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Contents

Pedagogically-Informed Knowledge Mapping: Representing Contextualised Competences and Technology Implemented

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Abstract: Knowledge can be represented as concept maps or directed graphs. Our research focuses on the use of knowledge mapping within the educational technology domain. The purposes of using knowledge mapping can be varied such as for self-learning, visualizing individual knowledge and sharing knowledge mapping. Knowledge mapping tools in the educational technology domain currently support learners and teachers in creating and visualizing a knowledge repository, usually of subject matter content or links to such content. However, when we consider the context of learning and teaching, none of the tools are based upon a pedagogically informed approach to knowledge in such a context. In our research, we identify contexts as, at the least, the situation, the resources, and the tools involved or required for the knowledge to be effectively demonstrated. We propose a pedagogically-informed knowledge mapping design, where knowledge is conceptualised as a contextualized learner competence or intended learning outcome, and proposes a tool called Mytelemap for creating and visualizing knowledge and recommending appropriate learning and teaching materials. The research question was set as "Does the use of knowledge mapping and Mytelemap correlate with performance on the final project?". Academic performance was operationalized as the final project mark, and the explanatory path for identifying its correlates was particularly interesting. The experiment suggested that satisfaction in using, and the motivation given by using the Mytelemap tool for knowledge mapping and visualization were significant predictors of engagement which was in turn the significant predictor of academic achievement. We hence conclude that the use of knowledge mapping and the tool significantly correlated with academic performance. However, the suggested results were limited to the knowledge domain of web technology, where the academic contexts referred to tools used in developing web site prototypes in an undergraduate curriculum. Future work will investigate contextualized competences in different domains and different contexts.

Keywords: Conceptual Model, Learner Competence, Knowledge Mapping, Learning Context, Computer Assisted Learning

1. Introduction

Knowledge can be represented in many forms (Sowa, 2000) and visualized, for example, as concept maps (Novak and Canas, 2006) or directed graphs (Hwang, 2003). Our research focuses on the use of knowledge mapping within the educational technology domain. Most technologies which claim to support the construction, visualization, and storage of "knowledge" simply deal with subject matter content or links to such content. For example, the Cmap tool (Shaw, 2017) allows users to construct concept maps and create subject matter nodes with relationships, and Openknowledgemaps.org (openknowledgemaps.org, 2020) provides an open source software for individual and community knowledge mapping, describing the relationships among the subject matter. However, such approaches fail to align with current considerations in teaching and learning which are concerned with contextualized competences and learning outcomes. In this paper we articulate a theory of pedagogically-informed knowledge comprising contextualized competences, demonstrate its instantiation in a prototype knowledge-mapping tool, and report an experiment which investigated the use of the tool by an undergraduate student cohort in a course on web site development. An earlier version of the tool showed user satisfaction (Nitchot, Wettayaprasit and Gilbert, 2019) and better support for learning compared with free browsing (Nitchot, Wettayaprasit and Gilbert, 2018). The structure of the paper is described as follows. Section 2 provides a literature review of knowledge mapping design, samples of knowledge mapping, and knowledge mapping technology support. Section 3 explains contextualization and its use in learning. Section 4 describes our prototype implementation and how it adopts contextualized competence. Section 5 explains the experimental study, and Section 6 provides conclusions and future studies.

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2. Knowledge Mapping and Reviews

2.1 Knowledge Mapping Design

There are several ways of representing knowledge. Novak and Canas (2006) used concept maps as the graphical tool for organizing and representing knowledge. Concepts are enclosed in circles or boxes and linked with relationships. A concept is defined as an object or event designated by a label with a meaningful statement. Novak and Canas (2006) outlined the steps of constructing a knowledge mapping (or concept map) as 1) identifying a domain of knowledge, 2) defining the question or problem in the selected domain, 3) identifying key concepts that apply to this domain, 4) ranking the concepts, 5) constructing a preliminary map for revision, and 6) finalizing the map. Figure 1 shows a sample concept map.

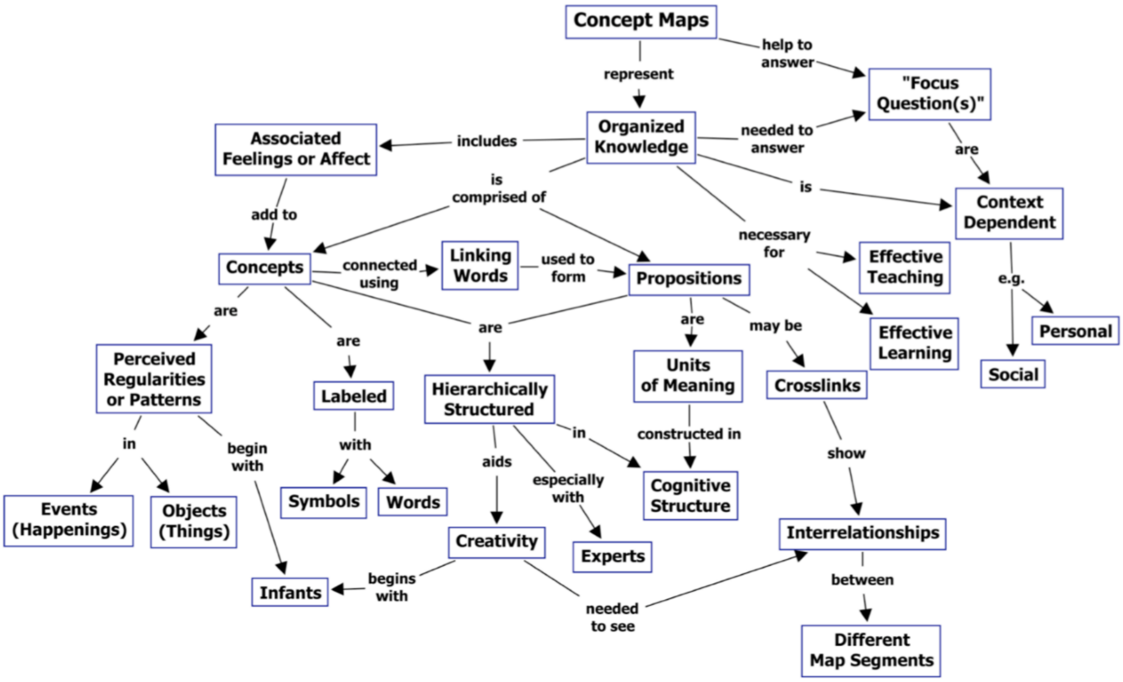

Figure 1: Sample Concept Map (Novak and Canas, 2006)

Lee, Lee, and Leu (2009) proposed a better way of defining concepts and their mapping to support a learning focus. Concepts in the structure are structured into learning sequences using epistemological ordering. A series or combination of such epistemologically ordered concepts is called a 'topological graph', considered to help teachers diagnose learning barriers and learner misconceptions.

Hwang (2003) presented a concept map called a 'concept effect graph'. The method, illustrated by an industrial case study, comprises six steps: 1) defining organizational knowledge, 2) process map analysis, 3) knowledge extraction, 4) knowledge profiling, 5) knowledge linking and 6) knowledge mapping validation. Relationships are modelled as prerequisites to be learned. The concept map from this research was used within an intelligent tutoring system to provide appropriate learner learning guidance and enhance learning performance. Figure 2 shows a sample concept map.

