the central noun in a sentence as the subject. This mistake is less common.

The following are examples of sentences that the ANN labeled incorrectly (in Hebrew with English translation). The subjects of sentences appear in **bold**, and the mistakes appear in underline.

(1) "**ערך** זה עוסק בוועדה לחקר אירועי מלחמת העולם השנייה"

(1) "This **entry** deals with the committee that investigated the events of World War II."

(2) "**בית** הפרלמנט נמצא בארמון וסטמינסטר בעיר הבירה לונדון"

(2) "The **seat** of the Parliament is in Westminster Palace in the capital city, London."

(3) "הסברים שונים לגבי העלאת תמונות **תוכל** למצוא בויקיפדיה תמונות וקבצים"

(3) "**You** can find various explanations about uploading photos in Wikipedia pictures and files."

(4) "מאידך **ויקישיתוף** הוא אוסף הצילומים של קרן ויקימדיה"

(4) "On the other hand, **Wikimedia-Commons** is the Wikimedia Foundation's photo collection."

(5) "**הוא** מזוהה בעיר עם קהילת יהודי סלוניקי."

(5) "**He** is identified in the city with the Thessaloniki Jewish community."

SURVEY OF MIDDLE SCHOOL AND HIGH SCHOOL STUDENTS

In this study, we hypothesized that that humans can learn from neuronal network errors and draw practical conclusions for humans. To test our hypothesis, we conducted a survey of 7th graders and of 11th graders. The 7th graders students had not yet learned to perform a syntactic analysis of a

sentence, while the 11th grade students had already taken high school final exams on the syntactic analysis of a sentence.

We distributed a total of 50 sentences to five seventh grade students. The students were asked to label the subject of each sentence. We gave the same 50 sentences to five eleventh grade students, who were also asked to label the subject of each sentence.

We studied all the sentences that the students analyzed. The 7th graders correctly labeled 26% of the sentences, i.e., 13/50. Of the 37 sentences that 7th graders incorrectly labeled, 67.57% were incorrectly labeled in the same way as ANN did. Unlike the seventh graders, the 11th graders correctly labeled 76% of the sentences; that is, 38/50 sentences were correctly labeled. Of the 12 incorrectly labeled sentences, 75% were labeled in the same way as the ANN did.

Common mistakes of the students: (1) Identifying the central message of a sentence as its subject. (2) Identifying an important noun in a sentence as its subject. These two errors are due to the centrality/importance of a word in a sentence. In the human consciousness, a person will "perceive" the central message that the sentence wants to express as its subject. However, syntactically, the central message of the sentence is not necessarily the subject; sometimes the central message of the sentence will be the object of the sentence. The same is true, though less frequently, of a prominent noun. If the sentence revolves around a noun, then there is a likelihood that it will be incorrectly labeled as the subject of the sentence. In both cases, the central issue of the sentence influences the student's incorrect identification of the subject of the sentence.

PRACTICAL IMPLICATIONS

Practically, at least in our case study, we saw a correlation between mistakes that were made by a machine that mimics a human brain and mistakes that were made by students. So, such machines can be assigned some tasks, and, at the same time, humans can be assigned the same tasks (of course, not every task that humans can perform, a machine can perform, at least not nowadays). While doing these tasks, both machines and humans make mistakes. While recruiting people to do a task can be a long and expensive process, running a process on a computer is a fast and very cheap process. Therefore, we should consider running a computer program as an alternative (or at the very least an aide) to human error surveys and tests. In addition, the computer, unlike humans, does not tire and can easily "answer" thousands of questions.

From the second part of the experiment, it can be seen that a machine that receives an overview of an issue can learn better and faster. From this, it can be tentatively concluded that a similar approach to school, university, or industry instruction will help to achieve a faster, higher quality and cheaper learning process.

This new approach can at least strengthen existing hypotheses and may give quantitative/numerical results (such as the ANN learning process) for problems that are difficult to quantify. It is reasonable to hope that examining ANN results can give new insights, suggest new ideas, and point to new directions, that without the use of ANN it would not be easy to discover.

CONCLUSIONS

In this study, we looked at what humans can infer about themselves from use of RNN (which is a type of ANN). We did the experiment on RNN because RNN is designed to mimic certain actions of the human brain. The experiment we did related to identifying the syntactical subject of Hebrew sentences. We did a survey of middle school students and of high school students who had finished studying Hebrew syntax. The results from the RNN experiment showed that the machine often makes mistakes in finding a syntactic subject in the sentence and incorrectly identifies the central idea of the sentence as its subject. The survey we did of middle school students revealed that these students made mistakes similar to those of the computer. In a survey we did of the high school students,

we found that they also made such mistakes, although at a much lower rate. Thus, the machine process is an inexpensive and efficient way to discover mistakes students are likely to make in the course of the learning process.

We have also shown that when the RNN receives input that contains an overview of the sentence, its learning process improves significantly, both in terms of quality of the results and of the speed of the learning process. We hypothesize that teaching and transferring information to humans similarly, i.e., introducing the topic with a brief overview, will lead to similar improved results of the human teaching process as well.

We conclude that before teaching students a task, it is possible and useful to use RNN as a tool to identify mistakes students are likely to make. The results derived from can help teachers to focus on teaching how to avoid (to the extent possible, even if not completely) common mistakes and other problems students have in mastering the material. Another conclusion we came to is that when a teacher starts teaching a topic, especially in a new field, they should present an overview of the topic.

These are the limitations of our research. (1) We assume that RNN mimics the human brain quite well. The reality is that we have not yet fully achieved this goal, and we doubt that we will do so in the near future. (2) We have presented only our own and specific observation of the experiments and results. In order to know if our conclusions can be generalized to other languages (in case of text analysis) or other tasks, more studies and experiments must be performed. (3) One of the problems with ANN (not specific to our current research) is the inability to know why ANN made its decision, regardless of whether the decision was right or wrong. In recent years, researchers are trying to deal with this problem, but so far without great success.

Looking Ahead (Further Research)

It seems that RNN (and maybe other ML processes) can give us new ideas about, and new approaches to, teaching, and perhaps to other areas.

We plan to take two groups of students of the same age. The first group will learn a task based on conclusions from the RNN errors. The other group will be a control group; the students in this group will study normally, without reference to the machine learning conclusions. At the end, we will ask both groups to perform the same, and we will examine and analyze the results.

We plan to investigate further mistakes in student learning processes that RNN can help us with.

We performed our research on the Hebrew language, which is a Semitic language. We should also investigate if, for other languages, such as English and German, we reach the same conclusions.

In the current research, we used word2vec vectors; we must investigate if the same results are obtained if we use glove vectors. We also must use word2vec and glove vectors created using a much larger corpus.

We must perform our research on a much larger and more representative data-set (sentences).

As a result of this preliminary study, we plan to consider applying this approach to other areas besides teaching.

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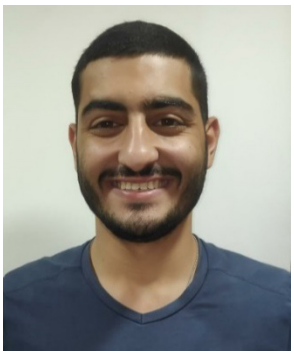

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AN INVESTIGATION OF DIGITAL THINKING SKILLS IN EFL DIGITAL INSTRUCTION

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ABSTRACT

Aim/Purpose	The purpose of the current study is to introduce a digital thinking skills (DTS) theoretical model (DTSM) that could support and enhance digital instruction best practices in schools.
Methodology	We have taken a mixed-methods approach. Our respondents represent diverse cultural, linguistic, pedagogical, and social heritages.
Contribution	The study provides a theoretical model developed by Eshet-Alkalai and Aviram that could impact subsequent digital teaching in schools. The highly accessible model may help teachers understand the cognitive learning outcomes that derive from frequently used digital tools.
Findings	We found that teachers do not have a pedagogical concept of digital thinking skills, though many believe such skills might have a positive effect on their learners' achievements. School culture plays a key role in effective DI delivery. Teachers want better in-service IT instruction.
Recommendations for Practitioners	When distance learning has become the order of the day, we recommend practitioners connect pedagogical methodology and disciplinary content with new technology to boost learning outcomes. Recent world events have shown that in many cases practitioners have not been exposed to multiple digital options, especially those that not only present and review learning content but also boost the creation and dissemination of new knowledge.
Recommendations for Researchers	We recommend researchers review different types of available resources and their effective implementation in the school curricula in order to foster creativity and more profound thinking among teachers and learners.

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Impact on Society	Better informed and greatly improved DI in schools is clearly crucial for twenty-first-century systems. As we go to press, in the middle of the coronavirus world-wide lockdown, these words resonate more than ever before. Our research both highlights this obvious need and provides a heuristic bridge between basic research and classrooms.
Future Research	Future studies should focus on a pedagogical digital model that can enhance DI best practices in schools.
Keywords	digital pedagogy, thinking skills, digital innovation, information and communication technology, digital policy, school improvement

INTRODUCTION AND STUDY BACKGROUND

While technology provides many new opportunities for greater enhancement of learning, students do not acquire sufficient abilities in digital competence or working with knowledge (Kiili, 2012; Lundahl et al., 2010). Teachers using digital software in their instruction have continued to teach traditionally. The use of sporadic digital components in classrooms often substitutes for traditional teaching tools (Macaro et al., 2012; Uluyol & Sahin, 2016). In many classrooms, "computer work" has become a source of entertainment or a new form of "busy work" (Cook & Babon, 2017). "Busy work," which includes simple drilling and gap filling, is a well-known way of keeping learners occupied, quiet, or passive in a classroom. Quizlet is an example of digital "busy work". Although governments have invested hugely in incorporating technology into schooling and digital teacher education, there is still a distinct need to develop more honed DI. The 'Learning Compass 2030' (OECD, 2019) clearly points in this direction.

This study proposes an innovative, flexible, theoretical model, established by Eshet-Alkalai (2004, 2012), as an approach to digital instruction. We investigated whether the Eshet-Alkalai digital theoretical framework, a set of digital thinking skills, could be applied to digital pedagogy, thereby enhancing digital instruction (DI) best practices in schools and closing the perceived gap between the potential of DI and its current use.

Our research was conducted in English as a foreign language (EFL)classrooms in Israel but, based on case-study extrapolation, we deem our findings applicable to other countries and various school subjects.

LITERATURE REVIEW

Many have written about the constraints surrounding digital school instruction. Uluyol and Sahin (2016) highlighted the weaknesses of digital instruction; Hobbs and Tuzel (2017) and Judson (2006) pointed out that teacher attitudes and perceptions often preclude them from integrating technology effectively with instruction. Tigelaar et al. (2004) discussed the shortcomings of digital instruction in schools. Hobbs and Tuzel (2017) remind us that for many teachers "digital learning motivation profiles reveal distinctive identity positions" (p. 20). In a discussion of computer-assisted language learning (CALL), Macaro et al. (2012) found that the enthusiastic take-up of new media by young people was not necessarily accompanied by an understanding of how new media content is produced, nor by a capacity to read it critically, or play a role in the collaborative co-creation of knowledge. Attwell and Hughes (2010) pointed out such shortcomings a decade ago; they are still unaddressed.

We argue that highly complex epistemological and methodological challenges are involved in digital pedagogy and that these are consistently neglected by educators and policy makers.

Recent research into pedagogy that integrates technology for learning, advocates a move toward constructivist approaches (Garreta-Domingo et al., 2017). In order to help students succeed in today's digital knowledge society, schools should become knowledge-building organizations (Attwell & Hughes, 2010). This suggestion is in line with the idea of learning as knowledge creation (Iiomaki &

Lakkalam, 2018). Moreover, recent research on digital instruction in higher education posits that incorporating technological applications has advanced active learning, furthered learner engagement, and fostered knowledge construction (Seifert, 2012, 2016). Nowadays, technology is the only way to dramatically expand access to knowledge. Digital instruction allows students greater accessibility and variety in knowledge creation (Siemens, 2005).

In the TPACK model, Koehler and Mishra (2008), expounded upon the nature of knowledge required by teachers for integrating technology into the classroom, while addressing the complex, multifaceted and situated nature of teacher knowledge. The TPACK framework extended Shulman's (1987) idea of pedagogical content knowledge.

TPACK calls for a complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK). The TPACK approach goes beyond viewing the three knowledge bases in isolation by emphasizing what lies at the intersections of these primary knowledge forms. This idea is further explained by Koehler and Mishra: "The interaction of these bodies of knowledge, both theoretically and in practice, produces the types of flexible knowledge needed to successfully integrate technology use into teaching" (2008, p. 60).

The step from TPACK to digital learning models seems constructive as regards improving technological pedagogical content knowledge (i.e. the relationship between pedagogical practices, digital instruction, and specific learning objectives). Our research looks in depth at the Eshet-Alkalai model. Other models that delineate effective learning strategies within technology-enhanced learning include the 5C competences model embedded in seamless flipped learning (Lai & Hwang, 2014; Hwang et al. 2015).

The Eshet-Alkalai Flexible Digital Thinking Skills Model (DTSM)

Eshet-Alkalai and Aviriam (Eshet-Alkalai, 2004, 2012; Eshet-Alkalai & Aviram, 2006) developed a conceptual framework for digital literacy underpinn(ed by constructivist theories of learning. The model is further discussed in papers by Eshet-Alkalai and Chajut, (2009, 2010). Recent research into digital instruction (Taber, 2016; Kwan & Wong, 2015) continues to highlight the significance of constructivism in digital instruction. A major assumption of constructivism is that individuals learn better when they discover things on their own as a function of their experiences. The design of instruction thus moves away from knowledge dissemination towards knowledge creation. DTSM is essentially based on knowledge frameworks and proposes six theoretical cognitive digital skills.

Photo-visual skills (PVS): Effective photo-visual communication involves the promotion of good visual memory and strong intuitive-associative thinking. Decoding and understanding visual messages easily and fluently is an integral part of new-age learning.

Reproduction skills (RS): With the immense expansion of all boundaries due to digitalism, it has become essential to foster student abilities to create new meanings or interpretations by rearranging and combining preexisting information in any form of media (text, graphic or sound).

Branching skills (BS): The digital world, like the post-modern experience, is messy and nonlinear. Teachers need to grapple with this if they are to upgrade their digital instruction and encourage pupils to think divergently.

Real-time skills (RTS): These involve utilizing the ever-changing digital highway as a more coherent body of knowledge and incorporating it effectively into schools and communities. Knowledge is power.

Skepticism skills (SKS): Digital skepticism demands awareness; students need to evaluate and assess the credibility of digital information in a "brave new world."

Socio-emotional skills (SES): This new assortment of digital skills requires the use of sociological and emotional skills in the personal space of the digital world in order to share emotions and avoid internet traps such as hoaxes and deceptions.

Within this theoretical framework, DTSM offers an accessible model that is helpful to teachers in both choosing digital tools and encouraging skills to foster varied cognitive learning outcomes.

Information and Communications Technology (ICT) Context

The study was conducted in Israeli state schools. In the past 20 years, the Israeli government has supported a very expensive digital instruction enterprise (Ministry of Education's Project 'Computer for Each Child'). The budget for purchasing hardware was distributed via local and municipal authorities. Software is often supplied by text-book publishers, most of whom function as competitive, private enterprises. A publisher's textbooks must receive Ministry approval before being used in schools. Teachers also use additional software taken from the internet. In Israel, most classrooms have internet access and overhead projectors; teachers bring their own Ministry-provided laptops to class.

Many education policy makers in Israel view ICT as the sole pedagogical opportunity to improve national scholastic performance. Over the years, Israeli education has leaned strongly towards a traditional reliance on matriculation exams and high-stakes testing at all educational levels. This policy has been strongly criticized by those who view standardized testing as entrenching mechanistic and formal teaching methods, and endangering creativity and higher-order thinking skills. These critics "see in the development of ICT a golden opportunity to create challenging new teaching methods relevant to the pupil's world" (Volansky, 2010, p. 624). Yet, in the actual classroom, there appears to be little knowledge of Volansky and very few changes in pedagogy or learning outcomes.

EFL Context in Israel

DTSM seamlessly dovetails with the New Israel National Curriculum (Mazkirut Pedagogit, 2019) for English Language Education, as the curriculum is based on the descriptions of language activities and communicative competences of real life can-do statements delineated in the national curriculum (NC) for English. There is also direct reference to the required integration of ICT in the NC, whereby "learners are provided with tools to competently access, manage, store, create, critically evaluate and use information media and technologies as required" (p. 14).

Our study examined the perceptions and use of ICT in the context of English as a foreign language. English is by far the most important foreign language in Israel and regarded as a gatekeeper to higher education. It plays a powerful role in social mobility, academic recognition, and economic success. English studies mostly commence in Grade Three (ages 8-9) and end with matriculation at age 18.

Research Questions

We examined the following four research questions:

1. What are teacher perceptions of the importance of DTS to pupil learning?
2. To what extent do teachers use DTS in their practice?
3. Is there a relationship between the degree of DTS use in the instruction of English as a foreign language and teacher perceptions of the importance of DTS in learning outcomes?
4. Is there a correlation between actual use of DTS and teacher perceptions of the potential of IT to further develop and enhance their school culture?

RESEARCH METHODOLOGY

OBJECTIVES AND RESEARCH APPROACH OF THE STUDY

The study investigates teacher perceptions and use of DTS. A mixed-methods approach (Guba & Lincoln, 1989) was employed. Mixed-methods research, combining the collection and analysis of two different types of data (quantitative and qualitative) illuminates the findings from different points of view, supporting or expressing reservations about them (Johnson et al., 2007).

RESEARCH TOOLS

We employed two methods for the data collection, the semi-structured interviews described below and an online questionnaire, specifically devised for this study and posted on a popular online English teachers network in Israel (www.ETNI.org). The questionnaire examined teacher perceptions and use of Eshet-Alkalai's digital skills (2004, 2012). Table 1 presents the digital thinking skills posited by Eshet-Alkalai with concomitant practical applications and classroom practices in classroom discourse.

Table 1. Descriptions of digital thinking skills with paraphrased classroom discourse

Digital Thinking Skill	**Descriptions of examples provided for learning processes/outcomes with DTS**
Branching Digital Thinking Skill	Constructing knowledge by using "hypermedia skills," going on Wikipedia journeys using *NaraView* (e.g. examining extended themes when teaching important concepts).
Reproduction Digital Thinking Skill	Formation of new entities replicating existing elements for enhancing projects and class debates e.g. *To-Be Education*, Tricider.
Photo Visual Digital Thinking Skill	Interpreting & displaying graphic/visual (not text based) information (e.g. using *Imovie*, *Venngage*, *storyboard* or *AR Flashcards* for visual representations such as infographics in reading & writing assignments. 
Real-time Digital Thinking Skill	Making use of real-time aspects of digital environments using *QR codes*,  *Aurasma, Genial.ly* for identifying current themes/problems (Team Based Learning).
Skepticism Digital Thinking Skill	Critically evaluating the credibility of digital sources when searching for information for project-based learning (PBL) when using blogs.

To ensure content validity, three pedagogical experts were provided with the table above and asked whether each example was applicable for a specific digital skill. The experts came to a 97% agreement between the paraphrased statements of DTS and the digital tools at hand. Statements that did not receive a high consensus were omitted.

Semi-Structured Interviews

Twenty-five interviews were conducted with four school principals (two elementary, one junior high and one high school; all Hebrew-speakers). We interviewed three advisory teachers, two educated in South Africa and one educated in Moscow, and 18 teachers of English who had participated in an in-service course conducted by one of the authors. They included nine high school teachers from Hebrew medium high schools. Five had immigrated to Israel from the US and the UK, two were educated in Israel, and two were educated in the former Soviet Union. We interviewed four elementary school teachers from Arabic medium schools, all with Arabic as their first language. We interviewed five elementary teachers from Hebrew medium schools: two native speakers of Hebrew, one native speaker of Russian and one native speaker of Spanish. Experts examined and validated the interview questions and reached consensus about them with the researchers (Appendix A).

Data Collection

The researchers had developed a long-standing trust with the participating principals, coordinators, and teachers. Interviews were recorded and transcribed. An online database was created to store and encode interviews. Responses were coded according to identified categories (iterative review). Code frequencies were later manually highlighted and subsequently categorized into themes.

Interviews were generally conducted in schools. Nearly all participants were very keen to share their experiences, dilemmas, and involvement in instruction using IT with the researchers. Interview responses were analyzed using the reiterative review and sorting of identified topics and notions, using color coding in the raw data. The two open-ended questions were similarly analyzed. Closed questions were statistically analyzed using SPSS software.

Online Questionnaire

There were 64 respondents: 68% were high school (HS) teachers (10th-12th grades), 22.5 % taught in junior high (JH) schools (7th-9th) and 9.5% in elementary schools (4th-6th grades); 30% were English teachers and department heads. Advisory teachers for English and IT advisory teachers accounted for 5% of respondents; 67% had participated in IT in-service training. There was no significant difference in the average teaching tenure by grade levels taught. The overall mean teaching tenure was 19 years (M = 19) with a wide SD (= 10.63), and the median was 17.5 years.

A first name only online questionnaire was widely distributed, using email recruitment, social media, and snowball sampling during a three-month period. It was posted on a site frequently visited by teachers of English in Israel and also on the English Teachers' Facebook site. A detailed explanation of the questionnaire is included in Appendix B. The questionnaire relates to a teacher's professional background (teaching tenure, participation in IT in-service training, and perception and use of IT as part of the IT culture.

1. Professional background of teachers:
   a) Teaching tenure as defined by the number of years teaching.
   b) Participation in IT in-service training: 0=no, 1=yes.
   c) Perception of IT school culture was measured by one item where teachers rated the extent to which IT is part of their local school culture from 1 to 5.
   d) A teacher's general perceptions of ICT was measured by five items on a five-point scale ranging from 1=strongly disagree to 5=strongly agree. The items related to teacher perceptions of how much IT contributes to pupil learning. Samples of questions is included in Appendix C. An index was calculated as the mean response to items, with Cronbach reliability coefficient .734.
2. Teacher perceptions that IT can develop DTS were examined using five items from DTSM, each of which referred to a different DTS. Responses to statements were on a five-point scale

from 1=strongly disagree to 5=strongly agree. An index was composed for this item with Cronbach's alpha (reliability) = 0.813. Samples of statements are included in Appendix C.

3. Teacher use of DTS (i.e. practice) in the classroom was measured indirectly by five items relating to the extent of pupil application of each of the five digital skills. Each item was accompanied by a five-point scale from 1= they cannot do this, to 5=they can do this very well. An overall use index was calculated that had a Cronbach's alpha reliability coefficient of .803. In order for teachers to understand the concepts of digital thinking skills, examples were provided for each digital skill. Samples are included in Appendix C.

ETHICAL CONSIDERATIONS

It was made clear to all participating principals, coordinators, and teachers that data was for research purposes only. In addition, participants were assured that their names and those of the schools would be eliminated from research files.

FINDINGS

In order to provide a unified picture, quantitative findings are first presented and thereafter reinforced by qualitative findings. The findings related to our first research question are below:

What are teacher perceptions regarding the importance of DTS to pupil learning?

We conducted an analysis of variance with repeated measures followed by a Bonferroni test. The findings reveal differences ($F(4.27) = 6.25$; $p<.001$). The source of these differences is in Realtime> Skepticism. Means are presented in Figure 1.

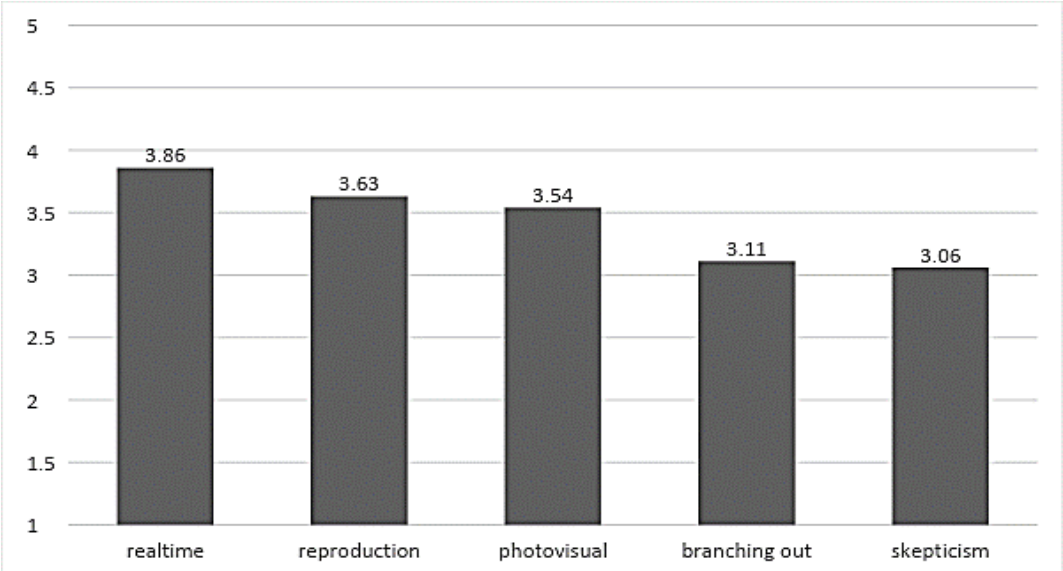

Figure 1. Teacher perceptions of IT ability to develop DTS

As can be seen from the Figure 1, in the opinion of teachers, all DTS skills can be developed to a moderate degree (> 3 and < 4 on a Likert scale 1-5). Realtime (M=3.86), Reproduction (M=3.63), Photovisual (M=3.54), Branching out (M=3.11) and Skepticism (M= 3.06). These findings are reinforced by the qualitative data.

Teachers also expressed a positive attitude towards the importance of digital thinking skills in their pedagogy. T1 claimed:

> *Digital thinking skills could be excellent.*

However, she was not alone when bringing up her need for better preparation for IT instruction, adding:

> *…but teachers need a lot of training, and interactive programs need to be developed, particularly in subjects like English.*

She was specific in mentioning that:

> *We must find better ways to incorporate a digital platform into our daily lesson plans.*

In her late 30s and with five years of experience in high school teaching, she states that she loves using technology in the classroom for many reasons*:*

> *It increases interest, creates excitement, and improves thinking skills. My students love learning this way. They are engaged on a multi-sensory level. It keeps them focused and they get to work right away. A lot of learning can take place. Sometimes my pupils think of clever things. Joe in Grade 10 is conducting digital research into his Jewish ancestors. He has made a website with links to a variety of sources he selected himself.*

Below are our findings relating to our second research question:

> **To what extent do teachers use DTS in their practice?**

We conducted an analysis of variance with repeated measures, followed by a Bonferroni test of the five relevant items. The findings reveal differences in perception ($F(4.48) = 8.89$; $p<.001$). The source of these differences is RS> all digital thinking skills. The means are presented in Figure 2.

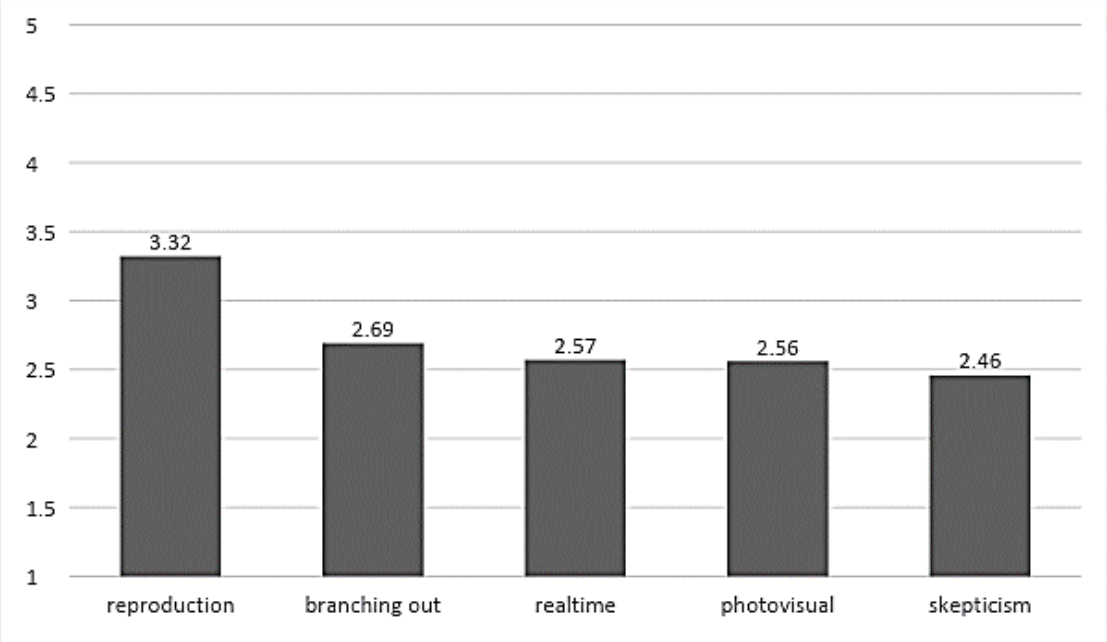

Figure 2. Teacher perceptions regarding pupil use of DTS in their classes

As seen in Figure 2, teachers reported moderate to little use of all DTS by pupils. RS is used markedly more than any other skill (M=3.32), and the skepticism skill is applied the least often (M=2.46).

In the interviews, 15 out of 17 teachers reported that they had been using IT in the past five years. Teachers focused most on reproduction skills and least on digital skepticism. T2 reported:

> *At the end of each unit, students were requested to present a summary of what they had learnt using a different medium such as Powtoon, and Goanimate. Students were really excited about this assignment.*

She regretfully adds:

> *My students believe what they see and often just cut and paste. They do not ask questions as to reliability, credibility or even the quality of their sources.*

She claimed that teachers were uncomfortable applying the Skepticism DTS, and were unsure of how to guide their students to search for reliable online sources: She explained:

> *I'm a bit worried … pupils are often requested to search for sources on the internet and I find it difficult to explain what a credible online source is. And anyway, I work in a religious school and we have a more closed internet system so the reliability of sources really is problematic.*

Our third research question asked:

> **Is there a relationship between the degree of DTS use in the instruction of English as a foreign language and teacher perceptions of the importance of DTS in their pupils' learning outcomes?**

Below are our findings. A t-test (paired) was conducted in order to check the differences between these variables. The results are shown in Figure 3.

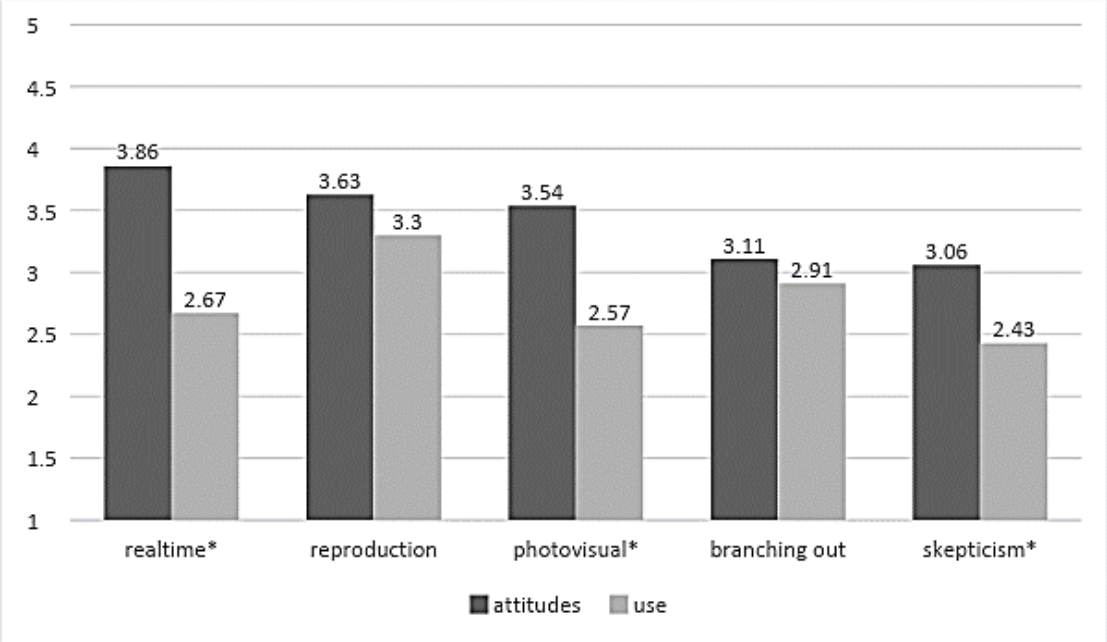

Figure 3. Differences between attitudes towards IT use of DTS and classroom use of DTS
***Significant differences p<.001**

Figure 3 illustrates that the use of DTS in the classroom as reported by teachers is consistently lower than their perceptions that DTS could be developed through IT.

We found no significant differences between perceptions and reported use with regard to RS and BS; however, we did find differences when it came to RTS, PVS, and Skepticism.

Teachers added further perspectives on perceptions and classroom practices. T3 elucidated:

> *There is huge potential in DTS to make digital learning far more relevant for our students…*
>
> *Your questions made me think about the difference between using the computer as a text book extension and the potential of digital thinking.*

Interestingly, she affirms:

> *…but we teachers need to be taught the connection between pedagogy and the specific learning outcome we are interested in when using digital tools. So, I suppose, eventually, learning outcomes will change, too.*

Our fourth question was:

> **Is there a correlation between actual use of DTS and teacher perceptions of the potential of IT to further develop and enhance their school culture?**

Here we looked at the extent to which teacher use of DTS related to their perceptions regarding the potential of IT to develop their school IT culture and their participation in IT in-service training. Table 2 presents correlations between the various variables.

Table 2. Correlations between use of DTS and other variables

Variable	**Correlation with use index**
Teacher perceptions in IT development of DTS	.374**
Overall attitudes towards IT	.508***
Teaching tenure	-.254
In-service training	.225
IT in school culture	.312*

* Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level
*** Correlation is significant at the 0.001 level

As seen in Table 2, three variables significantly and positively correlate with the use index: teachers' overall attitudes towards IT, teacher perceptions regarding the IT development of DTS, and IT in the school culture. Teaching tenure and previous participation in IT in-service training were not statistically correlated with use.

Multiple regression analysis was conducted with three independent variables which were significantly correlated with the dependent variable-use index: teacher perceptions of IT to develop DTS, IT in their school culture, and their tenure. The results were statistically significant ($F=4.758$, $p=.006$) and 23.7% of the variance in the use index explained. As seen in Table 3, all three independent variables were significant (or near significant in the case of tenure). Accordingly, the greater the IT school culture, the greater the teacher's perception of IT use for DTS; the lower the teacher's tenure, the more likely they will be using DTS in the classroom.

Table 3. Multiple regression results for predicting the use index

Independent variable	*Beta*	*SE*	*P*
IT school culture	.278	.108	.041
Tenure	-.239	.011	.072
Teacher perceptions of IT for DTS	.294	.148	.031

The findings show three significant variables in the use index: IT school culture, tenure, and teacher perceptions of IT for DTS.

The importance of the IT school culture was a recurring theme in the questionnaire, open questions, and interviews. T3 encapsulated this idea, stating:

> *If principals were on top of IT there would be more knowledge, more guidance, and better-quality IT in-service. Workshops would improve…Our IT in-service meetings are a bit dull. So twentieth century!! There is no space in which we talk about critical thinking or developing out-of-the-box ideas. We mainly gripe about faulty infrastructure. Sometimes we learn to use new closed programs and apps such as Mentimeter, Flipgrid, Gimkit, and Edpuzzle.*

DISCUSSION

This paper centers on an adaptation of the DTSM of Eshet-Alkalai. Other models could also be rendered into pedagogical outcomes, such as Hwang and Wang's 5 C model (Lai & Hwang, 2014; Hwang et al., 2015), which offers pedagogical adaptations to a theoretical model. Many scholars have observed that teacher attitudes and perceptions often prevent them from moving forward and accepting change in their practice (Judson, 2006). Our research strongly echoed the literature in this respect. Resistance to change is deeply ingrained in the teaching profession.

As we have noted, Seifert (2012; 2016) observed that recent research into addressing digital instruction in higher education posits that the incorporation of technological applications advances active learning, furthers learner engagement, and fosters knowledge construction. Siemens (2005) strongly advocates technology as the only way to dramatically expand access to knowledge. Digital instruction allows students greater accessibility and variety in knowledge creation. Our research points out that school instruction still lags behind in fostering knowledge construction and discovery-based learning.

In our case, the respondent reactions to the questionnaire testified that formulaic concepts have the potential to foster DTS which encourages superior learning outcomes, creativity, and innovation. For all that, the Eshet-Alkalai model is easily accessible, simple and clear, but not all teachers saw its immediate practical pedagogical implications. Further scaffolding, expansion, and exemplification within the model would assist teachers; additionally, more INSET and a new kind of conversation are needed regarding classroom development of digital thinking skills. Current research reports that digital instruction requires different pedagogical knowledge in order to attain new educational goals (Rossi & Mustaro, 2015).

School culture is a determining factor in school climate, so School Principal 1's words were not surprising:

> *It's all about exams. Projects and stuff like that are wonderful, but while high stakes test results count for so much ... forget it… They will research later in life … or not!*

Our study was based in a single country, characterized by a specific culture of education, technology, and its implementation in schools. It would be interesting to explore how DTSM could work in different educational settings. Although our questionnaire was posted onto a national site, there was a disproportionate reply rate from teachers of junior high and high schools; far fewer elementary school English teachers responded. It would be significant to include their views.

It is clear that educational changes are necessary in three obvious settings: (a) practice (classrooms), (b) in-service programs (INSET), and (c) within school goals. These are also known as school visions or principals' objectives. The strength of the model lies in addressing these gaps.

This study raises important questions. First, how do we best rethink classroom practice in order to enhance digital thinking? INSET, always a convoluted endeavor, also requires careful planning and

restructuring if it is to provide teachers with the critical twenty-first-century skills that they are demanding. Last but not least, is it possible to establish goals that promote critical thinking, creativity, and autonomous learning while standardized testing directs school leadership?

CONCLUSIONS

Although our data indicate an overall enthusiasm for using IT in class, our findings strongly suggest that there is still a need to deepen the teacher conversation regarding DTS in the class. Teachers appear to understand the difference between using technology "because it exists" and really making the most of new-age technology to foster creativity, thinking, innovation, and understanding among pupils. Analyses of teacher replies (digital skeptical skills) point, nonetheless, to a ubiquitous frisson of fear of digital usage: Are sources reliable? Are we exposing our students to subversive knowledge? Will all this technology work in my class on Monday morning?

Our research explored whether there is a relationship between the degree of classroom application of digital thinking skills in the instruction of EFL (= Use index) and teacher positions regarding the importance of these skills in improving teaching/learning a language (= Perceptions). The most prominent concern here is the differences between teacher perceptions of importance and perceptions of use in the Realtime, Photo-Visual, & Skepticism DTS.

It is clear from both the qualitative and quantitative findings that DI has changed the way students carry out assignments. Student production skills are highly developed and appear to be getting better. Paradoxically, teachers are behind their students in their knowledge of digital production potential. Some teachers ruefully blamed their in-service provision for this digital gap.

The findings indicate that the merit of DTS is the added value of digital instruction to dramatically expand access to knowledge, the capacity to read critically, and contribute to the collaborative co-creation of knowledge. Teachers are dealing with innovative, exciting teaching modes in technology but are not yet making full use of their potential. We are often in a paradoxical situation, one which has become a new norm, where students are more capable than their teachers in using and recognizing the potential of the digital world. Even teachers who are aware of the potential of new-age technology to foster creativity, thinking, innovation, and understanding among pupils still only use IT "because it exists." Such teachers are at a loss as to how to initiate required changes. Could DTSM be the trigger for change? Could this be the match that ignites the bonfire?

Especially in light of the COVID-19 crisis, new technologies provide unprecedented opportunities for knowledge creation. Now and in the foreseeable future, technology can support new pedagogies which focus on learners as active, critical participants with tools for inquiry-based learning. It is incumbent upon us to re-evaluate how, why, and when we use technology in our schools, what we need to do in order to bring our schools rapidly up to speed, what the budget is, and who is responsible for establishing clear goals and objectives. It is at this interface – where government, local authorities, and school management converge – that decisions are either made or obfuscated.

Clearly, two steps must be urgently taken by leadership and policy makers to upgrade digital instruction and allow its potential to come to the forefront: the improvement of the in-service teacher conversation within the in-service framework, and the identification of productive and creative IT assisted learning outcomes. It is to our own peril if we do not "rise up and live out the true meaning" of technology in the classroom. We need to uncover, address, and close digital gaps.

We believe Eshet-Alkelais' formulaic digital thinking skills contribute to the ongoing conversation about expanding digital use into the domain of critical thinking and creative skills. Our research suggests we are only at the start of a paradigm shift.

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The participation in this research was anonymous. The study was approved in compliance with ethical standards and the conflict of interest specifications of David Yellin College and the Jerusalem Institutional Ethics Committee. The authors declare that they have no conflict of interest.