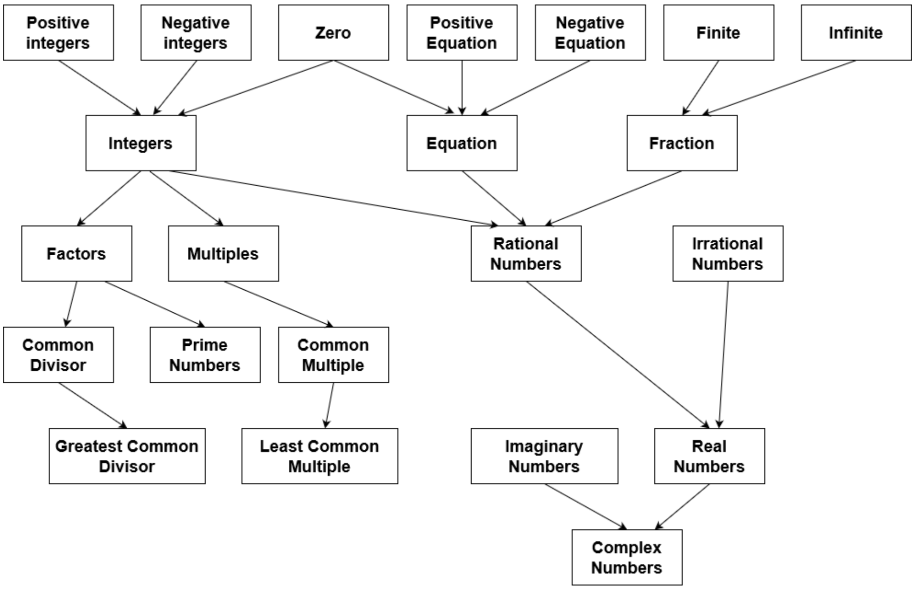

Figure 2: Sample Concept Effect Graph (Hwang, 2003)

Lee and Segev (2012) used data mining to automatically generate a knowledge mapping. This used the TF/IDF (Term Frequency-Inverse Document Frequency) algorithm that extracted keywords and then ranked pairs of keywords according to the number of appearances in the sentence and the document. The map was used to identify important ideas.

2.2 Knowledge Mapping Use

Knowledge mapping has been used for educational purposes. Zhu et al. (2018) proposed a learning path recommendation algorithm based on a knowledge mapping, where the paths helped learners to identify their learning needs and improve their learning efficiency. Li et al. (2020) constructed a knowledge mapping to help users navigate Q&A documents and reduce their information overload during the Q&A browsing process. Results showed that the approach was feasible and the knowledge mapping performed well in helping the users. Shaw (2017) studied the effectiveness of different knowledge mapping construction methods in the domain of programming language learning. The results suggested that different methods used with different learning styles significantly increased learning satisfaction (Shaw, 2017). Huang et al. (2018) proposed a knowledge mapping incorporating a learning log, exercise difficulty level, and learner ability. The map was used to personalize and recommend learning materials and guide teachers' observation of students' learning (Huang et al., 2018). El-bishouty, Ogata and Yano (2006) implemented a personalized knowledge awareness map (PerkamII) which allows the learners to share knowledge, interact, collaborate, and exchange individual experiences. The recommendations are given to learners via peer helpers according to learners' interests and current task.

Knowledge mapping has also been used in other domains. Woo et al. (2004) used experts' tacit knowledge in Architecture, Engineering and Construction (AEC) to develop a map which supported communication among experts. Kim, Suh and Hwang (2003) used a knowledge mapping to represent organizational knowledge and to transfer knowledge from experts to novices. Ong et al. (2005) presented the automatic generation of a hierarchical knowledge mapping based on online Chinese news in the domains of finance and health. Pyo (2005) developed a knowledge mapping in the domain of tourism, assisting users find destinations which matched their preferences and budgets.

2.3 Knowledge Mapping Based Learning Technology

Section 2.2 presented some uses of knowledge mapping within different research fields. Section 2.3 presented some research on the use of knowledge mapping for technology supported learning and teaching.

Shaw (Shaw, 2017) used the graphic tool IHMC Cmap (Cañas, Hill and Lott, 2003) for learners to design knowledge maps as an in-class activity. Cmap allows users to construct concept maps representing their understanding of a domain of knowledge, creating nodes and linking them to resources. Figure 3 shows a sample knowledge map.

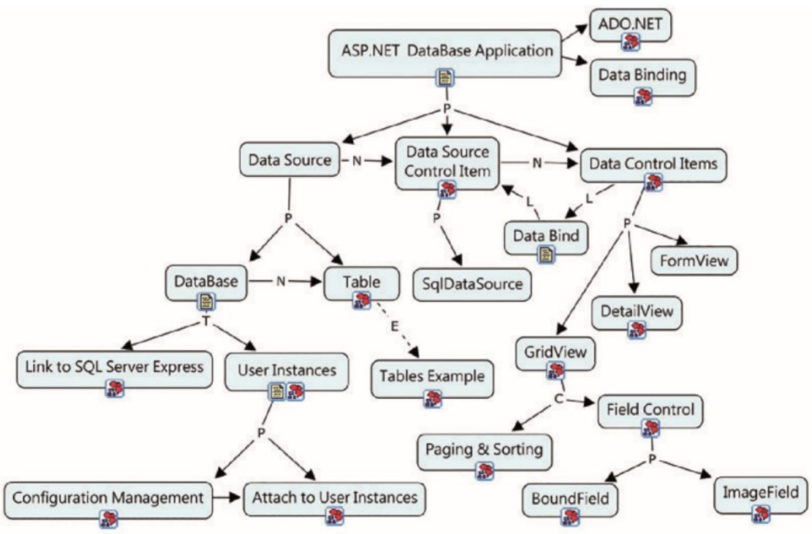

Figure 3: Sample Knowledge Mapping Created in CMap Tools (Shaw, 2017)

Lin et al. (2005) presented map-based knowledge management as a knowledge-sharing web-based platform for visualizing a project, helping users find needed knowledge more easily and effectively. This technology support helped users reuse knowledge maps from the knowledge bank repository database and present their knowledge maps more clearly, instead of relying on paper-based hand-drawn maps.

Kraker, Kittel and Enkhbayar (2016) introduced Open Knowledge mappings as a visual interface to scientific knowledge, providing an open-source software for individual and community knowledge mapping. Figure 4 shows sample of Open Knowledge maps interface when the search terms are "Web Technology". This interface consists of knowledge nodes and suggested links with metadata. However, there are no links connection between nodes provided or visualized.

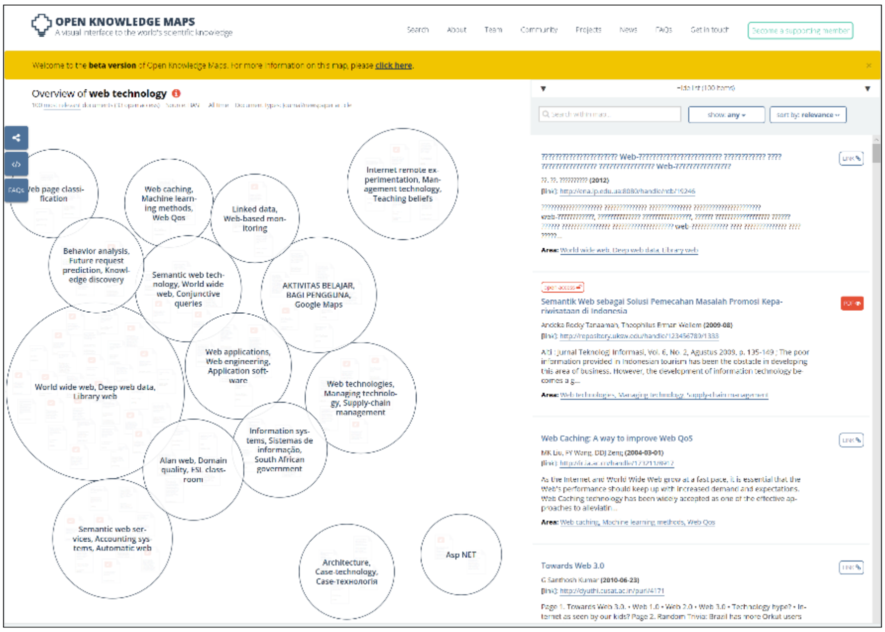

Figure 4: Interface of Open Knowledge mappings with Search Term "Web Technology"

(openknowledgemaps.org 2020)

Brewer (2009) described a knowledge map as a visual aid that showed where knowledge can be found, and developed a prototype called Mindmanager to manage and share knowledge maps among users. This software used drag-and-drop, making maps easy to edit, change, or correct. The relationships were expressed as arrows. This software is, however, more a drawing tool than a knowledge mapping tool.

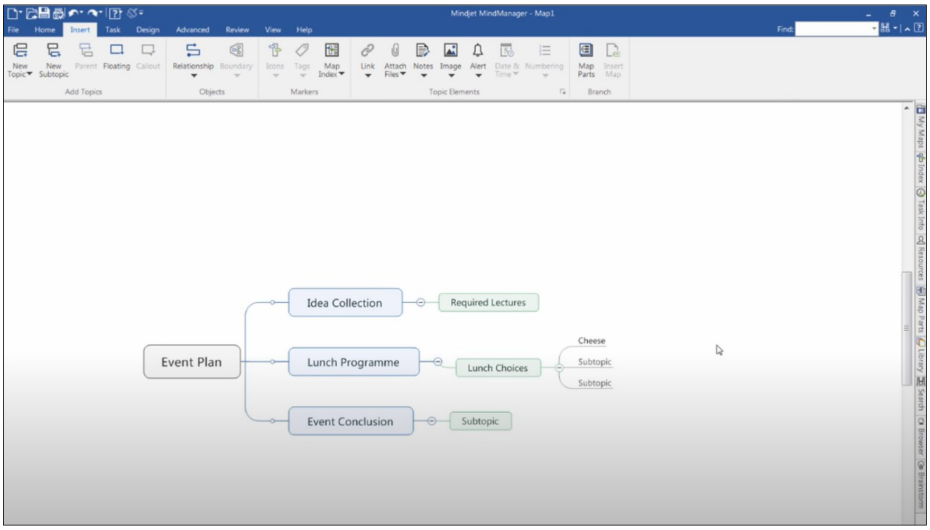

Figure 5: Interface of Mindmanager Showing a Knowledge Map of "Event Plan"

(Brewer, 2009)

Zheng et al. (2015) developed a computer-assisted knowledge mapping tool to analyze and measure knowledge elaboration. The tool automatically generated the relationships between new knowledge and prior knowledge and calculated the level of knowledge elaboration. Figure 6 shows a resulting knowledge mapping with generated relationships. Creating such knowledge mappings initially required the definition of all learning objectives and the coding of information flows.

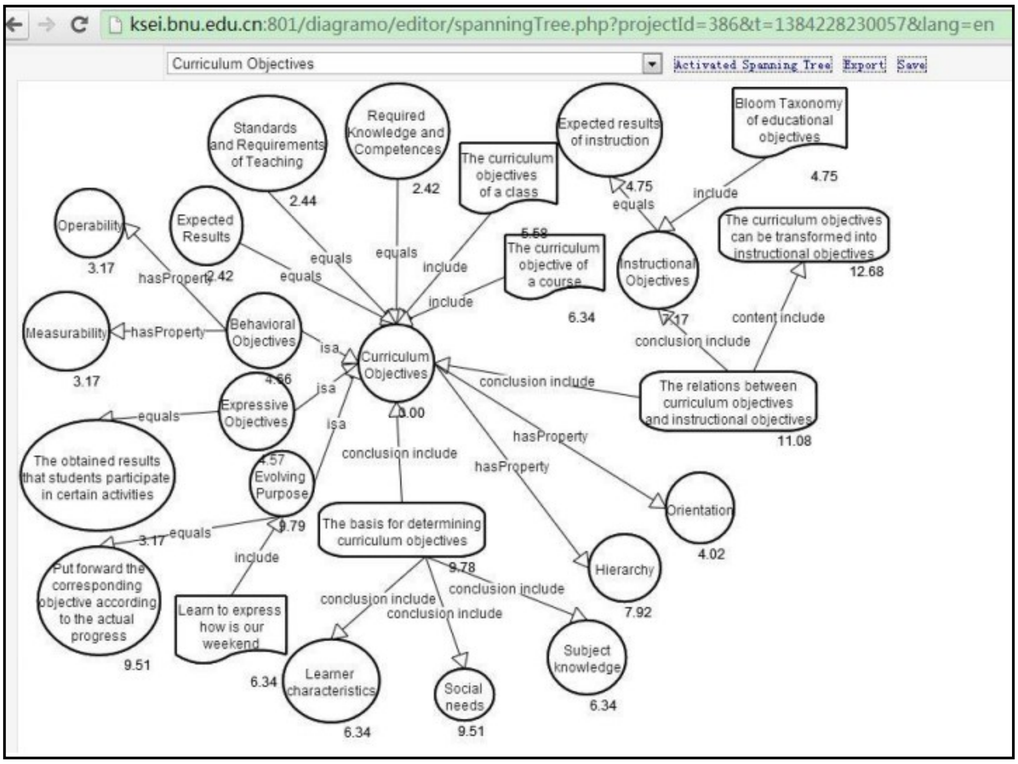

Figure 6: Interface of Computer-Assisted Knowledge mapping Tool (Zheng et al., 2015)

Other applications for creating and expressing knowledge mapping are Mindmeister (Anjomshoaa et al., 2010) and Knowledge mapper (Chung, Baker and Cheak, 2002), offering similar features to Mindmanager and Cmap tool. In our research, we propose Mytelemap tool which allows users to create their own knowledge mappings, link to learning materials, and review learning paths. Mytelemap prototype will be discussed in next section. This variety of applications is summarised in Table 1.

Table 1: Comparison Table of Knowledge mapping Application

Knowledge mapping Application	Software	Web-based	Knowledge mapping Creation	Free	Learning Path	Suggested Materials	Pedagogical Approach
CMap Tool	✓		✓	✓			
Open Knowledge Maps		✓		✓		✓	
Mindmanager	✓		✓				
Mindmeister	✓		✓	✓			
Knowledge Mapper	✓		✓	✓			
Mytelemap		✓	✓	✓	✓	✓	✓

From the lists of application in visualizing and managing knowledge map mentioned in this section, most help learners in visualizing and serving as the knowledge map repository. When we consider the context of learning and teaching, none of them are based upon a pedagogically informed approach to knowledge in such a context.

3. Learning Through Contextualization

3.1 Contextualization Definition

The literature discusses various aspects of context, though this concept is still not well defined. De Jong (2007) specifies the idea of context as identity, location, time, environment, and relation. Sampson and Fytros (2008) define context as job, occupations, function, life outcome, situation and task. Most classifications of context relate to context-aware computing and consider matters such as the location of users (Dey, 2001, Abowd et al., 1999) and the collection of nearby people, hosts, and accessible devices, as well as the changes to such matters over time (Schilit, Adams and Want, 1994). The three important aspects of context are where user is, who the user is, and what resources are nearby (Schilit, Adams and Want, 1994).

3.2 Contextualization Approach in Learning

Schmidt and Winterhalter (2004) defined context as the working environment, workflow system, human resources system, web browser, office application, and custom application. They also defined the context considered within the learning environment as the learning history, role of learners, and desired skills. This is similar to the definition given by Jovanović et al. (2007), who defined the context as the learning situation which includes the learner's experiences, skills, and competences. The learning context can also be learner preferences as learning styles, goals, motivation and learning time. Nabeth, Angehrn and Balkrishnan (2004) identified three contextual dimensions: educational, relating to situated learning (cognitive, social, and experiential); organizational, related to the particular characteristics and needs of an organization; and individual, connected to the specific characteristics of individual learners.