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APPENDIX A: SAMPLE QUESTIONS

- Can you describe the kind of support teachers receive in digital instruction?
- Can you tell us how digital instruction has changed teaching in your school?
- Can you list ways in which you use digital tools to foster cognitive learning processes?
- Do the following digital tools (Table 1) foster knowledge construction?
- Do your pupils construct new knowledge (learning outcomes) when they use the following digital tools (Table1)?
- Do you believe there is a connection between a pupil's ability to construct new knowledge and produce learning outcomes when using a specific digital tool?

APPENDIX B: ONLINE QUESTIONNAIRE

https://docs.google.com/forms/d/145xB9MouAwzEsKu9yKL5NSNJ1ytFoZMI1CdQAAWYMWo/edit

IT Lessons in the EFL Classrooms in Israel

Dear Colleague,

We know how busy teachers are and we appreciate your valuable time and assistance.

We are currently conducting research into digital instruction and we'd like to ask you a few questions about IT (Information Technology) teaching in your English classes. The purpose of our research is to develop pedagogical methodology in this area. As you know, Information Technology (IT) is the use of any computers, storage, networking and other physical devices, infrastructure and processes to create, process, store, secure and exchange all forms of electronic data.

Filling out and sending back this questionnaire will help us enormously.The data will be collected only for the purpose of this research. Your participation or continued participation is voluntary and you may ask at any time to cancel your participation.The questionnaire is anonymous and will take you approximately 10 minutes to complete.

Thank you for your help,
Tamar and Shai

Personal information

1. Which grade levels do you teach?

- ◯ 4th - 6th
- ◯ 7th - 9th
- ◯ 10th -12th
- ◯ אחר: _____

2. What role do you currently hold at school?

- ◯ English teacher
- ◯ Technology consultant
- ◯ English teacher & Tech Consultant
- ◯ Coordinator of English
- ◯ אחר: _____

3. How many years have you been teaching

4. How many years have you been a technology consultant?

5. Have you attended IT specific Inservice training (השתלמויות)?

- ☐ Pisga
- ☐ School
- ☐ Other
- ☐ None

6. Is your school involved in the "Digital Schools Project"?

- ○ Yes
- ○ No
- ○ Don't Know

7. If yes, how many years have you taken part in the "Digital Schools Project"?

- ○ One year
- ○ Two years
- ○ אחר:

8. To what extent is IT part of your school culture?

	1	2	3	4	5	
the lowest level	○	○	○	○	○	the highest level

9. How many times a week do you involve technology in your lessons?

- ○ once
- ○ twice
- ○ three
- ○ four
- ○ more than four
- ○ אחר:

10. What percentage of the pupils' homework or external tasks include technology?

	0%	25%	50%	75%	100%
estimated percentage	○	○	○	○	○

11. During your (the teacher's) digital instruction, what percentage of your students actually use technology, on task, in class time ?

	0%	25%	50%	75%	100%
estimated percentage	○	○	○	○	○

12. Do you think IT lessons improve creativity?

	1	2	3	4	5	
Do not improve	○	○	○	○	○	Improve to a great extent

13. There is a connection between using IT and the improvement of learner achievements in English as a Foreign Language.

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

14. To what extent are you pleased with the use of IT in your English Teaching?

	1	2	3	4	5	
very low	○	○	○	○	○	very high

15. To what extent do you think that limited knowledge of English causes frustration in coping with tasks in a digital lesson

	1	2	3	4	5	
experience little frustration	○	○	○	○	○	experience considerable frustration

16. Integration of technology in English Instruction

To what extent do your pupils apply the following digital skills in their learning? 1- can not do this, to 5 - can do this to a very good extent

	1	2	3	4	5
1. the construction of knowledge in multiple ways (e,g., using software for concept maps, mind mapping, diagrams).	○	○	○	○	○
2. within the Domain of Appreciation of Literature: to construct knowledge by using "hypermedia skills" (e.g., teaching literature by entering links & using several sources of digital input.)	○	○	○	○	○

3. within the Domain of Presentation: to creatively reproduce learning outcomes using a variety of digital media (e.g., filming posters, videos of class debates when presenting projects)	○	○	○	○	○
4. within the Domain of Access to Information: to interpret digital graphic/visual representations/icons (not text based) that allow pupils to comprehend & interact with a theme (e.g., interpreting visual representations such as Infographics, emoticons, 'Emoji' icons in writing tasks.)	○	○	○	○	○
5. within the Domain of Access to Information: to make use of the real time aspect of digital environments as a trigger for identifying theme/problem (e.g., QR Code, forums,.)	○	○	○	○	○
6. within the Domain of Access to Information: to critically evaluate the credibility of digital sources when searching for information in order to construct new knowledge.	○	○	○	○	○

17. Which one of the above digital skills do your pupils apply the most in their learning?

○ 1
○ 2
○ 3
○ 4
○ 5
○ 6

18. Which one of the above digital skills do your pupils apply the least in their learning?

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6

19. Please express your opinion regarding the following statements:

1 -strongly disagree to 5- strongly agree

	1	2	3	4	5	I don't know
1. There is a connection between pupil ability to digitally access information in a non linear disordered manner and pupils' knowledge construction.	○	○	○	○	○	○
2. There is a connection between IT instruction and pupil ability to construct multiple ways of understanding information (e.g., mind mapping)	○	○	○	○	○	○
3. There is a connection between IT instruction and student engagement with real-time websites (e.g., news/general content, such as Ynet, Walla, others) that are relevant to subject being studied.	○	○	○	○	○	○
4. There is a connection between using IT instruction and pupil ability to create new meanings/interpretations of existing materials in any form of digital media (text, graphic, sound).	○	○	○	○	○	○
5. There is a connection between using IT instruction and pupil ability to integrate a variety of digital visual cues/prompts into the learning process (e.g., pictures, icons, films).	○	○	○	○	○	○

6.. There is a connection between IT instruction and pupil ability to critically evaluate the credibility of digital information.	○	○	○	○	○	○

20. Which one of the above statements do you agree the most ?

○ 1
○ 2
○ 3
○ 4
○ 5
○ 6

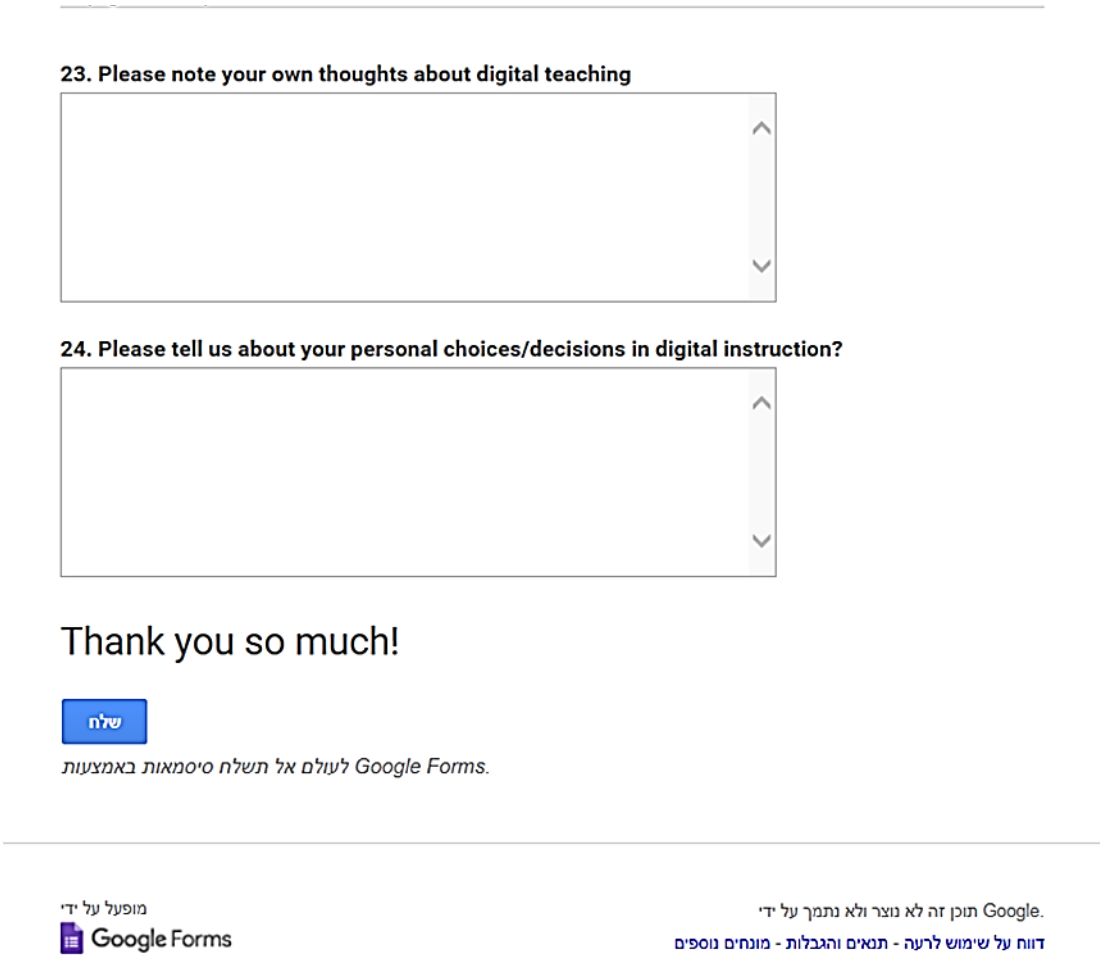
21. Which one of the above statements do you agree the least?

○ 1
○ 2
○ 3
○ 4
○ 5
○ 6

22. Please indicate to what extent do you agree or disagree:

1 - strongly disagree to 5- strongly agree

	1	2	3	4	5
1 Digital media empower pupils towards divergent thinking .	○	○	○	○	○
2. In IT lessons, pupils are exposed to a language-rich environment.	○	○	○	○	○
3. In IT lessons, pupils are merely exposed to a variety of sites with verbal stimuli (e.g., Starfall).	○	○	○	○	○



23. Please note your own thoughts about digital teaching

24. Please tell us about your personal choices/decisions in digital instruction?

Thank you so much!

שלח

לעולם אל תשלח סיסמאות באמצעות Google Forms.

מופעל על ידי Google Forms

תוכן זה לא נוצר ולא נתמך על ידי Google.

דווח על שימוש לרעה - תנאים והגבלות - מונחים נוספים

APPENDIX C: TEACHER PERCEPTIONS

Perceptions of IT as contributing to pupil learning – sample questions:

- To what extent is there a connection between using IT and the improvement of learner achievement?
- To what extent are you pleased with the use of IT in your English classes?
- To what extent do IT lessons empower pupils towards divergent thinking?
- To what extent do IT lessons foster construction of knowledge in multiple ways?
- To what extent are learners exposed to a language-rich environment in IT lessons?
- Do IT lessons improve creativity?

Teacher perceptions about whether IT can develop DTS – sample teacher statements:

- There is a connection between IT instruction and pupils' ability to digitally access information in a nonlinear disordered manner and pupils' knowledge (e.g. NaraView)
- There is a connection between IT instruction and pupils' ability to construct multiple ways of understanding (e.g. mind mapping).
- There is a connection between IT instruction and pupils' engagement with real-time websites to foster knowledge construction (e.g. Augmented Reality software, HP reveal, digital news).
- There is a connection between IT instruction and pupils' ability to integrate a variety of digital cues/visual representations into the learning process (e.g. Infographic).
- There is a connection between IT instruction and pupils' ability to create new meanings/new learning outcomes of existing materials in any form of digital platforms in inquiry-based pedagogies (e.g. Itimelapsepro & Imovie for filming videos foster project-based and inquiry-based learning).
- There is a connection between using IT instruction and pupils' ability to critically evaluate the credibility of digital information (e.g. Blogs & Forums).

Explanation and exemplification of digital learning skills –examples:

- To what extent do your pupils apply the following digital skill in the construction of knowledge in multiple ways (e.g. creating concept maps, mind mapping in Mindmeister, Mindmup)?
- To what extent do your pupils apply the following digital skills to construct knowledge using hypermedia skills (e.g. teaching literature by going on Wikipedia journeys using nonlinear sources of digital input such as in "NaraView")?
- To what extent do your pupils construct knowledge by creatively reproducing learning outcomes using a variety of digital media (e.g. using "Imovie" to film videos when presenting project-based and inquiry-based learning or software for simulations in role playing)?
- To what extent do your pupils construct knowledge by interpreting digital graphic/visual representations/icons (not text-based) that allow pupils to comprehend and interact with a theme (e.g. interpreting visual representations such as in "Venngage, Infogr.am" using Infographics, emoticons, in writing tasks)?
- To what extent do your pupils construct knowledge by making use of the real time aspect of digital environments as a trigger for identifying theme/problem (e.g. digital news such as Ynet, QR Codes and Augmented Reality software "HP reveal", "Cospaces")?
- To what extent do your pupils construct knowledge by critically evaluating the credibility of digital sources (blogs, forums) when searching for information in order to construct new knowledge?

BIOGRAPHIES

Dr Tamar Meirovitz is a lecturer and teacher educator at Beit Berl College. She has developed English Teaching Certification Programs and served as institutional coordinator at the David Yellin College in the international Erasmus+ (CURE) Curriculum Reform Project. Tamar was nominated as regional consultant for TEFL for the Israel Ministry of Education. Her interests are mentorship and dilemmas in teacher education, educational leadership and digital instruction.

Dr Shai Aran served as Ministry of Education Inspector for English and teacher educator at David Yellin Academic College of Education, Jerusalem, until her retirement. She currently teaches English in a pre-academic setting at the Hebrew University of Jerusalem. She has written published textbooks. Her interests are her family, school improvement, her students, cycling and pop music.

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EFFECTS OF MULTICULTURAL TEAMWORK ON INDIVIDUAL PROCRASTINATION

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ABSTRACT

Aim/Purpose	The purpose of this study is to discover usage differences in task performance by students of different cultures, by examining procrastination patterns from a national cultural perspective and exploring the effect of multicultural virtual teamwork on students' individual procrastination.
Background	This study aims to examine higher-education entrepreneurial learning in the context of multicultural virtual teamwork, as performed during participation on a Global Entrepreneurship course.
Methodology	The methodology consists of quantitative comparative data analytics preceding and subsequent to intercultural team activities. This research is based on analyses of objective data collected by Moodle, the LMS used in the In2It project, in its built-in log system from the Global Entrepreneurship course website, which offers students diverse entities of information and tasks. In the examined course, there were 177 participants, from three different countries: United Kingdom, France and Israel. The students were grouped into 40 multicultural virtual (not face-to-face) teams, each one comprised of participants from at least two countries. The primary methodology of this study is analytics of the extracted data, which was transferred into Excel for cleaning purposes and then to SPSS for analysis.
Contribution	This study aims to discover the effects of multicultural teamwork on individual procrastination while comparing the differences between cultures, as there are only a few studies exploring this relation. The uniqueness of this study is using and analyzing actual data of student procrastination from logs, whereas other studies of procrastination in multicultural student teams have measured perceived procrastination, collected using surveys.

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Findings	The results show statistical differences between countries in procrastination of individual assignments before team working: students from UK were the most procrastinators and Israeli students were the least procrastinators, but almost all students procrastinated. However, the outcome of the teamwork was submitted almost without procrastination. Moreover, procrastination in individual assignments performed after finishing the multicultural teamwork dramatically decreased to 10% of the students' prior individual procrastination.
Recommendations for Practitioners	The results from this study, namely, the decline of the procrastination after the multicultural virtual teamwork, can be used by global firms with employees all over the world, working in virtual multicultural teams. Such firms do not need to avoid multicultural teams, working virtually, as they can benefit from this kind of collaboration.
Recommendations for Researchers	These results can be also beneficial for academic researchers from different cultures and countries, working together in virtual multicultural teams.
Impact on Society	Understanding the positive effect of virtual multicultural teamwork, in mitigating the negative tendency of students from diverse cultures to procrastinate, as concluded in this study, can provide a useful tool for higher education or businesses to mitigate procrastination in teamwork processes. It can also be used as an experiential learning tool for improving task performance and teamwork process.
Future Research	The relation between procrastination and motivation should be further examined in relation to multicultural virtual teams. Further research is needed to explore the effect of multicultural virtual teamwork during the teamwork process, and the reasoning for this effect.

Keywords	procrastination, virtual teams, multicultural teams, individual procrastination

INTRODUCTION

Today's global business environment usually requires working in international multicultural teams. With the development of online technological tools, those teams often do not meet face-to-face and work virtually, on a daily basis. Courses in the academy try to train and habituate the students to their future environment; thus, they provide virtual-multinational-multicultural courses, in which students in different countries have to work together. Research shows both negative and positive effects of cultural diversity on team performance and on the teamwork process. Multicultural teamwork creates challenges that are inherent to culture, as people coming from different cultural value systems and managerial practices may react in different ways. Those challenges, mainly communication, problem solving and decision-making, leadership, task and relationship conflicts, may hamper team-members' willingness to cooperate (Dzionek-Kozlowska & Rehman, 2017; Goldstein & Gafni, 2019; Lans et al., 2013; Mueller & Thomas, 2001; Stahl et al., 2010).

The main framework used in research to explain the effect of diversity on teamwork has been social categorization, a depersonalized perception that the similarities and differences possessed by group members are used as a basis for categorization. Those distinguish between one's own in-group and one or more out-groups (Chatman & Flyn, 2001; Guillaume et al., 2017; Harush et al., 2018; Stahl et al., 2010; Van Knippenberg et al., 2004). When these categorization processes are along the lines of cultural diversity, they are reflected in team members' various cultural identities, perspectives, and values. Moreover, they may lead to team conflicts, mistrust, fault lines, communication barriers and disagreements on regulations, norms, expectations, and decision- making processes (Cramton &

Hinds, 2014; Dau, 2016; Earley & Mosakowski, 2000; Harush, Lisak & Glikson, 2018; Hinds & Bailey, 2003; Hinds & Mortensen, 2005; Liu et al., 2010; Stahl et al., 2010; Staples & Zhao, 2006).

The national culture of each team member in multicultural teams may generate differences across national and regional boundaries (Mueller & Thomas, 2001). The differences in tendency to procrastinate (Ariely & Wertenbroch, 2002; Cerezo et al., 2017; Gafni & Geri, 2010a), diurnal patterns of work (Gafni et al., 2011; Gafni & Filin, 2015; Tu et al., 2017) and performance of non-mandatory tasks (Gafni & Geri, 2010b), may result in teamwork task-related conflicts (Jehn, 1995). Those conflicts may be mitigated if the team-members perceive their multicultural teamwork as a learning process (Ely & Thomas, 2001).

In the past decade, there has been a noticeable trend toward greater tribalism and ethnocentrism, that corresponds with the global business environment. Globalism, tribalism and ethnocentrism influence one another, but also have an impact on multicultural collaborations and multicultural teamwork (Machida, 2012). This research will not refer to multicultural teamwork in the context of tribalism and ethnocentrism, but will only be limited to the context of culture.

Virtual technology enables communication between the multicultural team members that are geographically dispersed, and allows monitoring their performance (Gefen et al., 2008; Hertel et al., 2005). Yu and Liu (2009) stressed the importance of creating a psychologically safe online learning space for learners that enables support, openness, trust, mutual respect, and risk-taking. Martinho et al. (2014) found that Moodle, which is common in the higher-education environment, is a psychologically safe learning environment. Tracing the students' mode of use of the given LMS (Learning Management System) platform can reveal diurnal time patterns (Gafni et al., 2011; Gafni & Filin, 2015; Spennemann, 2007; Spennemann et al., 2007; Tu et al., 2017) and time management of students from different countries (Foltynek & Motycka, 2009; Vryonides, 2008).

Following prior research, this study aims to examine higher-education entrepreneurial learning in the context of multicultural virtual teamwork, as actually performed during participation on a Global Entrepreneurship course, conducted under the In2It project, an Erasmus+ project funded by the European Union. In2It was a three-year-long project (2016-2018), conducted by a consortium of seven Israeli Colleges and seven Universities from Europe. Its aim was to develop online courses on a virtual platform. The In2It LMS platform was developed on Moodle, as a common psychologically safe environment. This study is based on analysis of objective data collected by the log of Moodle used throughout the course. The online course consisted of a variety of components stored in Moodle's course repository, such as short explaining videos, short pieces of information to read, quizzes, assignments, and questionnaires, some to be performed individually and others in cooperation with the team members. The students go through the components during a specific time, at their own pace, taking into consideration the cooperative activities.

The purpose of this study is to discover usage differences in learning and task performance by students of different cultures, especially by examining procrastination patterns and behaviors from a national cultural perspective, exploring the effect of multicultural virtual teamwork on individual student procrastination. Understanding the differences using technology in order to work in multicultural teams is expected to provide useful guidelines for deciding how these differences can be used or decreased, according to their value, in future training of multicultural teams or working processes.

THEORETICAL BACKGROUND

STUDENTS' PROCRASTINATION IN THE CONTEXT OF NATIONAL CULTURE

Procrastination is the deferment of actions or tasks to a later time, or even to infinity. It is defined as unnecessarily postponing or avoiding tasks that must be completed (Schraw et al., 2007). Ferrari et al. (1995) proposed two different forms of procrastination, situational-specific task delays, and chronic dispositional delay behavior patterns. They divided chronic procrastination into two types. The first,

arousal procrastination, is the delay that makes a person stimulated when rushing to complete a task. The second, *avoidant procrastination*, is the delay of tasks such that completion would reflect one's abilities. In avoidance procrastination, when not completing a task by a specific deadline, the person may claim that poor performance was influenced by lack of effort or greater rates of time pressure instead of lack of personal ability (Ferrari et al., 1995). Academic procrastination, defined as the tendency to postpone learning activities, is a consequence of post-modern values that are prominent in post-industrialized societies (Dietz et al., 2007). In Western societies, there is an increase in procrastination for two reasons. First, modern technology (social networks, computer games, e-mailing, music-streaming, etc.) can negatively affect the ability to focus and cause procrastination toward tasks. Second, modern values indicate a preference for school, future goals and hard work while post-modern values indicate a preference for social activities and pleasure now. In many cases, there is limited time to pursue different academic and leisure activities, leading to a motivational conflict between the two activities. When students strive for leisure goals and have no structured routines for academic tasks, delaying strenuous learning activities becomes probable. In the modern school learning environment, which advocates autonomous and team learning, delay or failure to complete schoolwork is a common and serious problem among elementary school students (Chiu et al., 2020).

Gafni and Geri (2010a) add that in individual tasks, which are seen and commented on by others, the behavior of the first participants defines norms for the whole class. A wide array of studies link procrastination to personal behavioral factors, such as lack of motivation, deficiencies in self-regulation, external locus of control, perfectionism, disorganization and poor time management (Ackerman & Gross, 2005; Phillips et al., 2007), but only a few studies have explored procrastination using a cross-cultural framework (Zhang & Zhang, 2007; Klassen et al., 2010). Research has shown that procrastination is common in general populations, and is almost universal among university students (Steel, 2007); nevertheless, a student's academic practices, such as study time and procrastination, may be related to culturally different understandings of academic values and behaviors. Cultural background and values may also influence an individual's choices about engaging in or avoiding a challenging task, or may influence the interpretation of procrastinating behaviors (Klassen et al., 2010). Students from collectivist yet achievement-oriented environments may interpret procrastination more negatively than students from individualist environments. This is caused by higher levels of fear of failure and a stronger inclination to avoid family shame and embarrassment (Chong, 2007; Klassen et al., 2010). The perceived cost of procrastination may be greater for students from collectivist contexts because procrastination might be construed as conflicting with personal/academic goals and family expectations (Klassen et al., 2010).

Using Hofstede's (1984) individualist-collectivist dimension while analyzing cross-cultural student groups, Dunn and Wallace (2004) found that Singaporean students spent more time studying, memorized more material, and requested more explicit instructions for assignments and exams than students in a Western cultural context, such as Canada. In another study, Ferrari et al. (2005) found no significant differences in arousal and avoidance procrastination of adults across United Kingdom, United States and Australia, and conclude that chronic procrastination is a common occurrence among adults living in westernized, individualist, English-speaking countries. On the other hand, Olson and Olson (2003) found that in individualist countries, time is spent on accomplishing tasks, and in more collectivist countries, time is spent on building relationships. Saunders et al. (2004) contend that "time visions", which are different perceptions of time across sets of time dimensions, are based on different ethnic and national orientations about time, which affect team-member perceptions of deadlines and team success. Even though individuals' sense of time is psychologically based, it is refined by participation in society and culture.

Multicultural Virtual Teamwork - Effect on Student's Procrastination

Gafni and Geri (2010) examined procrastination in academic environments, and found differences in procrastination tendency to perform individual and collaborative tasks. Their findings suggest that students tend to perform their individual task, obligatory or voluntary, on time, but tend to procrastinate compulsory collaborative tasks, and not complete at all the voluntary ones. However, in this study, and others (Van Eerde, 2003; Özer et al., 2009) the students participating were homogeneous, and not from different cultures.

Marquardt and Horvath (2001) define cultural diversity in student teams as a collaboration of two or more individuals from different cultural or national backgrounds, who have been assigned to interdependent tasks and are jointly responsible for their results. These individuals see themselves, and are seen by others, as a collective unit embedded in an academic environment, managing their relationships within a certain educational environment. Studies on virtual-multicultural teams, which add the virtual aspect (Gibson & Gibbs, 2006; Hertel et al., 2005), focus on four characteristics:

(1) Geographic dispersion, where at least one of the team members works at a different location, or at a different time zone.
(2) Communication is based on electronic technology (e.g. email, fax, phone, video conference, etc.).
(3) Structural dynamism.
(4) National diversity.

Hartmann and Gerteis (2005) define multiculturalism as the creation of social conditions under which diversity can be sustained and new conceptions of solidarity can be created within the reality of increasingly diverse societies. Research on multicultural teams shows both negative and positive effects of cultural diversity on teams in two potentially opposing ways (Mannix & Neale, 2005; Stahl, et al., 2010):

(1) The negative effect relates to social theories, which show that people are attracted to working and cooperating with those they find similar in terms of values, beliefs, and attitudes. Moreover, they tend to categorize themselves into specific groups with others as outsiders, and they treat members of their own group with favoritism, and may judge "others" according to group stereotypes. Therefore, managerial practices and techniques, such as goal setting, incentives, socialization, communication, problem solving and decision-making, may be considered legitimate and acceptable in one culture, and may not be acceptable in another (Erez & Early, 1993; Earley & Gibson, 2002; Shokef & Erez, 2006).

(2) Research finding positive effects suggests that diversity brings different contributions and benefits to teams. A diverse team covers a broader territory of information, taps into a broader range of networks and perspectives, and can have enhanced problem-solving, creativity, innovation, and adaptability (Ely & Thomas, 2001; Bunderson & Sutcliffe, 2002; Bouncken, 2004), both in individual level and team level (Tadmor et al., 2012).

Jehn (1995) defined two kinds of conflicts in multicultural teams: (1) relationship-related conflict; and (2) task-related conflict. Relationship-related conflict might arise due to attitudinal problems, such as dislike, mistrust and lack of cohesion, free riding, and procrastination as a form of free riding that, in excess, can jeopardize a team's ability to meet a deadline (Gans & Landry, 2016). Furthermore, in virtual teams, opportunities for free riders and procrastinators may be enhanced because their (reduced) efforts are more likely to go undetected. Additionally, team members may feel that it is easier to set aside their virtual teamwork when their local demands take precedence (Reeves & Furst, 2004). Task-related conflicts might occur because of a clash of opinions with respect to the tasks,

such as adhering to timelines or different attitudes towards deadlines (Behfar et al., 2006; Harush et al., 2018; Ren & Gray, 2009). Japan, Germany, and the United States are very high on task focus, whereas France, Russia, and the Netherlands are quality-of-life focused. People in collectivist cultures have a stronger preference for avoiding and less for contending than people in individualist cultures (Boros et al., 2010; Leung, 1997). An important factor in overcoming many multicultural teamwork challenges is the existence of a shared meaning system that reflects a common global work culture beyond their distinct socio-culturally national cultures (Earley & Gibson, 2002; Shokef & Erez, 2006).

Using a lens of Positive Organizational Scholarship (POS), Stahl et al. (2010) draw upon recent research on cultural diversity to explore the positive aspects of cross-cultural dynamics in teams and identify some of the processes underlying these effects in rigorous ways. They suggest that individuals' positive trait-like states, such as optimism, hope, efficacy, and resilience, can create synergistic effects in teams, and it is possible that if one person in a team embodies these states the entire team can benefit. High-performing teams can create positive contagious effects throughout an organization, while boosting the states of individual members. In recent research, Goldstein and Gafni (2019) found that multicultural teamwork was a trigger for German and Israeli students and young professionals to participate in a virtual entrepreneurial accelerator, and that in the context of entrepreneurship studies, German and Israeli cultures were found by participants as complementary, stimulating and fruitful. Through the multicultural teamwork experience, participants improved their individual entrepreneurial skills and mindset. Ely and Thomas (2001) argue that diversity perspectives in multicultural teamwork are classifiable into three types: (1) integration and learning, (2) access and legitimacy, and (3) discrimination and fairness. They found that only the integration and learning perspective provided the rationale and guidance needed to achieve sustained benefits from diversity. They conclude that if the team's diversity is seen as a learning resource for the team, it enhances adaptation of change and redefining goals, markets and products. Tadmor et al. (2012) add that multicultural teamwork experience enhances not only the creativity of individual team members but also the joint creativity of the team so that the creative whole is greater than the sum of its parts.

THE EU ERASMUS IN2IT + PROJECT

The EU Erasmus+ In2It (Internationalization by Innovative Technologies)three-year project developed and implemented an innovative technological infrastructure (In2It LMS platform) and online courses for the purpose of advancing internationalization in higher education, and thereby to expand the practical applications of internationalization. Faculty team-members from seven Israeli academic colleges and seven European universities (Kingston University London and Brunell University in the UK, Université de Montpellier in France, Pädagogische Hochschule Ludwigsburg in Germany, Politechnico di Milano and Università Cattolica del Sacro Cuore in Italy, and Warsaw University of Technology in Poland), collaborated and developed a learning platform based on Moodle, and four collaborative online courses in English. In these courses, the Israeli and European students, worked together in virtual multicultural teams, strengthening their English skills, and exchange of knowledge and experience within an international forum.

This study is based on the Global Entrepreneurship online course, a short-term virtual multicultural Ideation Hackathon (an opportunity-centered entrepreneurial teamwork online course), that was developed on the In2It LMS platform. Figure 1 shows the design structure of this course.

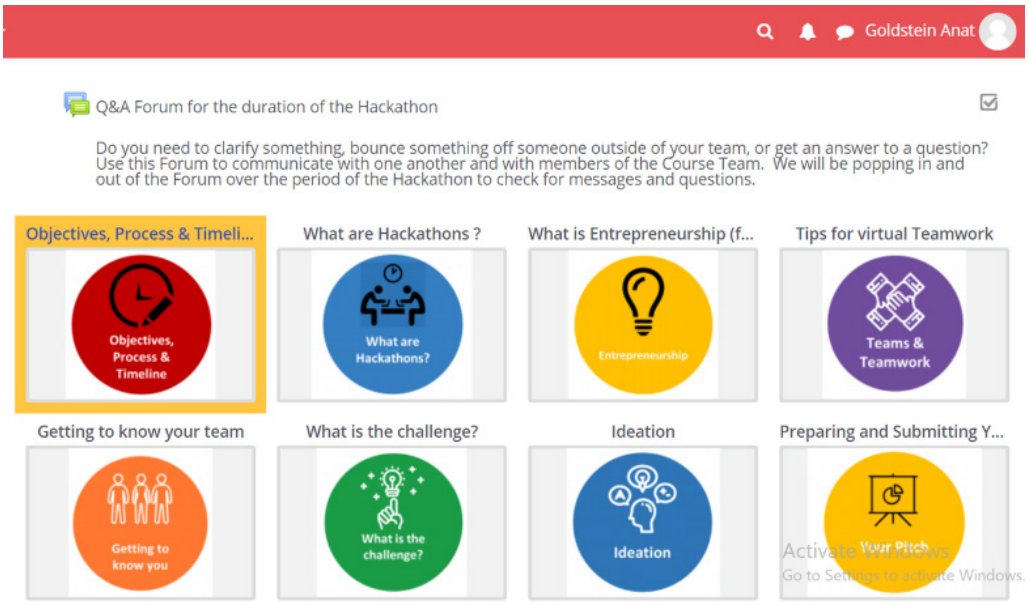

Figure 1. Global Entrepreneurship Course LMS design on Moodle

The first Ideation Hackathon was conducted through the In2It platform in 2017. Students from British, French, and Israeli academic institutes were grouped in short-term multicultural virtual teams, aiming to learn entrepreneurial skills and mindset through this experience. The content of the Ideation Hackathon was designed using Rae's (2003) opportunity-centered entrepreneurial learning process, which encompasses four stages: (1) exploring the opportunity; (2) relating the opportunity to personal goals; (3) planning to realize the opportunity; and (4) acting to make the opportunity happen. A narrated presentation of the innovative solutions, using the Business Model Canvas (Osterwalder & Pigneur, 2010), was the collaborative teamwork outcome.

The In2It virtual platform was designed to enable psychologically safe communication. This was based on the following.

(1) Moodle platform was chosen as a base for In2It project development, as it is the common collaborative learning platform that the participating academies used as their course LMS. As a common platform in higher education environment, Moodle was widely researched, and was found to enable building of trust, motivate engagement, and easy to use generally (Erez et al., 2013; Gibson & Gibbs, 2006; Hertel et al., 2005; Kirkman et al., 2013; Schepers et al., 2008; Yu & Liu, 2009).
(2) Team allocation – during grouping, tutors avoided the assignment of team members from the same academic institutes, in order to mitigate sub-groups communication (Earley & Mosakowski, 2000). Moreover, an online team-building task preceded the Ideation Hackathon, to enhance openness between team members (Ren & Argote, 2011).
(3) Online tutor support – announcements through Moodle and a Q&A forum were offered during the Ideation Hackathon. Martinho et al. (2014) researched communication through Moodle as a psychologically safe environment, and found that Moodle is easy use, posting activities regularly makes students interact more in the forums, and it is an advantage to get succinct answers and tutor support.

Management and Information Systems students, undergraduate and graduate, from Kingston University of London, Brunel University of London, Montpellier University of France, and several Colleges from Israel participated in the Global Entrepreneurship online course.

RESEARCH QUESTIONS

This research aims to discover differences in students' attitudes regarding procrastination when working individually or in international multicultural teams. Two main research questions were investigated.

R1: Are there differences between cultures in students' individual and interdependent task procrastination?

> H1: There will be differences between cultures in procrastination of individual participants. This hypothesis is based on the literature review, where differences between collectivist-individualist, European-Mediterranean cultures, showed differences in attitudes towards procrastination (Klassen et al., 2010; Olson & Olson, 2003; Saunders et al., 2004).

R2: How does the international multicultural teamwork affect the individual procrastination of the students?

> H2: Cultural diversity in teamwork will affect the procrastination of individual participants after teamwork (Mannix & Neale, 2005; Stahl et al., 2010; Tadmor et al., 2012). This study aims to draw on Stahl et al.'s (2010) POS approach, and suggest that individuals' cultural approach towards time and procrastination may affect individuals from other cultures in a positive way.

METHODOLOGY

This research is based on analysis of objective data collected by Moodle, the LMS used in the In2It project, in its built-in log system, from the Global Entrepreneurship course website, which offers students diverse information and tasks. The data was collected during the course, which took place in 2017. The primary methodology of this study is data analytics, which is a growing trend in research (Levy & Ramim, 2012; Ravid et al., 2007), as well as in business environments (LaValle et al., 2011; Pakkala et al., 2012), due to the gigantic data sets that information systems produce when recording and storing the logs of all the users' activities.

The examined data included the number of visits to each course element, the diurnal time when it was done, the type of activity, etc., according to the data stored in the log. Most of the data contained in the log were in the form of text, which needed to be elaborated, in order to enable data analysis

The students were divided into teams with each team consisting of students from different countries (UK, France, and Israel) and institutions. The online course was a compound of a variety of components stored in Moodle's course repository, such as short explanatory videos, short pieces of information to read, quizzes, assignments, questionnaires, etc., some to be performed individually and others in cooperation with the team members. Each task of the course had a due date, which was taken into consideration for calculating the procrastination. The students had to go through all the components on their own pace, taking into consideration the cooperative activities and the due dates. The tasks of the course, according to its syllabus, are presented in Table 1. For each task, its position in the course schedule, its characteristic (individual, interdependent, or team) and due date are presented.

The students were assigned into teams manually, following a "multicultural" criterion: each team consisted of students from different countries (UK, France, and Israel) and from different institutions. The online course was compound of a variety of components, stored in the Moodle's course repository, such as short explaining videos, short pieces of information to read, quizzes, assignments, questionnaires, etc., some to be performed individually and others in cooperation with the team members. Some teamwork online tools outside the In2it platform (such as Asana. Trello, Whatsapp, etc.) were recommended for communication between students in teams, and the teams decided

which tools to use during their teamwork. There were also guidelines for collaborative teamwork, including brainstorming an idea, and an innovative process for choosing the right idea (as shown in Figure 2).

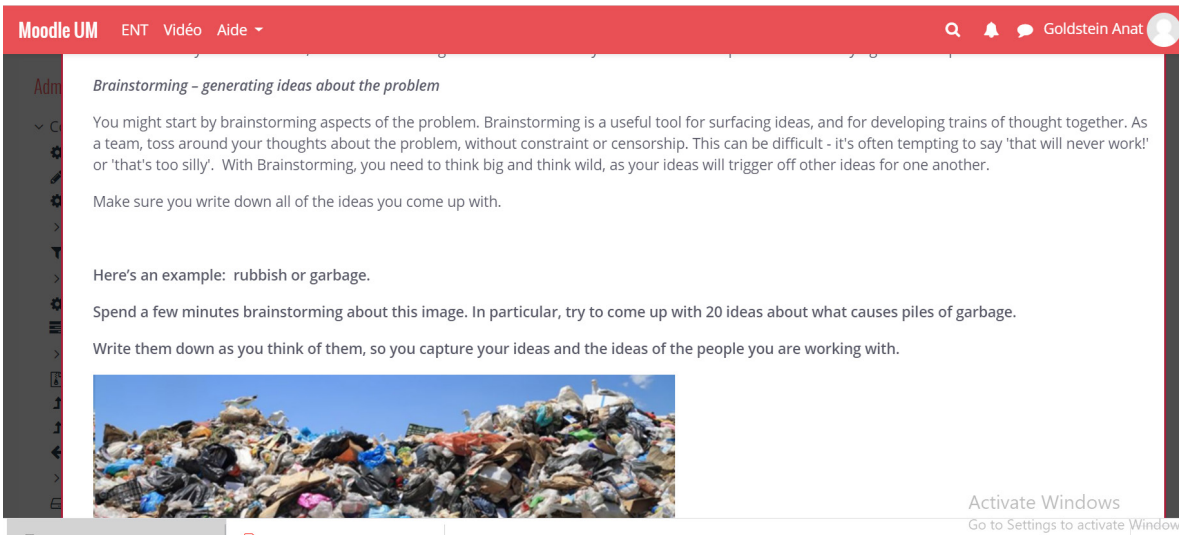

Figure 2. A screenshot of the Ideation and Brainstorming guidelines on LMS

Each task of the course had a due date, which was taken into consideration for calculating the procrastination. The students had to go through all the components on their own pace, taking into consideration the due date for each task, either in individual or cooperative activities. The tasks of the course, according to its syllabus are presented in Table 1. For each task, its position in the course schedule, its characteristic (individual, interdependent or team), and due date are presented.

Table 1. Global Entrepreneurial tasks

Task	Position in course timeline	Characteristic	Due date
Pre-course survey	1	Individual	10/11/2017
Quiz 1	2	Individual	19/11/2017
Quiz 2	2	Individual	19/11/2017
Quiz 3	2	Individual	19/11/2017
Individuals ideas submission & individual comments on other's ideas	2	Interdependent	19/11/2017
Team work	3	Team (not on platform)	20-26/11/2017
Pitch Submission	4	Team	26/11/2017
Post-course survey	5	Individual	7/12/2017

The tasks were differentiated by their characteristic: "individual", "interdependent" and "team". The "individual" tasks were performed by each of the students separately, without collaboration between students. The "interdependent" tasks were performed by students separately in a designated common

ideation forum, and were viewed and commented on by other students. The "team" tasks were collaborative (on the In2It platform and other communication tools), and were performed by all members of the team.

Most studies on procrastination (e.g., Ackerman & Gross, 2005; Ariely & Wertenbroch, 2002; Lavoie & Pychyl, 2001; Özer et al., 2009; Phillips et al., 2007; Van Eerde, 2003) are based on questionnaires that are filled in by the participants. In this study, the procrastination was calculated from actual performance, as in the research of Gafni and Geri (2010a). In order to calculate the procrastination, which is the dependent variable, the actual date of the performance of the task by the student, as recoded in the LMS In2It log, was compared to the due date. If the dates were equal, the procrastination was defined as 0 (zero). If the task was performed before the due date, the procrastination was defined as a negative number showing the number of days before the due date. If the student procrastinated, the procrastination was defined as a positive number, showing the number of days of procrastination. The pre-course survey questionnaire included demographic data, which was used in order to classify the students and to divide them into teams.