Learning systems able to provide adaptive support according to users' location are called context-aware ubiquitous (Hwang, Tsai, and Yang, 2008). Mobile learning and ubiquitous learning are related, where mobile learning concerns the general use of mobile devices in learning with little consideration of context, while ubiquitous learning concerns the use of context (such as time and location, which can be obtained from a mobile device) in the provision of adaptive support. Context-aware ubiquitous learning has been applied within different learning domain, for example Wu et al. (2012) developed a context-aware mobile learning system for nursing training course. This study used the sensing devices and mobile phones to detect locations in a dummy patient's body for assessing related specified diseases.

Muntean and Muntean (2009) propose Performance-based E-learning Adaptive Cost-efficient Open Corpus frameworK (PEACOCK), a ubiquitous e-learning environment that provides a meeting place for content providers and e-learners. PEACOCK considers the learners' e-learning experience and increases their learning satisfaction by selecting and providing e-learning content that best matches their expectations given existing cost, device, and network constraints.

In our research, we consider a conceptual model of "knowledge" as a contextualized competence as shown in Figure 7. In our previous research in proposing a tool for constructing a knowledge mapping (Nitchot, Wettayaprasit and Gilbert, 2019), only the subject matter of the map is concerned. This research adds contextualization data to the map representation, being the contextual factors, which are inherent in practical educational and training applications. For example, consider the competence of a computer science student to write HTML code using an online simulator (e.g. Codepen.io) or an offline text editor (e.g. Notepad); the output produced, and their associated ability, will be different and context-dependent.

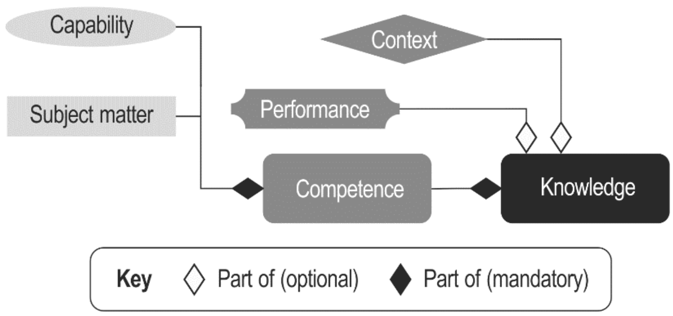

Figure 7: Conceptual Model of "Knowledge" as a Contextualized Competence

In our research, we identify contexts as, at the least, the situation, the resources, and the tools involved or required for the knowledge to be effectively demonstrated. We separate performance elements from contextual elements since they may vary within similar contexts, and note they are generally used when knowledge must be evidenced by way of certification or qualification, or recorded, perhaps in a personal portfolio or a personal resumé. These are illustrated in Figure 8.

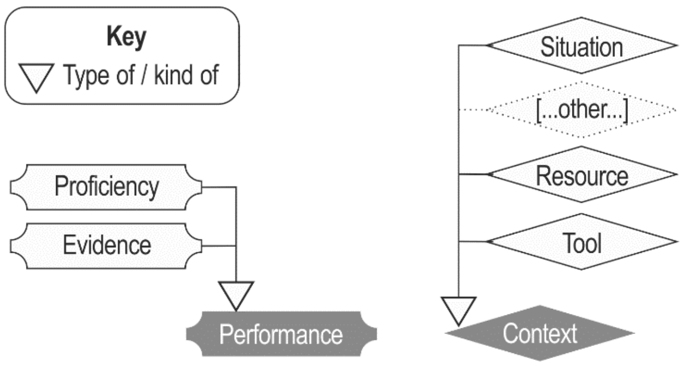

Figure 8: Some Context and Performance Elements of Knowledge

4. Mytelemap

4.1 Overview

Mytelemap is a web-based technology assisted learning and implemented to use the function of learning knowledge mapping for learners. This prototype was built to visualize the knowledge mapping from the graph visualization libraries (Ellson et al., 2004) and offering the study links based upon Google API service. In the first stage of implementation which described in Nitchot, Wettayaprasit and Gilbert (2019), there are features under consideration as link recommendations, learning paths, missing prerequisite service and learning resources management (as highlighted in red in figure 9). Linked learning recommendations were generated using Google API services given keywords from the knowledge map. There were two experiments conducted in the first stage. First experiment was conducted to test the overall satisfaction by the users and they felt satisfaction in using Mytelemap in general (Nitchot, Wettayaprasit and Gilbert, 2019). Second experiment compared the learning outcomes of learners using MyTeLeMap and using a free-browsing mode. The results showed that MyTeLeMap helped learners more than free browsing (Nitchot, Wettayaprasit and Gilbert, 2018).

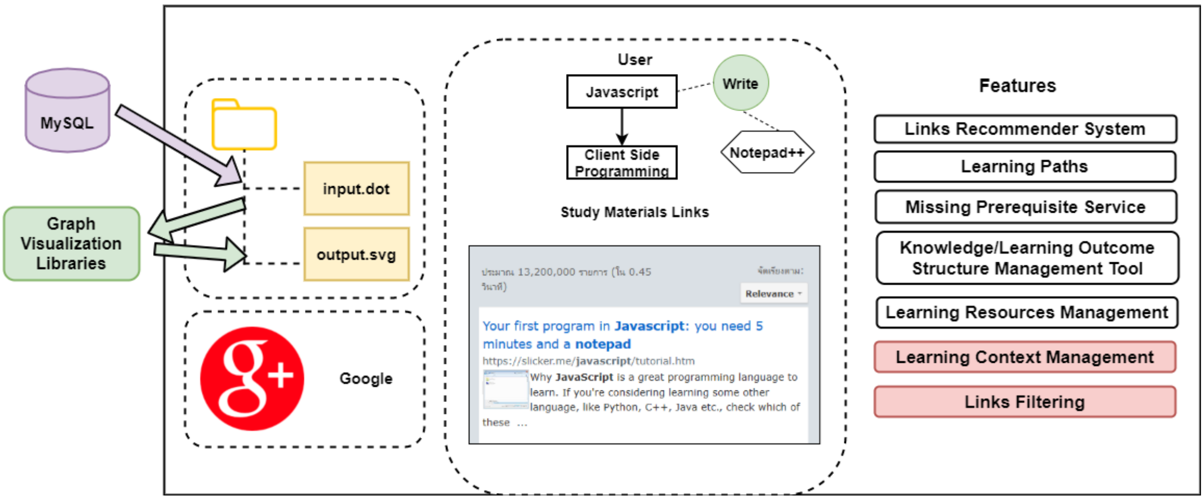

Figure 9: Architecture of Mytelemap System

4.2 Contextualization Feature

In second stage of Mytelemap implementation, the contextualization feature is concerned. As mentioned in section 3.2 about the importance of context considered within learner competence, our research adds contextualization data to the map representation, being the contextual factors, which are inherent in practical educational and training applications. For each node under one map, Mytelemap allow the map author create/mange learning outcome details (as shown in figure 10). In this sample, the map author has identified the learning outcome as 'Write JavaScript using notepad', where a capability is 'Write' and a context is 'Notepad' as shown in figure 11.

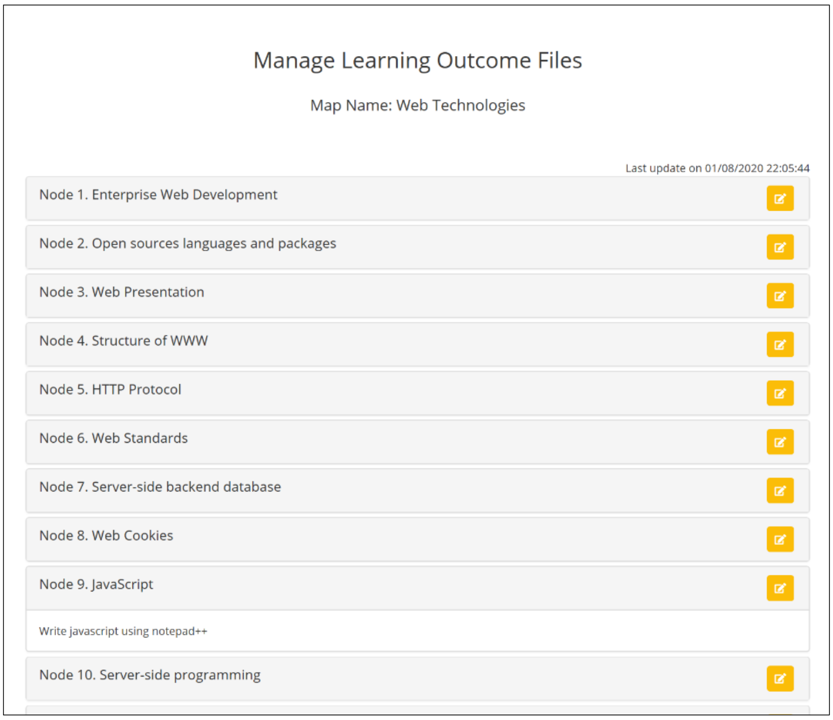

Figure 10: Mytelemap Page Showing a Page of Managing Learning Outcome Under One Map

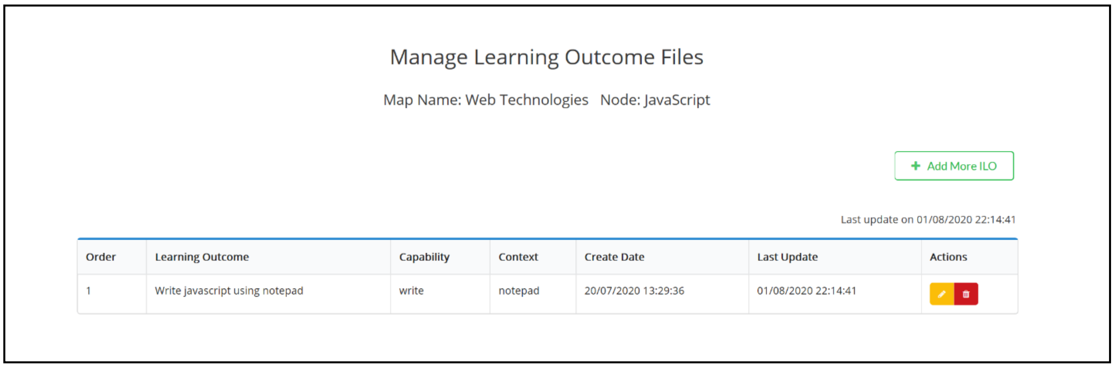

Figure 11: Mytelemap Page Showing a Page of Managing Learning Outcome Under Node ‘JavaScript’

The context is used to filter the learning recommendation links resulting from the Google API call. For example, Figure 12 shows a knowledge map domain, ‘Web Technologies’, with link recommendations based on the keyword ‘JavaScript’ from the node name and filtered with the context keyword ‘notepad’.

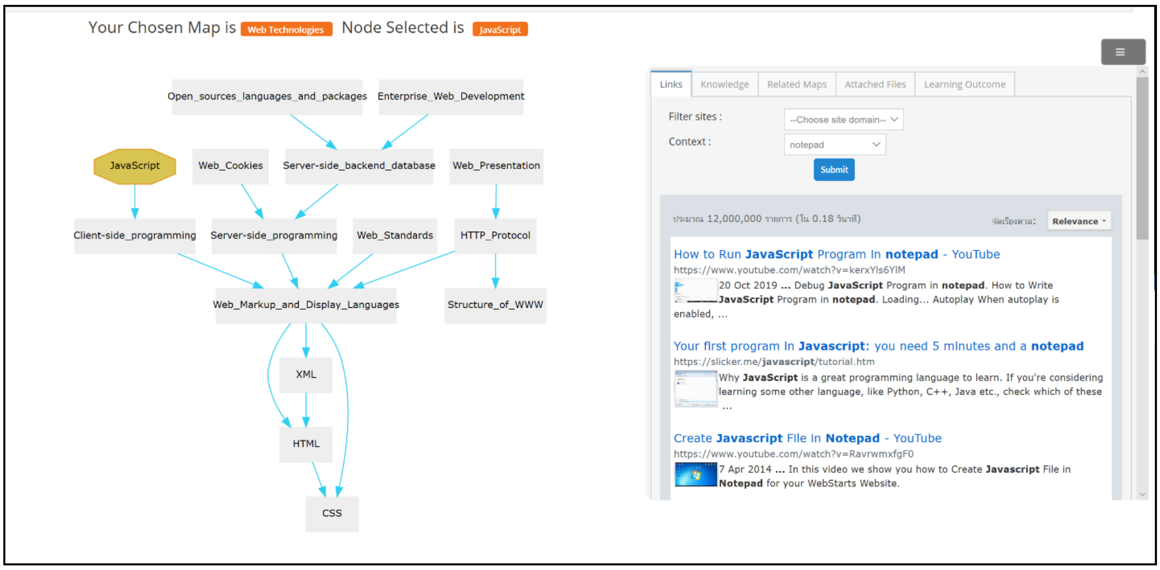

Figure 12: Mytelemap Page Showing the Web Technologies Map with Suggested Links for the JavaScript Node Filtered by the Context Term “Notepad”

5. Experimental Design and Results

5.1 Research Question and Experimental Design

The main research question in this study was “Does the use of knowledge mapping and Mytelemap correlate with performance on the final project?”. The research was granted ethical approval by the University’s Ethics Institutional Review Board under reference 2020-PSU-L-005. A sample size power analysis using GPower 3.1 (Faul et al., 2009) for a linear regression study with five predictors suggested that N = 20 would yield 90% power at the 5% level of significance in testing for R = 0.7 (R2 = 0.5). Accordingly, the 20 students enrolled in the Web Technology course (academic year 2020) at Prince of Songkla University International College were considered an adequate sample for detecting the relatively large effect size appropriate to this exploratory study, achieving adequate power at the conventional level of significance. A similar experiment (Rossi and Magni, 2017) explored the role of e-learning and of intellectual capital in value co-creation between the final user and the experimental team, mainly focusing on Italian participants in their investigation. At the start of the study, the participants provided their gender and GPA and their experiences of using ICT in learning in terms of the hours per week spent using different hardware (mobile, tablet/laptop, pc, etc) and their satisfaction ratings in using ICT compared with traditional tools (paper, pencil, pen). They were introduced to knowledge mapping and the use of Mytelemap as assisted learning tools.

During the study, participants used Mytelemap and knowledge mapping for four weeks in completing the course project, the development of a runnable website. Time stamps were recorded of logins and edits. At the end of the study, their knowledge maps were scored according to the number of subject matter nodes, capability verbs, and context tags, their projects were assessed and marked, and their opinions of knowledge mapping and Mytelemap tools were recorded in terms of intention to use, satisfaction, usefulness, and motivation.