All data received from the LMS log was extracted to an Excel file, and then it was organized and cleaned manually, leaving only relevant data in the file. This was performed by both authors of this study. Records that traced the tutors' activities were deleted. The LMS log keeps each kind of transaction performed by each of the users, like logging-in to the LMS, reading a page, viewing a video, performing a quiz, submitting an assignment, etc. Each transaction logged contains the user's ID, the timestamp when the transaction started, the activity performed and the course element that was operated (the specific video/text/quiz/etc.). The records not needed for this research, have been omitted, leaving only the data about students' transactions regarding the submission of the quizzes, the submission of the individuals' ideas, the pre- and post-course surveys submission, and the pitch submission. The procrastination was calculated by the difference between the due date for each task, and the actual date of submission of the specific task for each student, as recorded in the LMS.

The elaborated data was then transferred to IBM® SPSS® where it was statistically analyzed. The final file included the following columns: User-ID, Country, Gender, Team number, Task (quiz submission, pitch submission, etc.), Performance time (timestamp), Calculated procrastination (difference between due-date of the specific task and its submission date).

RESULTS

In the examined course, there were 177 participants, from three different countries: United Kingdom, France and Israel. Their ages range from 20 to 40 years old, with an average of 26. Table 2 summarizes demographic data about the students. The students were grouped into 40 multicultural teams, each one composed of participants from at least two countries. Table 3 presents the details according to the different tasks in the course.

Table 2. Demographics (totals)

	Number of Students		
Country	**Total**	**Male**	**Female**
United Kingdom	18	7	11
France	46	21	25
Israel	113	59	54
Total	**177**	**87**	**90**

Table 3. Demographics according to the tasks on the LMS In2It platform

			Number of students that performed the task on the platform					
Task	**Position - course timeline**	**Charac-teristic**	**Total**	**France**	**Israel**	**UK**	**Male**	**Female**
Pre-course survey	1	Individual	177	46	113	18	87	90
Quiz 1	2	Individual	120	41	70	9	50	70
Quiz 2	2	Individual	119	39	72	8	49	70
Quiz 3	2	Individual	123	39	77	7	50	73
Individuals ideas submis-sion	2	Interde-pendent	91	19	67	5	38	53
Team work	3	Team (not on platform)	-	-	-	-	-	-
Pitch Submis-sion	4	Team	40	-	-	-	-	-
Post-course survey	5	Individual	157	39	106	12	75	82

Procrastination of the submission of each task was calculated, as explained in the methodology section, using the task-defined due-dates as a reference. The pre-course survey was a requirement for starting the course, and only after completion of the pre-course survey, the course material and tasks were opened on the platform. Therefore, the completion of the pre-course survey was not counted in the procrastination calculation.

In order to examine the first research question (R1), regarding the possibility of differences between cultures in students' individual and interdependent tasks procrastination, T-tests were performed, for each kind of task.

Quizzes are individual tasks that were not obligatory, but had a due date. All quizzes had the same due date, so data were examined for all quizzes together. Table 4 shows the procrastination percentage of individual Quizzes submissions (all three quizzes) compared by country. The table is a result of the frequency percent by country of all quizzes submissions until the due date (negative and zero procrastination) and after (positive procrastination).

Table 4. Procrastination in Individual non-mandatory tasks (all 3 quizzes) according to Countries

% of Submissions	**France** N=119	**Israel** N=219	**UK** N=24
Up to due date	56.3%	58.0%	41.7%
Procrastinated	43.7%	42.0%	58.3%
Total	100.0%	100.0%	100.0%

The post of the student idea submission is an interdependent task. Although this task is performed by each student, like the individual tasks, the submission is posted to a forum to which all students have access. Moreover, other students can comment or criticize the idea. Students may be shy to submit before seeing what others have submitted. Table 5 shows the procrastination, by country, in the interdependent task. No statistical differences in any of the countries were encountered when the data were further investigated by gender.

Table 5. Procrastination in Interdependent non-mandatory tasks (Individuals' idea submission) according to Countries

% of Submissions	France N=19	Israel N=67	UK N=5
Up to due date	73.7%	50.8%	60%
Procrastinated	26.3%	49.2%	40%
Total	100%	100%	100%

In order to examine the second research question (R2) regarding the change in individual procrastination after performing multicultural teamwork, the procrastination of teams in the team-task (pitch submission) was calculated, as well as the individual procrastination, as evidenced in the post-survey. The only team-task performed and recorded by the In2It LMS platform was the task of submitting the team's pitch. This task was performed by one member of each team, after working together during the Global Entrepreneurship online Ideation Hackathon. The teamwork during this period was not performed using the In2It LMS platform, so there is no recorded data evidence about their intergroup communications and teamwork process. The teams used Skype, WhatsApp, and Facebook to communicate between them and work together. The final outcome of this teamwork was a narrated pitch. The submission of the pitch to the In2It LMS platform was recorded, and the procrastination was calculated for the teams: 35 teams submitted on time, two teams submitted one day before, and three teams submitted after the due date (one day after). Overall, it can be seen that almost no procrastination was found in the team task.

In order to examine if the teamwork process, which resulted in almost no procrastination in the team-task submission, affected the individual procrastination, the procrastination of the students who finished the course, namely performed the quizzes and the last task (post-course survey) was calculated for both tasks, for the same students and compared. Table 6 presents the outcomes, aggregated for all the students in each country. Figure 3 presents the frequencies of change in procrastination per student, where the "before multicultural teamwork" procrastination was calculated for each student according to the average procrastination of the quizzes the student submitted, and the "after multicultural" procrastination was calculated according to the post-course survey procrastination. The difference in procrastination for each student was calculated, taking into account only those who performed at least one quiz and post-course survey (N=131). Results of both Table 6 and Figure 3 clearly show that after teamwork almost all individuals improved their procrastination.

Table 6. Change in Individual Procrastination after multicultural virtual teamwork

% of submissions	Quizzes (before multicultural teamwork)			Post-course survey (after multicultural teamwork)			Difference in procrastination (before and after)
Country	**N**	**Until due-date**	**Procrastinated**	**N**	**Until due-date**	**Procrastinated**	
France	119	56.3%	**43.7%**	39	95%	**5%**	38.7%
Israel	219	58%	**42%**	106	99%	**1%**	41%
UK	24	41.7%	**58.3%**	12	92%	**8%**	50.3%
Mean (all students)		52%	**48%**		95%	**4.7%**	

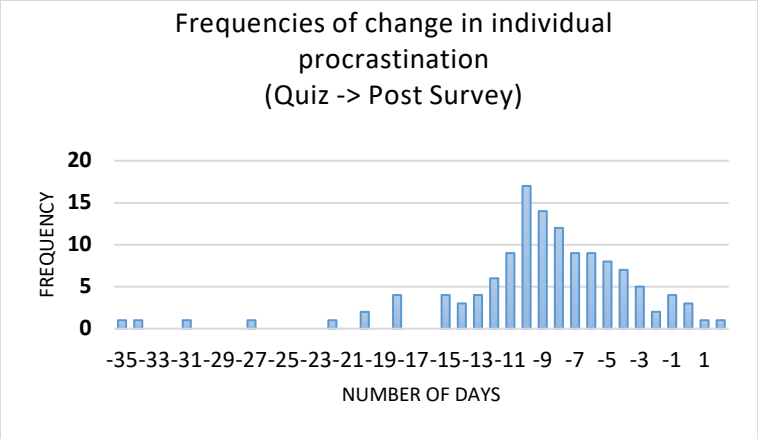

Figure 3. Frequencies of change in individual procrastination

DISCUSSION AND CONCLUSION

Academic procrastination is almost universal for students (Dietz et al., 2007; Steel, 2007), and can be seen in almost all countries and cultures. Nevertheless, cultures have different attitudes towards time in general (Hall & Reed Hall, 1990), time visions (Saunders et al., 2004) and procrastination as a specific appearance of time (Klassen et al., 2010).

In this study, students from different countries and cultures worked together in multicultural teams, on a virtual platform (In2It LMS), with scheduled pre-dictated deadlines. The research goal was to explore individual procrastination through the "eyes" of culture differences, and to examine a possible effect of multicultural teamwork on individual procrastination.

Regarding R1**,** the possibility of differences between cultures in students' individual and interdependent tasks procrastination, results show statistical differences between countries in procrastination of Quizzes individual assignments. According to Table 4, students from UK were the most procrastinators (58.3%), and Israeli students were the least procrastinators (42%). French students were a little bit more procrastinators than Israeli students, but much less than the UK students (43.7%). According to Hofstede's Culture Compass (Hofstede Insights, 1984), the Individualism-Collectivism dimensions of the three countries are as follows: UK is the most individualist country (89), France is less individualist than UK (71), and Israel is the most collectivist (54). The results of procrastination by country on Quizzes individual assignments are consistent with literature. Research shows that students in collectivist cultures (Israel) interpret procrastination more negatively than students from individualist cultures (UK), because procrastination might be construed as conflicting with personal/academic goals, fear of failure, and family expectations (Chong, 2007; Klassen et al., 2010). France has a higher score in Individualism-Collectivism dimensions than Israel, but lower than UK, and therefore its procrastination, according to research, is positioned between Israel and UK in the percentage of procrastination. The fact that UK students were the most procrastinators, much more than Israeli and French students, is also consistent with Ferrari et al. (2005), who examined procrastination in English-speaking countries, and found that chronic procrastination is a common occurrence among adults living in westernized, individualist English-speaking countries.

The results of procrastination by country on individual Idea submission assignments, which was also a non-mandatory task, but has the interdependent characteristic, are different than quizzes. Israeli students, who were the least procrastinators in the quizzes, have the highest percentage of procrastination in the idea submission assignment. UK and French students' procrastination percentage declined, and they became less procrastinators. The difference between results of quizzes assignments

and idea submission assignment might be explained by the difference between assignments. Although both were individual assignments, the idea submission assignment was seen on a platform by all other students, who could also comment on ideas of the other students. This finding correlates with Gafni and Geri (2010), who found that the behavior of the first students of each group when posting their assignments defined norms for the whole class. It seems that the perceived cost of procrastination may be greater for students from collectivist contexts because procrastination might be construed as conflicting with personal/academic goals and family expectations (Klassen et al., 2010). Moreover, the differences could also be explained as two different forms of perceived chronic procrastination. The quizzes could have been perceived by students as *arousal procrastination;* delays that make a person stimulated when rushing to complete tasks, and therefore affected by cultural norms of individualism-collectivism. The idea submission could have been perceived as *avoidant procrastination,* delay of tasks that completion would reflect one's abilities, such as in the eyes of the other students. In avoidance procrastination, by not completing a task by a specific deadline, the person may claim that poor performance was influenced by lack of effort or greater rates of time pressure instead of lack of personal ability (Ferrari et al., 1995). This also correlates with the reasoning for procrastination. Students in collectivist yet achievement-oriented settings may interpret procrastination more negatively than students from individualist environments. This can be explained because of higher levels of fear of failure and their stronger inclination to avoid family shame and embarrassment (Chong, 2007; Klassen et al., 2010). Israeli students, who are more collectivist than the other students, might have been procrastinators in this assignments, as they feared shame and embarrassment when other students could see their submission, and even comment on it.

Regarding R2, examining the change in individual procrastination after performing multicultural teamwork, the procrastination of teams results show that in the final assignment of multicultural teamwork (Pitch submission) almost no procrastination was found in all submissions. The difference between individual procrastination of all students before multicultural teamwork and after multicultural teamwork was dramatically cut (48% before, 4.7% after), almost mitigating the procrastination appearance for all students from all cultures. Table 6 and Figure 3 show the change in procrastination of each individual student, showing that all students except five improved their procrastination, with an average of 9 days improvement in procrastination before teamwork (quizzes) and after teamwork (post-survey). Although this research does not analyze student motivation to complete the tasks, it should be noted that both quizzes and post-survey were non-obligatory tasks; therefore, it was assumed that students had the same motivation for both tasks.

This dramatic positive effect of multiculturalism on individual procrastination may be explained using the Ely and Thomas (2001) study, who argue that if the team's diversity is seen as a learning resource for the team, it enhances adaptation to change and redefining goals, markets and products. In this study, teamwork was conducted in a higher-education learning environment, and for learning purposes, so it can be assumed that students perceived diversity as a learning resource. Also, the fact that all students, regardless of their culture, mitigated their procrastination dramatically, may be supported by adopting Tadmor et al. (2012), who found that multicultural teamwork experience enhances not only the creativity of individual team-members, but also the joint creativity of the team so that the creative whole is greater than the sum of its parts.

One of the major conflicts of multicultural teamwork is task-related conflicts that might occur because of a clash of opinions with respect to the tasks, such as adhering to timelines or different attitudes towards deadlines (Jehn, 1995). In these teams, multicultural teamwork resulted in a positive outcome of mitigating procrastination of individuals. This might be explained using the research of positive effects of multicultural teamwork, which shows that one of the major advantages of multicultural teamwork is sharing of culturally divergent knowledge, experiences, and skills. This sharing that students bring to the team allows them to create something new by interacting across traditional disciplinary boundaries, and learn from each other (Goldstein & Gafni, 2019; Lans et al., 2013).

Following Table 6, it seems that the differences between cultures in their procrastination has also been affected by the multicultural teamwork. Procrastination by culture **before** multicultural teamwork ranged from 42% to 58%. However, procrastination by culture **after** multicultural teamwork ranged from 1% to 8%. It seems that the differences in procrastination behavior and attitudes between cultures, which usually creates a conflict (Jehn, 1995), were mitigated and reduced dramatically. This can be explained by the fact that they had a shared goal that reflected a common global work culture beyond their distinct socio-cultural procrastination (Earley & Gibson, 2002; Shokef & Erez, 2006). It seems that all students perceived their multicultural teamwork as a collaboration between different cultural or national backgrounds, who have been assigned to interdependent tasks and are jointly responsible for the final results (Marquardt & Horvath, 2001).

Although this research did not analyze the pre- and post-surveys that were completed by students, but only the actual LOG data, the students' answers to the post-survey could strengthen the conclusions, and should be further researched. For example, replying to the post-survey's open-ended prompt, "*Please tell us the thing you enjoyed most about the Global Entrepreneurship course*", many students replied that they enjoyed the teamwork a lot and that it contributed to their learning, and motivation. Some of the answers are reported here: "*I enjoyed the motivation and connection with my group*"; "*I enjoyed meeting people that think different*"; "*I enjoyed working with other people from other countries*"; "*I enjoyed the leadership of my team and the experiential cooperation*". The students' answers to the post-survey reflect their enjoyment from the multicultural teamwork, which can strengthen the connection between procrastination, motivation and learning, as reflected in this research. This connection should be further researched.

Regarding gender, no differences were found between cultures or even in the same culture. This correlates with some studies (Gafni & Geri, 2010a; Kachgal et al., 2001), but not with others (Özer et al., 2009). Further research is needed to explore gender diversity in multicultural teams, as this was not the aim of this study.

THEORETICAL AND PRACTICAL CONTRIBUTIONS

The purpose of this study was to discover usage differences in learning and task performance by students of different cultures, especially by examining procrastination patterns and behaviors from a national cultural perspective, exploring the effect of multicultural virtual teamwork on students' individual procrastination. Research has shown that procrastination is common in general populations, and is almost universal among university students (Steel, 2007); nevertheless, a student's academic practices, such as study time and procrastination, may be influenced to culturally different understanding of academic values and behaviors (Klassen et al., 2010). This study aims to further discover the effects of multicultural teamwork on individual procrastination, comparing the differences between cultures, if differences exist. Existing studies have focused on comparing US and Canada, with Northern European culture or Middle Eastern cultures (Ferrari et al., 1995; Klassen et. al., 2010; Olson & Olson, 2003), but no Mediterranean cultures. This study focuses on Israel, as a Mediterranean culture, compared with European cultures (UK and France).

Klassen et al. (2010) suggest that future cross-cultural procrastination research should focus on incorporating other methodological approaches. The uniqueness of this study is also using and analyzing actual data of student procrastination from logs (In2it LMS platform). Other studies of procrastination in multicultural student teams have measured perceived procrastination, collected using surveys based on Tuckman's 16-item procrastination measure as collected from students' subjective self-reported data (surveys) (Klassen et al., 2010; Tuckman, 1991). Understanding the positive effect of virtual multicultural teamwork in mitigating the negative tendency of students from all cultures to procrastinate, as concluded in this study, can provide a useful tool for higher education to mitigate procrastination in teamwork processes.

The results of this study could also be used by the global business environment that requires working in international virtual multicultural teams. With the development of online technological tools, and following the COVID-19 times, as teams cannot meet face-to-face and are forced to work virtually on a daily basis, it is important to control the implications of procrastination in their multicultural teamwork.

LIMITATIONS AND FURTHER RESEARCH

Results of this study clearly show a positive effect of multicultural teamwork on student procrastination, by examining the actual procrastination before and after multicultural teamwork. Yet, further research is needed to understand the reasoning for this effect. Is it the specific combination of cultures (Israel, UK, and France)? Further research is needed to explore other cultural combinations of teams, and strive for the optimal mix in relation to student procrastination. Also, as the global higher education environment attracts students from all cultures and countries, further research should examine the implications of students' origin.

Moreover, this study was conducted on a virtual platform (In2it LMS on Moodle platform) that was designed as a psychologically safe virtual environment, yet the platform's effect on students' procrastination was not measured. Further research should examine this effect, as an intervening mechanism or as a cause for the effect of multicultural teamwork on students' individual procrastination.

This research had several methodological limitations. First, two-thirds of participants in this study were from Israeli culture, and the number of participants from UK was very low. This might have affected the results, and the teamwork process. Second, not all students were graded for this project, so they had different motivation to participate. The relation between procrastination and motivation was broadly explored in prior research and should be further examined in relation to multicultural teams. Finally, the effect of multicultural teamwork was examined only after one task submission, the final task. Further research is needed to explore the effect during multicultural teamwork processes.

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ACCELERATED PROFESSIONAL IDENTITY DEVELOPMENT THROUGH SOCIAL NETWORK SITES

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ABSTRACT

Aim/Purpose	This study aims to uncover how Social Network Sites (SNSs) active users who are eager to be knowledgeable about a specific domain develop a professional identity, what practices they use, and how do SNSs afford professional identity development.
Background	Some researchers have shown that SNSs play a central role in personal development, but there is a lack of studies tracing the actual role of SNSs affordances in professional identity development.
Methodology	Seven participants were followed during a whole year; we examined their professional identity development based on data collected from interviews, cued retrospective reports, and online activities.
Contribution	The study shows that SNSs create a new context for professional identity development, a context whose new characteristics bring specific actors to a spectacular development in their professional identity. Based on the findings we suggest a new framework of professional identity development with SNSs.
Findings	We identified a wide range of activities and changes in the perceived professional identity. We found that there are four phases of SNS's professional identity development. The study also uncovers the three aspects of identity development: self-presentation, around-the-clock sociality, and interaction with information. The model of professional development through intensive use of SNSs is validated by our reports on the actual behaviors afforded by SNSs.

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Recommendations for Practitioners	The conceptual framework displayed in the article can help educational institutions to implement SNSs in order to enhance professional identity development. Guidance will allow students to handle self-presentation, sociality, and information management. By doing so, the guides will help achieving meaningful SNS activities and encouraging students to be involved in their fields of interest, thereby enhancing their professional identity.
Future Research	Future studies may examine the implementation of SNSs for the exploration process leading to identity development in various educational institutions. A few years longitudinal study may examine the lifelong professional identity development in varied SNSs. Moreover, in the COVID-19 world crisis when life is in digital spaces more than ever, it will be interesting to study the role of SNSs of professional identity development in the population that lost their jobs.
Keywords	professional identity development, SNSs affordances, digital information organization

INTRODUCTION

Social Network Sites (SNSs) are no longer just digital platforms that merely facilitate connections between people. SNSs are part of the everyday environment and, as such, are artifacts that many people fully use in their daily lives. SNS users create or find information on a wide range of subjects and contexts, which they share and discuss with other users. Hence, SNSs have become environments that may be crucial for various aspects of the SNS users' development (Barker & Rodriguez, 2019; Heidaria et al., 2020; Manago, 2014; Novakovich et al., 2017). The incessant interactions with others that SNSs provide may change the rules of the developmental game, in the same way as other tools that gave new opportunities to interact with others impinged on culture and development in the past (Rogoff, 1990). As non-formal informational spaces, SNSs may summon learning and support collaborative processes. However, considering them as learning spaces is a controversial statement: SNSs were not designed for triggering learning, and many of the activities in SNSs are not oriented to learning. Still, many people use SNSs to seek information and discuss it with other people, and, as such, SNSs are non-formal Computer-Supported Collaborative Learning (CSCL) environments (Forkosh-Baruch & Hershkovitz, 2013, 2019; Manca, 2020; Wise & Schwarz, 2107). And indeed, we will see that SNSs have affordances and constraints for learning and development. In this paper, we consider contexts in which SNSs enable developmental processes, identify the affordances SNSs provide for triggering these processes, and what practices SNS users enact when they develop.

Our use of the term "Social Network Sites" is based on Boyd and Ellison's (2007) definition as "web-based services that allow individuals to construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system." The nature of these connections may vary from site to site. And SNS users share and retrieve their emotions, private life events, learning and academic materials, and professional information. It is commonplace that SNSs have become public information spaces in which information on almost any subject or field of interest can be found, presented, and discussed. Such public information spaces are often created by individuals who share not only information, but also their life events and personal information in their profiles, thereby making the boundaries between the personal information space and the public information space unclear (Brandtzaeg & Chaparro-Domínguez, 2020; Chayko, 2019; Cheek & Øby, 2019; Kasperiuniene & Zydziunaite, 2019; Manaca & Ranieri 2017). Such a blurring of spaces turns personal information management actions – keeping, organizing, and retrieving – into a social activity. The information SNS users hold becomes an act of self-presentation, and today our digital information is a part of us (Floridi, 2014, p. 98). Recent studies have examined SNS affordances for the organization of information and found that SNSs set new challenges for the organization of information. The organization of personal information in SNSs depends on the types of relationships that

one has with other users – friends, followers, or users who share fields of interest (Bouadjenek et al., 2016; Hajibayova; 2019); users are notified about new information and seek for information according to their friends and their friends' interests. Furthermore, they choose what information to share knowing who are their friends (their audience) and what are their fields of interest In addition to activities of organization of information, in her review of adolescence identity development in the digital age, Manago (2014) claimed that SNSs impact on identity development: SNSs facilitate broadcasting of self-representation to wide audiences and afford customized sociality, meaning that SNSs enable to build social circles that meet the user needs. Hence, adolescent SNS users can search for social circles and communities that meet their needs, and gain from high levels of interaction and feedback from other users. The present study focuses on how adults who have a subject of interest capitalize on SNSs to find, keep, organize, and share personal information in order to develop their professional identity through the intensive use of SNSs for acquiring, organizing and sharing information.

The developmental direction appears to be feasible, since SNS progressive self-presentation and interaction among peers, through the handling of information, are observable, and research on the development of the self focuses on whether and how one processes information. For example, exploration, which characterizes its highest manifestations, is defined as "a deliberate internal or external action of seeking and processing information in relation to the self" (Flum & Kaplan, 2006). Flum and Kaplan (2006) assert that the outcome of the exploration process is the development of self-relevant meaning, which facilitates identity development. The identity has a role in the way people perceive their abilities to deal with content in a self-regulated learning (Kaplan et al., 2019). Although they did not refer to the use of SNSs for identity development, according to Flum and Kaplan (2006) theoretical analysis, SNSs seem to be appropriate tools for the facilitation of development of an exploratory orientation. Manago (2014), in her literature review on adolescence identity development aspects in SNSs, suggests that SNSs play a central role in adolescents' identity development through two main characteristics – public self-expression and customized sociality. Both have their pros and cons for identity development. Here analysis focuses on youth and the reviewed studies did not trace development processes among adult users. Starcic et al. (2017) also found in young students' attitudes survey (21-25 years old) that they believe that SNSs change professional and career practices and, therefore, help to shape professional identities. However, this latter study also focuses on young people who "believe that SNS shape identities"; it does not trace processes of identity formation. The field of adults' professional identity development in SNSs is relatively unexplored: empirical longitudinal studies are missing.

This study aims at uncovering the role of sharing and organizing knowledge in SNSs on adult's professional identity development in a non-formal learning context. In addition, it traces the development impact, motivations, characteristics, phases, challenges, and the SNSs affordances to professional identity development.

The present study is based on data collected over a year from various sources: interviews, cued retrospective reports, and online activities. It focuses on professional identity development– a particular case of identity development. It is an ongoing process whereby a person develops over the course of one's life, which concerns one's self-perception through social interaction (Erikson, 1968). Professional identity is based on attributes, beliefs, values, motives, experiences, and achievements which are related to groups of peers in the professional field (Beijaard et al., 2004; Gee, 2000). This study describes seven adult users who organized and shared information in a specific field of interest. We trace their identity development trajectory and offer a conceptual framework for professional development through SNSs.

LITERATURE REVIEW

The literature review refers to many studies on SNSs, of which some are empirical studies, and many propose reasonable conjectures for rigorous research. The literature on SNS affordances is important

for our study, although it is often conjectural. We first review the affordances and constraints provided by SNSs, then review research on professional identity development, when SNSs are cultural artifacts of the professionals.

SNS Affordances

SNSs were initially created for social interaction purposes – to connect, interact, and share information with people in a digital social sphere. In a study of the use of SNSs in organizations, Treem and Leonardi (2013) suggested that SNSs afford visibility, persistence, editability, and association. Visibility is the ability to make the user information behaviors visible to others. Visibility affordances facilitate the sharing and saving of information: information which includes behaviors, knowledge, preferences, and networks. The visibility of SNSs also affords meta-knowledge and allows SNS users to understand information about topics and peers with an accumulation of information collections. Persistence is the possibility that the information can remain and that users can go back to information that was uploaded or shared in SNS platforms. It remains available for future use and does not disappear. The knowledge is maintained over time, and the content grows all the time. Editability is the possibility given to users to edit and change content; users can endlessly modify the materials they create. The association affordance means that SNSs make it possible to establish connections between individuals. In a study based on daily online diaries, Zhao and colleagues (2013) found that SNSs afford self-information archiving, creating, managing, and curating content, and become meaningful memories repositories.

SNS affordances have added new dimensions to the concept of personal information; they summon new activities and facilitate a new component of organization – the relationships with other users as friends, members, and followers. SNSs change the roles in personal information management and make them highly reliant on the social dimension. The fact that personal information storage/archives are becoming public, or at least visible to other users, changes the basic definition and goals of personal information. The digital information items of one's SNSs, *walls* and *profiles* become an archive of valuable information items, an archive for one's life events, social circles, and fields of interest. They represent one and one's identity (Cheek & Øby, 2019; Cushing, 2013; Floridi, 2014; Zhao et al., 2013).

SNSs also afford new ways of social conversations and peers discussions. SNSs enable the creation of groups, the uploading of information, and feedback provision (through icon and texts). Therefore, SNSs can summon discussions about information, and, consequently, some educators have found SNSs to be a potential platform that enables learning processes that can be used as a personal learning environment (PLE), which are the single student's digital system, a place where the student interacts, creates, and shares information with other students or teachers (Dabbagh & Kitsantas, 2012; Jin et al., 2015; Manca 2020; Van Harmelen, 2006). The ease of sharing and the appealing discussion features have brought creative teachers to implement SNSs in their teaching. Previous studies reveal how innovative teachers have found a variety of ways to use SNSs and that SNSs can enhance social learning, autonomy, and active engagement in their classrooms (Greenhow & Askari, 2017; Lampe et al., 2011; Schwarz & Caduri, 2016).

SNSs are interesting environments for enhancing teacher-student interaction: Forkosh-Baruch & Hershkovitz (2013, 2018, 2019) examined teachers' perceptions of teacher-student relationships in SNSs and found that teachers are often connected with students as 'friends' in SNS, and most of them would like to be connected to students on SNSs. SNSs afford teachers' higher responsivity and care for their students, beyond school boundaries (Manca, 2020; Wallace et al., 2016).

Some studies have checked the conjectures about the alleged affordances of SNSs. For example, a series of studies found that academics and schoolteachers use SNS for sharing experiences, knowledge, practices, political issues, and professional events (Greenhow et al., 2019; Ranieri et al., 2012; Robson, 2018; Rutherford, 2013). Carpenter and Krutka (2015), examined how teachers use

Twitter and showed that Twitter affords contextual demands, helps meeting specific pedagogical and emotional needs, enables the creation of new connections, and by such enables a new conception of professional identity. Robson (2018) examined teachers' professional identity in digital context through interviews and traces of their activities in forums, Facebook pages, and groups. He discerned active users and passive users. The active teachers use the online social space for presenting themselves. The passive teachers engage in reading and learning from the information active users shared. Robson (2018) showed that both (active and passive participation) enable professional identity development in two different ways. Rutherford (2013) explored teacher's professional development through interaction in SNSs and the informal opportunities for teachers to engage in professional development. The study examined posts over a year in a teachers' Facebook group and shows that teachers are using the group for discussions and engagement as informal professional development environment. These studies describe SNSs potential and constraints for teacher professional development through close examination of the teacher's activity, and they focused on teacher professional development – the profession which is already part of their identity. Our study emphasizes the self-identity development of SNSs users' through their interaction with information organization in SNSs, and the emergence, then changes in their professional identity. Like Robson (2018), we use a holistic view of personal and professional identity as two unseparated parts of one's identity. However, our study aims to understand the users' interactions with information and to find how SNSs afford processes of development.

Furthermore, if was conjectured that the information collected in digital spaces affords lifelogging as a new way of learning, and new tools for self-management and self-monitoring by using quantified self-application and automatic statistical analysis, which are meant to enhance awareness and reflection. However, much advancement is required in order to fulfill their potential for learning and development (Arnold at el., 2017; Buongiorno, 2017; Kristensen & Ruckenstein, 2018). The present study capitalizes on the literature on the affordances of SNSs but checks empirically the realization of the potential of the above affordances. We examined how users learn and develop a field of interest, while organizing and sharing information, with others in informal learning contexts, and what role SNSs profiles, friends, and information sharing play in their professional identity development. An important step in our approach was to delve into the literature on the other side of the coin – on the constraints SNSs provide to users.

SNS Constraints

SNS platforms, with their current features of information organization (the 'save' feature in Facebook, 'boards' in Pinterest, 'channels' and 'playlist' in YouTube, 'hashtags', etc.) do not only afford desirable actions but also pose some challenges: it is hard to keep information. It is also hard to manage information. For example, it is difficult to save a post in the list of 'saved' on Facebook as a primary organization component for information or to share it with oneself by sending it by email. It is challenging to retrieve old information from previous posts in SNSs, and, finally, the sharing activity – which is one of the leading components in any SNS platform – is overdone. True, users use sharing options to share with others on a daily basis and for saving, retrieving, and organizing information for future personal use. However, people who share information have difficulties in controlling the sharing preferences, particularly the preferences of who can see my shared information and for how long (Tolmie & Crabtree, 2018). As a result, SNS users suffer from information overload. These facts question the potential of SNSs for professional development.

Manago (2014) also highlighted the costs of SNSs for identity development. She pointed at the absence of SNSs sociality, which is reflected in shallow relationships, seeking acceptance in large networks, and promoting the desirable self which might not be the real one. Her review also reveals the deficiencies of SNSs as the self-expression is not authentic and indicators of identity markers are many times based on a list of contacts (list of 'friends' or 'followers') and therefore the individual self-identity highly depends on others verification. Robson (2018) also showed in his findings how

online professional self-presentation summon presentation of idealized identity' and how carefully the professionals choose the contents and resources they share.

Another SNS constraint is the difficulty to maintain boundaries between work and one's private life. SNSs merging public and private identities (Kasperiuniene & Zydziunaite, 2019). It was found that users want more control over their perceived sociability and morality; therefore, some employees prefer to separate professional and private contacts (Van Prooijen et al., 2018). The boundaries also challenge the transformation from youth into adulthood and professional identity construction. Brandtzaeg and Chaparro-Domínguez (2020) found in qualitative in-depth interviews with young journalists that they struggle to develop effective ways to manage previous identity expression in their present professional identity; moreover, some felt that they were trapped in their own SNS history. Kimmons and Veletsianos (2014), who examined educators' identities on SNSs, also found that teachers demonstrate the problematic side of identity development through SNSs. They shaped their participation in SNSs to be "acceptable" to their audiences and felt that their self-expression represented small fragmented parts of their complete identity. The study of the educators' identity sheds light on the tensions teachers experience, which is related to personal and professional identity in SNSs. Another problematic issue was raised in an academic context, where previous studies show that students share information very extensively in SNSs for educational purposes; nevertheless, the use of shared information for reading is low, and there is a lack of meaningful conversation about the shared information content (Bar-Tal & Asterhan, 2017).

These findings raise questions about the value of SNS affordances for professional identity development. In this study, we take an in-depth look at how active SNS users, who organize and share information in a specific field of interest, cope with SNSs constraints. We trace how they learn and develop in SNSs, and what makes SNSs a platform for a unique process of professional identity development.

Professional Identity Development and SNSs

Identity development is an ongoing process of interpretation of the self in a variety of contexts, and it answers the questions 'who am I', 'what am I' and 'what peer group do I belong to' (Erikson, 1968). The self is developed through interactions with the environment, social settings, and social communication, which adopts the role of 'others' (other people) to monitor our actions (Mead, 1934). It is constructed dynamically in a continual process of organization of motivations, abilities, beliefs, and the individual's historical events. Identity development leads to a higher awareness of one's own personal uniqueness, similarity to others, strengths, and weaknesses (Marcia, 1966). Identity development involves the motivation to acquire information and engagement, and it is based on the innate curiosity, which translates into an active search for information, examination, and evaluation of the information in a self-reflective manner, in an ongoing process of exploration (Flum & Kaplan, 2006). Grotevant (1987), suggested a process model of a life-span perspective on identity formation. The model includes four components: individual characteristics – the unique abilities and orientations; identity formation – a process in a specific domain; contexts of development – society, family, peers, work, school; and interdependencies among the identity domains – which represent the connections between the identities that individuals have in different domains.

Manago (2014) reviewed how SNSs impact on the identity development of young adults and adolescents in the digital age. Her review highlights two main characteristics: customized sociality and public self-expression. Customized sociality is SNS's ability to support the individual's pursuit of social resources, which meet his or her needs. SNSs enable a heightened level of exploration; a large network of peers increased expectations of creating an image of the self that is appropriately packaged for an audience. Customized sociality provides a window into the lives of peers who are outside the immediate social circle; it might enable a sense of belonging to more similar peers, in particular for minorities that might have difficulties in finding similar peers in the real-life reality. Self-expression

on SNSs also differs from self-expression before SNSs appeared in our lives. Expression by one individual meets one's large number of contacts, a contact list which is usually anchored in offline relationships. SNS's public expressions enable one to validate, shape, and express self. It also allows seeing other individuals' selves, and it might sharpen the awareness of our self-image, and when we have multiple groups, we may find ourselves maintaining multiple identities in SNSs (Manago, 2014).

One of the identities is the professional identity. Professional identity is one's professional self-concept; it relies on attributes, beliefs, values, motives, and experiences. Professional identity, like personal identity, develops over time with a variety of experiences and meaningful feedback, which allows people to gain insight into their professional talents and values. Professional identity is more adaptable and can develop through the work environment. Ibarra (1999) distinguishes between image or persona and professional identity. Persona refers to the impressions people believe they convey to others. She claims that people adapt to professional roles by experimenting with images or persona that have not yet developed fully into their professional identities, which she refers to as "provisional selves". The role of these provisional selves is to bridge the gap between one's role and one's self-conception.

In the last few years, studies start examining SNSs as tools for career development. A previous survey study (Starcic et al., 2017) found that 21-25 years old students believe that a SNS supports professional identity development and career control, impacts on professional identification, provides professional networking, creates a sense of belonging to a professional community, helps in making career decisions, and impacts on work exploration, self-presentation and learning for self-development. A qualitative action research (Novakovich et al., 2017), which focused on students' competencies to use SNSs as tools, found that SNSs enable networking and self-presentation for the students' career development. In a systematic literature review on professional identity construction through social media, Kasperiuniene & Zydziunaite (2019) found that social media are characterized by blurring of occupational stereotypes and reconstruction of multiple professional selves, merging public and private identities, and enabling belonging. Bridgstock (2019) explored LinkedIn's potential for career development, especially the connectedness capabilities and the broader employability. He suggested those potentialities can enable the emergence of new learning activities in higher education that promote students' skills of career development. These studies lack a developmental depth, though. Previous studies suggest providing institutional guidance for students regarding the use of social networking sites and forming their digital professional identity in SNSs (Jackson & Bridgstock, 2020; Jawed et al., 2019; Starcic et al., 2017). There is a lack of studies tracing the actual role of SNSs affordances in professional identity development: How do adults, in their lifelong professional development, use SNSs? What can we learn from them for others?

RESEARCH QUESTIONS

We investigated three main questions: (1) How adults, who use extensively SNSs, develop their professional identity? (2) What are the components of identity development of these users, and (3) How do SNSs afford professional identity development?

METHOD

In the present study, we adopted a qualitative phenomenological mode of inquiry, in which we set a longitudinal design, in order to observe information organization and development as perceived by the participants. The phenomenological approach enables to understand phenomena in their context, particularly when the phenomenon and its context are vague (Creswell, 1998). This study focuses on structures, themes, and changes to uncover participants' insights and meanings of the investigated phenomenon and to examine shared SNSs activities, along with participants' narrated experiences and their interpretation. Participants were followed during a whole year. The setting enabled us to identify practices of information organization through SNSs. Through the lenses of these practices, we investigated how participants developed their specific interest. We identified implications of the

activities that the participants undertook with SNSs for their lives as professionals, through questions focusing on their experiences and the meanings they ascribed to them (Seidman, 2006). Furthermore, the mode of inquiry allowed us to trace and understand the developmental dynamics, changes in motivation and actions over time. Interviews and reports as well as screen records and online data collection were used. This combination of tools facilitated the understanding of the computer-mediated discourse structure, meaning, and interactions of the participants (Herring, 2004), and helped identifying actual SNS affordances as they appeared in the user interactions with the environment in varied events (Gibson, 2000).

PARTICIPANTS

Seven active SNS users participated in the study. Table 1 shows the profile of each participant. All participants acquired and shared information in their fields of interest through SNSs. The age span of the seven SNS users was very broad: from 19 to 53 years old. We included this wide range of ages in order to have varied perspectives on the use of SNSs to organize and share information in a chosen subject. The selection of the participants relied on two criteria. We chose SNS users who (1) are active daily in a specific domain and engage in information organization, and (2) use more than one SNS in this domain (see Table 2). The participants were recruited via personal and professional connections. First, we asked active online users to recommend users who are active SNS users in one or two main subject areas. Then we approached them and checked with them that they are daily users of SNSs and use more than one SNS platform. All seven participants were interviewed, and 6 of them recorded their own actions on SNSs and then watched the records with the interviewer they retrospectively reported their activities.

Table 1. Profile and data collected for each of the seven participants

Participant	Age	Fields of Interest	Retrospective Report Events
Yael	19	Art, poetry slam	3 (15-30 min)
Shira	38	Teacher, technology-pedagogy, PhD student	8 (5-20 min)
Michal	50	Family economics	3 (15-20 min)
Barak	53	Urban agriculture	3 (10-43 min)
Adi	36	Poetry	6 (5-8 min)
Or	50	Arts and crafts	2 (5-60+ min)
Gilad	49	Marketing and SNS trends - lifestyle groups	0

Table 2. SNS use for each of the seven participants

Participant	Number of SNSs	Everyday use	More SNSs
Yael	7	Facebook, Instagram, Pinterest	Etsy, YouTube, Tumbler, snapchat
Shira	5	Facebook, Instagram, Pinterest	Forums, YouTube
Michal	4	Facebook, blog, Pinterest	Instagram
Barak	5	Pinterest, Facebook	YouTube, blog, Instagram
Adi	3	Facebook, Instagram, blog	
Or	4	Pinterest, Facebook, Etsy	Instagram
Gilad	3	Facebook, Instagram,	Pinterest

PROCEDURE AND RESEARCH TOOLS

Data was collected at different points of time, along the year-long activities of the professionals. The departure point consisted of an in-depth interview that lasted two to four hours. Interviews were conducted with the participants while their personal computers were at their disposal. All interviews included three stages. The first part of the interview focused on the participants' background on their use of social networks for their subject of interest, as well as on the ways they became involved in that field of interest. In the second part of the interview, users described their current activities in SNSs. Participants were asked to describe and show their work on various SNSs. They were asked how they perceived the role of SNS activities and what they mean for them. At the end of the second stage, participants were asked to record three events of their future SNS activities for at least five minutes each, at different times. Table 1 show the recording numbers and duration. The first and second stages of the interview occurred in the same session.

The last session took place later – after the retrospective records reports. They reported on their ongoing activities and were requested to add new information about what occurred since the last meeting. Then, they presented the recorded events and gave explanatory comments on them (Seidman, 2006). These sessions lasted from 90 minutes to 4 hours. The reports revealed the participant's strategies and practices. They also revealed the SNS affordances as well as the challenges the participants faced, and the ways they deal with them.

Collection of data

The research questions necessitated observing how participants used SNSs. In particular, we aimed at whether the affordances of the SNSs yielded desirable behaviors. The affordances of an environment are a net of facilitators and abilities for humans' interaction (Gaver, 1991; Gibson, 2000). Affordances of SNSs are ways their users understand and use them, without being given any explanation (Jones, 2003). Therefore, in order to check whether affordances led to specific behaviors, we focused on events of interaction: The participants used the Flashback application and recorded three to five events at different times. The recorded events lasted from 5 minutes to 43 (only one event lasted more than 60) minutes: they included navigation in various SNS, sharing activities, and interactions with others. The first author invited participants to give cued retrospective reports – reports that enable participants to re-examine their actions and goals by watching records of past activities (Van Gog et al., 2009). During the year, six out of the seven participants took part in such meetings and reported retrospectively about their chosen activity events, as they were presented the actual recorded SNS activity events.

In addition to the cued retrospectives, the participants' public posts and comments on SNS were collected at least once a week from the first meeting throughout a year. The data collection was completed by email communication to clarify specific issues that came up. The in-depth interviews, cued retrospective reports, participants' posts on SNS, and follow-up clarifications were recorded and transcribed.

Analysis of data

The analysis of data was done in two main ways. The longitudinal analysis consisted in a description of each participant's organization of activities over time. The second analysis was a categorial analysis aimed at unearthing development components, and identifying SNSs' affordances, users' strategies, and practices involved in professional identity development in SNSs.

Longitudinal analysis

The longitudinal analysis was aimed at tracing professional development through stories, actions (identified in the cued retrospectives and online data – which included the participants' SNSs posts), and self-perceptions. This longitudinal analysis was done at an individual level and across individuals.

At each level, three points in time were considered: 'the beginning' as narrated retrospectively in the first meeting, 'the present point' at the time of the in-depth interview, and the follow-up information collection from SNS activities as we found in the content of the online data collection - public SNSs posts on SNS walls up to the end of the year.

Categorial analysis

We classified all data collected in interviews, retrospective records, and online into categories and subcategories. All texts were segmented into units and analyzed with the Atlas application. The preliminary categories that we created to answer the three research questions were based on two main theoretical frameworks: Manago's (2014) identity development in SNS, and Flum and Kaplan (2006) Exploratory orientation as a process of development for education in the 21st century (Flum & Kaplan, 2006, 2012). The preliminary categories were Customized sociality, Public and Self-expression (Manago, 2014), and Engagement, Motivations, Acquiring knowledge, Awareness and reflection (Flum & Kaplan, 2006). Data were analyzed three times, in order to create the new set of categories. Initially, each unit was conferred one or more category from the preliminary categories (based on literature), and some were left out or were conferred a new optional category. In a second analysis, new categories were combined with the originals and separated according to the revealed new aspects which arose from the full data. At the third phase, units were analyzed again into the categories which were redefined into new categories in order to convey the distinctive activities that characterize the work of experts' development as they continuously (re-)organize information and interact with other users of SNSs in their trade.

Ethical issues

The institutional ethics board authorized data collection. In addition, each participant agreed with the data collection at each stage. One participant did not want to participate in the retrospective reports, and one participant did not approve the public post and comments collection. Although the participants' public SNSs walls and comments included other users posts and comments, such data were not included in the data collection. All findings of peers' interactions relied on the transcripts of the participants' interviews and retrospective reports.

FINDINGS

The findings part includes three sections. The first section presents the accelerated identity development as perceived by the participants, the four phases of professional development as identified in SNS platforms, and the participants' motivations. The second part presents the three components that characterize this unique kind of professional identity development: extended self-presentation, around-the-clock sociality, and intensive interaction with information. The third section defines SNSs affordances for each component, shows the tensions between affordances and constraints, and describes the participants' practices.

HOW SNS USERS DEVELOP A PROFESSIONAL IDENTITY
PERCEIVED ACCELERATED IDENTITY DEVELOPMENT – FROM AMATEURSHIP TO EXPERTISE

We identified a wide range of activities and changes in the perceived professional identity. The development of each participant is 'a different story'. However, a common feature of these stories was that the participant observed it as a fast process.

Fast process

Or said: "It was fast… I realized I could not trace my feedbacks" (O:F:50), (Participants id code [Letter of first name, gender, age]), which would be for example Or, Female, 50 years old.). Yael implied

that sometimes it was too fast: "It serves my learning, but it runs fast" (Y:F:19). Michal expressed a big change, as she said in the interview: "If you told me four years ago that I would write a blog I would tell you: you are nuts" (M:F:49); "It happened so fast" (G:M:48). Adi, in her first interview, showed the new Facebook page that she opened for poetry. A few weeks later, in the retrospective report, she had already organized her first evening of poetry reading. Another example of her progress was illustrated by the change she made in the contents she shared. In the first interview, she said she avoided interpretation of the poems, as she didn't feel that she could present herself as one who understands poetry. She said, "I do not dare to write my interpretation [of the poem she shared]," and "I prefer not to share a poem on my private wall because it says something about me and my feelings at a specific point in time". However, after one month, she wrote an interpretation on her wall of a group of poems she gathered for a reading evening. And today she does it from time to time. In the follow-up of her Facebook activity we found that she closed her poetry page, and she explained that she hired a legal advisor, and that 'she understands the legal copyright issues'. She decided to publish the poems from her personal profile which requires as she said "more awareness of personal exposure" (A:F:36). We can identify in this example the rise of professional awareness in her development. She found a way to bridge the gap between the personal and the professional in a situation where what she considered as a hobby starts to represent the self, her knowledge, and self-perception, and this change leads her to say that she understands about poetry - "To come and say: I know". Adi (F:36) still has her main profession (career development) but her activity in poetry is prominent in her life, and she organizes a poetry reading evening with a different theme every month.

Significant changes

A second theme in the stories of the participants was they experienced a significant change. Yael (19), in the second meeting with her for the cued retrospective report, declared that she had made significant changes since her last meeting (six months earlier). She was proud to say: "I just opened my artist page…" (Y:F:19). By contrast, in her first interview, she did not call herself an artist even though she discussed her work. In her first interview, it was clear that SNS activities were representing her and she was also aware of the challenges "I do not share personal information… I want to choose when and how I disclose…". However, now her page has become part of her identity, and she is now an artist, and this is the way she presents herself to the world and to her SNS peers in different social circles. The longitudinal analysis suggests an enormous development in her self-perception within a short period of time. She not only presents her work; she presents it as the 'work of an artist.'

This phenomenon repeats itself for the other participants: SNS iterated activities change and promote the way in which these users progressively perceive themselves as professionals, how they perceive their impact in the field, and how their activities become meaningful for their peers. The evaluations of the peers, through the feedback they receive, is of crucial importance in this development. Or (F:50) said that one day while she was reading the feedback of one of her peers, she realized her impact: "I understood that I am a kind of inspiration to people" (O:F:50). Adi (F:36) said that presenting information in SNSs means "To come and say: I know", to come and say: "I am an expert…" (G:M:48), or "people perceive me as an expert" (M:F:49).

From hobby to profession

A third theme in the stories of the participants is that they perceived that they were amateurs and that they became professionals. Gilad (M:48) brought a different story of a professional change in his life which started from a leisure activity. He began a lifestyle group one year before we met him for the interview. In the interview, he said "It started one afternoon on my balcony; a few friends were looking to do something interesting… one year later it has become a monster with 7,000 members…", "I have about 7,000 members, and 2,000 of them are active in our activities (trips, parties, small events). His Facebook activities a few months later involves 9,905 members, a new Instagram account for the

group and a wider range of activities (workshops and courses). Moreover, he shares wide media exposure on the group he established: an article in a popular newspaper on Gilad and the group he has built as well as a 10-minute item on TV (all shared with the Facebook group). Now he understands that he must manage the group carefully. In one of his posts, he wrote to the group members: "Many people want to join the group and I have to select the active ones." He has also published rules and regulations that he formulated with a lawyer. Moreover, a few months later, he published a post in which he declared that he does a lot of work for the group in order to manage it and to organize events, and he makes a profit from this. He told the members of the group that this is now his profession and that he lives from this hobby which has become a profession. We can also identify his growing awareness of his responsibilities as a professional because he declared to the group that he also takes care of the activities of participants in real-life events, which he initiated from SNS, and he takes care of the members' complaints or that are related to the Facebook group interaction.

'Ups and downs'

Another theme in the participants' stories is that they experienced ups and downs in their development. Barak (M:53) also made changes over the short period of time during which we monitored his SNS activities. In the first interview, he presented himself as an expert; he said he made the development over the last few years. However, six months later, in a third follow-up meeting, he shared his 'ups and downs' in the profession through his SNS activities - "I put it aside [his field of interest], and you can see it in my profile, I did not have things to share. Still, I was on Facebook every day… I am now coming back. Now I have put it [his field of interest] in the center of my activity again, now I share more again" (B:M:53). Barak demonstrates that identity development is not a linear process. We met him in the first interview when he felt like an expert; however, life made him neglect his field for a while. It was interesting to discover that he perceives SNS activities as the platform for making his comeback.

The findings reveal that each participant analysis indicates a process where an eager interest or hobby becomes a dominant component of the individual's identity and his/her profession. It seems that each participant was deeply engaged in his or her field of interest, and that, overall, SNS activities enhanced identity development.

Identification of the phases of SNS's professional identity development

The participants' self-reports on what they perceived as their professional development is important. In parallel with this (subjective) perception, we adopted analytical approach to identify developmental processes in the participants' posts and actions. We will show that we identified four phases: (1) the initial experience of the **development of interest**, told retrospectively in the interview; (2) the **recognition phase** - when others get interested in my interest; (3) the **validation and commitment phase** - when participants understand that I am validated as being an expert, and (4) **the maintenance phase**, which includes awareness and understanding of the process, the practices and how to manage them wisely.

The **development of interest** phase is characterized by the early identification and construction of an interest and the decision to start sharing interest related information on SNSs. The attraction to the field of interest was clear in all of the interviews: "I caught the bug in Vancouver …" (B:M:53); "this is what I was looking for" (M:F:49), "I found myself doing that for hours at night" (O:F:50); "it began with regular searches in Google, and then it became much more…" (Y:F:19); "I always loved writing and telling stories" (A:F:36). It is also not surprising that it took some courage to start sharing: "It took me three to four posts to understand that I am O.K." (M:F:49). Shira, the teacher, said that she "was looking for that [the development], I love technology… I am very connected…" (S:F:36). She also explains that, at the beginning, she did not use SNS for information about her field of interest, "at the beginning I used the Facebook solely for private purposes, only when I started

studying, did I find the SNSs to be a source for professional information sharing" (S:F:36). Or said: "It began as a hobby… only later I realized that this is my calling" (O:F:50).

In the **recognition** phase participants realize that other people are interested in the information they share. Moreover, they are even perceived as a person "who knows" (A:F:36), "a person who has a say…" (Y:F:19). As one that people are looking for because of the information that she shares "people are waiting for the poem" (A:F:36). This phase is characterized by the high motivation to keep going and to engage in "this 'work' consistently" (B:M:53).

The following phase is the **validation and commitment** phase - the 'I am an expert' phase. In this phase, the participants realize that people are not just following them, they do so because they perceive them to be experts. The 'I am an expert' phase is often marked with a 'WOW' feeling: "In a short time I realized… people see me as an authority in the field" (O:F:50). This phase is also characterized by a sense of responsibility and commitment to information sharing and audiences, "I know I have to share on a daily basis" (A:F:36), "I am committed to the information I publish" (O:F:50). "I have to share this information with others" (S:F:36) .

In the next phase, the focus is on the **maintenance** of their newly developed commitments, accompanied by personal and practical insights about their professional meanings and implications. During this developmental phase three components come to the fore simultaneously: self-presentation actions, sociality interactions, and the construction of knowledge they share. Participants report a developing awareness of SNS challenges and potential, along with its affordances as a platform for their activities. They engage in adjustment of their activities and fine tunings of practices.

All these phases, with exploratory activities and experiences leading to a sense of commitment and committed behavior and hence the process as a whole, could be described as having formative impact on participants' personal identity development, and more specifically on their professional identity (e.g. Kroger, 2015; Marcia, 1966, 1993).

Motivations for SNS professional identity development

The emergence of the four phases of professional identity development could be discerned in different times. However, signs of previous phases continued to appear after latter phases began. In other words, phases were nested in each other. This is the case for the development of interest. It was initially vague and materialized through changes of motivation that expressed this development of interest. The initial eagerness to learn was similar for all of our participants. However, their motivations differed. Shira and Gilad were mostly characterized by what Kozinets (2015) calls 'consociation' or 'consocial motivation' – "a commonplace, largely instrumental, and often incidental form of association, one that we often take for granted because it has become so natural" (pp. 11). Indeed, Shira and Gilad share a lot, almost immediately, in wide circles, and don't follow the responses unless they are looking for something. They use SNS as a channel, keep personal matters personal, and professional matters professional, and are not emotionally involved in their activities. They share in order to broaden their connections, use their knowledge of "…how the SNS works." (G:M:48); "Something I think more people should know" (S:F:36), "I share immediately in the relevant group" (S:F:36). Barak and Michal are characterized by two main motivations – to learn more by themselves, they become autodidacts – and to self-brand their names as experts in their fields. "…to brand myself as an expert… a one-man show" (B:M:53). Or also found herself being motivated by branding her name, but her primary motivation was purely to learn, her motivation was an autodidact process of learning and engaging with interesting discoveries in the SNS. "I did it for myself… and suddenly it turned out that it is interesting for other users… I found that people are following me…" (O:F:50). Yael (F:19) and Adi (F:36) are motivated by their desire to learn as autodidact learners and the motivation to develop through confrontation and expression of who they are and what their fields of interest are. "Can you be a feminist and not a vegan?" (Y:F:19), "I felt that I am developing professionally… she came to me… it was meaningful for her…" (A:F:36). Table 3. Summarizes the motivations of each of the seven participants.

Table 3. Change in participants' motivations

Names	Field of Interest	Initial Motivation	Motivation after one year
Yael	Art, poetry slam	Deep interest Searching for development	To learn through confrontation with others To become an autodidact
Shira	Technology and education	Searching for development	Consocial
Michal	Family economics	Encounter meeting with new field	Self-branding
Barak	Urban agroecology	Life event deep interest	Self-branding To become an autodidact
Adi	Poetry	Deep interest Childhood hobby	To learn through confrontation with others Self-branding
Or	Arts and crafts	Life event childhood hobby	To become an autodidact
Gilad	Lifestyle	Life event Searching for development	Consocial

Three Components of Identity Development in SNS Platforms

We described the four phases of identity development, As just explained, these phases are nested in each other. The longitudinal analysis revealed another characteristic of professional identity development, the fact that this process involves three components in all its phases: self-presentation, around-the-clock sociality, and interaction with information. Figure 1 shows the three main components and the linkage between the components.

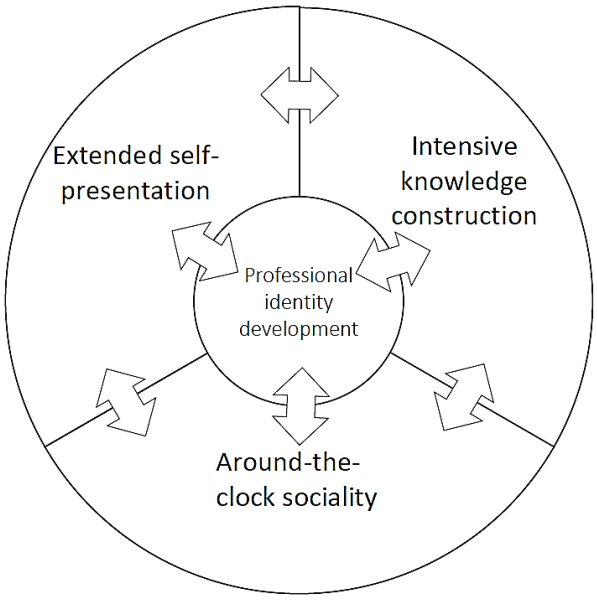

Figure 1. Professional identity development in SNS

Extended self-presentation

Our participants were highly engaged in extended self-presentation using texts, pictures, videos, and sharing information in a variety of SNSs. All seven participants used SNS platforms on a daily basis – Facebook as the primary site, but Pinterest, Blogs and Instagram were also frequently mentioned for acquiring, presenting, and discussing information in their fields of interest. The extended self-presentation on SNSs arise from its three unique SNS characteristics: various forms of self-expression, high frequency of self-presentation, and self-broadcasting to wide audiences.

Various forms of self-expression – The forms of self-expression varied according to the SNSs they worked. The participants used five main platforms for their self-presentation: Pinterest, Facebook, Instagram, Blogs, and YouTube. For example: "I use three SNSs. The main one is Facebook. I also publish a little on Instagram and Facebook, and I share on Pinterest" (M:F:49). They use them in a variety of ways, and their self-presentation changes in each SNS, from building a different profile to sharing different content and interacting with different people: "Pinterest is for pictures… In Facebook, I have a professional page and a private page" (M:F:49); "This is represented in YouTube, and here there are the drafts (word copies)" (Y:F:19); "for me, Pinterest is for visual" (O:F:50); "Pinterest is for presenting my work" (B:M:53); "In Pinterest, I upload pictures of stuff I make from old wave boards" (G:M:48).

Self-presentation on SNSs is based on varied formats of information. The participants use images, videos, and texts to present information about themselves. Barak and Michal upload and share pictures of their work and workshops they have given. The SNS profile is naturally the main place for self-presentation: the urban agriculture participant posted a picture of a pool he made on his private profile, and on Adi's poetry page, we find a picture of a whisky bottle and a pile of reading books. Gilad, with the lifestyle group, shows a picture of a beach in his private profile. Michal presents a picture in her private profile of her family and her professional "family economics consultant". Adi posted a picture in her private profile of one of her favorite writers. The profiles can be changed, so these are just pictures that present the self over a certain period of time. The self-presentation in SNSs is very dynamic, and the participants frequently use SNS profiles and walls to change their self-presentation and the information they reveal to present themselves.

High frequency of self-expression and self-exposure were demonstrated by all participants: "Over the last two weeks I have uploaded a poem every day" (A:F:36). Moreover, it seems as if they like this part of SNS: "I love to talk or share' I really love to share" (A:F:36). Barak reflected on the way the subject he talks about or shares represent him, and the dynamic change in the self-presentation: "I used to present political information, and today I prefer to present more information about my field, about worlds that are connected to me" (B:M:53). Barak raises the relationship between information "I present and myself". He related the move, from political content to professional content, as a process of development, a change from general and private contents to professional. He changes his activities by asking the leading question: what does he want to be connected to, and how would he like to present himself.

As Adi said, "I have to admit there is value to the exposure…" and, by saying that, she raises an important motivation for self-exposure - "to be seen". This exposure in SNSs is also characterized by the lack of control and the wide range of people who are watching. The self-presentation in SNSs is often more like Manago (2014) called it - Self-broadcasting. Our participants identified how they use SNSs for **self-broadcasting** to wide audiences. Moreover, what they say and the information they share are broadcast to unexpected audiences, and they are willing to receive comments and feedback from this broadcasted information and exposures of selves: "you just publicize yourself in the SNS, people can contact you from all around the world" (O:F:50); "this movie, I did not plan… it had a thousand views… for me, it was a lot…" (Y:F:19). The feeling of self-broadcasting in SNS, as raised in the interviews, is accompanied by self-presence – here I am!: "There is something about presenting stuff that makes you feel that people see you" (A:F:36). Moreover, in the professional context, it is used by Barak, Michal, Gilad, and Or for self-branding: "this is your self-visibility" (O:F:50); "This is

the group I built [he gave the name]… now it is a brand…" (G:M:48). As Barak said, it is all due to: "positioning yourself as an expert" (B:M:53).

The participants extended their presentation during the time they are involved in their field of interest. They were highly aware of the choices they made about how and what they present in their SNS profiles. As showed, they also talk about how the information they share represents them. The retrospective reports and the follow-up data collections (the second and third meetings) reveal the fast and dynamic characteristics of the development and the changes in the participants' perceptions of themselves. Moreover, the retrospective report demonstrated how they learn to enhance and control the way they use the various SNS features for self-presentation.

Around-the-clock sociality

Our participants engage in SNS activities every day, "day and night" (O:F:50). They share information and interact with friends and followers: "I check notifications to follow and to answer…" (M:F:49); They frequently connect to their SNS profiles, walls and, in particular, to their notifications. Their peers are also there, "someone is always connected at any time" (S:F:36). They connect to the SNS platforms from their PCs, laptops, tablets and cell-phones. The interaction is often with people from far away, and most of them also have connections around the world. Some of the connections are with peers and people they never met before they interacted with them on SNSs. The analysis of our participants' sociality in SNSs, in the context of developing professional identities, is characterized by building compatible peer circles, giving and receiving meaningful feedback, experiencing social events in real life (which are initiated online), and ongoing peer comparisons.

Compatible peer circles - It was found that our participants built a customized social world (Manago, 2014) and created compatible peer circles – groups of peers in their field of interest, social peer circles with a mutual interest. Moreover, we found that our participants are also connected to people in the field, "here [on my wall] they found her artwork" (O:F:50); "I created the connection between them" (B:M:53). The social circles our participants create are dynamic, they grow with time and we can identify a process of ongoing customization of their sociality in SNSs: "now [as opposed to in the past], I have many artists here [Facebook friends]" (Y:F:19); "I stay only in groups which are good… I can write and comment there [in the group] without anyone attacking me…" (M:F:49). This dynamic process of sociality is part of their identity development, they become more specific and they are engaged with more specialists in the field, and over time their social circles gather more friends in their fields of interest.

Meaningful feedback - The social circles are crucial, and the participants revealed how they build them through the comments and feedback. In this way, their knowledge is evaluated, and their professionality is recognized. The participants indicated that they get meaningful feedback from peers who are in the same field; moreover, we found that they also developed ways to summon these feedbacks: For example, Or published a post in which she asked:"…do you know of an interesting Hamsa collector?" (Retrieved from O:F:50 Facebook posts).

It is interesting to see the linkage created by participants between the customized peer circles and the meaningful feedback: "there is a dialog… people [in the professional circle] are waiting for this poem… it answers someone's needs" (A:F:36); "The comments show me that it is valuable to people,"; "her comment gave me a new idea" (M:F:49). Through these meaningful interactions the participants talk and build their compatible social circles.

Social events in real life - What was not anticipated was to find that the SNS's sociality goes beyond virtual interactions: "a few days ago, while walking, someone said to me – hi, you are Michal, I read your blog…" (M:F:49). These real-life events are based on professional and social meetings (e.g., dinners, workshops, tours). Six of our participants took part in social events in real life with peers who they first 'met' in SNSs: "we have a group of bloggers… we meet each other occasionally…"

(M:F:49). "I met her at her gallery…" (O:F:50); "This group from Facebook meets all the time in social events" (G:M:48).

Peer comparisons - The groups played an important role in identity development. They created a feeling of belonging, alongside a demarcation and comparison processes: "I know what comments I will get, and they will be very hostile, I have been able to position myself in the SNS as a person who has a say…" (Y:F:19). "We had a workshop together… it is interesting to see what she is doing now…" (B:M:53), "you see other people's lives all the time and you compare yourself…" (A:F:36). It is interesting to see how from the intense sociality on SNS in a field of interest, emerges a professional community in which the amateurs can develop their unique professional identity as part of a process that includes peer comparisons. They understand and perfect their professional identity, during an ongoing estimation of how they belong and how similar they are to their peers and in what ways they are unique and in what ways they differ from them.

Interaction with information towards knowledge construction

The interaction with information was found to be remarkable and we identified wide aspects of it: engagement, compatible knowledge exposure, creating and presenting knowledge, and the acquisition of information skills (searching, evaluating, categorizing, etc.). All seven participants were highly engaged in everyday interaction with information acquisition: reading, saving, retrieving, and sharing: "I learn a lot from reading other people's stuff, I am exposed to many Blogs, from some of which I learn a lot…" (M:F:48). The cue retrospective reports revealed that participants have high levels of alertness of their SNS interaction with information, although it appeared from the records as if they were merely scrolling their feeds: "I scroll fast, but I can catch the important and relevant information" (S:F:36); " I learn something new on the network every day " (M:F:49), "I can see that I read many items seriously and evaluate them" (Y:F:19); "I scroll fast but when my eye picks up some interesting information, I stop to read it" (S:F:36). Moreover, it was found that they are involved in ongoing information collection activities, keeping information for themselves, sharing with peers, and creating an information archive in their field of interest: "It was a good article so I sent it to myself" (M:F:49); "If it is interesting I will save it or 'like' it" (Y:F:19).

The massive interaction with information is characterized by an eager interest for information in their fields: "I am a Google freak … I have always loved technology, I am always connected, at first I build all kinds of learning and games" (S:F:36), "I love this song [she shared]" (A:F:36). All our participants were talking about their field of interest with enthusiasm, they are deeply engaged in their fields and in the information they acquire and share with their peers: "I learned this for myself… I said that this is exactly what I was looking for" (M:F:49); "I found myself acquiring things that I love day and night" (O:F:50).

Apart from the interaction with much information in the SNSs, it was also found that the information they share and use is also compatible with their needs and interests. Or (F:50) described how she filters contents to increase her exposure to information in her field: "I follow artists, so you can see art on my wall." (O:F:53). Barak (M:53) said that he prefers some subjects over others and identified how, over the period, he moved from information sharing on one subject to more specific information in his field of interest. We can identify a process of information customization in which the participants interact and are exposed mostly to information that is relevant to them, "I use notifications to filter the information I want to see" (S:F:36). The information goes through a process of evaluation and organization, and then it is presented to peers "I share only good articles" (S:F:36), "I look for special things [crafts]" (O:F:53).

The participants jump between a few typical activities for knowledge construction: ongoing studying by free intuitive navigating (S:F:36; G:M:48; Y:F:19); in-depth curation activities of organizing and interpreting presented information (O:F:50; A:F:36); focusing on learning and developing while building a professional information archive (M:F:49; B:F:53); and exploratory interaction and sharing of information relating to their fields of interest, mixed with information relating to self (Y:F:19;

A:F:36; O:F:50). Table 4 demonstrates the different knowledge construction activities of each participant.

Table 4. Knowledge construction activities of the participants

	Field of Interest	Knowledge construction activities
Yael	Art, poetry slam	Exploratory creation and sharing information relating to self and to her fields of interest
Shira	Technology and education	Ongoing interaction with information by free intuitive navigation, and focusing on sharing
Michal	Family economics	Building a professional archive
Barak	Urban agroecology	Learning and developing professional expertise
Adi	Poetry	Creating knowledge Share information
Or	Arts and crafts	Curation and peer interaction
Gilad	Lifestyle	Ongoing interaction with information by free intuitive navigation, and focusing on **deliberate** sharing

To sum up, the participants acquired new knowledge with new professional peers; they present themselves, what they know, and what they have learned through SNSs.

How SNSs Afford Professional Identity Development

In the first part of this article, we reported on the affordances of SNSs. These affordances are potentialities for desirable behaviors, and often the affordances are only wishful intentions of designers, which do not lead to the behaviors envisioned. We report here on the actual behaviors afforded by SNSs that led to professional identity development, through their role in self-presentation, around-the-clock sociality, and interaction with knowledge. This section presents the role of SNSs affordances in the three main constructs that supported professional identity development as arises from the analysis of the participants' interviews, retrospective reports, and SNS activities.

The participants used SNS on a daily basis; the retrospective reports enabled us to look carefully on this interaction and to reveal what are the SNSs affordances for the accelerated professional identity development that we have found, and the participants' wide range of practices, which they acquired in order to enhance their extended professional identity development through SNS. The participants progressively enacted practices. The process of uncovering the practices was undertaken with the participants themselves, using the reports given by them, while watching their recorded activities in SNS.

Self-expression affordances

It was found that SNSs enable wide ways of self- expressions, the participants use SNSs for self-broadcasting to broad audiences for many of their activities: "you can share everything with anyone" (O:F:50); "I have invited everyone to the event" (G:M:48). However, on the other side, we also found that SNSs enables very intimate peer interactions. It was shown that participants use SNS for private interactions: "people ask me in private" (O:F:50), "comments are sometimes personal" (O:F:50). In the retrospective records, they say, "I met her here" or "we are very close, we share many boards [on Pinterest]" (B:M:53). Moreover, we found that sometimes the participants tailored their self-presentation as Manago (2014) claimed, "I rearranged my profile" (Y:F:19). However, it

happened that they aimed at creating authentic self-presentation: "I write very personally, I give examples from my private life" (M:F:49) or "This is exactly who I am" (O:F:50). They moved between antagonistic affordances and chose how to present their self in wide range of affordances.

The main practices the participants used for self-expression are focused activity in the field of interest, enhanced privacy skills acquiring expertise in SNS, and enabling judgment on personal and professional presentation

Sociality affordances

Unsurprisingly, the participants' social interaction in SNS was very rich. We found that the participants belonged to permanent social circles, which included people they know: "Those who comment are part of a wide permanent group of people" (O:F:50). However, we found that SNSs also expose users to "friend" requests from unknown people. These requests are approved for various reasons, and therefore previously unknown people became 'friends'. Moreover, SNSs enabled comments and interaction and afforded meaningful feedback, such as "I know I give people value, I know it from their comments" (M:F:49). Nevertheless, we found that the affordances of meaningful feedback was contradicted by the fact that the participants also indicated that they spend a lot of wasted time in social interactions with peers. Participants also reported on the burden that these interactions yielded; Or declared "I will answer all comments later in the evening" (O:F:50); in a retrospective report, she added "I have to answer all comments"; "I answer all comments. Moreover, it is a lot…" (O:F:50). These findings reveal that sociality affordances are also characterized by antagonism, and participants have to decide how to construct their social interaction through SNSs. The participants' practices to enjoy the potential of sociality and to avoid the constrains are to reply to peer comments and feedback, enabling judgment on the diverse circles of audiences, and to follow peer activity in a variety of SNSs

Information interaction affordances

The last group of affordances is the construction of knowledge/information. It appeared that for all participants, SNSs afford an everyday exposure to information; they afford easy public information sharing and flexible consumption: "Every day I share information I find in SNS" (S:F:36). Moreover, we found that participants use SNSs in order to keep information in personal spaces and to create personal information spaces for keeping previous activities and important information items. "All my work [objects he builds from previous surfing] is here [Pinterest board]" (G:M:48). SNSs also afford our participants exposure to information by subject, but also afford exposure to information by peers. The participants revealed that they follow peers to see what they share and what they are looking for with respect to knowledge and groups by subject. In addition, the participants point on varied of SNSs' affordances for acquiring information. In the acquiring information we also identified the contradiction between affordances for intentional acquiring and unplanned information encounters: "in Pinterest I get my information from notifications, or I look for it by searching…"(B:M:53) "in Facebook I look for peers that share information in my field" (M:F:49). In order to construct knowledge from SNSs the participants apply a variety of practices for dealing with information: regularly create and share new information, acquiring knowledge from varied SNSs, organizing information from SNS sources for reuse (immediately or later in time by sending emails, using save options, or sharing in other SNSs like Pinterest boards), search information by people and by subject (this means using other peers or experts in order to find relevant information), and using notifications (to control the information overload).

To sum the findings about SNS affordances we would like to light some general insights of the participants. Some participants identified SNS constraints and dilemmas and the feel that they have to control their use; Yael said that she had just deleted the Facebook App from her cellphone and that she was trying to limit her use of Facebook, even though it is important and convenient to share and read from it (Y:F:19). Or and Adi also shared that they have to control their use of SNSs (Or felt that

she spends a lot of time in Pinterest, and Adi on Facebook). Barak said that he must give more attention and control of how he uses Facebook. The overall analysis of the retrospective reporting raises the suggestion that SNSs summon antagonistic affordances (shown in Table 5 in the Discussion section) and, therefore, create the need to be aware and to monitor activities.

Moreover, it was identified that the participants developed critical information skills, implanting them in the SNS context: they developed search skills for SNSs, and we can see that they look for information in SNSs in various techniques which are based on sociality filtering and tags, and not just by keywords. They have a variety of skills to control overload information, they are skilled at taking care of their privacy, and they have developed skills for promoting their information.

DISCUSSION

The present study shows that SNSs create a new context for professional identity development, a context whose new characteristics brings specific actors to a spectacular development in their professional identity. The participants in this study were carefully selected. We deliberately looked for SNS users who initially actively organized and shared information in their field of interest. Therefore, it is not surprising that we found that professional identity developed among these highly motivated participants. Nevertheless, considering the short period of time we were given, we were surprised by how spectacular was the development of their professional identity. The findings indicate that SNS users underwent abrupt changes in the way they perceive their own identity and in the ways their peers perceive them, as experts or as people of standing.

To begin with, the more expectable findings, from the time of Marcia (1966), it is well known that identity development in general involves commitment (Marcia, 1966). We observed that our participants were highly committed to the acquisition and sharing of knowledge. This was one of the prominent practices that we identified. Our participants intensively used Facebook, Instagram, YouTube and Blogs in their professional life, and this use led to the development of their professional identity. We agree with Bridgstock (2019), who stated that other platforms such as LinkedIn might also help developing professional identity, although the latter study was not based on long-term observation of professionals. We also believe that there is a teachable knowledge that can enhance students' identity development through SNSs as claimed by previous studies (Jackson & Bridgstock, 2020; Jawed et al., 2019; Starcic et al., 2017).

Another expectable finding echoes what Floridi (2014) already noticed: the study clearly demonstrated that SNS activities became part of the users' info-space and that their information became part of them and part of their identity. Floridi's concept about the Onlife identity in the digital age (as opposed to online or offline concepts) is salient in the SNSs of our participants (where their activities take place online and offline). For example, Adi arranged with her 'followers' and 'friends' on Facebook a meeting for a reading event in a bar, and Or organized a trip to galleries in Europe. Our study provides clear evidence that when SNSs are adopted as tools for professional development, their use extends online interactions and knowledge exchange into 'real life events' (such as face-to-face meetings and collaborations). These findings agree with Barker and Rodriguez (2019), who found that, among other reasons, students share selfies to say something about who they are.

The present study brings new insights about the role of SNSs in identity development. We showed, like Manago (2014), that SNSs afford the self-presentation and the social feedback for identity formation and, like Treem and Leonardi (2013), that SNSs afford information interaction, visibility, editability, and content creation. We confirmed that the unique mixture of self-presentation, social interaction, and the information accessibility provided by SNSs led to an accelerated development of professional identity. Our findings also correspond with Kasperiuniene & Zydziunaite's (2019) review. We suggest framing the impact of SNSs on professional identity development in three main aspects: extended self-presentation, around-the-clock sociality, and intensive knowledge construction.

However, extended self-presentation, around-the-clock sociality, and intensive knowledge construction do not necessarily lead to professional development. Our participants were intensely involved in information interaction in their field of interest. These exceptional SNS users were actively and deeply involved in several topics, and this initial involvement turned their daily navigations with SNSs into meaningful exploration processes that facilitate identity development (Flum & Kaplan, 2006, 2012). The longitudinal method we adopted revealed how eagerness to learn, activeness in a field of interest, high motivation for development, intensive acquisition of information activities, and the ongoing process of building social circles and social interaction, all led to accelerated professional identity development. The main novelty of this study relies on the identification of a phenomenon that fueled professional development – the antagonism between affordances and constraints, which creates tensions that trigger the users' awareness to self-expression, sociality, and interaction with information. Our findings are in line with previous studies according to which SNSs create tensions and summon antagonist features that create these tensions: tension between private and public (Shane-Simpson et al., 2018), the tension between professional identity and personal identity (Kimmons & Veletsianos, 2014) and between past and present self-expressions and self-presentation (Brandtzaeg and Chaparro-Domínguez, 2020). Previous studies also indicate that SNSs have their benefits and costs, as they challenge self-presentation, privacy, sociality, and overload users with information and connections (Gao, 2018; Manago, 2014). Our study shows that these tensions are at the root of professional identity development.

More specifically, SNSs are generally understood as affording online social connections. And in the last few years it was found that they also afford extended self-expression (Manago, 2015). These two affordances are a priori antagonistic. However, we found that, among our highly motivated participants, SNSs afforded the cohabitation of antagonistic affordances towards the promotion of three SNS components of professional development – self-expression, sociality, and interaction with information. In Table 5, we present how SNSs afford antagonistic processes, based on the analysis of the users' events of interacting with SNS.

Table 5. Antagonistic SNS affordances identified in the participants' interactions

Intimate peer interactions	vs	Self-broadcasting	Self-expression affordances
Authentic presentation		Tailored self-presentation	
Discussion group		One-on-One interaction with peer groups	
Peer comparison	vs	Meaningful feedback	Sociality affordances
Real-time (immediate) interaction		A-synchronic interaction	
Unknown people as 'friends'		Compatible peer circles	
Copyright awareness		Privacy awareness	
Personal information spaces	vs	Public information sharing	Information interaction affordances
Exposure to information by peers		Exposure to information by subject	
Unplanned information encounters		Intentional information acquisition	
Information overflow and exposure to non-relevant information.		Relevant information	

We suggest that the tensions that arise from the antagonistic affordances and the challenges SNSs provide for us also play a crucial role in identity development, since they raise user awareness. The antagonistic affordances require our participants to make choices, to decide how to present themselves, in what circle of friends they wish to publish, and what to publish; the SNSs antagonistic affordances forced the user to decide how to acquire information and how to organize it. On the one hand, the need to choose makes SNSs challenging, but on the other hand, it also acts as a facilitating factor. It makes SNSs suitable platforms to summon awareness to the possibilities opened by SNSs, to the challenges they raise and to possible implications on professional identity development. The antagonistic affordances made the users more reflective. The participants spoke about the implication of their actions for themselves, their challenges, and their development. The following reports, gleaned from the participants' interviews, exemplify these phenomena: "me and my Facebook have a very complicated relationship… you should be careful with comparisons in SNS…" (A:F:36); "these concepts are related to my feminist identity." (Y:F:19); "What's interesting is my creativity and my development…" (O:F:50); "This came when I was much more emotionally mature, I didn't know how much I knew, and I didn't know how to express it. You need courage to expose" (A:F:36); "I said to myself OK, this [Pinterest's' followers] is a monster, and I cannot control it, and I have never controlled it until today, and control is not the purpose" (O:F:50). Therefore, the participants are aware of their SNS activities, they choose when to be authentic and where to position themselves. Manago (2014) wrote that SNS is characterized by tailor-made self-presentation; it has its benefits and costs. However, the awareness of professional identity formation comes with the motivation to create and control the self-presentation; SNSs enable editing and the frequent change of self-presentation and, therefore, they enable the development.

To sum up, we suggest that SNSs enable the enhanced development of identity since they afford many different activities, which are antagonistic to one another. Hence, in order to learn and develop through SNSs, users must be aware and reflect on their activities and their choices. These observations broaden the understanding of SNSs as platforms, which are characterized by public self-presentation and compatible sociality (Manago, 2015), and show that SNSs bring new and unique characteristics for valuable professional identity development – intensive interaction with knowledge construction.

CONCLUSIONS

To conclude, we found that SNSs have the potential to afford an accelerated process of professional identity development through an extensive process of organizing and sharing knowledge in a specific field of interest. This process is based on three main components: extended self-presentation, intensive knowledge construction, and round the clock sociality. SNSs were found to afford antagonistic actions for each of the components. Based on our findings, we suggest a new framework of development in SNSs. The framework is diagrammatically displayed in Figure 2.

The suggested framework can be adopted in higher education and high schools in order to use SNSs as tools for learning and developing through a process of deliberate activity of interaction with information related to the self-exploration activities (Flum & Kaplan, 2006). Bridgstock (2019) already claimed that SNSs should be used for professional development in academic courses. Brandtzaeg and Chaparro-Domínguez (2020) show how social media may have long-lasting consequences in life transitions, from youth to professional adults. Studies suggest providing institutional and academic guidance for students regarding the use of SNSs in forming digital professional identity (Jackson & Bridgstock; 2020; Jawed, Mahboob & Yasmeen, 2019; Starcic et al. 2017).

Our framework displayed in Figure 2 provides a specific model for how the SNSs affordances can function as a collaborative learning and development space when users enact proper practices. The framework can fit a classroom, college, or university situation and can help enabling young students to acquire the skills and experiences of how to develop a field of interest using SNSs. It shows the three main components and their antagonistic affordances.