Table 2: Descriptive Statistics Results (N=20)

Variable	Mean	Std. Deviation
Opinion against Mytelemap		
Intention to use Mytelemap	8.7	1.1
Satisfaction in using Mytelemap	8.3	1.3
Usefulness of Mytelemap	13.0	1.9
Motivation from using Mytelemap	8.2	1.1
Opinion against Knowledge mapping		
Intention to use Knowledge mapping	8.2	1.0
Satisfaction in using Knowledge mapping	8.6	1.1
Usefulness of Knowledge mapping	12.7	1.3
Motivation from using Knowledge mapping	8.2	1.4
Other variables		
On-line engagement	12.5	5.2
Knowledge mapping score	33.8	12.7
Project mark	139.4	18.3
GPA	3.3	.38
Number of hours in using ICT	81.3	15.3

Table 3: Questions for Opinion Ratings of Mytelemap and Knowledge mapping

Variable	Question
Intention to use	I intend to use [Mytelemap | knowledge mapping] to help me complete other assignments
	I intend to use [Mytelemap | knowledge mapping] to help my learning in other modules
Satisfaction	I feel satisfied with my overall experience of using [Mytelemap | knowledge mapping]
	My experience with using [Mytelemap | knowledge mapping] was better than I expected
Usefulness	Using [Mytelemap | knowledge mapping] improved the quality of my final projects
	Using [Mytelemap | knowledge mapping] enhanced my effectiveness in completing my final projects
	Using [Mytelemap | knowledge mapping] helped me visualize knowledge mappings better
Motivation	I felt motivated when using [Mytelemap | knowledge mapping]
	I enjoyed using [Mytelemap | knowledge mapping]

Table 2 shows the descriptive statistics of each variable. For the use of Mytelemap and knowledge mapping, ratings (intention to use, satisfaction, usefulness and motivation) were given on a Likert scale (Strongly agree – 5, Agree – 4, Neither agree nor disagree – 3, Disagree – 2, Strongly disagree – 1) as shown in Table 3. On-line engagement was derived from the time stamps (login count, map creation count, map modification count, node count, capability count, and context count). Knowledge mapping scores were from the number of ILOs identified, and their relevance, context, links, and labels.

The project involved the creation of a portfolio website and a WordPress website. Marks were given for proper installation, the use of themes, usability, accessibility, installed plugins, completion of the required site pages, extra features added. The number of hours per week in using ICT was the total from using ICT hardware (mobile tablet/laptop, pcm etc) in different study types (searching, reading/viewing, conversing/meeting, writing/recording notes, writing assignment, and sending/downloading files).

5.2 Results

The variables of Table 2 were entered as variables in a backwards regression (Field, 2000) where the dependent variable was Project mark and the remaining 12 variables (as described in Table 2) were predictors. As shown in Table 4, the only significant predictor was the Knowledge mapping score (adjusted $R^2 = 0.38$, beta = 0.64, $p = .002$).

Table 4: Coefficients Table When Dependent Variable is Project Mark

Variable	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	p
Knowledge mapping Score	0.92	0.26	0.64	3.55	0.002

Adjusted $R^2 = 0.38$

Because the correlations matrix for the variables of Table 2 showed a range of variables with significant correlations which did not appear as significant predictors, a second backwards regression was undertaken where the dependent variable was Knowledge mapping score and the remaining 11 variables (excluding Project mark) were predictors. As shown in Table 5, the only significant predictor of Knowledge mapping score was Online engagement (adjusted $R^2 = 0.62$, beta = 0.80, $p < .001$).

Table 5: Coefficients Table When Dependent Variable is Knowledge mapping Score

Variables	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	p
Online Engagement	1.95	0.35	0.80	5.64	<0.001

Adjusted $R^2 = 0.62$

Because both the correlations matrix for the variables of Table 2 showed a range of variables with significant correlations which did not appear as significant predictors, and the adjusted R^2 was higher in the second regression, a third backwards regression was undertaken where the dependent variable was Online engagement and the remaining 10 variables (excluding Project mark and Knowledge mapping score) were predictors. As shown in Table 6, there were five significant predictors of Online engagement (adjusted $R^2 = 0.59$).

Table 6: Coefficients Table When Dependent Variable is Online Engagement

Variables	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	p
Intention to use Mytelemap	-6.64	1.30	-1.44	-5.12	<0.05
Satisfaction in using Mytelemap	6.48	1.42	1.63	4.57	<0.05
Motivation in using Mytelemap	3.23	1.08	0.71	2.98	=0.01
Usefulness of Knowledge mapping	-5.74	1.28	-1.48	-4.48	<0.05
Number of hours in using ICT	-0.27	0.07	-0.78	-3.66	<0.05

Adjusted $R^2 = 0.59$

The significant predictors were Intention to use Mytelemap ($p < 0.05$), Satisfaction in using Mytelemap ($p < 0.05$), Motivation in using Mytelemap ($p < 0.05$), Usefulness of Knowledge mapping ($p < 0.05$), and Number of hours in using ICT ($p < 0.05$). Satisfaction in using Mytelemap and Motivation in using Mytelemap were significant positive predictors of engagement, while Intention to use Mytelemap, Usefulness of Knowledge mapping, and Number of hours in using ICT were significant negative predictors. These three predictors were suppressor variables (Lancaster, 1999).

5.3 Discussion

Academic performance was operationalized as the Project mark, and the explanatory path for identifying its correlates was particularly interesting. The regression of all independent predictor variables against Project mark was expected to show a set of usefully significant predictors; instead, only Knowledge mapping score was shown as a significant predictor of Project mark. This was unsurprising, because Knowledge mapping score was the measure of performance closest in time to the participants' delivery of their project, but it was also puzzling given that the correlation matrix showed numerous significant relationships between the other predictors and with Project mark. A regression of the independent variables against Knowledge mapping score was undertaken, with renewed expectation of a set of useful predictors; instead, only Engagement was shown as a significant predictor of Knowledge mapping score. As before, this made sense, because Engagement may be considered an important prerequisite to academic performance, but again it was puzzling that no other predictors were significant in this regression. A final analysis was undertaken where the remaining independent variables, located earlier on the path leading to academic performance (as shown by Knowledge mapping score and Project mark), were regressed against Engagement. The results revealed the reasons for the initially puzzling lack of a predictive relationship, in the form of three highly significant suppressor variables (Intention to use, Usefulness, and Hours spent with ICT) coupled with two highly significant positive predictors (Satisfaction and Motivation). The path to academic performance suggested by these results is shown in Figure 13.

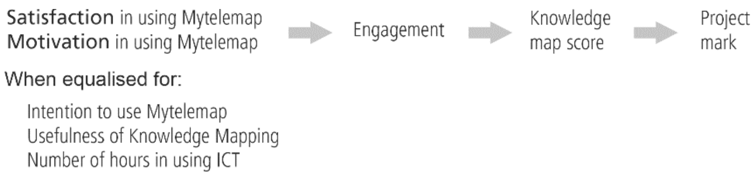

Figure 13: Explanatory Path for Academic Performance

6. Conclusion and Future Work

This research presents a conceptual model of pedagogically-informed knowledge as contextualized competences. This model adds contextualization data to the competence representation, allowing subject matter links to be more related to the learning context. The experiment suggested that satisfaction in using, and the motivation given by using the Mytelemap tool for knowledge mapping and visualization were significant predictors of engagement which was in turn the significant predictor of academic achievement. We hence conclude that the use of knowledge mapping and Mytelemap positively contributed to performance on the final project as mediated by learner engagement with the technology.

The experiment conducted was in the knowledge domain of web technology, where the academic contexts referred to tools used in developing web site prototypes in an undergraduate curriculum. However, there are some limitations of the knowledge domain explored and the number of participants considered within the experiment. Future work will investigate contextualized competences in different domains and different contexts, for example, training in the treatment of a poisoning incident.