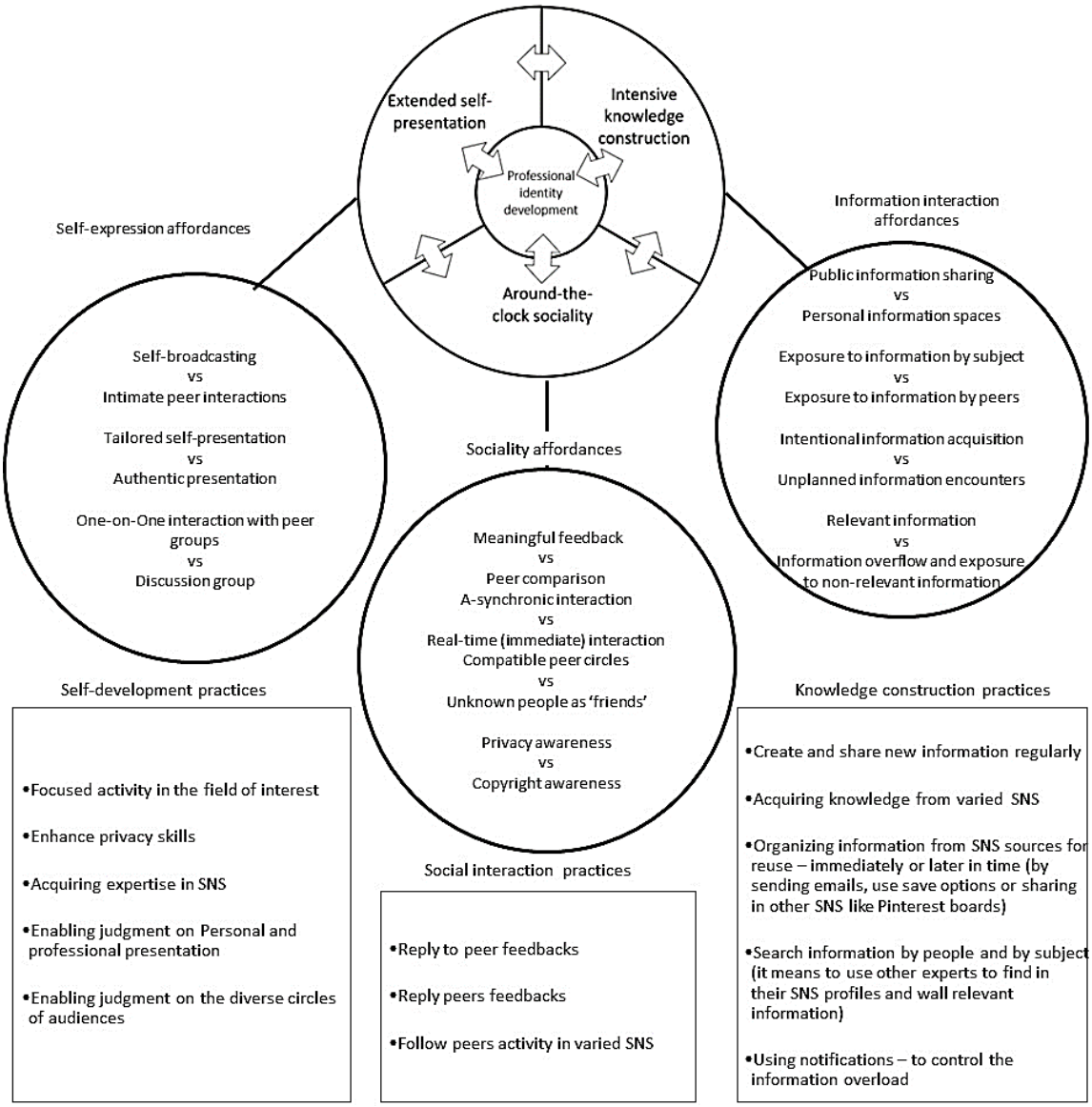

Figure 2. A conceptual framework of development of professional identity with SNSs

The conceptual framework can help educational institutions to implement SNSs in order to enhance professional identity development by helping teachers to guide professional identity development. Guidance will allow students to handle the antagonistic affordances for self-presentation, sociality, and information management. By doing so, the guides will help achieving meaningful SNS activities by encouraging students to be focused and involved in their fields of interest, thereby enhancing their abilities and helping to turn their interests into expertise. Future studies may examine the implementation of SNSs for the exploration process leading to identity development in various educational institutions. Moreover, when self-monitoring and self-management tools are available for learning by quantified-self applications (Arnold at el., 2017; Buongiorno, 2017; Kristensen & Ruckenstein, 2018), our framework may be used in order to combine SNSs in future self-monitoring and self-management tools. It may help handling information available through automatic analysis, on the one hand, while, on the other hand, adding an intelligent quantified-self application, which will help SNS users to harness its potential for professional identity development. The quantified-self application might help learners to monitor and manage presentation of the extended self, to afford around-the-clock

sociality and intensive knowledge construction of SNSs, to enhance awareness and reflection, and to help learners enhance their professional identity development by using SNSs.

The fact that our conceptual framework is based on seven participants who accepted to share the information and their knowledge limits the scope of the present study. Further research is required to observe more users and the implication of SNSs information organization and sharing in a formal assignment in academic or other professional identity development settings. Moreover, the study followed the participants for one year. It is needed to keep following these users to understand how stable their professional identity development is in longer periods.

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BIOGRAPHIES

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AN EXPLORATORY STUDY OF ONLINE EQUITY: DIFFERENTIAL LEVELS OF TECHNOLOGICAL ACCESS AND TECHNOLOGICAL EFFICACY AMONG UNDERSERVED AND UNDERREPRESENTED STUDENT POPULATIONS IN HIGHER EDUCATION

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ABSTRACT

Aim/Purpose	This study aims to explore levels of Technological Access (ownership, access to, and usage of computer devices as well as access to Internet services) and levels of Technological Efficacy (technology related skills) as they pertain to underserved (UNS) and underrepresented (UNR) students.
Background	There exists a positive correlation between technology related access, technology related competence, and academic outcomes. An increasing emphasis on expanding online education at the author's institution, consistent with nationwide trends, means that it is unlikely that just an increase in online offerings alone will result in an improvement in the educational attainment of students, especially if such students lack access to technology and the technology related skills needed to take advantage of online learning. Most studies on levels of Technological Access and Technological Efficacy have dealt with either K-12 or minority populations with limited research on UNS and UNR populations who form the majority of students at the author's institution.
Methodology	This study used a cross-sectional survey research design to investigate the research questions. A web survey was sent to all students at the university except first semester new and first semester transfer students from various disciplines (n = 535). Descriptive and inferential statistics were used to analyze the survey data.
Contribution	This research provides insight on a population (UNS and UNR) that is expanding in higher education. However, there is limited information related to levels of Technological Access and Technological Efficacy for this group. This paper is timely and relevant as adequate access to technology and

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	technological competence is critical for success in the expanding field of online learning, and the research findings can be used to guide and inform subsequent actions vital to bridging any educational equity gap that might exist.
Findings	A critical subset of the sample who were first generation, low income, and non-White (FGLINW) had significantly lower levels of Technological Access. In addition, nearly half of the survey sample used smartphones to access online courses. Technological Efficacy scores were significantly lower for students who dropped out of or never enrolled in an online course. Transfer students had significantly higher Technological Efficacy scores while independent students (determined by tax status for federal financial aid purposes) reflected higher Technological Efficacy, but at a marginally lower level of significance.
Recommendations for Practitioners	Higher education administrators and educators should take into consideration the gaps in technology related access and skills to devise institutional interventions as well as formulate pedagogical approaches that account for such gaps in educational equity. This will help ensure pathways to sustained student success given the rapidly growing landscape of online education.
Recommendation for Researchers	Similar studies need to be conducted in other institutions serving UNS and UNR students in order to bolster findings and increase awareness.
Impact on Society	The digital divide with respect to Technological Access and Technological Efficacy that impacts UNS and UNR student populations must be addressed to better prepare such groups for both academic and subsequent professional success. Addressing such gaps will not only help disadvantaged students maximize their educational opportunities but will also prepare them to navigate the challenges of an increasingly technology driven society.
Future Research	Given that it is more challenging to write papers and complete projects using a smartphone, is there a homework gap for UNS and UNR students that may impact their academic success? What is the impact of differing levels of Technological Efficacy on specific academic outcomes of UNS and UNR students?
Keywords	underserved, underrepresented, technological access, technological efficacy, COVID-19, pandemic

INTRODUCTION

Over the past decade, institutions of higher education have been offering more online courses and programs, and the number of college students enrolled in at least one online course, as well as the proportion of all enrolled students who are studying online have been increasing (Allen et al., 2016; Cohen & Baruth, 2017; Ginder et al., 2017). In the US, online student enrollment has increased over 14 consecutive years (Seaman et al., 2018). Online learning has become mainstream (Allen et al., 2016) and has made learning accessible, convenient, and flexible (Parsad & Lewis, 2008).

While the institutional desire to increase student access to post-secondary education has resulted in the roll out of more online programs and course offerings, important questions to be considered with respect to uniformity of online educational access remain, given that the digital divide continues to be a persistent problem in the United States (Gonzales, 2016; Ritzhaupt et al., 2013; Rowsell et al., 2017; Warf, 2019). Online students also need to possess medium to high levels of confidence and skills with respect to utilizing the Internet for performing online tasks and interacting with others (Hauser et al., 2012; Kuo & Belland, 2016).

The share of minority students and students who are in poverty are on the rise at minimally selective and open admission post-secondary colleges and universities (Fry & Cilluffo, 2019). In light of this, questions exploring the extent of students' access to technology (Technological Access) and level of technological competence (Technological Efficacy), which together are essential for success in online educational endeavors at the post-secondary level, are pertinent. This is especially true for students whose demographic backgrounds are strongly suggestive of risk factors that impact academic achievement.

In keeping with national trends over the past decade, decreasing post-secondary enrollment coupled with continued declines in state funding have led to reduced enrollment at the author's institution, a small Midwestern public university. Recognizing the key role of tuition and fee revenue as a significant component of its sustenance, the institution has been growing its online courses and programs to attract more students. Consequently, the share of online courses as a percent of total courses offered has increased from 12.4% in 2017-18 to 18.1% in 2018-19 to 21.1% in 2019-20 (online course offerings - 2017-18: 421; 2018-19: 573; 2018-19: 699). While the uncertainty stemming from Covid-19 precludes an accurate projection of online course offerings for 2020-21, the general consensus in the institution is that online course offerings will remain constant at the very least, if not grow in response to the public health crisis.

As per university data, the author's institution caters to a demographic characterized by students who are first generation (55%), low income (40%), minority (35%), adult (25%), and academically underprepared (70%) with overall low post-secondary education completion outcomes (6 year graduation rate of 30.5% for first time, full time first year students; 39.6% for transfer students). The institution also draws students from inner city, high poverty zip codes. Given the increasing focus at the author's institution on expanding its online course offerings, the concerns about levels of Technological Access and Technological Efficacy acquire specific relevance as a significant part of the institution's student demographic may be characterized as underserved and underrepresented.

Underserved (UNS) students refer to those who may possess one or more of several at risk characteristics, such as belonging to lower economic status, first generation college attendees, minorities, academically unprepared, under credited and not on track to graduate (Zielezinski & Darling-Hammond, 2016). Underrepresented (UNR) students refer to those with one or more of the following characteristics: low income, first generation, minority background (Gershenfeld et al., 2016; Hurd et al., 2016).

Research indicates the existence of a positive correlation between technology related access and academic outcomes (Anderson & Perrin, 2018; Liu et al., 2007) as well between technology related competence and academic outcomes (Hauser et. al., 2012). In light of the above, the institution's student demographics, and its increased focus on expanding online education, it is unlikely that an increase in online offerings alone will result in an increase in the educational attainment of UNS and UNR students if such students lack the appropriate access to technology and the technology related skills needed to take advantage of online learning. In order for increased online course offerings to translate to improved access and sustained success, it is important to undertake a critical examination of whether there exists technology related access and efficacy barriers to online learning within the subject population. Such findings may then guide and inform subsequent actions vital to bridging any educational equity gap that might exist. The effect of the digital divide as it relates to Technological Access and Technological Efficacy needs to be examined closely for institutions serving a higher proportion of UNS and UNR demographics. This is an important topic of inquiry given the changing demographics of post-secondary enrollment (Fry & Cilluffo, 2019) and that student learning is taking place increasingly in digital environments (Seaman et al., 2018).

There is significant amount of research on both the existing gap in technological skills as it pertains to K-12 students, minority students, and the digital divide in American societies (Cotton et al., 2011, 2014; Gonzales, 2016; Huang et al., 2017; Kuo, 2018; Vigdor et al., 2014). However, there is limited

research that delves into technology related access and efficacy woes of a mixed group of college students who may be of White or minority status but may also possess other characteristics such as lower economic status, first generation college attendee status, and academic under preparedness, all of which, standalone or in combination, may predispose them to underachievement, thereby classifying them as disadvantaged students (UNS and UNR). Additionally, given that the author's institution has had a recent uptick in online offerings and draws its students from primarily UNS and UNR communities, it is crucial to examine whether such students possess the necessary Technological Access and Technological Efficacy to take advantage of online learning.

The objective of this study was to explore and gain insights into levels of Technological Access and Technological Efficacy for UNS and UNR students, as this would help determine whether there exist gaps in access to technology and gaps between technology related competence and the skills needed to be successful in an online learning environment. The outcome of the study could reveal differences in either levels of Technological Access or levels of Technological Efficacy or both, or, alternatively, the absence of any meaningful differences. The findings are expected to help inform institutional and faculty outreach efforts, should the existence of differential levels of Technological Access and/or Technological Efficacy be confirmed. In order to do so, the following research questions were investigated:

1. What levels of Technological Access (ownership of, access to, and usage of computer devices as well as access to the Internet) do students have and use to complete coursework in a small public Midwestern university that primarily serves underserved and underrepresented populations?
2. What is the Technological Efficacy level of students in a small public Midwestern university that primarily serves underserved and underrepresented populations?

These questions were examined using a cross sectional survey design. Data was collected via an online survey administered to the entire student population excluding all first semester students (new and transfer) to ensure that respondents had had the opportunity to complete an online course at the author's institution. A survey sample consisting of 535 student responses was analyzed using SPSS.

The paper details existing literature on Technological Access and Technological Efficacy. The survey instruments, sample, and types of statistical analysis performed are discussed, and discussions of results and consequent recommendations as well as topics for possible future research are provided.

LITERATURE REVIEW

UNDERSERVED AND UNDERREPRESENTED CHARACTERISTICS

Underserved (UNS) populations refer to a broad group of learners who may possess one or more of several at risk characteristics such as belonging to lower economic status, first generation college attendees, minorities, testing into remedial courses (academically unprepared), under credited (not full time status), and not on track to graduate (Zielezinski & Darling-Hammond, 2016). Other studies have included transfer students in this category as well (Finley & McNair, 2013). In the context of educational inequities, underserved students have been identified as those that lack access to high-quality educational and career planning opportunities and resources (Moore et al., 2018). Underrepresented (UNR) populations refer to students who are economically disadvantaged, and/or minorities (Gershenfeld et al., 2016), and/or first generation (Hurd et al., 2016).

In this study, the words underserved (UNS) and underrepresented (UNR) are used to describe disadvantaged students -- either low income, and/or first generation, and/or students of color, and/or academically at risk students where academically at risk refers to, singly or in combination, academically underprepared, and under-credited. First generation is defined as students whose parents' education is high school or less. Low income is synonymously used with Pell Grant eligibility. Students of color

are those who identified their race/ethnicity anything other than White. Under-credited refers to students who carry an academic course load of less than 12 credit hours per semester. Academically under prepared refers to students who enter college needing remedial coursework. Students who are first generation, low income (Pell Grant eligible), and non-White, are designated as FGLINW. For the purposes of this research, use of the terms "underserved (UNS)" or "underrepresented (UNR)" is meant to refer to students with one or more of the aforementioned socio-demographic markers and is not intended to stand in for a comprehensive definition of the term. Rather, it is being used as the operational lens delineating the scope of the review.

The Digital Divide

The digital divide may be defined as a social inequity between individuals regarding (1) access to information and communication technology (ICT), (2) frequency of use of technology, and (3) the ability to use computing technology for different purposes (Hohlfeld et al., 2008). Digital inequalities are defined as differences in actual access to technology and digital literacy – the extent to which individuals have the knowledge and competence to access digital technologies such as computers, internet, mobile devices and applications, and utilize the same to obtain benefits from the use of such technologies (Beaunoyer et al., 2020). As per the authors, such inequities in access and skills are deeply embedded in social, economic, and cultural contexts which are likely to place socioeconomically challenged populations at a greater disadvantage with respect to obtaining benefits from use of technology.

In the context of the changes in the higher education landscape with institutions offering more online courses and programs (Allen et al., 2016), and especially more so in the wake of a global pandemic, questions with respect to the existence of the digital divide and its impact on student learning outcomes acquire primacy. This is pertinent for UNS and UNR students who are liable to be particularly susceptible to the effects of the digital divide.

In this study, Technological Access refers to access to ICT – access to and use of computers, mobile devices, and access to Internet. Technological Efficacy refers to technology related skills and competence that, standalone or together, allow for utilization of digital technologies such as computers, mobile devices, and the Internet for the purposes of learning.

Technological Access

There is considerable amount of research, as discussed below, on unequal access to technology in the US in relation to UNS and UNR characteristics such as socioeconomic status and ethnicity, variables relevant to the demographics of this study. Accordingly, students coming from minority and lower income households are less likely to have access to reliable computer devices and Internet at home.

A PEW Research Center survey on how different demographic groups in the US have fared in the digital age reports that the digital divide persists even as lower income Americans have made gains in technology adoptions (Anderson & Kumar, 2019). According to this report, for households with annual income less than $30,000, approximately 29% do not own a smartphone, 46% do not own a computer, and 44% do not have home broadband services. In contrast, higher-income Americans are more likely to have multiple devices that enable them to access the Internet. Roughly two-thirds of adults living in high-earning households (64%) have home broadband services, a smartphone, a computer, and a tablet, compared with 18% of those living in lower-income households.

According to another PEW Research study (Anderson & Perrin, 2018), this stratification and differential access by annual household income acts as an impediment to completion of homework assignments, commonly known as the homework gap for those on the lower end of the income scale. Overall, about 15% of US households with school-age children (6 to 17 years) do not have broadband internet connection at home which constitutes about 35% of lower income households. The authors cited Horrigan's (2015) findings to note that this disparity is particularly pronounced in

African American and Hispanic households. According to this report, lacking reliable Internet service at home, these teens seek out public Internet services to complete assignments. Teens whose family income is below $30,000 a year are far more likely to say that they use public Internet services to complete assignments than those whose annual household income is $30,000 or higher (21% vs. 9%). This facet of the digital divide is an additional burden on African American and Hispanic youth that contributes to the achievement gap.

A study by Vigdor et al. (2014) examined computer ownership and access to broadband Internet services among middle school students in North Carolina Public School system. Computer access was negatively associated with race and socioeconomic status (SES). While 90% of White students had a computer at home, computer ownership was 75% for African Americans. The study reported existence of significant differences in device ownership and frequency of computer use for school work based on race and socioeconomic status. Affluent and White students used computers to complete homework more frequently compared to students from lower income and minority populations.

In a national study, Mossberger et al. (2006) looked at home computer access and frequency of home Internet use in high poverty zip codes that comprised of White non-Hispanic populations (70%) as well as minorities, based on Census data from all 50 US states. The study found concentrated poverty to have a significant impact on lower access to technology. In zip codes where income levels were at least one standard deviation below that of the median poverty level, the study reported that Whites, Asians, African Americans, and Hispanics had lower access rates to home computers and the Internet. A second finding of the study was that within zip codes impacted by concentrated poverty, African Americans and Hispanics had relatively lower access outcomes than Whites. This was due to the fact that levels of racial segregation increased with increase in levels of poverty, and segregated communities, in turn, had differential levels of access to public infrastructure and facilities as well as social interactional dynamics that impede technological awareness and access.

A similar study by Mossberger et al. (2008) on patterns of computer use and Internet access in three disadvantaged Ohio communities that were poor and either White or African American reported work, school, friend/relative's residence, and libraries to be frequent destinations for computer and Internet access in the absence of such amenities at home. Respondents who were more affluent were statistically more likely to use the Internet at home than those who were poor. A subsample who did not have access to a computer at home or at work were mostly African American with lower incomes, even though income was not found to be a predictor of Internet use, perhaps because of the homogeneity of the subsample. Overall, African Americans were statistically less likely to have access to a computer and were less likely to use the Internet when compared to Whites.

In Gonzales' study (2016), qualitative interviews from 72 low-income urban US residents revealed the struggles that poor communities face to maintain stable Internet access. Respondents from impoverished communities experienced regular disruptions in access to and use of Internet, primarily due to the inability to pay monthly service bills, repair malfunctioning hardware, and constraints on public access (e.g., library hours, time-limits at terminals, distance to public resources and limitations of transportation options). Consequent to the absence of Internet services at home or restricted/intermittent access to the same, the study found that almost half of the respondents resorted to smartphones to access the Internet. According to the study, cost of acquisition and maintenance of device hardware as well as access to resources that might be able to provide technological assistance related to maintenance and repair of devices were other issues where lower income residents suffered in contrast to individuals with higher incomes.

Tsetsi and Rains (2017) analyzed smartphone dependence and usage patterns on a nationally representative sample of 2,254 adults. Topics covered in the phone interviews included Internet access, use, and perceptions of the importance of the Internet in respondents' lives. Whites were significantly less likely to be smartphone dependent and more likely to be owners of multiple devices than minorities. Economic status was a significant factor with individuals from lower income backgrounds

reporting limited or no access to the Internet. Additionally, smartphone dependent users tended to belong to significantly lower income groups when compared to multimodal users.

A national study on undergraduate students' (n = 64,536) use of technology in 114 doctorate granting institutions by the non-profit agency Educause Center for Analysis and Research reported that minority, first generation, and low income college students viewed smartphones as significantly contributory towards their academic success (Galanek et al., 2018).

Results from a 2018 nationally representative survey of 1,500 exclusively online students in the US (over 50% had annual household income of less than $40,000) indicated that 67% completed some or all of their coursework using a mobile device (tablet or smartphone but not a laptop), 20% used mobile devices solely for coursework completion, and a significant plurality reported using mobile devices to access educational materials online (Magda & Aslanian, 2018).

These findings were corroborated by another PEW Research survey that reported 19% of millennials and 17% of Gen Xers in the US do not have home broadband and rely on smartphones only to access the Internet (Vogels, 2019). Anderson and Kumar (2019) also reported that the share of lower income Americans relying solely on smartphones to go online (effectively, respondents who owned a smartphone but did not have broadband internet at home) had doubled from 12% in 2013 to 26% in 2019.

Anderson and Perrin (2018) also reported that 35% of teens often or sometimes complete homework on their smartphones. The authors noted that although this might have reflected a trend with younger generations, this was especially prevalent among lower income teens where 45% with annual household income less than $30,000 reported sometimes relying on their cell phones to complete homework.

Rubinstein-Avila and Sartori (2016, p. 563), in discussing the variety of issues that allow for a nuanced understanding of the digital divide that impacts access to and engagement with ICT, noted that "cell-mostly" users tend to come from demographics characterized by lower educational attainment. In a meta-analysis of research on the digital divide, Rowsell et al. (2017) found that students who used smartphones mostly or solely to complete coursework tended to belong to demographics characterized by lower educational attainment. The authors found this to be particularly troublesome as this put such students at greater risk of poorer educational outcomes despite the access provided for by smartphones.

The findings from the studies referenced above indicate that the disparity in Technological Access is stark along socioeconomic and racial lines, with individuals belonging to these groups lacking adequate computer and Internet access. Liu et al.'s (2007) meta-analysis of the determinants of online course dropout rates in a community college context found that access to technology (necessary hardware and software) were key factors that influenced success in online learning environments. This further underscores the significance of such disparities. This issue was also discussed by Rowsell et al. (2017) in noting that lack of adequate Technological Access is likely to impede student engagement in online educational activities and interaction thereof in ways that help foster critical thinking.

Therefore, gaps in Technological Access, if present, are likely to impede realization of learning outcomes despite the increase in access to education via increase in online offerings. This, then, gives rise to the need to evaluate levels of Technological Access in UNS and UNR students in higher education.

Technological Efficacy

Research on levels of technology skills possessed by undergraduate students in a minority serving US institution found that students did not possess the necessary technology skills needed to be successful in college and that there was a gap between the students' skill levels and the computer skills necessary for success (Buzzetto-Hollywood et al., 2018). The study found this gap to be more

pronounced for underrepresented students. These findings support the concerns regarding the presence and impact of the digital divide in higher education, at least in the dimension that references student ability to use computing technology. This leads to the question of whether such a gap exists in student ability and skills as they relate to use of technology for a post-secondary student population in an institution that serves a higher proportion of UNS and UNR students.

Digital technologies are playing an increasing role in education due to the increase in online courses aimed at bridging the access gap to post-secondary learning (Allen et al., 2016; Parsad & Lewis, 2008). This observation leads to questions about whether there exists any gap between student ability/skills and computer skills necessary for success, and whether such gap is likely to act as an impediment to student learning in an online setting, thereby negating some, if not all of the gains in educational access that are sought to be achieved by moving to online course delivery mode.

In light of the above, Technological Efficacy, then, refers to skills related to use of computer devices and skills related to use of the Internet that, standalone or together, facilitate the use of technology for the purposes of learning. Technological self-efficacy, on the other hand, consists of a person's perception in his or her own capabilities to use computer skills in the accomplishment of a computer related task, also known as Computer self-efficacy (Compeau & Higgins, 1995b), and a person's "belief in one's capabilities to organize and execute courses of Internet actions required to produce given attainments," also known as Internet self-efficacy (Eastin & LaRose, 2000, p. 1).

Existing literature indicates that Technological self-efficacy and performance in technology related tasks are positively correlated (Compeau & Higgins, 1995a; Hauser et al., 2012), and that Technological self-efficacy contributes to development of technological skills that constitute Technological Efficacy (Compeau & Higgins, 1995a; Compeau et. al., 1999; Eastin & LaRose, 2000). As such, in the absence of tests examining actual levels of Technological Efficacy of a sample, self-assessment of technological skills or Technological self-efficacy is used to infer Technological Efficacy. The linkage between Technological self-efficacy and development of technological skills has been progressively established via the findings of several studies, which are discussed below.

Two related Canadian studies (Compeau and Higgins, 1995b; Compeau et al., 1999) conducted on managers and professionals found computer self-efficacy to exert a significant influence on individuals' expectations of the outcomes of using computers, their emotional reactions to computers (affect and anxiety), as well as their actual computer use. Together, the findings indicated that individuals with high levels of computer self-efficacy experienced less anxiety, had higher outcome expectations, perceived themselves to be able to accomplish difficult computer related tasks, judged themselves as capable of operating with less support and assistance, and used computers more. These findings were similar to Kuo's study (2018) of African American working adult undergraduate students at an US institution that found learner's levels of computer self-efficacy to be a good predictor for computer anxiety. The correlation between levels of computer self-efficacy and anxiety and attitude towards computers was echoed in another study of African American working adult undergraduate students (Kuo & Belland, 2019) that found that learners with lower levels of computer self-efficacy exhibited anxiety related negative attitudes towards computers while learners with higher levels of computer self-efficacy exhibited positive attitudes towards computers.

Such a relationship between levels of computer self-efficacy and anxiety and attitude towards computers appears to be reasonable given that negative emotions towards computers is likely to impact learners' confidence level in performing computer related tasks. This is supported by Saadé and Kira's study (2009) on first year undergraduate students at a Canadian university that found (1) computer anxiety had a significant effect on perceived ease of use of a learning management system (LMS), (2) computer self-efficacy acted as a significant mediator in reducing the strength and significance of the impact of computer anxiety on perceived ease of use of an LMS, and (3) the existence of a strong and significant relationship between computer self-efficacy and computer anxiety.

Additional research, as discussed below, indicates that higher levels of technology related self-efficacy are not just correlated to reduced levels of learner anxiety related to technology but also positively affect levels of learner confidence in adoption and use of technology. Gangadharbatla's study (2008) found Internet self-efficacy to be a significant predictor of willingness to join in and exhibit positive attitudes towards social networking sites among undergraduate college students at a large southwestern US university. The study cites Daugherty et al.'s (2005, p. 71) findings that usage and adoption of internet related technologies depends on the individual's "confidence in their ability to successfully understand, navigate, and evaluate content online" (p. 7). The study further surmises that the greater the ease with which an individual can perform tasks online, the greater should be the individual's ability to participate in online forums.

The findings from Gangadharbatla (2008) were consistent with another study (Eastin & LaRose, 2000) of undergraduate students enrolled in an introductory communication course at a large US university that found Internet self-efficacy and Internet use to be directly and significantly correlated. This was attributable to the fact that students were more likely to persist in behavior that they felt capable of performing (Oliver and Shapiro, 1993, as cited in Eastin & Larose, 2000). The study also found that Internet self-efficacy (1) directly influenced learner outcome expectancies, (2) was positively correlated to Internet usage, and (3) was strongly influenced by prior experience. The authors surmised that positive assessment of Internet self-efficacy directly influenced learners' outcome expectations, and such expectations along with lower stress and/or higher confidence associated with higher levels of Internet self-efficacy, promoted greater task persistence and influenced effort levels towards realizing such expectations. This, in turn, promoted greater use of technology and expanded technology related experience.

This assessment by Eastin and LaRose (2000) indicates that higher technology related self-efficacy leads to greater usage of technology that helps develop learner technology related skills, which then further bolsters technology related self-efficacy, thereby completing a positive feedback loop. Therefore, higher levels of Technological self-efficacy are likely to lead to higher levels of technology related skills or Technological Efficacy while lower levels of Technological self-efficacy are likely to lead to lower levels of Technological Efficacy. This is consistent with research conducted on 95 professionals and managers by Compeau and Higgins (1995a) that reported a significant positive relationship between prior experience and performance and between Technological self-efficacy and performance in technology related tasks. This study concluded that Technological self-efficacy strongly influences performance outcomes and that Technological self-efficacy represents a unique and important contribution to the development of technology related skills (Technological Efficacy).

The linkage between computer self-efficacy and online performance was also reported in a longitudinal study by Hauser et al. (2012) that examined the effect of computer self-efficacy, amongst other variables, on that of student performance. This study found that higher computer self-efficacy scores positively correlated to higher performance in online courses for undergraduate students at a midsized US university. Kuo and Belland's study (2016) of African American working adult undergraduate students found a similar linkage between Internet self-efficacy and performance. The study found higher Internet self-efficacy to be significantly and positively correlated with learner-content interaction, learner-learner interaction, and learner-instructor interaction in an online learning environment, which in turn, was positively correlated with satisfaction in online courses. Higher levels of satisfaction, in turn, was correlated with better academic performance.

The link between technology related efficacy and performance was also examined by Liu et al. (2007) in a meta-analysis of the determinants of online course dropout rates in a community college context. The authors noted that technology related efficacy, among other variables, was a key factor that influenced the decision to drop courses. The study found that the ability to use technology to achieve one's learning objectives was a significant factor influencing online success.

The literature shows that specific skills and knowledge related to technology (computer and Internet) are needed to perform tasks in an online learning environment, and that the ability to leverage such skills and use technology is a key factor that influences performance and success in online learning contexts. Therefore, lower levels of Technological Efficacy are likely not to lead to improvement in learning outcomes despite the increase in access to education via increase in online modes of instruction, which then gives rise to the need to evaluate levels of Technological Efficacy in UNS and UNR students in higher education.

The development of such skills (Technological Efficacy) needed to accomplish tasks is influenced by the learner's level of Technological self-efficacy. Technological self-efficacy determines level of anxiety, confidence, task persistence and effort, usage of technology, technology related experience, and development of skills eventually leading to Technological Efficacy. Technological Efficacy, in turn, leads to increase in Technological self-efficacy, thereby completing the learning reinforcement loop. In light of this, Technological self-efficacy is used as the appropriate construct for assessment of Technological Efficacy in a survey sample, in the absence of skills based tests for the latter.

METHODOLOGY

DESIGN, SAMPLE, AND DATA COLLECTION

Participants were 535 undergraduate students at University of Wisconsin-Parkside, a small public university in the Midwestern part of the United States, in the state of Wisconsin. The study used a cross-sectional survey research design to investigate the research questions. The author's institutional human subjects review board approved the study. Informed consent was obtained prior to participation in the survey and participants could discontinue at any time. Adequate steps were taken to protect participants' confidentiality.

Data was collected through a Qualtrics web survey. Email invitations to participate in the online survey were sent to the entire student body except for first semester new and first semester transfer students, thereby ensuring that the respondents had completed at least one semester at the institution – this was to ensure that the students had had the opportunity to complete online course(s). This yielded a student population of 2,800 students.

Procedures outlined by web survey experts to increase response rates, such as follow up contacts and incentives for survey completion, were employed. The initial email invite survey link was sent to all 2,800 students during the 7th week of the semester. Weekly reminder emails were sent to those who had not completed until the 14th week of the semester. Instructors were approached to announce the survey verbally in their face-to-face courses or in writing on their learning management system homepage. To increase response rate, the survey was incentivized. Students who completed the survey were placed in a draw to win Amazon gift cards.

The survey response rate of 19.1% was in line with the typical e-survey response rate range of 20-30% (Bosnjak & Tuten, 2001; Sheehan, 2001) and was consistent with general guidelines for descriptive research which deems a sample size of between 10-20% of population as acceptable (Gay, 1996).

RESEARCH QUESTIONS

The major research questions are outlined below:

1. What levels of Technological Access (ownership of, access to, and usage of computer devices as well as access to the Internet) do students have and use to complete coursework in a small public Midwestern university that primarily serves underserved and underrepresented populations?
2. What is the Technological Efficacy level of students in a small public Midwestern university that primarily serves underserved and underrepresented populations?

INSTRUMENTATION

An online course was defined in the survey as a course where 100% of the course content was delivered online. The survey included a section to assess Technological Access and a section to assess Technological Efficacy. A third section gathered information on student personal and demographic characteristics.

The Technological Access questionnaire included questions on computer device usage and ownership and Internet connectivity, arranged in four subsections (Table 1). The first subsection had questions on the types and frequency of devices used to complete readings and assignments – laptop, desktop, tablet, and smartphone. The second subsection had questions on the types and frequency of use of public computers, such as school computer lab, borrowed devices from school, work device, community computer lab (Public Library, Workforce Development Center, or YMCA) to complete readings and assignments. The third subsection had questions on types and frequency of access to residential and public Internet services (Public Library, Workforce Development Center, commercial stores such as MacDonald's, Starbucks, or shopping mall) to complete readings and assignments. The last subsection had questions on ownership and access to technological devices (desktops, laptops, printers), availability and adequacy of software resources, and access to resources outside of school for tech support.

Table 1: Research Question 1 – Technological Access

Research Question	Independent Variable	Dependent Variable	Instrument	Scale	Analysis
Technological Access level of students	Group (Entire sample vs. FGLINW group)	Computer devices used to complete coursework	TA Questionnaire	1=Never 4=Frequently	Chi- Square analysis Table 5
	Group (Entire sample vs. FGLINW group)	Public computer devices used to complete coursework	TA Questionnaire	1=Never 4=Frequently	Chi- Square analysis Table 6
	Group (Entire sample vs. FGLINW group)	Access to Internet services to complete coursework	TA Questionnaire	1=Never 4=Frequently	Chi-Square analysis Table 7
	Group (Entire sample vs. FGLINW group)	Hardware and software access (Technological Access) characteristics	TA Questionnaire	1=Yes 2=No 3=Don't Know	Chi- Square analysis Table 8

The Technological Access questionnaire was developed by the researcher and was informed by a review of access characteristics investigated and reported in the literature as reported herein. The Pew Research Center analysis of 2015 and 2018 US Census Bureau data was based on questions that examined ownership of and reliable access to computer devices such as desktops, laptops, tablets, and smartphones, access to reliable Internet services at home, the use of public Internet services to complete coursework in the absence of access to the Internet at home, and use of cellphones to complete coursework (Anderson & Kumar, 2019; Anderson & Perrin, 2018).

Mossberger et al.'s study (2006) examined issues of computer access at home and frequency of home Internet use in high poverty zip codes that comprised of mostly White non-Hispanic populations based on 2000 Census data on all 50 US states. A similar study by Mossberger et al. (2008) examined patterns of computer use and Internet access in three Ohio communities that were poor and either White or African American. The survey asked questions about such usage at work, home, school, library, and friends/relatives' place. Vigdor et al.'s study (2014) examined computer ownership and access to broadband Internet service among secondary school students in North Carolina Public School system. A 2018 study (Galanek et al., 2018) surveying mostly 114 doctorate granting US institutions examined undergraduate students' computer and mobile device access and ownership attributes as well as residence/off campus Internet access features.

Questions on availability and adequacy of software resources and access to resources outside of school for tech support were developed by the author based on over ten years of personal experiences with students facing technology related hardships at the author's institution. Additional support for the survey question with respect to availability of tech support was found in Robles' study (2006) that examined, amongst other variables, the impact of support services on student satisfaction levels in online courses at an US undergraduate institution.

The Technological Efficacy questionnaire (Table 2) was based on a scale that required students to self-assess their skills and degree of comfort with respect to basic technological skills (Technological Efficacy). Technological Efficacy was an 8 item measure on a 5 point Likert scale with 1 = strongly disagree to 5 = strongly agree. The 8 items included perceptions of skillsets and preparedness related to using the computer and the Internet and to taking online courses.

The items included perceived comfortability with tasks related to typing, saving, and organizing files in a computer; surfing the Internet; finding Internet resources and setting bookmarks; uploading and downloading files; installing software and changing configuration settings; navigating a learning management software; and two items on perceived confidence related to taking and completing online courses.

Table 2: Research Question 2 – Technological Efficacy

Research Question	Independent Variable	Dependent Variable	Instrument	Scale	Cronbach's alpha	Analysis
Technological Efficacy level of students	Group Characteristics (Online course completion, Transfer, Federal Income Tax status – dependent / independent)	Mean TE Score	Felt comfortable typing, saving, and organizing files in a computer	1=Strongly disagree 5=Strongly agree (5 point Likert Scale)	0.82	Independent Samples T test; & ANOVA Table 9
			Felt comfortable surfing the Internet			
			Felt comfortable finding Internet resources (web search) and setting bookmarks			
			Felt comfortable uploading & downloading files			
			Felt comfortable installing software and changing configuration settings			
			Felt comfortable navigating a learning management software			
			Felt prepared to take an online course			
			Felt confident to complete an online course			

The Technological Efficacy questionnaire was developed based on a review of relevant literature and in consultation with faculty experienced in online teaching, and subject matter experts in the field of adult and distance education in the institution's Teaching and Learning Center.

The Technological Efficacy questionnaire was loosely based on review of three instruments: the Computer self-efficacy (CSE) questionnaire used by Santoso et al. (2014), the Internet self-efficacy questionnaire developed by Torkzadeh and Dyke (2001), and the Internet self-efficacy scale used by Robles (2006). The 29 item CSE questionnaire (Santoso et al., 2014) had three subsections on beginning skills (10 items), advanced skills (12 items), and file and software skills (7 items) with Cronbach's alpha scores of .93, .88, .90 respectively. The Internet self-efficacy questionnaire (Torkzadeh & Dyke, 2001) consisted of 17 items with three items representing confidence with browsing, another six items on encryption/decryption, and eight items on system manipulation. Cronbach's alpha reliability scores were .93, .98 and .94 for browsing, encryption/decryption and system manipulation, respectively. Overall reliability for the 17-item scale was .96. The 9 item Internet self-efficacy scale (Cronbach's alpha reliability score of .93) used by Robles (2006) consisted of student self-assessment of their abilities in browsing and navigating the Internet (7 items) and self-assessment of their abilities in taking and completing an online course (2 items).

Cronbach's alpha Reliability coefficient for the Technological Efficacy questionnaire used in this survey was .82 and can be considered reliable for perception related instruments (Wallen & Fraenkel, 2001). Construct validity for Technological Efficacy was established by pilot testing the instrument on a small sample (n = 50) at the author's institution.

The student personal and demographic characteristics section contained questions pertaining to students' gender, age, race/ethnicity, Pell Grant eligibility, independent/dependent tax status for financial aid, income, transfer student status, and first generation college attendee status.

According to Creswell (2008), content validity is typically established by researchers having a panel of judges or experts identify whether survey questions are valid. Content validity for the entire questionnaire was established as the instruments were developed based on a review of relevant literature and in consultation with subject matter experts in the field of adult and distance education in the institution's Teaching and Learning Center as well as faculty experienced in online teaching. Construct validity for the entire questionnaire was established by pilot testing the instrument on a small sample (n = 50) at the author's institution.

Data Analysis

Data were analyzed using quantitative methods. Tables 1 and 2 list the analysis methods used for each research question. The survey data was exported to SPSS 24.0 to run descriptive and inferential statistics. The Kolmogorov-Smirnov (K-S) test was used to check for non-normality. K-S test value of 0.05 or lower informs lack of fit and warrants non-parametric methods. Non-parametric (chi-square) test was employed while testing for Technological Access due to the non-normal nature of the distribution and the smaller sample size of the subgroup (FGLINW group; n = 61) being compared (with the larger sample; n = 535). However, if the sample size is sufficiently large, parametric tests (t-test and ANOVA) can be used to detect significance (Lumley et al., 2002), and as such parametric tests (t-test and ANOVA) were used to detect group differences with respect to Technological Efficacy.

Group differences between the main sample and the FGLINW subset with respect to Technological Access was measured using Chi-square test of significance. Group difference was the independent variable while types of computer devices used (desktop, laptop, tablet, and smartphone), types of public computer devices used (school lab, community computer lab, work computer), types of Internet access (home, school, work, community), and hardware/software access characteristics were dependent variables.

Technological Efficacy was the dependent variable used to discern if there were group differences (independent variable) among demographic variables such as race/ethnicity, low income, and first generation status and other personal characteristics such as independent or dependent status for financial aid purposes and transfer status. Independent sample t-test (for two categories in the independent variable) and analysis of variance (for three or more categories of the independent variable) were employed to check for significant group differences in mean Technological Efficacy scores.

Sample Demographic Characteristics

There were a total of 535 respondents. A critical subset (n = 61) of the sample consisted of students who were first generation (FG), low income (LI), and non-White (NW), termed as FGLINW.

Females constituted 69% of the total sample and 72% of the FGLINW group. The majority of the sample (71.6%) and FGLINW group (73.8%) were 24 years or younger while non-traditional students comprised 28% and 26% of the sample and FGLINW group respectively (Table 3). A majority of respondents were White (66.6%) followed by Hispanic (15.1%), African American (8.3%) and Asian (5.1%). The FGLINW group comprised of Hispanic (50.8%), African American (24.6%), and Asian (14.8%) students.

For purposes of federal financial aid, students were asked to identify their federal tax status as independent (42.5%) or dependent (57.5%) and to report their individual or family income (if dependent status). A large majority (72.4%) of independent students (n = 221) in the total sample had incomes lower than $30,000 (official US poverty threshold in 2018 was $25,100 for a family of 4 and $29,420 for a family of 5) while the corresponding figure for the FGLINW group was 86%. For students who reported dependent status (n = 299), 30% had family incomes less than $30,000 while the corresponding figure for the FGLINW group was 58%. For those students who reported independent

status, 88% had income less than $50,000 (below the US median income of $63,179 in 2018) while 93% of the FGLINW group had income less than $50,000.

For dependent students, 52% had family incomes lower than $50,000 compared to 79% in the FGLINW group who had family incomes lower than $50,000. Almost half (46.4%) of the respondents were Pell Grant recipients. Of the survey respondents, 38% were first generation college students, and 37% were transfer students (29.5% of the FGLINW group were transfer students).

Table 3: Demographics of Participants

	Survey Sample		FGLINW Group	
Age	**N**	**%**	**N**	**%**
24 or younger	383	71.6	45	73.8
25-34	86	16.1	11	18.0
35-44	41	7.7	3	4.9
45-54	21	3.9	2	3.3
55+	4	0.7	0	0.0
Total	***535***	***100.0***	***61***	***100***
Gender	**N**	**%**	**N**	**%**
Female	367	68.9	44	72.1
Male	161	30.2	16	26.2
Other	5	0.9	1	1.6
Total	***533***	***100.0***	***61***	***100***
Race/Ethnicity	**N**	**%**	**N**	**%**
African American	44	8.3	15	24.6
Asian	27	5.1	9	14.8
Hispanic / Latinx	80	15.1	31	50.8
Native American	2	0.4	2	3.3
Native Hawaiian/Pacific Islander	1	0.2	1	1.6
White	353	66.6	0	0.0
Multiracial	23	4.3	3	4.9
Total	***530***	***100***	***61***	***100***
Income Status (Independent Students)	**N**	**%**	**N**	**%**
Less than $10,000	73	33.0	11	39.3
$10,001-$20,000	59	26.7	10	35.7
$20,001-$30,000	28	12.7	3	10.7
$30,001-$40,000	18	8.1	1	3.6
$40,001-$50,000	16	7.2	1	3.6
More than $50,000	27	12.2	2	7.1
Total	***221***	***100***	***28***	***100***
Income Status (Dependent Students)	**N**	**%**	**N**	**%**
Less than $10,000	28	9.4	11	39.3
$10,001-$20,000	20	6.7	10	35.7
$20,001-$30,000	38	12.7	3	10.7
$30,001-$40,000	31	10.4	1	3.6
$40,001-$50,000	37	12.4	1	3.6
More than $50,000	145	48.5	2	7.1
Total	***299***	***100***	***28***	***100***
Federal Pell Grant Recipient	**N**	**%**	**N**	**%**
Yes	248	46.4	61	100.0
No	286	53.6	0	0.0
Total	***534***	***100***	***61***	***100***
First Generation College	**N**	**%**	**N**	**%**
Yes	201	37.7	61	100.0
No	325	61.0	0	0.0
Don't know	7	1.3	0	0.0
Total	***533***	***100***	***61***	***100***
Transfer Student Status	**N**	**%**	**N**	**%**
Yes	196	37.0	18	29.5
No	334	63.0	43	70.5
Total	***530***	***100***	***61***	***100***

RESULTS

Of the 535 respondents, 233 (43.6%) had successfully completed an online course, another 225 (42.1%) never enrolled in an online course, and 77 (14.4%) had enrolled but dropped an online course (Table 4).

Table 4: Online Enrollment		
	N	**%**
Enrolled and never dropped an online course	233	43.6
Enrolled but dropped an online course	77	14.4
Never enrolled in an online course	225	42.1
Total	***535***	***100***

TECHNOLOGICAL ACCESS

Due to the non-normal nature of the distribution, a chi-square test of significance was performed to discern if there were meaningful differences in device ownership as well as device and Internet usage characteristics between the whole sample (n = 535) and a critical subset of the sample who were first generation (FG), low income (LI = Pell Grant recipient), and non-White (NW), termed as the FGLINW group (n = 61).

Tracking the type of devices used to complete coursework (Table 5) revealed that 90% of the respondents (n = 535) regularly or frequently used a laptop to complete readings and assignments. About 39% said they regularly or frequently used a desktop to complete readings and assignments. Chromebook or iPad usage was low. Comparatively, 45% of the respondents for the entire sample reported using their smartphones regularly or frequently to complete readings and assignments. For the FGLINW group, half of the respondents (n = 61) used smartphones to complete their readings and assignments. The chi-square test of significance did not detect significant difference in device use characteristics for completing coursework between the larger sample and the FGLINW group.

Table 5: Computer Devices Used to Complete Coursework					
	N = 535		**N = 61 (FGLINW*)**		**Significance**
Types of Devices	**Never/Rarely**	**Regularly/Frequently**	**Never/Rarely**	**Regularly/Frequently**	**Y / N**
Laptop	56 (10.5%)	479 (89.5%)	5 (8.2%)	56 (91.8%)	N
Desktop	320 (61.1%)	204 (38.9%)	32 (54.2%)	27 (45.8%)	N
iPad	458 (87.7%)	64 (12.3%)	53 (86.9%)	8 (13.1%)	N
Chromebook/Android tablet	480 (91.6%)	44 (8.4%)	53 (93.0%)	4 (7.0%)	N
Smartphone	294 (55.5%)	236 (44.5%)	30 (50.0%)	30 (50.0%)	N

*FGLINW = First Generation, Low Income, non-White; $^{*}p <= .05$, $^{**}p <= .01$, $^{***}p <= .001$

Table 6: Use of Public Computer Devices to Complete Coursework					
	N = 535		**N = 61 (FGLINW*)**		**Significance**
	Never/Rarely	**Regularly/Frequently**	**Never/Rarely**	**Regularly/Frequently**	**Y / N**
School Lab	386 (72.1%)	149 (27.9%)	40 (65.6%)	21 (34.4%)	N
Check out from school	497 (93.1%)	37 (6.9%)	50 (82.0%)	11 (18.0%)	Y (χ^2=21.411*)
Work computer	408 (76.3%)	127 (23.7%)	46 (75.4%)	15 (24.6%)	N
Use community computer device (Public Library/Workforce Dev./The Y)	501 (93.8%)	33 (6.2%)	50 (82.0%)	11 (18.0%)	Y (χ2=10.989***)

*FGLINW = First Generation, Low Income, non-White; $^{*}p <= .05$, $^{**}p <= .01$, $^{***}p <= .001$.

With regards to usage of public computers to complete coursework (Table 6), the FGLINW group differed significantly from the larger sample in two categories. The FGLINW group checked out computer devices from the institution at a higher rate than the rest of the sample (18.0% vs. 6.9%;

χ^2=21.41, p=.012) and utilized community computers at a higher rate compared to the rest (18.0% vs. 6.2%; χ2=10.99, p=.000).

When asked about how students accessed Internet services to complete coursework (Table 7), the majority in the larger sample (n = 535) reported using residential (93.6%) or campus Internet services (87.6%). In contrast, a small number used Internet services at work (30.3%), community (13.7%) or at a store (15.6%) to complete homework and assignments. A chi-square test of significance indicated significant intergroup differences with the FGLINW group reporting greater usage of work based Internet services (45.9%; χ^2=7.45, p=.05), community based Internet services (34.4%; χ^2=14.70, p=.002), and store based Internet services (29.5%; χ^2=12.99, p=.005).

Table 7: Access to Internet Services to Complete Coursework

	N = 535		N = 61 (FGLINW*)		Significance
	Never/Rarely	Regularly/Frequently	Never/Rarely	Regularly/Frequently	Y / N
Home Internet	34 (6.4%)	500 (93.6%)	4 (6.6%)	57 (93.4%)	N
School Internet	66 (12.4%)	468 (87.6%)	3 (4.9%)	58 (95.1%)	N
Work Internet	371 (69.7%)	161 (30.3%)	33 (54.1%)	28 (45.9%)	Y (χ^2=7.450*)
Community Internet (Public Library/Workforce Dev./The Y)	459 (86.3%)	73 (13.7%)	40 (65.6%)	21 (34.4%)	Y (χ^2=14.698**)
Store Internet (MacDonald's, Starbucks, shopping mall, etc.)	448 (84.4%)	83 (15.6%)	43 (70.5%)	18 (29.5%)	Y (χ^2=12.990**)

*FGLINW = First Generation, Low Income, non-White; *p <= .05, **p <= .01, ***p <= .001.

In terms of computer device ownership, most everybody (95.7%) reported owning a laptop or desktop in the larger group (Table 8). The FGLINW group differed significantly in not owning a computer (13.1% vs. 4.3%; χ^2=4.90, p=.02). Almost a quarter of the respondents reported sharing their computer at home with family members compared to 30% in the FGLINW group. A chi-square test of significance detected a significant difference in printer ownership (χ^2=24.80, p=.000) and access to a printer (χ^2=18.11, p=.000) compared to the larger group. Within the larger group (n = 535), 85% reported having the latest software compared to 80% in the smaller subset, with no statistically significant difference observed between the two groups. Significant group differences were detected for having virus protection software (χ^2=9.17, p=.01) and the ability of devices to play multimedia content (χ^2=8.34, p=.015). Approximately 10% in the FGLINW group did not have access to reliable internet services at home compared to 6% in the larger group. When asked about access to resources in terms of knowing someone who might be able to provide help with computer/technology related matters, a larger majority (72.7%) in the sample reported availability of such a resource compared to 56% in the FGLINW group (χ^2=14.23, p=.001), a significant difference.

Table 8: Technological Access

	N = 535			N = 61 (FGLINW*)			Significance
	Yes	No	DK	Yes	No	DK	Y / N
Own a laptop/desktop	512 (95.7%)	23 (4.3%)	NA	53 (86.9%)	8 (13.1%)	NA	Y (χ^2=4.902*)
Share a laptop/desktop	123 (23.5%)	401 (76.5%)	NA	18 (30.0%)	42 (70.0%)	NA	N
My computer runs reliably on the latest software	452 (84.6%)	36 (6.7%)	46 (8.6%)	49 (80.3%)	5 (8.2%)	7 (11.5%)	N
Own a printer	376 (70.4%)	152 (28.5%)	6 (1.1%)	31 (50.8%)	30 (49.2%)	-	Y (χ^2=24.799***)
Access to a printer	507 (94.9%)	23 (4.3%)	4 (0.7%)	56 (91.8%)	5 (8.2%)	-	Y (χ^2=18.106***)
Virus protection	393 (73.7%)	98 (18.4%)	42 (7.9%)	39 (63.9%)	15 (24.6%)	7 (11.5%)	Y (χ^2=9.165**)
Browser will play multimedia	463 (86.7%)	28 (5.2%)	43 (8.1%)	52 (85.2%)	5 (8.2%)	4 (6.6%)	Y (χ^2=8.338*)
Access to reliable Internet services at home	487 (91.4%)	32 (6.0%)	14 (2.6%)	52 (86.7%)	6 (10.0%)	2 (3.3%)	N
Know someone outside of school for tech help	388 (72.7%)	116 (21.7%)	30 (5.6%)	34 (55.7%)	26 (42.6%)	1 (1.6%)	Y (χ^2=14.233***)

*FGLINW = First Generation, Low Income, non-White; *p <= .05, **p <= .01, ***p <= .001.

TECHNOLOGICAL EFFICACY

Even though the K-S test was significant for Technological Efficacy scores, indicating a non-normal distribution, the sufficiently large sample size allowed for the use of parametric tests (t-test and ANOVA) to detect significant group differences in Technological Efficacy scores (Lumley et. al., 2002).

Mean Technological Efficacy scores for the entire sample was 4.08 on a scale of 1 to 5. An analysis of variance (Table 9) showed that mean Technological Efficacy scores were significantly higher for online course completers (F=26.079, p=.00), compared to those who enrolled but dropped or never enrolled in an online course. Transfer students had significantly higher scores than their counterparts (t=2.41, p=.02). Students who identified as independents for federal financial aid purposes had higher scores compared to those who identified as dependents but at lower significance level (t=1.85, p=.06). Group differences for underserved characteristics of first generation, low income, and race/ethnicity were not significant.

Table 9: Technological Efficacy

Mean Technological Efficacy Score - Overall							**N = 535**
	N	**%**	**Min**	**Max**	**Mean**	**SD**	**Test Stat**
All Survey respondents	535	100	1.00	5.00	4.08	0.62	NA
Mean Technological Efficacy Score by Online Course Enrollment							**N = 535**
	N	**%**	**Min**	**Max**	**Mean**	**SD**	**Test Stat**
Completed an online course	233	43.6	2.50	5.00	4.26	0.56	F=26.079***
Enrolled but dropped an online course	77	14.4	2.88	5.00	4.19	0.59	
Never enrolled in an online course	225	42.1	1.00	5.00	3.87	0.62	
Total	***535***	***100***	***1.00***	***5.00***	***4.08***	***0.62***	
Mean Technological Efficacy Score by Transfer Status							**N = 530**
	N	**%**	**Min**	**Max**	**Mean**	**SD**	**Test Stat**
Transfer	196	37	1.00	5.00	4.17	0.62	t=2.41*
Not Transfer	334	63	2.50	5.00	4.04	0.61	
Total	***530***	***100***	***1.00***	***5.00***	***4.09***	***0.62***	
Mean Technological Efficacy Score by Federal Income Tax Status							**N = 531**
	N	**%**	**Min**	**Max**	**Mean**	**SD**	**Test Stat**
Dependent	308	58	1.00	5.00	4.04	0.64	t=.1.85+
Independent	223	42	2.50	5.00	4.14	0.58	
Total	***531***	***100***	***1.00***	***5.00***	***4.08***	***0.62***	

+p <= .1, *p <= .05, **p <= .01, ***p <= .001.

DISCUSSION

TECHNOLOGICAL ACCESS

The digital divide with respect to Technological Access was apparent for this sample of UNS and UNR students in several areas of usage, ownership, and access to computer devices, and usage and access to the Internet. This was observed across both the larger sample and especially within the FGLINW subset, which critically lagged the main group in several categories.

Respondents' overall usage of public computers (Table 6) indicated that outcomes for the FGLINW group were worse than that of the main group across all categories. Significantly, for the FGLINW group, 18% checked out computers from school (main sample: 7%) while 18% availed of computer devices in community settings to access courses materials (main group: 6%).

There were significant intergroup differences in access and usage of Internet resources outside of school and home (Table 7) with the FGLINW group using Internet resources at higher rates at work (46% vs 30% for the main sample), in community settings (34% vs 14% for the main sample), and in store settings (30% vs 16% for the main sample). In addition, 6% and 10% of respondents from the main sample and the FGLINW group, respectively, reported not having access to reliable Internet services at home (Table 8). These findings underscore uneven and differential access to Internet resources at home, which in turn, explain greater usage of work and community based resources.

With respect to Technological Access (Table 8), while outcomes for the FGLINW group were worse across the board, crucially, there were statistically significant differences in outcomes between the FGLINW group and the main group with 13% not owning a computer (main sample: 4%), 49% not owning a printer (main sample: 29%), 8% not having access to a printer (main sample: 4%), 25% not having adequate virus protection (main sample: 18%), 8% not having browser capability to play multimedia (main sample: 5%), and 43% not having access to a resource that might assist with technical issues associated with device usage (main sample: 22%). Additionally, although intergroup differences were not significant, it is worth highlighting that within the main sample, almost a quarter shared a computer device with their family members, and 7% did not have a computer that reliably ran the latest software. The corresponding figures for the FGLINW sub group were 30% and 8%, respectively.

The results from this survey also indicate noteworthy usage of smartphones to access course materials and complete assignments (Table 5), with 45% of the respondents in the larger sample and half of the respondents in the FGLINW group reporting usage of smartphones regularly or frequently to access course materials. Additionally, these results indicate that such usage of smartphones to meet academic needs is likely informed by the lack of adequate Technological Access (appropriately functioning desktops & laptops, Internet connectivity, etc.) as discussed earlier.

The access, ownership, and usage characteristics discussed above, especially in categories where intergroup differences (between the overall sample and the FGLINW group) were found to be statistically significant, further allude to the presence of the digital divide with respect to Technological Access. The worse outcomes for the FGLINW group as they relate to ownership of and access to technological devices (computer devices and printers), including incidence of shared device usage, ties in to the greater usage of public computers as discussed earlier with reference to Table 8.

The above findings have resonance with national statistics aggregated by the PEW Research Center (Anderson & Kumar, 2019) that indicate that, in American households, access to computer devices and Internet is differentially distributed based on annual family income. The study also reports that the relative lack of access to computer devices or Internet for students from lower economic backgrounds impedes their ability to complete academic coursework/homework at a much higher rate than their counterparts from higher economic backgrounds, thereby alluding to the possibility of the existence of a "homework gap" (Anderson & Perrin, 2018). This is a pertinent area of future investigation given that Anderson and Perrin (2018), citing Horrigan (2015), also note that these disparities are particularly pronounced in African American and Hispanic households, given the strong correlation between income and race/ethnicity.

The results from this study hew closely to the findings of past research that has reported differential access to technology being concentrated in minority and low income households (Gonzales, 2016; Vigdor et al., 2014), and demographics impacted by concentrated poverty (Mossberger et al., 2006). This is salient as the author's institution draws a section of its student population from communities that are low income, impoverished, and of minority status.

Additionally, survey results with respect to respondents' access to the latest software, virus protection, or a resource who could assist them with technology related problems were consistent with prior research that indicates that disparities in access to devices alone is not the only problem facing students (Vigdor et al., 2014), and that a nuanced evaluation of the incidence of digital divide among

disadvantaged groups should include consideration of issues related to Internet speed and software (Rubinstein-Avila & Sartori, 2016).

Mossberger et al. (2008) reported that the issue of differential access to technology for low income demographics results in increased usage of public resources to access computers and the Internet. Gonzales (2016) reported that the lack of adequate Technological Access impacting impoverished communities coupled with lack of accessible and reliable public resources led to significant numbers in such populations to resort to smartphones to access the Internet. Similar findings about higher usage of smartphones to access digital media as evidenced in populations characterized by low income and minorities were reported by Rubinstein-Ávila and Sartori (2016). Along the same lines, Magda and Aslanian (2018) reported that two-thirds of surveyed online students completed some or all of their coursework via smartphones, with 20% using smartphones entirely to complete all course related activities. The use of smartphones to access online content in lieu of reliable access to the Internet were also reported in other studies (Anderson and Kumar, 2019: lower income Americans; Anderson and Perrin, 2018: lower income youth; Vogels, 2019: millennials and Gen Xers). Tsetsi and Rains (2017) found low income and minority adults in the US to be more dependent on smartphones to access the Internet as compared to higher income and White adults. Such usage also mirrored US national trends (Galanek et al., 2018) with minority, first generation, and low income college students viewing smartphones as significantly contributory towards their academic success.

The findings of these studies resonate with results of the current study that indicates that the FGLINW group used public resources (devices and/or Internet) at a significantly higher rate than that of the main sample, and that nearly half of the survey respondents regularly or frequently used smartphones to complete coursework. Given that the survey sample consisted of UNS and UNR students characterized by one or more of at risk variables such as first generation, low income, and minority status, the consistency of the findings of this study to prior research is salient.

Previous studies pertaining to issues of Technological Access refer to findings limited to population specific subsets in the US (Anderson & Kumar, 2019: low income households nationally; Anderson & Perrin, 2018: minority households nationally; Vigdor et al., 2014: minority and low income middle school students in North Carolina; Mossberger et al., 2006: concentrated poverty nationally; Mossberger et al., 2008: low income households in Ohio; Gonzales, 2016: low income residents in mid to large sized Midwestern urban town; Rubinstein-Avila & Sartori, 2016: low income, minority, and/or infrequent Internet users in general population; Tsetsi & Rains, 2017: adults nationwide; Galanek et al., 2018: large private & public colleges nationwide; Magda & Aslanian, 2018: online only college students nationally). The results from this study not only corroborate the findings evident in the existing body of literature but extends the findings beyond the respective contextual subsets to a population of college students who are traditionally underserved and underrepresented.

This study is unique as it explores device ownership, access, and usage at a different level of granularity than has been previously explored, and in the way it highlights the incidence of digital divide pertaining to Technological Access among an already disadvantaged population of UNS and UNR students that is growing in higher education (Fry & Cilluffo, 2019), but on whose specific outcomes, there is limited research. An additional finding of this study is the likelihood that smartphone usage by the respondents is informed by the absence of ownership of and/or adequate access to suitable computer hardware such as desktops, laptops, and tablets.

Overall findings suggest that there are significant gaps in terms of access to technology in several aspects, and especially for a critical subset (FGLINW) of the survey sample. These findings acquire special significance not only due to the general trend of educational institutions increasing online courses in an effort to increase accessibility (Allen et al., 2016), but also due to the more extensive and far reaching impact of a global pandemic in COVID-19, the onset of which has led to a forced shift from face-to-face delivery to online delivery for most courses. This transition has been sudden and abrupt, and has left students already facing a technological equity gap with limited opportunity to

adapt to the changed realities of higher education characterized by online delivery, and the consequent outsized role of Technological Access in the changed scenario.

Gonzales (2016) and Mossberger et al. (2008) discussed the types of existing digital inequities that individuals from socioeconomically challenged backgrounds encounter while Beaunoyer et al. (2020) discussed the potential impact of such existing digital inequities being further exacerbated by COVID-19. Given that 47% of the respondents from this study had annual household incomes less than $30,000 (57% had annual incomes less than $40,000), and that 33% of the sample was non-White (Table 3), pre-existing inequities in access are likely to be exacerbated with the impact of COVID-19, as discussed below.

With not just students but also the majority of the population confined to home due to the health-related restrictions imposed by COVID-19, the resultant increase in simultaneous use of the Internet by multiple members in the household makes reliable access to the Internet a major concern for students. This is likely to be especially true for those students who do not have the resources that allow for subscription to uninterrupted higher bandwidth Internet services. With additional pandemic related restrictions on visitation of public spaces such as libraries or stores as well as homes of relatives or friends and with traditional work spaces that otherwise provided a way to access the Internet being out of bounds, the barriers to access are likely to be exacerbated.

The effect of these events on student access outcomes should be considered against the backdrop of survey respondents, almost half of whom are economically challenged and, therefore, unlikely to be in a position to tap into resources needed to upgrade to reliable Internet service when confronted with pandemic related circumstances (home isolation for multiple household members and resultant use of bandwidth for entertainment and work from home scenarios). In this study, the survey sample reported (Table 8) lack of reliable access to Internet services at home (sample: 6%; FGLINW: 10%). Furthermore, a significant portion of the UNS and UNR survey sample and an even greater share of the smaller sub sample of FGLINW students reported regular to frequent use of Internet resources outside of home and school – work based Internet (sample: 30%; FGLINW: 46%), community based Internet (sample: 14%; FGLINW: 34%), and store based Internet (sample: 16%; FGLINW: 34%) to complete coursework (Table 7). These findings bring into stark relief the potential impact of COVID-19 on student access outcomes.

Resource strapped students, likely to be working with older devices and with limited financial resources available to repair hardware or upgrade the same in response to the demands placed on them by the pandemic induced circumstances, are also likely to suffer from the absence of opportunities to borrow computer devices from their institution to alleviate this issue. With lower income students more likely to share devices at home and with most, if not all, household members confined to home, the issue of shared device access is further likely to negatively impact the existing equity gap, as it relates to Technological Access. The respondents from this survey reported (Table 6) regular to frequent use of computer labs (sample: 28%; FGLINW: 34%), device checkout from school (sample: 7%; FGLINW: 18%), use of work computer (sample: 24%; FGLINW: 25%), and use of public computers (sample: 6%; FGLINW: 18%), all of which highlight the level and extent of dependence on external/public resources. Furthermore, survey responses (Table 8) indicated lack of computer device ownership (sample: 4%; FGLINW: 13%) and sharing of computer devices (sample: 24%; FGLINW: 30%) provide insight into how the pandemic related restrictions are likely to worsen pre-existing inequities related to Technological Access.

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insight into how the impact of COVID-19 related restrictions are likely to disproportionately impact UNS and UNR students and worsen pre-existing inequities related to Technological Access.

Students from disadvantaged backgrounds also tend to lack access to technologically savvy resources outside of school, and therefore, with the shift to online education, they are more likely to face deficits in technological support that would otherwise have been available at school and helped them troubleshoot technological problems related to devices and access to the Internet. This is evident from the fact that a remarkable number of survey respondents (Table 8) reported lacking access to technologically savvy resources outside of school who might be able to provide technical help needed to resolve problems related to devices and/or issues related to Internet access (sample: 22%; FGLINW: 43%). In light of the economic status of the sample, which impacts reliability of access to Internet, rate of device ownership and sharing, and constraints on acquisition and/or upgrade of devices, the lack of access to technological help further underscores the burdens encountered by students and how COVID -19 related circumstances can increase the barriers to Technological Access.

Finally, the issue of pre-existing resource deficiencies with respect to adequate access to the Internet and computer devices is likely to be further impacted by increased strains on allocation of household financial resources wrought by the unprecedented loss of employment and income as a result of the pandemic and the disproportionate impact of the same on households situated in lower economic strata to begin with.

These findings inform the recommendations, which in turn should help ameliorate the impact of barriers to Technological Access and facilitate better outcomes for students in an academic setting characterized by increased online course delivery.

Recommendations

In light of the survey finding that students faced various challenges related to Technological Access and the high prevalence of smartphone usage among respondents, it is important to consider whether such usage actually indicates closing of the Technology Access gap. Rubinstein-Avila and Sartori's (2016) report that mentions the correlation between lower educational attainment and cell-mostly usage should spur a more critical and nuanced evaluation about such students' prospects of academic success given the difficulty of completing assignments via smartphones as noted by Rowsell et al. (2017). In the absence of adequate access to computer devices (desktop/laptop) and broadband Internet services that can contribute to a homework gap, accessibility of course materials on mobile devices and the issue of assignment completion using such devices will remain critical factors impacting such students' success in an online learning environment.

With web content becoming more graphic based and involving the transmission of large data files, broadband Internet access has become more of a necessity. Online courses utilize a multitude of media to convey course content that include streaming video content, interactive content, and videoconferencing, all of which require newer devices, updated software, and fast and reliable Internet access. Findings from this research indicate gaps in access related to these categories that limits the ability of these students to be successful in an online environment.

Institutions may need to invest in technology and faculty training to ensure that course content is offered in multiple formats and mobile optimized, especially for those students who rely heavily on cell phones for accessing course materials. Faculty may need to embrace the concept of mobile learning. Considering that many in the FGLINW group did not own or have access to a computer or a printer and had low social support for technology related assistance, institutions have to pursue these students diligently and monitor their course access woes if the digital divide is to be ameliorated. There is also a need for greater consideration on the part of faculty in dealing with students that fall behind owing to device failure/malfunction, which they are unable to remedy as they either lack the wherewithal to troubleshoot on their own or do not have access to tech savvy resources who can help in resolving the issue in time.

TECHNOLOGICAL EFFICACY

The survey results point to overall high Technological Efficacy scores for the entire sample. However, the limited differentiation across various at risk categories may point to the overall homogeneity of the sample with respect to UNS and UNR characteristics, as discussed in subsequent paragraphs.

Technological Efficacy scores were significantly higher for online course completers compared to those who enrolled but dropped or never enrolled in an online course, indicating that both self-assessment of Technological Efficacy as well as actual Technological Efficacy are possible factors influencing enrollment in online courses and their successful completion, respectively. This mirrors Liu et al.'s (2007) reporting that highlighted Technological Efficacy as a key factor that influenced student decision to drop courses.

Existing research (Compeau & Higgins, 1995b; Compeau et al., 1999; Eastin & LaRose, 2000; Gangadharbatla, 2008; Kuo, 2018; Kuo & Belland, 2019; Saadé & Kira, 2009) indicates that low levels of Technological self-efficacy are directly correlated to anxiety, which in turn results in lower outcome expectations related to use of technology, and thereby influences actual usage of technology. Correspondingly, a higher level of Technological self-efficacy is positively correlated with higher confidence, higher outcome expectations, higher task persistence, and increased usage of technology. Compeau and Higgins (1995b), and Eastin and LaRose (2000) also reported that greater usage of technology contributed to more experience, which in turn led to development of actual technology related skills, thereby establishing the link between higher levels of Technological self-efficacy and higher levels of Technological Efficacy. Technological self-efficacy and Technological Efficacy were also found to be correlated to better academic performance and performance in online learning environments (Hauser et. al., 2012; Kuo & Belland, 2016; Saadé & Kira, 2009). These linkages, as established by previous research, comport with the findings of this study that show that Technological Efficacy scores were higher for students who successfully completed an online course as compared to those who never enrolled or enrolled but dropped an online course.

The significantly higher level of Technological Efficacy for transfer students may be attributable to transfer students' relatively greater exposure to and experience with technology by virtue of prior experience at a post-secondary level. This is consistent with research that indicates that greater exposure to technology, and experience with technology positively impact level of Technological Efficacy (Compeau & Higgins, 1995a; Eastin & LaRose, 2000; Kuo, 2018).

Students who identified as independents for federal financial aid purposes had higher Technological Efficacy scores compared to dependent students, albeit at a marginally lower level of significance ($p=.06$). This finding is consistent with the gap in digital literacy that exists in the UNS and UNR student demographic as the institution draws students from area high schools that cater to disadvantaged populations. As dependent students are typically of traditional age, the statistically significant lower scores for this group as compared to independent students is likely explained by the higher age and, consequently, greater exposure to and experience with technology that characterizes independent students. This finding resonates with the findings reported by Compeau and Higgins (1995a) and Eastin and LaRose (2000). Additionally, this is supported by Kuo's study (2018) of adult African American students that found age, hours spent online, and previous online course experiences influenced Technological self-efficacy.

The findings did not indicate significant differences between Pell Grant recipients and non Pell Grant recipients, thereby indicating that for this population of UNS and UNR students, income differentials did not impact levels of Technological Efficacy. The findings from this research also did not find low Technological Efficacy to be correlated to minority demographics or first generation status, in contrast to current research that indicates that minority students do not always come to college with the necessary technological skills (Buzzetto-Hollywood et al., 2018). A possible reason for these findings may be rooted in the fact that the sample itself is drawn from a population with UNS and UNR characteristics (students largely belonging to low income communities irrespective of

race/ethnicity, and academic under preparedness) thereby rendering it homogenous enough to preclude discovery of significant differences between groups (income, race/ethnicity, first generation status).

Prior studies pertaining to Technological Efficacy refer to findings limited to population specific subsets (Hauser et. al., 2012; Saadé & Kira, 2009: MIS college students, Buzzetto-Hollywood et al., 2018; Kuo, 2018; Kuo & Belland, 2016; Kuo & Belland, 2019: minority students in a minority serving college; Rubinstein-Avila & Sartori, 2016: low income, minority, and/or infrequent Internet users in general population). This research extends the findings beyond the respective contextual subsets to a population of college students who are traditionally underserved and underrepresented. An additional finding not previously captured in existing research is the incidence of higher levels of Technological Efficacy associated with transfer students and independent students, when compared to their respective counterparts.

In summary, the findings suggest the existence of differential levels of Technological Efficacy amongst certain cohorts of the survey sample of UNS and UNR students. This is possibly explained by differences in digital skills and preparedness and associated levels of confidence, as seen from results of those who completed online courses compared to those who did not or dropped such courses after enrollment. Also, the higher levels of Technological Efficacy pertaining to transfer and independent students would indicate that greater experience and exposure to technology is likely to have had a positive impact on levels of Technological Efficacy of survey respondents. Both results are consistent with findings from previous research, as discussed earlier.

With the advent of COVID-19, and the forced shift to online learning at short notice, the impact of differential levels of Technological Efficacy among learners, especially learners from underrepresented populations who are more likely to not have adequate levels of such skills (Buzzetto-Hollywood et al., 2018), is likely to be significant.

Existing research has shown higher computer self-efficacy to be positively correlated to higher performance in online courses (Hauser et al., 2012) and that Technological self-efficacy contributes to Technological Efficacy (Compeau & Higgins, 1995a). Findings from Eastin & LaRose (2000) and Compeau and Higgins (1995b), together provide insight into the linkages between the two that indicate that individuals with high levels of computer self-efficacy experienced less anxiety or greater confidence with respect to technology, judged themselves as capable of operating with less support, had higher outcome expectations that led to higher task persistence, and this promoted greater use of technology. Higher usage led to more experience, which in turn helped in development of technology related skills (Technological Efficacy), and this further bolstered Technological self-efficacy (Compeau & Higgins, 1995a; Eastin & LaRose, 2000), thereby creating a positive feedback loop.

Conversely, individuals with low Technological self-efficacy had higher anxiety with respect to technology, exhibited negative attitudes, deemed themselves as less capable of performing without support, had lower expectations and thereby lower task persistence, which in turn led to lower usage of technology and lesser experience stemming from the lower usage. This inhibited development of technology related skills (Technological Efficacy), which in turn further negatively impacted Technological self-efficacy, thereby completing a negative feedback loop.

This underscores the importance of 3 sequential factors that are likely to be influenced disproportionately by the changed circumstances wrought about by COVID-19:

a) Reduced levels of support from faculty, peer group, institutional labs and tech resources due to classes shifting online, support that learners with lower Technological self-efficacy and consequently higher anxiety deem important to working with technology;

b) Lower task persistence stemming from lower levels of Technological self-efficacy, further impacted by less access to technology by virtue of impediments related to technological access as

discussed earlier. The addition of obstacles stemming from the lack of support to this mix is likely to also contribute to less use of technology; and

c) Lower levels of technological experience due to lower level of technology usage is likely to further impede development of technology related skills (Technological Efficacy). This in turn further reduces confidence/increases anxiety due to the effect of the negative experiences on confidence, thereby impacting Technological self-efficacy.

This is likely to result in greater inequities stemming from the resultant lower levels of Technological self-efficacy as well as Technological Efficacy. This, in turn, is likely to further impede academic performance in an online setting as students less than adequately prepared skill wise to cope with the demands of online learning will be susceptible to falling behind due to a combination of the factors elucidated above.

The findings of this research show that, within the survey sample, groups of experienced learners with prior experience with technology, such as students with prior experience in online learning, transfer students, and students classified as independents for federal financial aid purposes, possess higher levels of Technological Efficacy as compared to their counterparts. With the impact of COVID-19 and the consequent additional obstacles to the development of Technological Efficacy, the gap between the student groups with prior experience and their counterparts is likely to widen further, thereby seriously impacting educational outcomes of an already disadvantaged population of UNS and UNR students.

These findings inform the recommendations, which in turn should help bridge the gap and facilitate better academic outcomes for students in an educational setting characterized by increased online course delivery.

Recommendations

The fact that lower levels of Technological Efficacy may adversely affect the academic achievement of the already at-risk student (Hauser et. al., 2012; Kuo & Belland, 2016; Saadé & Kira, 2009) has possible policy implications surrounding the question of how institutions need to bridge the gap to bring such students' skill levels up to par with computer skill sets required at the college level.

Early identification of deficiencies in Technological Efficacy levels among incoming students will be an important step towards developing preparedness initiatives at institutions serving significant UNS and UNR student populations. A careful assessment of entering students' technology related skillsets will be necessary to scaffold institutional services and allow instructors to employ complementary classroom learning strategies. In addition, institutional services such as pre-assessment tools, computer application courses, or similar competencies integrated into first year seminar courses may be considered as pathways to boost Technological Efficacy.

Given that disadvantaged students, especially in an online environment, may start with a deficit of attributes related to Technological Efficacy and that this may negatively impact confidence, self-belief, and engagement, faculty need to consider a larger role in motivating and engaging students so as to ensure success and develop an online culture of support that will help students overcome Technological Efficacy related self-doubt.

CONCLUSION

The main objective of the study was to assess if UNS and UNR students have the appropriate Technological Access and Technological Efficacy to take advantage of the expanding online classes and programs being offered by the author's institution.

The findings indicate the presence of a digital divide with respect to Technological Access and differential levels of Technological Efficacy among a sample of UNS and UNR students in a small Midwestern university that caters to primarily disadvantaged populations. The Technological Access gap

was pronounced in several areas of device ownership and access as well as Internet access and usage in both the overall sample and the critical subset of the FGLINW group, with the latter reporting worse outcomes across the board. There was a significant difference between the sample and the FGLINW group with respect to use of school and public resources (devices and/or Internet). Nearly half of the sample regularly or frequently used smartphones to complete coursework. The FGLINW group also reported significantly lower levels of technology related support outside of school. Technological Efficacy scores were significantly lower for students who have either never enrolled in, or dropped out of an online course, while transfer students had significantly higher Technological Efficacy scores. Additionally, independent students were found to have higher Technological Efficacy scores, but at a marginally weaker level of significance.

This study contributes to the understanding of the digital divide as it pertains to Technological Access and Technological Efficacy. The findings of this study not only confirm existing research findings but extend such findings to a demographic section of underserved and underrepresented students who form the majority of students at the researcher's institution, and whose numbers continue to grow in higher education, yet on whose specific outcomes there is limited research. Additionally, the findings highlighted higher levels of Technological Efficacy for transfer students, and, at a slightly weaker level of significance, for independent students, both categories representing population subgroups, hitherto unexplored, and thereby topics for further research.

As online learning proliferates and institutions further move their face-to-face courses online to address the global pandemic, the learning ecosystem is reshaping higher education. In order for increased online learning to translate to better academic outcomes especially for UNS and UNR students, higher education administrators and faculty should take into consideration the gaps in technology related access and skills. Institutional interventions may be devised along with formulation of pedagogical approaches that account for such gaps in educational equity, thereby ensuring pathways to sustained student success in an expanding landscape of online education.

Recommended measures to ameliorate the differential levels of Technological Access and Technological Efficacy that this study uncovered include (a) mobile optimized course design; (b) institutional support to ameliorate technological access related woes; (c) faculty consideration of technological woes that contribute to a homework gap; (d) institutional support geared towards early identification of technological skills gap; (e) institution of remedial steps to address such gaps; and (f) adoption of complementary teaching/learning strategies that provide support, foster positive attitudes, and enhance confidence towards adoption and use of technology.

This study was conducted on students attending a single institution whose student population exhibited UNS and UNR characteristics. A more heterogeneous and diverse sample demographic across several institutions could have allowed for more diversity in findings and possibly different levels of group differences. The design of the study was survey research using a self-report questionnaire, and thus is subject to the weaknesses related to self-reporting. Responses were limited to the honesty and accuracy with which respondents completed the questionnaire. Notwithstanding, the study sample represented the institution's student body stratification well in major demographic areas thus allowing for meaningful generalization.

Further inquiry in this area can include expanding this study to other institutions constituting similar underserved and underrepresented populations.

With respect to Technological Access, accessibility of course materials on smartphones has become a critical factor in online success. Given that it is more challenging to write papers and complete assignments using a smartphone, is there a homework gap for this demographic that may impact academic success? This is an area for possible further investigation.

Future research topics may also include further investigation of factors that might explain higher levels of Technological Efficacy amongst transfer students and students who identify as independents

for federal financial aid purposes. Additional research maybe conducted to investigate the impact that differing levels of Technological Efficacy might have on specific educational outcomes of UNS and UNR students.