Acknowledgement

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References

Abowd, G. D., Dey, A. K., Brown, P. J., Davies, N., Smith, M. and Steggles, P., 1999. Towards a Better Understanding of Context and Context-Awareness. *The 1st international symposium on Handheld and Ubiquitous Computing.* Karlsruhe, Germany: Springer-Verlag.

Anjomshoaa, A., Vo Sao, K., Tjoa, A. M., Weippl, E. and H, M., 2010. Context Oriented Analysis of Web 2.0 Social Network Contents - MindMeister Use-Case. *Intelligent Information and Database Systems*, Berlin, Heidelberg. Springer Berlin Heidelberg, pp. 180-189.

Brewer, L. J., 2009. Application Review of Mindjet Mindmanager Pro 7. *Journal of Technology in Human Services,* 27(2)**,** pp. 156-161.

Cañas, A. J., Hill, G. and Lott, J., 2003. Support for constructing knowledge models in CmapTools. *Technical Report No. IHMC CmapTools 2003-02*.

Chung, G. K., Baker, E. L. and Cheak, A. M., 2002. *Knowledge Mapper: Authoring System Prototype,* Center for the Study of Evaluation, National Center for Research on Evaluation, Standards, and Student Testing, Graduate School of Education & Information Studies, University of California, Los Angeles.

De jong, T., 2007. *Datamining context* [Online]. Available at: https://core.ac.uk/download/pdf/55534002.pdf [Accessed 15/6/2021].

Dey, A. K. 2001. Understanding and Using Context. *Personal Ubiquitous Computing,* 5(1)**,** pp. 4-7.

El-bishouty, M. M., Ogata, H. and Yano, Y., 2005. Learner-Space Knowledge Awareness Map in Computer Supported Ubiquitous Learning. 2006 Fourth IEEE International Workshop on Wireless, Mobile and Ubiquitous Technology in Education (WMTE'06), 16-17 November 2006. pp. 116-120.

Ellson, J., Gansner, E. R., Koutsofios, E., North, S. C. and Woodhull, G., 2004. Graphviz and Dynagraph -Static and Dynamic Graph Drawing Tools. *In:* JUNGER, M. & MUTZEL, P. (eds.) *Graph Drawing Software.* Berlin/Heidelberg, pp. 127-148.

Faul, F., Erdfelder, E., Buchner, A. and Lang, A.-G., 2009. Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods,* 41(4)**,** pp. 1149-1160.

Field, A., 2000. *Discovering statistics using SPSS.* London: SAGE publications.

Huang, N., Chen, C., T, J., Fang, T. T. and Lee, C., 2018. Concept Assessment System Integrated with a Knowledge Map Using Deep Learning. *2018 Learning With MOOCS (LWMOOCS)*, Madrid, Spain, 26-28 September 2018, pp. 113-116. IEEE.

Hwang, G.-J., 2003. A conceptual map model for developing intelligent tutoring systems. *Computers & Education,* 40(3)**,** pp. 217-235.

Hwang, G.-J., Tsai, C.-C. and Yang, S. J., 2008. Criteria, strategies and research issues of context-aware ubiquitous learning. *Journal of Educational Technology & Society,* 11(2)**,** pp. 81-91.

Jovanović , J., Gašević, D., Knight, C. and Richards, G., 2007. Ontologies for effective use of context in e-learning settings. *Journal of Educational Technology & Society,* 10(3)**,** pp. 47-59.

Kim, S., Suh, E. and Hwang, H., 2003. Building the knowledge map: an industrial case study. *Journal of Knowledge Management,* 7(2)**,** pp. 34-45.

Kraker, P., Kittel, C. andEnkhbayar, A., 2016. Open Knowledge Maps: Creating a Visual Interface to the World's Scientific Knowledge Based on Natural Language Processing. *027.7 Zeitschrift für Bibliothekskultur*, 4(2), pp. 98-103.

Lancaster, B. P., 1999. Defining and Interpreting Suppressor Effects: Advantages and Limitations.

Lee, C.-H., Lee, G.-G. and Leu, Y., 2009. Application of automatically constructed concept map of learning to conceptual diagnosis of e-learning. *Expert Systems with Applications,* 36(2)**,** pp. 1675-1684.

Lee, J. H. and Segev, A., 2012. Knowledge maps for e-learning. *Computers & Education,* 59(2)**,** pp. 353-364.

Li, M., Lu, X., Chen, L. and Wang, J., 2020. Knowledge map construction for question and answer archives. *Expert Systems with Applications,* 141.

Lin, Y.-C., Wang, L.-C., Tserng, H. P. and Jan, S.-H., 2005. Enhancing Knowledge and Experience Exchange through Construction Map-Based Knowledge Management System. *Construction Research Congress 2005*, pp. 1-10.

Muntean, C. H. and Muntean, G.-M., 2009. Open corpus architecture for personalised ubiquitous e-learning. *Personal and Ubiquitous Computing,* 13(3)**,** pp. 197-205.

Nabeth, T., Angehrn, A. A. and Balkrishnan, R., 2004. Integrating 'context' in e-learning systems design. *IEEE International Conference on Advanced Learning Technologies.* Joensuu, Finland, 30 August-1 September 2004 , pp. 355-359. IEEE.

Nitchot, A., Wettayaprasit, W. and Gilbert, L., 2018. Personalized learning system for visualizing knowledge structures and recommending study materials links. *E-Learning and Digital Media,* 16(1)**,** pp. 77-91.

Nitchot, A., Wettayaprasit, W. and Gilbert, L., 2019. Assistive tool for constructing knowledge structures and suggesting related study materials links. *Education Information Technologies,* 24(1)**,** pp. 219-230.

Novak, J. D. and Canas, A. J., 2006. The Theory Underlying Concept Maps and How to Construct Them. Pensacola, Florida, USA: Institute for Human and Machine Cognition.

ONG, T.-H., CHEN, H., SUNG, W.-K. and ZHU, B., 2005. Newsmap: a knowledge map for online news. *Decision Support Systems,* 39(4), pp. 583-597.

Openknowledgemaps.org, 2020. *Open Knowledge Map Official Website: A visual interface to the world's scientific knowledge* [Online]. Available at: https://openknowledgemaps.org/map/dbe307b00b6e04b2b883235c59436606 [Accessed 15/6/2021].

Pyo, S., 2005. Knowledge map for tourist destinations—needs and implications. *Tourism Management,* 26(4)**,** pp. 583-594.

Rossi, M. V. and Magni, D., 2017. Intellectual capital and value co-creation: an empirical analysis from a marketing perspective. *Electronic Journal of Knowledge Management*, 15(3), pp. 147-158.

Sampson, D. and Fytros, D., 2008. Competence Models in Technology-Enhanced Competence-Based Learning. *Handbook on Information Technologies for Education and Training.* Berlin, Germany: Spinger Berlin Heidelberg.

Schilit, B., Adams, N. and Want, R., 1994. Context-Aware Computing Applications. *1994 First Workshop on Mobile Computing Systems and Applications*, Santa Cruz, CA, USA, 8-9 December 1994. pp. 85-90. IEEE.

Schmidt, A. and Winterhalter, C., 2004. User context aware delivery of e-learning material: Approach and architecture. Journal of Universal Computer Science, 10(1)**,** pp. 28-36.

Shaw, R.-S., 2017. The Learning Performance of Different Knowledge Map Construction Methods and Learning Styles Moderation for Programming Language Learning. *Journal of Educational Computing Research,* 56(8)**,** pp. 1407-1429.

Sowa, J. F., 2000. *Knowledge representation : logical, philosophical, and computational foundations*, Pacific Grove, CA: Brooks/Cole.