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BIOGRAPHY

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ENABLING IT SELF-LEADERSHIP IN ONLINE EDUCATION

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ABSTRACT

Aim/Purpose	This paper investigates the factors contributing to student IT self-leadership in online education using an exploratory study. Specifically, our goal was to understand whether the instructors' transformational IT leadership and the students' personal innovativeness with IT contributed to student IT self-leadership.
Background	The study was conducted in an online course. While today's students are expected to be IT natives, they still lack the skills to find and learn technologies on their own. This is problematic for both online education and students' future careers. Directed-teaching methods are not appropriate to solve this kind of problem, a more constructivist teaching method is appropriate. We recommend that instructors adopt transformational IT leadership to set norms around technology use, to be role models in using online course technologies with utmost knowledge, and to encourage and support the students in their use of IT.
Methodology	An exploratory research is conducted with 46 students in an online management information systems course at a public university. The data were analyzed using PLS structural equation modeling technique.
Contribution	This paper introduces the unique concepts of student IT self-leadership and instructors' transformational IT leadership by adapting concepts from the self-leadership and transformational leadership theories. IT self-leadership refers to the ability to intentionally influence one's own thinking, feeling, and actions toward the use of IT to reach one's work and life goals. To increase IT self-leadership, students should try new technologies as much as possible. Instructors should set up norms about trying new technologies, troubleshooting one's own issues, and play a supportive and encouraging role, rather than employing directed-teaching methods.

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Findings	IT self-leadership skills are the ability to intentionally influence one's own thinking, feeling and actions towards the use of IT to reach one's work and life goals. The findings show that instructors' transformational IT leadership as well as students' innovativeness with IT contributes to students' IT self-leadership.
Recommendations for Practitioners	Practitioners may consider exhibiting transformational IT leadership skills including (1) giving encouragement about IT use, (2) fostering trust, (3) encouraging thinking about IT problems in new ways, (4) being clear about their values about IT by practicing what they preach in their IT use, and (5) inspiring students by being highly competent in IT. Potential ways that the instructors can exhibit these skills are discussed in the paper.
Recommendations for Researchers	Researchers are recommended to include IT-self leadership of both students and instructors in their investigations on learning success. Furthermore, the inclusion of transformational IT leadership in new studies of teaching and learning success is recommended.
Impact on Society	This paper includes students as part of the solution to challenges students face in online courses rather than treating them like passive recipients of educational changes. Thereby, it helps teachers and students to work together for a better solution to educational disruptions.
Future Research	Studies should be conducted to determine other antecedents and outcomes of IT self-leadership. Research is needed on specific ways practitioners can increase their IT transformational leadership. While this paper introduced how the instructor of the exploratory study provided transformational IT leadership, more than one way of reaching each goal was practiced. Future research should test the connection between each transformational IT leadership behavior presented here and its outcome.
Keywords	transformational IT leadership, IT self-leadership, personal innovativeness with IT, constructivism

INTRODUCTION

Today's students and soon to be employees are expected to be digital natives, who are able to figure out how to use various technologies without much instruction (Prensky, 2001). There are so many information technologies, many of which are freely available, that can help today's students and employees be more effective and efficient in achieving their work and life goals. Every day, new software, mobile applications and information systems are developed for increased effectiveness and efficiency. Yet, directed teaching all of these novel information technologies to students is virtually impossible. Instead, instructors can equip students with important skills, such as IT self-leadership, that will enable them to find and use various information technologies towards their study/work and life goals. IT self-leadership is the ***ability to intentionally influence one's own thinking, feeling, and actions towards the use of IT to reach one's work and life goals***. This definition of IT self-leadership is adapted from the self-leadership definition of Bryant and Kazan (2012). How can instructors and students work towards increasing students' IT self-leadership?

In terms of what instructors can do to develop student IT self-leadership, there are two approaches: directed-instruction methods and more student-centered, constructivist instruction methods. IT self-leadership is difficult to teach with directed-instruction methods, because the information technologies that may meet the needs of each student may not be the same and may not be known (Hannafin & Land, 1997). As opposed to directed-instruction, technology-enhanced, student-centered online

learning promotes sampling technologies, discovering, manipulating, and investigating new information technologies (Hannafin & Land, 1997, p. 175). Imagine an instructor who themselves provide transformational IT leadership by setting information technology norms such as trying new technologies. Imagine an instructor who provides support and encouragement about IT use, rather than teaching a number of information technologies step-by-step. Imagine an instructor who is a role model in using information technologies for online teaching in advanced and highly competent ways, thereby inspiring students to do the same. Imagine an instructor who does these and inspires students to go above and beyond specific course goals in students' IT use. Such an instructor is providing transformational IT leadership to their students.

In student-centered teaching methods, instructors and students are a team. Learning is not something that only the instructors take charge of. Therefore, we suggest that students can increase their IT self-leadership, simply by trying new technologies, experimenting with new information technologies and being the first one among their peer group to try out new information technologies. This is called personal innovativeness with information technologies.

In this study, we ask two research questions: "Does instructors' transformational IT leadership contribute to students' IT self-leadership?", and "Does students' personal innovativeness with IT contribute to students' IT self-leadership?" We answer these research questions with an exploratory study. In this study, we find that instructors' transformational IT leadership as well as students' innovativeness with IT contributes to students' IT self-leadership. We suggest the practitioners to consider exhibiting transformational IT leadership skills including (1) giving encouragement about IT use, (2) fostering trust, (3) encouraging thinking about IT problems in new ways, (4) being clear about their values about IT by practicing what they preach in their IT use, and (5) inspiring students by being highly competent in IT. Potential ways that the instructors can exhibit these skills are discussed in the paper.

LITERATURE

IT SELF-LEADERSHIP THEORY

We define IT self-leadership as the ability to intentionally influence one's own thinking, feeling and actions towards the use of IT to reach one's work and life goals. IT self-leadership concept was first introduced by Eseryel et al. (2014, 2016) in the context of team members using IT to improve team performance with regards to product and process innovation. In today's IT-dominated business world, more than ever, we need individuals who can use IT successfully to reach their goals and bring about innovation.

This concept originates from the well-known self-leadership construct from organizational behavior literature. Self-leadership is a skill for leading one-self across challenging and performing situations towards goal achievement and necessitate goal setting and goal striving (Gollwitzer, 2003; Gollwitzer et al., 1990; Manz & Neck, 2004; Neck & Houghton, 2006). Self-leadership (Manz, 1986) is a psychological construct that represents a student's capacity for high performance (in this context in online education) through a repertoire of cognitive, motivational and behavioral self-navigation strategies (Curral & Marques-Quinteiro, 2009; Manz & Neck, 2004; Neck & Houghton, 2006). The abbreviated version of the self-leadership construct measurement measures 9 dimensions (Houghton et. al, 2012). These measures and the items used in the survey are as follows: (1) Self goal setting (I establish how well I'm doing at work), (2) self-observation (I make a point to keep track of how well I'm doing at work), (3) self-goal setting (I work toward specific goals I have set for myself), (4) visualizing successful performance (I visualize myself successfully performing a task before I do it), (5) visualizing performance (Sometimes I picture in my mind a successful performance before I actually do a task), (6) self-reward (When I have successfully completed a task, I often reward myself with something I like), (7) evaluating beliefs and assumptions (Sometimes I talk to myself (out loud or in my head) to work through difficult situations), (8) self-talk (I try to mentally evaluate the accuracy of my own beliefs

about situations I am having problems with, and (9) evaluating beliefs and assumptions (I think about my own beliefs and assumptions whenever I encounter a difficult situation).

When we apply the self-leadership concept to information technology setting: Students with IT self-leadership would set for themselves the goal of successfully learning in an online class using new IT platforms; They would aim at mastering the tools and technologies needed for online learning; When they encounter difficulty during online courses, students would re-evaluate their own beliefs and assumptions, and gain the skills to overcome these difficulties such as by effectively finding information and by troubleshooting. Moreover, having IT self-leadership skills would also mean that students, who are connected to each other 24/7 through smart technologies and social media would find ways to create communities to find innovative solutions to course-related and other problems. Self-leadership significantly contributes to work role innovation (Curral & Marques-Quinteiro, 2009). Work role innovation refers to using creative ideas to effectively and significantly changing procedures concerning roles and tasks and changing the environment (Curral, 2005; Van de Ven, 1986; West, 2001).Translating this to the online learning context suggests that students with IT self-leadership could contribute creative ideas to online courses and take on leadership in their online learning to help the learning environment be more effective for themselves, rather than expecting their instructors to provide directed-learning in every aspect of the course.

While today's so-called digital natives are expected to be fluent in technology (Prensky, 2001), they are lacking many personal (Kaup et al., 2020), technological, informational (Combes, 2009, p. 8) and learning skills (Black, 2010). Because Gen Y and Gen Z were born to have access to smart-technologies and broadband access at young ages, it is generally assumed that they are highly technically savvy (Prensky, 2001; Tapscott, 1998). Yet, in reality many lack IT self-leadership skills needed to take charge of their education (Kaup et al., 2020). "[Students] are definitely not information literate. They are unable to locate, authenticate, deconstruct (make meaning from) and use information effectively or efficiently from a range of electronic sources" (Combes, 2009, p. 8). So called digital natives multitask during classes and usually do so ineffectively (Bowman et al., 2010; Ellis et al., 2010; Fox et al., 2009; Fried, 2008; Hembrooke & Gay, 2003; Kraushaar & Novak, 2010), they prefer visuals over reading (Black, 2010), they have low attention spans (Kaup et al., 2020) and they thrive on instant gratification to work (Black, 2010). These factors together result in digital natives having low IT self-leadership.

In online learning, students' low IT self-leadership becomes visible in their low technology self-efficacy (Johnson et al., 2018). Students struggle with online platforms, and with basic IT troubleshooting, finding assignment-related information, and with submitting their assignments. As a college freshman put it "***Remote learning could be made better if everyone had had more knowledge and guidance on how to use it, on how to effectively use the platforms,… from the professors to students"*** (Lytle & Lundy, 2020). Online learning poses challenges for many students who may not have the technology skills (Gonzales et al., 2020; Kaup et al., 2020), focus (Kaup et al., 2020) digital information literacy (Combes, 2009), or motivation (Lepp et al., 2019) to troubleshoot issues they face when using information technologies. We propose investing in students' IT self-leadership in order to better prepare students for effective online learning.

How to Enable IT Self-leadership

Instructors' IT Use in Online Instruction

How can we deal with these issues about students' technological skills? Direct instruction approaches emphasize instructional strategies such as teaching content, objective-relevant questioning, feedback and assessment (e.g., Dick & Carey, 1990; Gagne et al., 1988). As opposed to direct instruction approaches, in student centered-approaches, instructors allow learner choice and control (Chung & Reigeluth, 1992) on which technologies to use. In this paper, in line with student-centered instruction, we suggest that instructors move from traditional direct instruction approaches: We suggest that

the instructors become role models in helping students in online courses, take on leadership of their own learning and contribute to the instructors' efforts for an effective online learning experience.

There is a need for further research on the link between instructors' information technology use and student instruction (Cuban, 2001). In spite of the apparent commitment to technology of some schools, many instructors use information technologies to support their current traditional teaching practices rather than as a tool to promote more innovative practices (Cuban, 2001). The teachers' knowledge, beliefs, and actions about information technologies affect the success of the students when it comes to technology use (Gilakjani et al., 2013). The teacher should become one of the resources that the student may learn from. The instructor should become a role-model in terms of technology use in online courses. Furthermore, the instructor should engage students in experiences that challenge previous conceptions of their existing knowledge (Gilakjani et al., 2013). Instructors should encourage and accept student autonomy and initiative when it comes to information technology use (Gilakjani et al., 2013). These recommendations toward instructors are examples of instructors' transformational IT leadership. When instructors integrate technology well into the classroom, they can set up a constructive learning environment (Reeves, 1998) which helps learners to work together and support each other as they use information technologies to achieve learning goals (Rakes, 2006). In order for technology to positively affect teaching methods-and therefore student learning-teachers must possess the technology-related skills needed to use technology and must actively use these tools in their classrooms (Iding et al., 2002). Lack of instructor knowledge and skills (Hew & Brush, 2006; Rashid & Elahi, 2012) and negative teacher attitudes and beliefs towards information technology hamper successful technology integration (Hew & Brush, 2006).

Transformational Instructors with respect to IT Leadership

Yun et al. (2006) showed that effective self-leadership development and manifestation is strongly dependent on instructors' leadership style. While there are many theories of leadership that may affect students, the complete review of the literature is beyond the scope of this article. A thorough classification and presentation of the leadership literature is provided by Northouse (2007). Instructors who adopt directed-teaching methods reward students for repeating the learned knowledge in examinations, and in class. Directed-teaching methods are effective in enabling the students to achieve clear and non-complex learning goals, yet may fail when the learning goals are complex and all components of the learning goals are not knowable or definable.

Transformational leadership can be seen as a constructivist teaching method, rather than directed teaching. Transformational leadership basically involves inspiring students to go above and beyond (Podsakoff et al., 1990). It is more likely to enable students' IT self-leadership because of the following. Transformational instructors take risks to try new ways of teaching, change existing methods and try new information technologies for achieving long-term learning benefits (Pearce & Ensley, 2004). They inspire students to increase their creative initiatives, improve their problem-solving and analytical abilities (Sosik et al., 1998). Transformational instructors help students tackle challenging goals (Whittington et al., 2004), encourage their learning (Gong et al., 2009) and idea implementation by encouraging them to think out of the box solutions to learning problems (Afsar et al., 2014). They do so by providing encouragement, fostering trust, and providing intellectual stimulation (Afsar et al., 2014). Therefore, when instructors exhibit transformational behaviors in their teaching and how they treat students, this may contribute to developing students' self-leadership.

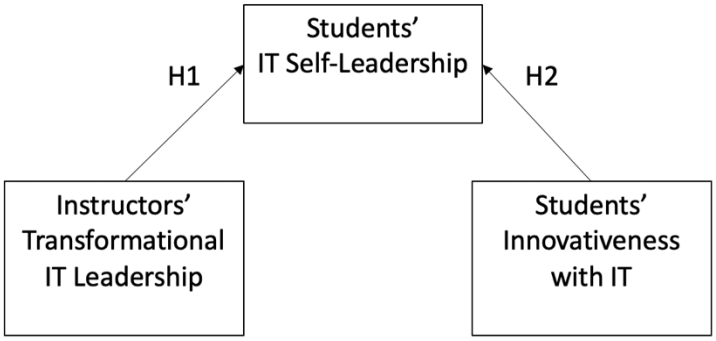

Figure 1: The Role of Transformational IT Leadership and Innovativeness with IT on IT Self-Leadership

While many researchers wrote about transformational leadership, they all share the common perspective. According to this, effective transformational instructors "transform or change the basic values, beliefs, and attitudes of followers so that [the students] are willing to perform beyond the minimum levels specified by the [university]." (Podsakoff et al., 1990). Transformational leadership of instructors does not really require the use of technology, or affect IT related values, beliefs or attitudes. In order to enable IT self-leadership, we need to transform the IT values, beliefs and attitudes of students, who may have the attitude that "IT is difficult" or "I don't know much about technical stuff". This way, students can be open to learning about technologies through active experimentation and use. IT self-leadership requires a student to deal with challenging IT tasks that extend beyond their immediate knowledge. For an instructor to be a role model with respect to IT-related values requires the instructor to develop their own high values with respect to IT and also to practice these values by being competent in IT themselves. Furthermore, an instructor who is a transformational IT leader thinks about their own IT problems and challenges in new ways. We call this transformational IT leadership of instructors, adapting the well-known transformational leadership theory to the IT context (Avolio & Bass, 1988; Avolio et al., 1999; Podsakoff et al., 1996; Podsakoff et al., 1990; Purvanova & Bono, 2009; Tichy & DeVanna, 1986). We suggest that developing students' IT self-leadership requires instructors to exhibit transformational IT leadership in their teaching and how they deal with IT in their lives (Figure 1). Therefore, we propose:

H1: *Instructors' transformational IT leadership contributes to students' IT self-leadership.*

Students' (Personal) Innovativeness with IT

Student-centered online instruction is an instructional approach in which students influence the content, activities, materials and pace of learning in online education (Collins & O'Brien, 2003). Student-centered instruction can lead to increased motivation to learn, greater retention of knowledge, deeper understanding, and more positive attitudes towards the subject being taught (Collins & O'Brien, 2003). In line with student-centered instruction methods, technology is often employed as a tool functioning as cognitive tools for experimentation, manipulation and generation of ideas (Land & Hannafin, 1998, p. 239). Achieving positive results with technology means that students augment their thinking, and build meaning upon their self-driven actions (Salomon et al., 1991). However, achieving such positive results require that learners interact positively with technologies, and that they are able to overcome the technological challenges they face.

With IT self-leadership skills, the students take control of their own IT use. The students take charge of which information technologies to choose to reach their own goals. Technology-enhanced, student-centered online learning environments promote sampling technologies, discovering, manipulating, and investigating new information technologies (Hannafin & Land, 1997, p. 175). The individual must reason before acting, assess what needs to be understood, which technologies can help them,

and then practice various approaches to use these technologies. Technology-enhanced, student-centered online learning environments create contexts within which knowledge and skill are authentically anchored and provide a range of tools and information technology functionalities with which to navigate and manipulate (Hannafin et al., 1994). They afford opportunities to seek rather than to comply, to experiment rather than to accept, to evaluate rather than to accumulate, and to interpret rather than to adopt.

A student's (personal) innovativeness with IT identifies the degree to which a student is willing to try out any new information technologies (Agarwal & Prasad, 1998). Wang et al. (2011) measure this concept with three items: (1) If I heard about a new information technology, I would look for ways to experiment with it, (2) among my peers, I am usually the first one to try out new information technologies, and (3) I like to experiment with new information technologies. Innovativeness with IT is associated with more positive beliefs about technology use (Wang et al., 2008). Students with higher innovativeness with IT are more likely to have positive perceptions about novel information technologies (Wang et al., 2008). Therefore, we expect that when those students face difficulties with IT, they would be more likely to evaluate the correctness of their beliefs and assumptions, a self-leadership behavior. Students who are more innovative with IT are sensitive to new information and would therefore collect more novel information that provides inspiration for novel behaviors (Hirschman, 1980). Therefore, it would be expected that students with higher level of innovativeness with IT may be more willing to take risks and may better tolerate the uncertainty that information technologies bring (Wang et al., 2011).

Students who are personally innovative with IT, meaning those who experiment with new information technologies (Agarwal & Prasad, 1998) are likely to show high IT self-leadership. This is because when students practice working with various new technologies, they develop their self-confidence and effectiveness with IT. Therefore, we propose that:

H2: *Students' innovativeness with IT contributes to students' IT self-leadership* (Figure 1)

In the next section, we present a study conducted at an online management information systems course, to illustrate how to enable students' IT self-leadership through the transformational IT leadership manifested by the instructor.

METHODOLOGY

A quantitative data analysis method is selected to answer the question "Which factors contribute to students' IT self-leadership skills?". The factors to be tested, namely instructor's transformational IT leadership and students' innovativeness with IT were identified based on the literature review. We conducted an exploratory study with a single introductory online course. An introductory online course is selected because it is taken by all college majors in the college of business, thereby it does not discriminate among students who may be more or less apt to use technology. Due to the exploratory nature of the study and due to the small sample size, PLS structural equation modeling is used in the data analysis. PLS structural equation modeling is a non-parametric method that does not require that the data meet certain distributional assumptions, thereby it is an appropriate analysis method for this study.

In the remainder of this section, we present the data and discuss the steps the instructor took to exhibit transformational IT leadership.

DATA

The data used in our study is collected at the end of an online management information systems course, which is a required course in the business curriculum at a public American university. The students were offered bonus points for participating in the survey. The students were informed that other bonus point options were available if they chose to opt out of this survey. 46 students in the

course participated in the survey, which constitutes 95% of the class participants. This high response rate is probably due to the ease of responding to survey questions rather than doing another assignment. Table 1 presents a summary of the student profiles.

Table 1: Summary of Participant Profiles

Year	Freshman (2); Sophomore (9); Junior (31); Transfer (2)
Gender	Male (27); Female (19); Other (0)
Average GPA	3.09
Range of GPA	2.4-4.0
Ethnic Background	Caucasian (34); African American (5); Hispanic American (4); Asian (2); Middle Eastern (1)

The technology used for this study included Canvas learning management system for most asynchronous course activities and WebEx for all synchronous course activities. Asynchronous course activities included watching course videos posted by the instructor, participating in online discussions with other students either by posting written comments or by posting video-comments, downloading group assignments and uploading their finished assignments. While most students are familiar with WebEx, Canvas was a new system for the students. Most students were used to using Blackboard, which used to be the standard learning management system for the college. Canvas presented the students with a different navigation system than the one students were used to, which posed a challenge to students. Canvas learning management system and the WebEx virtual meeting application are the information technologies which the instructor used to exhibit transformational IT leadership, and which presented the opportunity for students to exhibit IT self-leadership.

Table 2 shows the items used to estimate the predictor latent constructs. A seven-point Likert scale with anchors of strongly disagree to strongly agree was used to measure each item. The IT Transformational Leadership scale is adapted from the short form of the transformational leadership scale (Carless et al., 2000) through discussions with several master's students who have tested the scale in their masters' theses. The items' wordings were discussed multiple times with the team of students and revised based on pilot studies. Two items were removed during the factor analysis. These were specifically about vision (communicating a clear and positive vision of the future with IT use), and student development (treating students as individuals, supporting and encouraging their development in the IT area). These two items were removed due to their weak loading with their respective factors. These two items are *reflective* of the construct, meaning that the direction of causality moves from the constructs to the item. When the items are reflective, adding or dropping items does not change the nature of the construct (El-Den et al., 2020, p. 327).

The IT Self-Leadership scale is adapted from Houghton et al. (2012) abbreviated IT self-leadership survey instrument. Four items were removed from IT self-leadership scale during the factor analysis. Specifically, we removed items on self-observation with IT, self-goal setting with IT, visualizing successful performance with IT, evaluating IT beliefs and assumptions due to weak loading with their respective factors.

Personal Innovativeness with IT scale (Agarwal & Prasad, 1998) has been adopted from (Wang et al., 2011). Table 2 presents the items used for all three constructs.

Table 2: Predictor Latent Construct Items

Transformational IT Leadership (IT-TL)
IT-TL1 Gives encouragement and recognition to students about IT use
IT-TL2 Fosters trust, involvement and cooperation among students in IT projects
IT-TL3 Encourages thinking about IT problems in new ways and questions assumptions
IT-TL4 It's clear about their values about IT and practices what they preach with their IT use
IT-TL5 Instills pride and respect in others and inspires me by being highly competent in IT
IT Self Leadership (ITSL)
ITSL1 I establish specific performance goals for myself with the help of IT
ITSL2 Sometimes I picture in my mind a successful performance with IT before I actually use IT
ITSL3 When I have mastered at IT tool, I often reward myself
ITSL4 I try mentally to evaluate the accuracy of my own beliefs about challenging IT tools
ITSL5 I think about my own beliefs and assumptions whenever I encounter difficulty when using IT
Personal Innovativeness with IT (PIIT)
PIIT1 Among my peers, I am usually the first to try out new IT tools
PIIT2 If I hear about a new IT, I would look for ways to experiment with it
PIIT3 I like to experiment with new IT tools

To exhibit transformational IT leadership, the instructor paid particular attention to (1) incorporating into the course a main intervention that enabled her to exhibit transformational IT leadership where possible, and (2) repeating the IT transformational leadership behaviors with small interventions throughout the course. These two types of interventions are provided in Table 3. For the main interventions, mostly small group projects called "Group Participation Assignment (GPA)" were used. The group participation assignments were small assignments that the students could complete by meeting online among themselves for an hour, and which require minimal or no extra work beyond that meeting. These assignments can be taught of an equivalent of in-class group assignments that are used to teach a specific subject matter. The small interventions were the comments that the instructor made to students in video responses to student discussions, or responses to student emails. The instructor also included these comments in general announcements to the students using Canvas system's announcement feature. These interventions should not be thought of as a firm recipe, rather they can be used by the reader as guidelines as to the numerous ways instructors can exhibit transformational IT leadership for their students.

Table 3: Instructor's Transformational IT Leadership Interventions

	Main Intervention	Ongoing Small Interventions
IT-TL-1 Gives encouragement and recognition to students about IT use.	One group participation assignment was specifically focused on group-level information technologies, in line with the course material. The assignment specifically asked the students to set up mobile and web-based technologies to collaborate together. The students were prompted to think outside the box and think of as many technologies as possible to collaborate. These two criteria were also reflected in the grading of the assignment.	• Compliment students specifically about using technology in unique ways. • Compliment students when they are able to solve IT-related problems, such as when their computer is stuck and they can resolve the issue.
IT-TL-2 Fosters trust, involvement and cooperation among students in IT projects	The first group participation assignment focused on team building, where the team was asked to get to know each other, their hobbies, their work styles, how to accommodate each other, and set norms around how to give each other constructive feedback, when a member is not contributing as expected.	• Remind the students several times throughout the class that we are a team, and we must work together. • Incorporate into an appropriate lecture rules about how to best work together, and how to best give critical feedback in a gentle way. • When students complain about other students, instruct them on how to give critical feedback using email or using synchronous technologies.
IT-TL-3 Encourages thinking about IT problems in new ways and questions assumptions	• Part of the course required learning technologies (such as Excel or business analytics). • The instructor questioned students' assumptions that they should know technology features by heart to properly use the technology. • The instructor had a 15-minute discussion on students' general attitude towards technology which is often voiced by students as "I am not good with technology". She emphasized that similar to many things in life (sports, playing instrument, art), being good at technology is not a gift, it is a skill that is learned and improved with practice.	• Repeatedly remind the students to use Google to find out various functionalities. • Illustrate how to use Google search to find out functionalities when the students cannot answer questions on features, or when they are having problems while doing their assignments. • Inform the students that you (the instructor) do not memorize functionality, that you also search the web to troubleshoot IT problems. • Remind the students several times that the goal in class is not to get the students to memorize software functionality, but to be able to solve business problems when they come up.

	Main Intervention	Ongoing Small Interventions
IT-TL-4 Is clear about their values about IT and practices what they preach with their IT use	At the beginning of the course, the instructor set up course norms that include the following: • Not to multitask with technologies (such as mobile phone) during the coursework, • To use information technologies as innovatively as possible to collaborate effectively • To treat all students in the class as team members • To treat this class as a learning environment where making mistakes are okay	• Abide by all the norms you set for students. • Turn your phone off (by stating explicitly what you are doing) at the beginning of WebEx sessions, to be a role model to students. • If you forget to turn the phone off, and it rings or makes noise, apologize for breaking the rule and turn your phone off immediately by explicitly stating what you are doing, thereby role modeling to the students. • Give examples during the course where you used IT innovatively to solve the business problem that is relevant to the course topic. • Use various functionalities of Canvas that are not commonly used by other instructors, e.g.: Sending video comments to students, or incorporating quiz questions into videos. • Call on the students during synchronous video lectures and when they cannot answer correctly, gently and without punishing them, correct their mistakes.
IT-TL-5 Instills pride and respect in others and inspires me by being highly competent in IT	The instructor attended multiple training sessions on Canvas learning management system to increase her competency. The instructor took time to practice features of WebEx synchronous meeting tool to ensure competency.	• Put in extra time to learn Canvas functions well. • Put different new features of Canvas to use. • Never make apologetic comments about technology when facing technological issues during teaching, rather stay calm and try to resolve issues with patience and by trying different methods. • Treat all students kindly, and when students make mistakes, treat them with light humor as you would like to be treated.

Analysis

The research model of Figure 1 was analyzed using Smart-PLS (version 3.3.2), a PLS structural equation modeling tool (Ringle et al., 2015). Smart-PLS assesses the psychometric properties of the measurement model and estimates the parameters of the structural model. However, the parametric significance tests cannot be applied to test whether coefficients such as outer weights, outer loadings and path coefficients are significant. Instead, PLS-SEM relies on a nonparametric bootstrap procedure (Davison & Hinkley, 1997) to test the significance of various results such as path coefficients, Cronbach's alpha, and R^2 values. In bootstrapping, subsamples are randomly drawn observations from the original set of data (with replacement). The subsample is then used to estimate the PLS path model. This process is repeated until a large number of random subsamples has been created (1,000 in this study). The estimations from the bootstrap subsamples are used to derive standard errors for the PLS structural equation modeling results, which help calculate the t-values, p-values, and confidence intervals to assess the significance of the PLS structural equation modeling results that are reported below. While extensive discussion of bootstrapping beyond our context here, this information is provided by Hair et al. (2017).

Findings

The Structural Model

Figure 2 shows the structural model results. All beta path coefficients are positive (i.e. in the expected direction) and statistically significant ($p < 0.0001$).

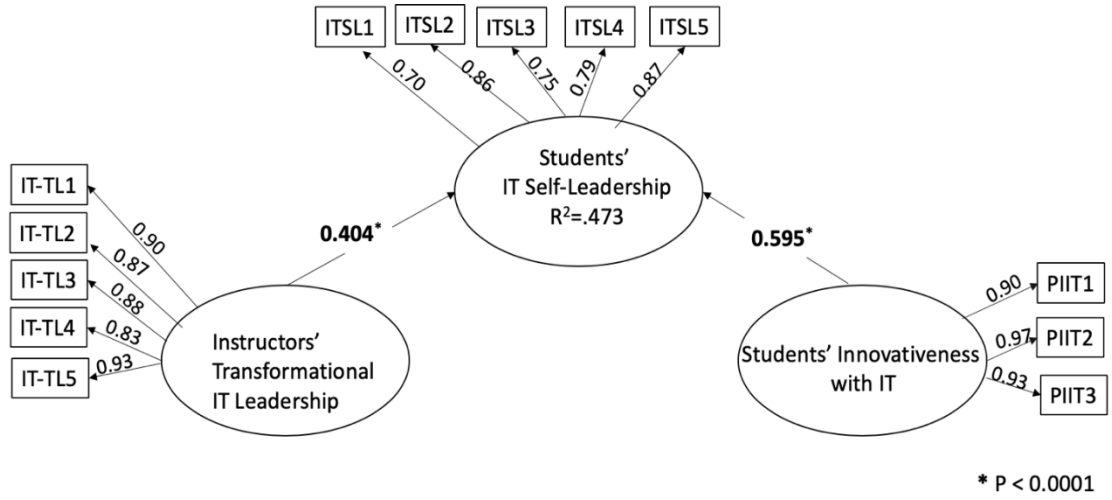

Figure 2: Structural model results

Our study showed that the instructors' transformational IT leadership contributed to students' IT self-leadership, therefore our first hypothesis was confirmed. Secondly students' innovativeness with IT contributed to students' IT self-leadership, therefore our second hypothesis was also confirmed.

Transformational IT leadership of the instructor had a positive influence on the IT self-leadership of the students (beta = 0.404, $p < 0.0001$). Students' personal innovativeness with IT values had a significant influence (beta = 0.595, $p < 0.0001$) on students' IT self-leadership. The model explains 47.3% of the variance in IT self-leadership behaviors of students.

The Measurement Model

Reliability results are given in Table 4. The data indicates that the measures were robust in terms of their internal consistency reliability as indexed by the composite reliability. The composite reliabilities of the different measures ranged from 0.90 to 0.95, which exceeded the recommended threshold

value of 0.70 (Nunnally, 1978). Moreover, consistent with the guidelines of Fornell and Larcker (1981), the average variance extracted (AVE) for each measure exceeded 0.50 indicating convergent reliability. Table 5 reports the results of testing the discriminant validity of the measure scales. The elements in the matrix diagonals, representing the square roots of average variance extracted, are greater in all cases than the off-diagonal elements in their corresponding row and column, supporting the discriminant validity of our scales.

Table 4: Assessment of the Measurement Model

Variable Constructs	Composite Reliability[(a)]	Average Variance Extracted[(b)]	Cronbach's Alpha[(c)]
Transformational IT Leadership	0.95	0.78	0.93
IT Self-Leadership	0.90	0.64	0.86
Personal Innovativeness with IT	0.95	0.87	0.92

a. All composite reliability (CR)>0.7 indicates internal consistency (Gefen et al., 2000)

b. All average variance extracted (AVE)>0.5 indicates convergent reliability (Bagozzi, & Yi, 1988; Fornell & Larker, 1981)

c. All Cronbach's alpha > 0.7 indicates indicator reliability (Nunnally, 1978)

Table 5: Discriminant Validity (Inter-correlations) of Variable Constructs

Latent Variables	1	2	3
Transformational IT Leadership	0.88		
IT Self-Leadership	0.35	0.08	
Personal Innovativeness with IT	-0.09	0.56	0.93

Convergent validity was tested by extracting the factor and cross loadings of all indicator items to their respective latent constructs. These results, presented in Table 6, indicated that all items loaded on their respective construct from a lower bound of 0.70 to an upper bound of 0.97, and more highly on their respective construct than on any other. Moreover, 13 items' factor loading on its respective construct was highly significant at ($p < 0.0001$). These were indicated by the T-statistics of the outer model loadings in the Smart-PLS graph output. These values ranged from 27.94 to 94.62. The constructs' items' loadings and cross loadings presented in Table 6, and the highly significant T-statistic for individual item loadings both confirmed the convergent validity of these indicators as representing distinct latent constructs.

Table 6: Factor Loadings (Bolded) and Cross Loadings

	Transformational IT Leadership	IT Self-Leadership	Personal Innovativeness with IT
IT-TL1	**0.90**	0.31	-0.05
IT-TL2	**0.89**	0.28	-0.12
IT-TL3	**0.88**	0.31	-0.13
IT-TL4	**0.83**	0.29	-0.02
IT-TL5	**0.93**	0.37	-0.08
ITSL1	0.30	**0.70**	0.44
ITSL2	0.23	**0.86**	0.55
ITSL3	0.27	**0.75**	0.41
ITSL4	0.35	**0.79**	0.34
ITSL5	0.25	**0.87**	0.46
PIIT1	-0.14	0.53	**0.90**
PIIT2	-0.04	0.53	**0.97**
PIIT3	-0.08	0.50	**0.93**

DISCUSSION AND CONCLUSION

Online teaching is becoming more and more common. What we have seen so far is the ineffectiveness of the sole use of directed teaching (i.e., rewarding student conformity to expected behaviors with grades). This is evidenced by many recent studies and surveys conducted after students moved from face-to-face to online teaching (see, for instance, Kim et al., 2020; Lytle & Lundy, 2020; Marinoni et al., 2020). The students disliked learning online so much that it was reported that 48% of students intended to defer enrollment or look for a different college if their colleges offer online learning only in the fall 2020 semester (Kim et al., 2020).

Effective online education depends on using many technologies seamlessly, whereas the students have not been effective users of technology in complex learning settings. This exploratory study was conducted when the instructor moved to a new technology platform for online education, which exposed the need for students to have IT self-leadership skills. Ever more urgently the students were forced to learn new IT platforms and technologies to accomplish their learning goals.

In this paper, we proposed that students' IT self-leadership is crucial to the success of online learning. IT self-leadership skills refer to the ability to intentionally influence one's own thinking, feeling and actions towards the use of IT to reach one's work and life goals. In this study, we answered the research questions "Does instructors' transformational IT leadership contribute to students' IT self-leadership?", and "Does students' personal innovativeness with IT contribute to students' IT self-leadership?". We proposed that two factors contribute to students' IT self-leadership. First, self-leadership development is strongly dependent on instructors' leadership style (Yun et al., 2006). Therefore, we argued that developing students' IT self-leadership requires instructors to act as transformational IT leaders in their teaching and how they treat students. Second, students who are personally innovative with IT, meaning those who experiment with new information technologies (Agarwal &

Prasad, 1998) are likely to show high IT self-leadership. We illustrated these two points with an exploratory study, which showed that and instructors' transformational IT leadership and students' personal innovativeness with IT explain 47.3% of students' IT self-leadership. Computer self-efficacy, IT playfulness, and general interest in information technologies are some of the factors that may explain the remaining 52.7% that is unexplained by our model. Future research should test these factors to increase the explanatory power of this study.

Below, we discuss the contribution of our study to theory and practice as well as recommended future research.

Contribution to Theory

The unique contribution of this exploratory study is the adaptation of self-leadership and transformational leadership theories to the informational technology field to develop the IT self-leadership and transformational IT leadership concepts as being relevant to constructivist learning theories. Transformational IT leadership is a student-centered approach where instructors allow learner choice and control (Chung & Reigeluth, 1992) specifically on which technologies to use and how to use them.

With this research, we respond to the call by Cuban (2001) for further research on the link between instructors' information technology use and student instruction and contribute to the development of this research stream. We specifically find that when the instructors use online education technology successfully, and when they set up explicit norms about trying new technologies, the students take charge of their thoughts, emotions, and actions towards IT use. Seeing the instructor as a supportive person, rather than one who gives step-by step instructions further helps students take charge of their IT use. Thereby, this study constitutes an example of teachers' use of technology to support student-centered instruction, which is rare (Judson, 2006; Palak & Walls, 2009). In this study, the instructor believed that the students should be able to independently troubleshoot basic information technology navigation issues, and encouraged the students to take charge of their information technology use by motivating the students to learn technologies on their own and supporting student troubleshooting by demonstrating it in synchronous videos. In that sense, the suggestion in (Gilakjani et al., 2013) that teachers' knowledge, beliefs and actions affects student success is confirmed when it comes to information technology use in online courses. This study also emphasized the role of the instructor as a role model to students (Gilakjani et al., 2013). This exploratory study showed that when students perceived the instructor to be highly competent in information technology, their own IT self-leadership had increased. This is also in line with (Iding et al., 2002), who suggested that in order for technology to positively affect student learning, teachers must possess technology-related skills needed to use technology, and must actively use these tools in their classrooms.

Contribution to Practice

Our study shows that part of the instructors' course preparation for online teaching is their investment in their own transformational IT leadership. When instructors contribute to their students' IT self-leadership this investment will pay back: The students will become active participants in their education. Then the students will be able to actively incorporate technology into their strategizing and tactical initiatives during their careers. Developing students' IT self-leadership will make the online courses more impactful for our students' and influence our students' future careers.

Future Research

Future research is recommended to test our findings from the exploratory study with larger sample sizes and at different courses and institutions. Researchers are recommended to include IT-self leadership of both students and instructors in their investigations on learning success. Furthermore, the inclusion of transformational IT leadership in new studies of teaching and learning success is recom-

mended. Studies should be conducted to determine other antecedents and outcomes of IT self-leadership. Research is needed on specific ways practitioners can increase their IT transformational leadership. Lastly, it is needed to conduct research in business settings to extend this study to organizational learning environments.

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CHANGING MULTITASKING INTENTION WITH COURSE-BASED UNDERGRADUATE RESEARCH EXPERIENCES (CUREs)

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ABSTRACT

Aim/Purpose	This article aimed to design and evaluate a pedagogical technique for altering students' classroom digital multitasking behaviors. The technique we designed and evaluated is called course-based undergraduate research experience (CURE). With this technique, the students wrote a research article based on a multitasking experiment that the instructor conducted with the students. The students conducted a literature review, developed their own research questions, they analyzed experiment data, and presented results. This study evaluated the how the CURE contributed to student multitasking behavior change.
Background	Multitasking is defined as doing more than one thing at a time. Multitasking is really the engagement in individual and discrete tasks that are performed in succession. Research showed that students multitasked very often during courses. Researchers indicated that this was a problem especially for online teaching, because when students went online, they tended to multitask. Extant research indicated that digital multitasking in class harmed student performance. Multiple studies suggested that students who multitasked spent more time finishing their tasks and made more mistakes. Regardless of students' gender or GPA, students who multitasked in class performed worse and got a lower grade than those who did not. However, little is known about how to change students' digital multitasking behaviors. In this study, we used the transtheoretical model of behavior change to investigate how our pedagogical technique (CURE) changed students' digital multitasking behaviors.

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Methodology	Using a course-based undergraduate research experience design, a new classroom intervention was designed and evaluated through a content analysis of pre- and post-intervention student reflections. As part of the course-based undergraduate research experience design, the students conducted a literature review, developed their own research questions, they analyzed experiment data, and presented results. This study evaluated the how teaching using a course-based undergraduate research experience contributed to student multitasking behavior change. Transtheoretical model of behavior change was used to investigate how our pedagogical technique changed students' digital multitasking behaviors.
Contribution	The paper described how teaching using a course-based undergraduate research experience can be used in practice. Further, it demonstrated the utility of this technique in changing student digital multitasking behaviors. This study contributed to constructivist approaches in education. Other unwanted student attitudes and behaviors can be changed using this approach to learning.
Findings	As a result of CURE teaching, a majority of students observed the negative aspects of multitasking and intended to change their digital multitasking behaviors. Sixty-one percent of the participants experienced attitude changes, namely increased negative attitude towards multitasking in class. This is important because research found that while both students and instructors believed off-task technology use hinders learning, their views differed significantly, with more instructors than students feeling strongly that students' use of technology in class is a problem. Moreover, our study showed that with teaching using CURE, it is possible to move the students on the ladder of change as quickly as within one semester (13 weeks). Seventy-one percent of the students reported moving to a higher stage of change post-intervention.
Recommendations for Practitioners	Faculty wishing to curb student digital multitasking behaviors may conduct in-class experimentation with multitasking and have their students write a research report on their findings. Course-based undergraduate research experiences may make the effects of digital multitasking more apparent to the students. The students may become more aware of their own multitasking behaviors rather than doing them habitually. This technique is also recommended for those instructors who would like to introduce academic careers as a potential career option to their students.
Recommendations for Researchers	Researchers should explore changing other unwanted undergraduate student behaviors with course-based undergraduate experiences. Researchers may use the transtheoretical model of change to evaluate the effectiveness of techniques used to change behaviors.
Impact on Society	The negative outcomes of digital multitasking are not confined to the classroom. Digital multitasking impacts productivity in many domains. If techniques such as those used in this article become more common, changes in multitasking intentions could show broad improvements in productivity across many fields.
Future Research	This paper constitutes a pilot study due to the small convenience sample that is used for the study. Future research should replicate this study with larger and randomized samples. Further investigation of the CURE technique can improve its effectiveness or reduce the instructor input while attaining the same behavioral changes.

Keywords digital multitasking, research-based learning, experiential learning, content analysis, behavioral change

INTRODUCTION

College students often multitask with information technologies during classes. Two-thirds of the students report using electronic media while in class, doing homework, or studying (Jacobsen & Forste, 2010, p. 279). Often, students use their mobile phones for texting and accessing social networking sites (Ellis et al., 2010, p. 4). Students multitask in both online and face-to-face courses (Lepp et al., 2019). Similarly, when using the Internet, college students commonly engage in multiple online activities simultaneously (Moreno et al., 2012). This means that if a college student needs to use the Internet for an online course, they tend to multitask (Lepp et al., 2019). Younger adults are more likely to multitask than older adults (Brasel & Gips, 2011; Carrier et al., 2009) both in electronic and nonelectronic multitasking (Zwarun & Hall, 2014) making students especially prone to multitasking.

While multitasking is defined as doing more than one thing at a time, it is really "the engagement in individual and discrete tasks that are performed in succession," (Dzubak, 2008, p. 1). While it may be possible to do two things at once, such as running and listening to the music, the mind often switches back and forth between tasks that are seemingly done in parallel. Researchers introduced a variety of terms around multitasking such as task switching, which is defined as switching attention from one task to another while receiving information about how to respond to these tasks (Brake et al., 2017).

Students have various motivations for multitasking. These motivations include satisfying information needs (Wang & Tchernev, 2012), satisfying hedonic needs by creating a pleasant feeling (Kononova & Yuan, 2017), or satisfying the need to feel more efficient, and satisfying the need to have a greater sense of control over tasks (Robinson, 2017). Indeed, Bardhi et al. (2010) found that multitasking gives the impression of control, enjoyment, connection and efficiency to individuals who do it. In their study of multitasking college students, Lin (2019, p. 1674) found four motivations for multitasking: (a) greater control over their media consumption experiences; (b) processing related content more efficiently; (c) greater hedonic experiences through multiple media stimuli; and (d) connecting with friends and family. Lastly, students may have an addiction to the Internet due to the ubiquity of Internet-connected smartphones and smart devices (Carrier et al., 2015).

In addition to students' motivations for multitasking, the instructors may be inadvertently contributing to the multitasking behaviors. The instructors may cause students to multitask due to how they design their courses. Content and the learning tasks that the instructors choose may influence students' multitasking behaviors. Aagaard (2015) observed that the difficulty of the content and structure of the lessons were crucial determinants of students' multitasking behaviors. When instructors build in tasks that do not require behavioral response from students, this increases the odds that the students multitask (Wang et al., 2015).

There are two key challenges with student multitasking. First, students are often ineffective while multitasking. Second, students usually do not make the choice of multitasking consciously. While the students satisfy many needs by multitasking, they are really hurting their class performance. Unbeknownst to many students, student multitasking is usually ineffective. Multiple studies suggest that students who multitask spend more time finishing their tasks and make more mistakes (Bowman et al., 2010; Ellis et al., 2010; Fox et al., 2009; Fried, 2008; Hembrooke & Gay, 2003; Kraushaar & Novak, 2010). Regardless of students' gender or GPA, students who multitask in class perform worse and get a lower grade than those who do not (Ellis et al., 2010).

Students' low performance while multitasking is especially problematic because students may believe that they are effective when multitasking. Moreover, a majority of multitasking students (59.5%) believe they are able to manage their multitasking behaviors fairly easily (Rogers, 2018). Students think that they can refrain from the multitasking behaviors when they feel it is appropriate to do so (Rogers, 2018, p. 45). This is contrary to the findings of Wang and Tchernev (2012), who suggest that individuals multitask with media as a habit rather than as a conscious choice. While the literature is clear on the problems with digital multitasking, few studies propose how to fix this problem. Literature does not show how to make students consciously understand the choices they make when digital multitasking, and how to enable students to reflect on and change their multitasking behaviors.

To change students' multitasking behaviors, we adopt an intervention as recommended by the psychotherapy field (Prochaska & Velicer, 1997). With an intervention, we expect to raise consciousness about the multitasking behavior. We also hope to bring to light problems with the multitasking behavior, resulting in motivation to change the behavior. Coupled with pedagogical theory, we choose to use an intervention that uses discovery learning techniques to change behavior. Through discovery learning, we engage students in inquiry about whether multitasking has advantages or disadvantages. We hope that the students discover for themselves the negative aspects of multitasking behaviors using the discovery learning. In particular, students need to be made aware of how their multitasking behaviors impact their learning performance for the learning to be meaningful (Novak, 2002). In order to evaluate the intervention to change their multitasking behaviors, we pose the following research question:

> RQ: Does course-based undergraduate research experience (CURE) technique change students' classroom digital multitasking behaviors?

In this paper, we present the impact of course-based undergraduate research experience method on digital multitasking during classes. Multitasking is relevant to all classes since it happens in all classes. Moreover, specifically teaching students to multitask successfully with information technologies and to help them reduce ineffective and inefficient multitasking behaviors should be key to success in many courses.

LITERATURE REVIEW

THE TRANSTHEORETICAL MODEL OF BEHAVIOR CHANGE

We adopt the transtheoretical model of behavior change (Prochaska & Velicer, 1997). We chose this model because it integrates processes and principles of change from different intervention and change theories. The integrated theories come specifically from psychotherapy and behavior change fields. Only in psychotherapy, there are more than 300 theories (Prochaska, 1984).

According to the transtheoretical model, change is a temporal phenomenon, and when individuals change their behaviors, they go through six stages of change. These are called precontemplation, contemplation, preparation, action, maintenance and termination. ***Precontemplation*** is the first stage, and this is the stage where people are not intending to take action in the foreseeable future, at least not in the next six months. The individuals who are in the precontemplation stage, as the name suggests, are not even contemplating any change. They avoid getting information about, discussing or reading about the subject that requires change. They may not be sufficiently informed about the consequences of their behaviors.

The second stage is called ***contemplation***. The individuals who are in this stage intend to change their behaviors within the upcoming six months. While they may not be at the moment ready to take direct action, they are acutely aware of the cons of their behavior, which causes them to intend to change in the foreseeable future (Prochaska, 1984).

The third stage is the ***preparation*** stage, which indicates people's intentions to immediately take action. The immediate term refers to within the next month. Individuals in this stage typically have a plan of action, and they are ready to follow action-oriented interventions(Prochaska, 1984).

Action is the fourth stage, which indicates that the people have changed their behaviors in an observable way within the last six months. It is important that the action helps attain a criterion that scientists and professionals agree is sufficient to reduce the risks of the situation/disease (Prochaska, 1997, p. 39).

The stage that follows action is called ***maintenance.*** In this stage, individuals may not put forth as systematic effort as they do in the action stage to eliminate/change behavior. They may be less tempted to continue their old behaviors although some temptation may still be there. This stage refers to the stage where individuals are working to prevent relapse, and it may last between 6 months to 5 years. Relapse in this stage may indicate a return to a previous stage of change (Prochaska, 1984).

The final stage of change is called ***termination.*** This is the stage where individuals have zero temptation and they have total self-efficacy over their behavior. A study of former smokers and alcoholics found that only 20% of the people reached this termination stage (Snow et al., 1994).

TEACHING RELATED EXPERIMENTS ABOUT MULTITASKING

Students multitask heavily in classes (Fried, 2008). When they are told by their instructors not to use technology, this frustrates the students (Downs et al., 2015). Perhaps, motivated by this worrying trend, much research has been conducted on student multitasking. Most of these studies found negative outcomes of multitasking based on experimental designs. A brief overview of these articles is provided below.

Hembrooke and Gay (2003) conducted an experiment called the Laptop and the Lecture with 44 college students, where only half of the group could use their laptops during the lecture as they wished. They found that the students who used laptops performed worse on the test after the lecture than the control group. They also found that even leaving tabs opened on their screen caused students to "perform significantly poorer on immediate measures of memory for the lecture material" (Hembrooke and Gay, 2003, p. 51). Ellis et al. (2010) conducted an experiment with 62 undergraduate business students. They allowed half of the participants to text during the lecture, whereas the other half was not allowed. They found a significant reduction in the exam grades of the students who were allowed to multitask by texting. Thus, they concluded that the learning performance of multitaskers were less than those who did not multitask. In a similar study, Froese et al. (2012) found that students performed 30% on a quiz when texting. Bowman et al. (2010) conducted a reading-based experiment where the multitasking condition was instant messaging. They found that the students who did instant messaging while reading a typical academic psychology text online read much more slowly and performed significantly less in a comprehension test.

The only unique finding where multitasking did not always reduce learning performance was in the experiment of Pashler et al. (2013) involving 82 undergraduate students. They found that when materials were presented in a spoken form and played without waiting for the learner, multitasking resulted in substantial reduction in information acquired. On the other hand, when the learner read the materials at their pace, the information acquired was not affected significantly, even when the interruptions occurred at moments not chosen by the student. Similarly, listening to the materials and pausing to do the concurrent task was also relatively harmless.

Rosen et al. (2011) conducted a multitasking experiment with mobile phones during a course lecture. Researchers sent students text messages and asked them to respond. Students in the high text messaging group performed worse on the test grade by 10.6%. Participants who received and sent more words in their texts received the lowest grades on the test moderated by time between receiving and sending a text. Those students who waited longer between receiving and sending a text had better

performance than those who waited less. Other studies comparing student performance under the conditions of texting and non-texting found that the non-texting group outperformed regardless of gender and GPA (Ellis et al., 2010). McDonald (2013) found a negative correlation between in-class texting and final grade score, regardless of texting condition. This negative correlation remained after controlling for GPA, ACT score, and attendance. In another experimental study, Kuznekoff et al. (2013) divided participants in three groups (non-multitasking, low-distraction, and high-distraction) and had them watch a video lecture while taking notes. To evaluate the learning performance, they were asked to complete assessments. Those in the control group recalled better, provided 62% more information, and their assessments were higher than the other groups.

May and Elder (2018) suggested that the purpose of multitasking, rather than multitasking itself, creates the negative learning outcomes. Wood et al. (2012) compared note taking on a piece of paper versus Microsoft Word together with multitasking. Multitasking conditions included texting, emailing, Instant Messaging (IM), and Facebook. Student learning performance was measured with a quiz. Results indicated that participants who did not use any technologies outperformed multitasking students. This happened regardless of medium. Downs et al. (2015) had 204 students watch a 25-minute video. They controlled students' multitasking behaviors by randomly assigning them to one of the six groups: (1) Facebook distracted; (2) paper note-taking; (3) no media use control group; (4) mixed distraction; (5) laptop note-taking; and (6) distracted combination. Participants who participated in non-class related multitasking (groups 1, 4, & 6) performed worse on the learning performance test than other groups. Brooks (2015) conducted a survey regarding multitasking in a natural classroom setting. Students completed a pre-task survey before watching a 15-minute video lecture. Following the video, students completed a quiz. Students also completed a survey regarding social media use, attentional control, multitasking computer self-efficacy, technostress, and happiness. The quiz findings indicated that social media usage negatively affected student performance. Attentional control and multitasking computer self-efficacy did not have a significant effect on this relationship. The authors concluded that the students were not as skilled at multitasking as they thought they were. Conard and Marsh (2014) examined the effect of interruptions via instant messaging and situational interest on learning during multitasking. Participants viewed a 16-minute video presentation. Participants simultaneously responded to instant messages sent at specific times by research assistants. Following the video, participants' learning was assessed using a test. The researchers found that multitasking interruptions reduced learning; but interest did not moderate the effect of interruptions. In a slightly different experiment, participants watched Netflix while they read a text, where the control group read without watching anything. The results showed that the group that that multitasked by watching a video scored lower in the reading comprehension than the control group (Lauer, 2017).

Lastly, multitasking not only affects the learning of the individuals who are doing it, but also those who are nearby as well. Sana et al. (2013) conducted an experiment with 40 undergraduate students in which students viewed a 45-min PowerPoint lecture in multitasking or non-multitasking conditions. Participants who multitasked on a laptop during the lecture scored lower on the test than non-multitaskers. Moreover, participants in direct view of a multitasking peer scored 17% lower than those who were not.

Overall, this body of research shows that multitasking with non-relevant tasks hinder learning. These negative effects on academics were demonstrated with varied outcomes – test performance, grades, comprehension, recall, and note-taking. Students habitually using laptops in class report low satisfaction with their education, are more likely to multitask in class, and are more distracted (Wurst et al., 2008). Laptop use negatively related to multiple learning outcomes including course grade, focus on lectures, reported clarity of lectures, exam performance, and comprehension (Fried, 2008; Kraushaar & Novak, 2010; Wood et al., 2012). Interestingly, laptop multitasking not only harms the multitaskers, but also distracts the nearby peers, affecting their learning negatively (Fried, 2008; Sana et al., 2013). Moreover, students do not have the correct knowledge of how much time they spend on multitasking (Tanner et al., 2008). Students spend 1.5 times more time on social media than they think

they do, and they estimate twice the time they actually spend on learning (Tanner et al., 2008). Furthermore, students overestimate their abilities to effectively and efficiently multitask (Downs, 2015).

Experiential Learning and Change Using Course-Based Undergraduate Experiences (CUREs)

Research and inquiry engages undergraduates meaningfully in their education. Research enables the undergraduates to learn how to inquire and to critically evaluate knowledge, which is crucial for today's complex work setting (Brew & Jewell, 2012). Many undergraduate research programs are in place across the USA and are growing in other countries (Healey et al., 2010).

We define course-based undergraduate experience as *an inquiry, investigation or a research-based activity, conducted by undergraduate students under the guidance of an instructor as part of a course design, that makes an original intellectual or creative contribution to the discipline and/or to understanding.* This definition is an extended version of the research based-learning definition of Brew and Jewell (2012).

Course-based undergraduate research experiences enhance the students' knowledge and understanding of their subject by their active engagement in their learning (Lambert, 2009). Further, it enriches the students' investment in education by their participation in the research culture of their intellectual disciplines (Lambert, 2009). A body of literature has documented the advantages to students of engaging with research (De Haan, 2009; Elsen et al., 2009; Garde-Hansen & Calvert, 2007; Healey, 2005a, 2005b; Jenkins et al., 2007; McGuinness & Simm, 2003; Seymour et al., 2004) and of doing so early (Walkington et al., 2011). In this article, we focus on the aspect of CUREs, not only on inquiry and learning, but also on personal change.

Course-based undergraduate research experiences (CUREs) have at their core the idea of experiential learning and the resulting change. Changing student behaviors requires students first to observe their own behaviors (Johnson & White, 1971). The fact that students don't have the correct knowledge of how much they multitask is a problem. Furthermore, students who have positive attitudes toward multitasking do not perform better than the rest of the students (Eseryel et al., 2021). Secondly, changing behavior requires the understanding of the negative outcomes of behavior and getting a feeling that the negative outcomes outweigh positive behaviors. This suggests that the students should not only be conscious about their own multitasking behaviors, but they should learn and internalize the outcomes of such multitasking. Conceptual change must occur prior to behavioral change. The theory of experiential learning (Kolb & Kolb, 2005) suggests that learning is "the process whereby knowledge is created through the transformation of experience" and "knowledge results from the combination of grasping and transforming experience" (Kolb & Kolb, 2005, p. 194). Principles of situated cognition and experiential learning suggest that if students were to arrive at that conclusion on their own, it would be a more potent learning experience than if they were simply told what they can and cannot do with their technology (Downs et al., 2015). Across many fields, college faculty teach through lecturing, while research indicates that other methods are more effective in motivating students to learn (Huba & Freed, 2000).

Experiential learning theory draws from scholars of human learning and development, such as John Dewey, Kurt Lewin, Jean Piaget, William James, Carl Jung, Paolo Freire, Carl Rogers, and others. The theory is built on six propositions that are shared by these scholars (Kolb & Kolb, 2005, p. 194):

(1) Learning is a process that includes feedback on student learning effectiveness.

(2) All learning is relearning. Namely, learning is a process that draws out the students' thoughts, ideas, and beliefs so that these can be tested and new ideas can be incorporated into existing knowledge.

(3) Learning requires resolution of conflicts between dialectically opposed models of adaptation to the world. Learning is the process of moving back and forth between opposing

thoughts and feelings. These opposing ideas are then resolved when one moves to incorporate a new idea and make it their own.

(4) Learning is a holistic process of adaptation to the world, meaning learning is not only about cognition of facts. It includes thinking about new knowledge, feeling, perceiving, and behaving according to new knowledge.

(5) Learning results from synergetic transactions between the person and the environment. Learning happens through the dialectical processes of integrating new experiences into concepts that exist in one's mind.

(6) Learning is the process of creating new knowledge. Learning is a process where social knowledge is created and recreated. Thus, learning is not the process of instructors transmitting ideas to students.

The instructor's role in experiential learning is threefold (Wurdinger & Carlson, 2009). First, instructors should guide the students to learn by making mistakes and learning from their mistakes. Second, the instructors should provide freedom to the students to experiment in order to discover the solutions to the problems they encounter. Finally, the instructors should provide the students with resources and information when they get stuck, so that the students can continue to make progress and learn.

Wurdinger and Carlson (2009) identify five different types of experiential learning: active learning, problem-based learning, inquiry-based learning, project-based learning, and service-learning. The course-based undergraduate research experience, detailed below, is an experiential learning approach that incorporates problem-based learning and active learning. Our study incorporates a problem-based educational approach by organizing instruction around a carefully crafted "ill-structured" problem of deciding whether multitasking is something that is good for them or not. Guided by their instructor as a coach, they design two experiments, conduct a literature review on multitasking, formulate hypotheses, analyze their data, and determine the solution to their question (Wurdinger & Carlson, 2009). In doing all these, they develop critical thinking, problem solving, and collaborative skills (Wurdinger & Carlson, 2009) in addition to gaining hands-on skills in conducting a quasi-experimental academic research study. The research-based teaching approach we adopted also incorporates active learning by embedding group participation assignments where the students have to engage in research-based activities thinking about and reflecting on these activities (Bonwell & Eison, 1991).

We have chosen active learning for the students to study the extant literature on multi-tasking because active learning is often more effective than being lectured (Prince, 2004), and active learning enables students to transfer their learning to multiple problem-solving contexts (Bransford et al., 1999). Having the students actively learn about different aspects of multitasking is an effective way of consciousness raising (Prochaska & Velicer, 1997), thereby prompting the change process in students.

METHODOLOGY

To answer our research question, we followed the design science research best practices to create an intervention technique and evaluate its effectiveness (Gregor & Hevner, 2013; Hevner et al., 2004). The evaluation focused on students' change in intention to multitask. We conducted a content analysis of their thoughts during two phases: pre-intervention and post-intervention. In this section, we: (1) detail how we designed our intervention; and (2) describe how we evaluated the resulting technique.

STUDY DESIGN

Study participants came from multiple sections of an introductory Management Information Systems class taught by the first author. The students were told that participation was NOT mandatory, and that for any assignments related to the task that are graded, the students were told that they had the right to opt out at any time and receive another assignment for the same grade. None of the students chose to opt out of the study or the experiments before or during the study. A total of 34 students agreed to participate.

In the pre-intervention phase, students completed a "brain-dump." Brain dumps show the general student attitudes towards multi-tasking before and after the intervention. The brain-dump was a time-limited assignment, for which the students were prompted to use the given time (15 minutes) to write as much as possible about the topic without thinking much, and without correcting their grammar or voice. This allowed them to write the first thing that came to their mind, which often reflected their true and original thoughts about the subject matter. A series of question prompts helped guide the student brain dumps.

The instructor told the students that multitasking may have advantages and disadvantages, and that the students will conduct a research assignment to find out the best way to multitask. There were further discussions on how students tended to multitask in this and other classes. The instructor created an open, non-judgemental atmosphere that allowed the students to easily talk about how they multitasked, even when they multitasked against the wishes of the instructors.

During the intervention, the students were given three "Group Participation Assignments". Each assignment asked the students to collect research articles and then summarize the key findings. The first group participation assignment asked the students to list the advantages of multitasking. The second group participation assignment asked the students to list the disadvantages of multitasking. The final group participation assignment asked the students to identify tips for successfully multitasking. Each of these three assignments constituted a change intervention provided by the instructor, called "consciousness raising" by Prochaska and Velicer (1997). Namely, the students were educated on the benefits and disadvantages of multitasking, and how to multitask best.

After the literature search by students, two controlled experiments were conducted with the students based on a discussion in class with all students on what kind of experiments they would like to do. The first experiment included doodling with pen and paper, while at the same time listening to the lecture. The second experiment included texting back and forth with a friend, while at the same time listening to the lecture. At both times, the students were prompted repeatedly that they should be paying attention to the lecture and that 5-6 questions were going to be asked (out of 40) in the midterm exam from the chapter at hand. This was a required prompting to get them to pay attention to the lecture as best as they could to manage their intentional attention. After the lecture, the students were given a 5-question quiz based on the key learnings of the lecture and, immediately after the quiz, they were given the answers and asked to calculate how many questions they answered correctly. Lastly, they were given a general survey that included their demographic information, their grades, interest level, and their general multitasking habits. Having the students experiment with multitasking, and then having the students immediately calculate the percentage of their learnings from the given lecture was another way of consciousness raising through feedback (Prochaska & Velicer, 1997).

The last change process that was incorporated into the class was the stimulus control (Prochaska & Velicer, 1997). The instructor introduced during the first class a set of class norms, one of which included keeping the laptops, cell phones and smart devices in students' bags during lectures. The instructor justified this value by previous literature which suggested that even having the phone with screen turned down on the table during conversations distracted the speakers and distracted learners (Duke et al., 2018).

To be fair to all students and ensure that the experiments would not affect student grades, the students were told after both experiments were concluded that none of the topics taught during the experiment were included in the exam. Furthermore, other means to learn the same information (such as videos and slides of the presentation) were provided for those who missed the content due to multitasking experiments.

During the post-intervention phase, the participating students wrote a research report and gave a presentation on the topic of multitasking based on in-class experiments. The research report that the students were asked to write followed a similar outline to that of a journal article in addition to having a reflections section. The literature section of the research report included an enhanced literature study that the students conducted using the group participation assignments. Then the students were given their own experiment outcome data as well as the survey results. The students were asked to formulate research questions by finding interesting patterns in the data. Then they were asked to analyze the data to answer their own research questions. The instructor guided this process by conducting other group participation assignments where the students were asked to come up with research questions, and where they received feedback on their research questions on how to improve them and how to analyze the data.

At the end of the report, each student separately shared their personal reflections on the experiments and their own experience of multi-tasking in classes. The personal reflection provided the second piece of content to be analysed for our investigation.

EVALUATION OF THE TEACHING TECHNIQUE

The evaluation of the CURE teaching technique was performed with a content analysis (Krippendorff, 2019). Two coders with postgraduate training were used to analyse the pre-intervention (brain dump) and post-intervention (personal reflection). To limit potential bias in the coders, neither coder was involved with the experiment nor the class setting. The coders were trained on the coding scheme and independently coded 4 students' documents over 7 categories for a total of 28 coded items. The coders agreed on 27/28 coded items resulting in a 96.4% interrater reliability. The coders discussed the one disagreement and came to a consensus on the coding strategy to employ. Because of the high level of agreement, all remaining coding was conducted by just one of the coders.

In both pre-intervention and post-intervention, the stage of behaviour change was captured. The change stage was based on the six stages in the transtheoretical model (Prochaska & Velicer, 1997). The appendix provides the coding schema that was used for this study.

For the pre-intervention, three additional items were coded in addition to the stages provided by Prochaska & Velicer (1997), developed using a grounded theory approach. These three were perception of skills, attitude toward multitasking, and frequency of multitasking. Perception of skills was defined at three levels: novice, medium-experienced, and highly skilled. Attitude toward multitasking ranged from mostly positive, neutral, and mostly negative. Frequency of multitasking was coded as high, medium, or low.

For the post-intervention, two items were coded, change in attitude and change in intention. Change in attitude was defined as increased negative, no change, and increased positive. Change in intention was classified as reduce, no change, and increase.

To analyze the data, raw counts and percentages were calculated for each category. Cross-tabulation between pre- and post-intervention category recorded associations to describe how the intervention impacted students. These findings are expressed below, supported by quotes from the students.

FINDINGS

Please note that due to missing documents or unclear participant responses, not all totals equal 34.

PRE-INTERVENTION

Prior to the intervention, the majority (71%) were in the precontemplation stage of change. These participants saw multitasking in a mostly positive way and were not inclined to change anytime soon. 22% of participants noted the potential problems with multitasking likely outweighed the benefits but had no immediate plans to change, putting them in the contemplation stage. Two of the participants stated they had already made changes to limit or stop multitasking, placing them in the maintenance stage. None of the participants made statements that would cause us to categorize them in the preparation or action stages.

Pre-intervention perceptions of attitude

Most participants reported that they multitask in class pre-intervention. This often entailed looking at their phone or computer to check email, scrolling through social media, doing homework from other classes, and texting friends. A few participants considered taking notes, marking up PowerPoint slides, completing homework assignments, and Googling confusing information to fall under multitasking.

Perhaps not surprisingly, many participants that multitasked in such a way tended to have a mostly positive attitude toward multitasking. For example, one participant stated, "I multitask during class by paying attention to the teacher and by taking notes down on my pc." And later says, "Yeah I like to multitask."

When participants had a negative attitude toward multitasking, they often felt stressed out:

> "It stresses me out because I am trying to listen while also trying to write."
>
> "It's stressful sometimes."
>
> "Multitasking stresses me out and for some reason I always feel rushed."

Although even some participants with neutral attitudes toward multitasking felt stressed sometimes, they still saw enough benefits to balance their attitude:

> "Multitasking sometimes stresses me out … but it's a way to get several things done at once."

Two participants recognized that multitasking inhibited their ability to focus, preventing them from doing their best work:

> "It makes me feel too busy, like my focus and attention is being split between two important tasks."
>
> "I feel like it hinders me from focusing."

Pre-intervention perception of skills

Of the participants, 17% perceived themselves to be highly skilled at multitasking, 38% perceived themselves to be skilled at a medium level, and 29% at novice level. Most participants (5 out of 6) that considered themselves to be highly skilled tended to have a mostly positive attitude toward multitasking. For example, one participant summarized it: "I multitask quite well. I do it in class, at work, and even at home. Multitasking makes me feel busy and the busier I am or need to be, then the more productive I am going to be." They later stated, "When I am successful, multitasking makes me feel accomplished."

Interestingly, each highly skilled multitasker also claimed their friends were good at multitasking, but their parents were not. For example, one highly skilled multitasker said:

> "My dad will not talk while he is writing an email and my mom cannot talk on the phone and write something down at the same time."

However, most participants (8 out of 10) classified as novice multitaskers claimed their parents were better at multitasking than they were. For example:

> "I honestly think my parents multitask better than me …"

Pre-intervention multitasking frequency

The frequency of multitasking was less clear in many documents with only 68% (23/34) giving some indication of frequency. Of those, 52% reported a high frequency, 17% reported medium frequency, and 30% reported a low frequency.

POST-INTERVENTION

In the post-intervention personal reflections, participants shared their changing thoughts on multitasking. Of the 34 participants, 32 completed the personal reflection.

Post-intervention, 15% of participants were at the precontemplation stage, 28% at contemplation stage, 43% at preparation stage, and 6% respectively at action and maintenance stages. (See the Appendix for examples of quotes from students at each stage.)

Post-intervention changes in attitude toward multitasking

In no cases was there an increased positive attitude toward multitasking. Of the participants, 61% explicitly expressed an increased negative attitude toward multitasking in class. Many expressed a sentiment such as:

> "When we started this project, I was anxious to see how the results would turn out. I felt like I could multitask without any drop off in my ability to do either activity. After looking at the results, I realized that there is a drop off in my learning ability when I multitask."

However, 26% of participants came away with a mixed attitude. This mixed attitude distinguished between multitasking with related tasks versus multitasking with unrelated tasks. A common observation of mixed attitude looked like this:

> "This lead [*sic*] me to realize there are two types of multi-tasking, good and bad. The good is when multitasking has to do with the assignment at hand, so taking notes on what you are listening to or working on an assignment that covers the material you are going over, anything that correlates [with] the other will be a better multitasking option. The other is just basically a distraction, anything that causes a switch in tasks or subjects like being on your phone or doing other classes [*sic*] work."

No change in attitude was shown by 13% of participants. They shared a sentiment such as:

> "My thoughts on multitasking have not changed doing this experiment or paper because I already knew what the outcome would be."

INTERVENTION EFFECTS

We next look at changes due to the CURE intervention. To do this, we looked at cross-tabulations between pre-intervention and post-intervention factors.

Ten participants did not express any movement in the stage of change. This includes the two participants who were in the maintenance stage of change pre-intervention. They stayed in that stage. The remaining participants were in precontemplation or contemplation stage pre-intervention. Of that group, 71% moved to a higher stage of change post-intervention (see Table 1).

Table 1. Cross-tabulations of pre and post intervention change stage

		Stage Post-Intervention					
		Precontemplation	Contemplation	Preparation	Action	Maintenance	Total
Stage Pre-Intervention	Precontemplation	5	6	9	2	0	28
	Contemplation	0	3	3	0	0	6
	Maintenance	0	0	0	0	2	2
Total		5	9	12	2	2	30

The intervention had a similar effect on participants, regardless of their perception of skill with multi-tasking or their attitude toward multitasking (see Tables 2 and 3). In Table 2, the distribution of novice, medium level, and expert perceptions of their multi-tasking skills showed no clear pattern across the stages of change post intervention. 88% of novices, 83% of medium level, and 80% of experts were beyond precontemplation stage of change post intervention. In table 3, the distribution of mostly negative, neutral, and mostly positive attitudes toward multitasking pre-intervention also showed no clear pattern across the stages of change post intervention. 100%, 83%, and 71% respectively of the negative, natural, and positive attitudes were marked in a stage of change of contemplation, preparation, action, or maintenance. The two participants who worried about their ability to focus pre-intervention were the only two participants that took action immediately after the intervention.

Table 2. Cross-tabulations of perception of skill and post intervention change stage

		Stage Post Intervention					
		Precontemplation	Contemplation	Preparation	Action	Maintenance	Total
Perception of Skill	Novice	1	3	3	0	2	9
	Medium	2	4	5	1	0	12
	High	1	1	2	1	0	5
Total		4	8	10	2	2	26

Table 3. Cross-tabulations of attitude toward multitasking and post intervention change stage

		Stage Post Intervention					Total
		Precontemplation	Contemplation	Preparation	Action	Maintenance	
Attitude Pre-Intervention	Mostly negative	0	3	3	0	2	8
	Neutral	1	1	4	0	0	6
	Mostly positive	4	4	4	2	0	14
Total		5	8	11	2	2	28

DISCUSSION

The goal of this study was to design and evaluate a pedagogical technique for altering student digital multitasking behaviors. The reason for altering the student behavior about multitasking was twofold: (1) the students are often ineffective while multitasking; and (2) the students usually do not make the choice of multitasking consciously. Our research question was "Does course-based undergraduate research experience (CURE) technique change students' classroom digital multitasking behaviors?"

Research indicated that students multitask heavily in classes (Fried, 2008). Students' multitasking behaviors are strongly motivated by their various attitudes, feelings, and needs (Bardhi et al., 2010; Kononova & Yuan, 2017; Lin, 2019; Robinson, 2017; Wang & Tchernev, 2012). Therefore, when students are told by their instructors not to use technology, this frustrates the students (Downs et al., 2015). Yet, often students use technologies to multitask on unrelated tasks (Ellis et al., 2010; Jacobsen & Forste, 2010). As a result, students who multitask spend more time finishing their tasks and make more mistakes (Bowman et al., 2010; Ellis et al., 2010; Fox et al., 2009; Fried, 2008; Hembrooke & Gay, 2003; Kraushaar & Novak, 2010). Even in cases when multitasking with IT does not decrease students' class performance, it may reduce their learning satisfaction (Eseryel et al., 2021).

To change students' multitasking behaviors, we adopted an intervention as recommended by the psychotherapy field (Prochaska & Velicer, 1997). We specifically used course-based research experience as our intervention. For this method, we asked the students to write a research paper on multitasking. The students provided input on the design and implementation on the research by suggesting ways they can do the multitasking experiments in class. The students were guided on the research project by using group participation assignments, which walked them through different stages of the research. For example, as part of group participation assignments the students found research articles on the advantages of multitasking, disadvantages of multitasking, and on how to multitask successfully. With the group participant assignment, the students summarized the literature they found. After we conducted the experiments, the students used group participation assignments to analyze the data, and to come up with research questions and to get feedback from the instructor on the appropriateness of their research question. Another element of the study was getting student reflections in order to measure the effectiveness of the study. Before the study began, we used "brain dumps,"

namely 15-minute free style writing sessions, to get information on student attitudes towards and behaviors of multitasking. After the study was conducted, the students added individual student reflections to their research reports, which provided post-intervention feedback. We used the brain dumps and the post intervention reflections to evaluate the effectiveness of the research-based experiential teaching method.

Our findings showed that course-based undergraduate research experience (CURE) is effective in changing student attitudes and in moving the students further in the stages of change. We found that 61% of the participants experienced increased negative attitude towards multitasking in class. This is important because research found that while both students and instructors believed off-task technology use hinders learning, their views differed significantly, with more instructors than students feeling strongly that students' use of technology in class is a problem (Zaza & Neiterman, 2019). Moreover, our study showed that with course-based undergraduate research experience (CURE), it is possible to move the students on the ladder of change as quickly as within one semester (13 weeks). In fact, 71% of the students moved to a higher stage of change post-intervention. According to the diffusion of innovations theory (Rogers, 2003), the diffusion of new ideas takes a long time, and only 2.5% of the population are the first ones to try a new idea/innovation, followed by 13.5% of the population, who are early adopters. This is followed by the early majority (34%), who are rarely leaders, but who tend to adopt new ideas before the average person. The late majority are the following 34% of the population, who are skeptical of change and will only adopt an innovation after it has been tried by the majority. According to these percentages, making a change in 71% of the students' post-intervention is a rather successful accomplishment that we will attribute to the course-based undergraduate research experience.

Our paper adds to the constructivist teaching approach. According to constructivism, each individual constructs their own knowledge. Adopting a constructivist approach, our design goal was to create a learning environment where the students were supported in developing their own knowledge and attitudes towards multitasking and its effect on their learning performance. The design of the course-based undergraduate research experience included discovery learning principles, where we engaged students in inquiry through which, guided by the instructor and the materials, students discovered the intended content (Hammer, 1997). We added the CURE method to the toolbox of the instructors in social sciences and STEM research who prefer discovery learning methods.

Our study further helped us identify another gap in the literature: when the students were doing the group participation assignments, they easily found many articles on the disadvantages of multitasking. However, they had a very tough time finding evidence for the advantages of multitasking. Further, the researchers rarely gave tips on how to multitask successfully, although many online (popular) resources exist for tips on how to multitask successfully. Our study showed the gap in the literature on the benefits of multitasking, and on studies that highlight how students can multitask effectively.

A side-benefit of the study, which is no less important, was to show the students how to conduct research, and showing them what the research part of an academic career looks like. Such early introductions towards academic research enable those students who like such work to identify academia as a potential career option. Research found that research experience during school predicted achievement in academic careers (Brancati et al., 1992).

LIMITATIONS

The limitation of this study is the small convenience sample size of 34 participating students. In our analysis, some of the student documents were missing or unclear, thus the tables we created for the analysis section did not always add up to 34. Moreover, while our intervention was thorough, it was also complex. It may be possible to attain similar results with fewer components. Future studies may incorporate some of the elements presented here to test the outcomes. Lastly, this was a pilot study.

Future studies should investigate the use of course-based undergraduate research experience (CURE) across different settings, and with larger sample sizes.

CONCLUSION

We conducted a course-based undergraduate research experience to influence multitasking behavior in undergraduate students. Our study was effective in changing student behavior, by causing a change in 71% of students' multitasking behavior post intervention.

We observed that the course-based undergraduate research experience caused the students to be more aware of their own multitasking behavior, and that they could see multitasking as a choice rather than an automatic habit. The literature review component of the study caused the students to learn from the extant research on the negative aspects of multitasking. Even though some students had positive attitudes toward multitasking, not being able to find much literature on the positive aspects of multitasking was eye-opening for the students according to their comments.

The findings suggested that course-based undergraduate research experience, which combines different types of experiential learning, may be used to enable wanted changes in student attitude and behavior. This study showed that using a course-based undergraduate research experience (CURE), the instructors can change the attitudes and behaviors of their students, by making the students aware of their behaviors and the outcomes of those behaviors. This approach further enables the students to benefit from the knowledge accumulated by extant research. Students learn to value the practical benefits of research and how to use research findings for practical purposes. The course-based undergraduate research experience produced strong effects in many students. It had the most immediate effects on individuals worried about their ability to focus. Because our intervention focused on students creating and collecting their own data, the method helped students to practice cleaning, analyzing, and presenting data using Excel (or another tool), which further actively engaged the students with the data analysis concepts core to the management information systems curriculum. By personalizing the process, students became more motivated and had a similar background with the ideas, promoting more meaningful learning (Drake, 2012).

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APPENDIX: CONTENT ANALYSIS SCHEMA

Code category	Code name	Code description	Reference	Code example	Rules about the code
Change in intention to multitask	Reduce	Starting to intend a reduction in the amount of multitasking	Grounded theory coding	"I will do it less in class"	From personal reflection
	Increase	Starting to intend to increase the amount of multitasking		None found	
	No change	Stated intention is not to change the amount of multitasking		"I will continue to not multitask"	
Change in attitude toward multitasking	Increased positive	Starting to believe that multitasking is good, while originally had neutral or negative beliefs about multitasking.	Grounded theory coding	None found	Comparison between brain dump and personal reflection. Student responses are more nuanced than this. Several students found multitasking when tasks are related to be beneficial, but not so when unrelated.
	Increased negative	Starting to believe that multitasking is not good, while originally had neutral or positive beliefs about multitasking.		"I think after these experiments it shows that I'm probably not being as effective as I think I am"	
	No change	No change in attitude			
Perception of their multitasking skills	Highly skilled	Claims that they are very skilled at multitasking.	Grounded theory coding	"I can multitask very well"	From brain dump. "How well can you multitask?" and "Are you good at it?"
	Medium	Claims that are moderately good at multitasking, usually with a disclaimer such as "pretty good".		"I'm pretty good at it"	
	Novice	Claims that they are okay or bad at multitasking		"I am not good at multitasking"	

Code category	Code name	Code description	Reference	Code example	Rules about the code
Reported frequency of multitasking	High	Claims that the student multitasked very often	Grounded theory coding	"All the time"	From brain dump
	Medium	Claims that the student sometimes multitasked		"Only during class or when the rest of my day is interrupted"	
	Low	Claims that the student rarely multitasked.		"When I'm bored, which doesn't happen very often"	
Attitude to multitasking pre-intervention	Mostly positive	Statements that attribute positive reflections towards multitasking	Grounded theory coding		From brain dump questions "Do you like multitasking?" or "How does multitasking make you feel?"
	Neutral	Statements that attribute neither positive more negative reflections towards multitasking		"I could care less about it, I just do it to get work done"	
	Mostly negative	Claims that attribute negative reflections towards multitasking		"It's stressful sometimes"	
Change stages	Precontemplation	Stage in which people are not intending to take action in the foreseeable measure usually measured as the next 6 months. They may have tried to change a number of times and become demoralized about their abilities to change. Indications on avoiding reading, talking or thinking about negative multitasking behavior.	(Prochaska & Velicer, 1997)	"I will not be changing my multitasking habits"	
	Contemplation	Stage in which people are intending to change in the next 6 months. They understand s the pros of changing but the cons seem to be higher.	(Prochaska & Velicer, 1997)	"…multitasking with unrelatable task will be much more difficult and you would not be as effective on you task."	

Code category	Code name	Code description	Reference	Code example	Rules about the code
	Preparation	Stage in which people are intending to take action in the immediate future, usually measured as the next month. These individuals have a plan of action such as relying on a self-change approach, doing research, etc.	(Prochaska & Velicer, 1997)	"I think that what I learned from this experiment certainly added to my current multitasking strategy."	
	Action	The stage in which people have made specific overt modifications in their multitasking behavior within the last 6 months.	(Prochaska & Velicer, 1997)	"Since the conclusion of the experiment I have tried to stop multitasking on tasks."	
	Maintenance	Stage in which people are working to prevent relapse but they do not apply change processes as frequently as people in action.	(Prochaska & Velicer, 1997)	"In the future, I will continue to not multitask"	
	Termination	Stage in which individuals have zero temptation and 100% self-efficacy	(Prochaska & Velicer, 1997)		

AUTHORS

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