Woo, J.-H., Clayton, M. J., Johnson, R. E., Flores, B. E. and Ellis, C., 2004. Dynamic Knowledge Map: reusing experts' tacit knowledge in the AEC industry. *Automation in Construction,* 13(2)**,** pp. 203-207.

Wu, P.-H., Hwang, G.-J., Su, L.-H. and Huang, Y.-M., 2012. A context-aware mobile learning system for supporting cognitive apprenticeships in nursing skills training. *Educational Technology & Society,* 15(1)**,** pp. 223-236.

Zheng, L., Huang, R., Hwang, G.-J. and Yang, K., 2015. Measuring knowledge elaboration based on a computer-assisted knowledge map analytical approach to collaborative learning. *Journal of Educational Technology & Society,* 18(1)**,** pp. 321-336.

Zhu, H., Tian, F., Wu, K., Shah, N., Chen, Y., Ni, Y., Zhang, X., Chao, K.-M. and Zheng, Q., 2018. A multi-constraint learning path recommendation algorithm based on knowledge map. 143**,** pp. 102-114.

Drawing as an Academic Dialogue Tool for Developing Digital Learning Designs in Higher Education

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Abstract: This paper reports on how drawing as an academic dialogue tool was explored as a crucial actor for driving design processes among humanistic master's students targeting their digital learning designs for online and blended learning contexts. The paper builds on a previous study that investigated students' use of self-produced visualisations during the digital design process. Although the study did not deal with visualisation and students were not trained to draw, the participants made extensive but unacknowledged use of visualisations. In the present study, a new group of students from the same master's programme were taught how to draw as a central component of the design process in order to investigate how this might expand their use of visual facilitation and drawing techniques to drive collaborative processes, design decisions and theoretical reflections. As design practices enter new interdisciplinary domains, in this case digital learning design, the aim was to explore how humanistic students can act as digital designers by adapting different design approaches and visual methods in particular. Likewise, the study offers an investigation of how students perceive these ways of working in an academic context. The empirical data, including teaching observations, students' visual productions and interviews with 27 students from nine groups after completing the course, were drawn primarily from an explorative case study in which master's students developed digital learning designs to solve a problem framed by an external stakeholder. Students' ways of producing visualisations in the different phases of their design process were analysed in terms of four design genres (explorative, investigative, explanatory and persuasive). The sociomaterial analysis traced how drawings and drawing activities unfolded during collaborative group processes which supported the development of digital learning designs. The findings confirmed the potential of drawing as a means for developing ideas, collaborating in different design phases and presenting and discussing design ideas with peers, target groups and external stakeholders. Furthermore, the findings revealed that drawing activities became a significant pedagogical consideration in the students' digital learning design and data collection process, where students balanced the interplay between initial analogue drawings and digital prototyping, testing their design concepts with target groups. The findings also showed that students perceived drawing and visual facilitation as practical tools but lacked an academic terminology for articulating these processes. The study suggests a need for substantial change to fully acknowledge the potential of drawing as an academic dialogue tool on the level with academic reading and writing when developing digital artefacts.

Keywords: visual facilitation, drawing as an academic dialogue tool, collaboration, digital learning design, higher education

1. Introduction

Western culture has consistently privileged the spoken and written word as the highest form of intellectual practice while regarding visual representations as second-rate illustrations of ideas (Mirzoeff, 2000; Bowen and Evans, 2015). Nevertheless, all scientific disciplines employ visualisations, and each discipline is characterised by a visual culture (e.g. Pauwels, 2006). For designers and architects, the act of drawing or 'sketching' is a familiar element of the iterative process of developing design products (Goldschmidt, 2003). Sketches are used both to reflect on and discuss ideas in design groups and when presenting design ideas to others (e.g. Schön, 1983; Tversky and Suwa, 2009). Within product design, sketches are also used to address and discuss users' experiences with digital products (Buxton, 2007). As design practices enter new interdisciplinary domains, such as learning design and communication design, researchers address the need for students to adapt concrete design methods when developing ideas (Hansen and Dalsgaard, 2012; Ejsing-Duun and Skovbjerg, 2019). When it comes to supporting the actual processes with learning how to design digital artefacts or processes, scholars of the humanities have tended to focus on texts and oral reflections on digital means and overlook the importance of the connected analogue means. Visual facilitation is one example of how drawing and visual methods are used to support group processes in organisations (e.g. Sibbet, 2008). They are based on the 1970s concept of *graphic facilitation* formulated by a group of organisational consultants in California (Qvist-Sørensen and Baastrup, 2020) who were inspired by how designers and architects utilise visualisations and sketching to present their ideas to clients (Sibbet, 2008). In the same way, visual facilitation can be understood as a point of entry to new organisational domains for design practices. However, little empirical research has been conducted on the use of visual facilitation as a formal learning method (Hautopp and Ørngreen, 2018).

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Other scholars have argued for the use of drawing and visual methods in education. Art Professor Betty Edwards (2012/1979) argued for teaching in drawing as an important part of our educational systems. Her work has received recognition within many fields, and her point of departure is neuropsychology, especially relating the act of drawing to Roger W. Sperry's work (1968) on brain hemispheres. Thus, teaching in drawing is mainly based on an individual cognitive argumentation on how our brain perceives and produces visualisations. In this paper, our focus is turned to the more *collaborative* aspect of using drawing in higher education as a crucial activity in designing digital artefacts. Visual facilitation involves the structured use of pen and paper methods to "facilitate interaction in a group of people, using structured visual content. It is a systematic way of *drawing together with others*" (Qvist-Sørensen and Baastrup, 2020, p. 20, our italics). Thus, in the field of visual facilitation, it is explicitly emphasised that the act of drawing should be accompanied with collaborative discussion among participants. As the visual facilitation has its origins in design, the teaching approach described in this paper draws on various design theories (e.g. Goldschmidt, 2003; Olofsson and Sjölen, 2007) and digital product design (Buxton, 2007). Furthermore, we refer to literature addressing both the term 'visual facilitation' and 'graphic facilitation', but use the term 'visual facilitation' to capture a broader definition of the field.

Previous studies of the use of visual methods in higher education in other domains of knowledge and practice (Gelting, Friis and Bang, 2015; Hyams, 2020; Hautopp and Ejsing-Duun, 2020) have shown that students from the design, architect and art fields benefit from using sketching and visual facilitation as academic practices, as these methods are familiar to them. The present study offers an investigation of the potential of visual facilitation among humanities students who were not familiar with drawing practices compared to design and art students. The inventive process of analogue drawings does not require wider skills: not necessarily a larger vocabulary or unlimited graphic techniques (Goldschmidt, 2003). Rather, what is required is an ability to use the representational act to reason and discuss design ideas (Goldschmidt, 2003; Buxton, 2007). Thus, we consider analogue drawings as an appropriate threshold for humanistic students to begin working as designers in cross-disciplinary fields. However, we argue that *an introduction* to the visual methods is crucial for students to rediscover and consider working this way in academic contexts. The aim was to explore how teaching drawing and visual facilitation can empower humanities students as digital learning designers by adapting visual methods for group work.

The exploratory case study was conducted in the master's programme 'IT, Learning and Organisational Change' (hereafter ILOO) in the Faculty of Humanities at Aalborg University, Denmark. The ILOO master's programme addresses research, development and the implementation of digital learning designs in a range of organisational and educational settings. Thus, it can be digital learning designs targeting the contexts of e.g. e-learning, flipped classrooms, video conferencing and so forth. ILOO master's students typically have a bachelor degree in pedagogy, teaching or computer science. Thus, they are skilled within those areas, but are not specifically trained in using drawing in an academic context. The course chosen for the study, 'IT and Learning Design', teaches students the theories of digital learning and education (e.g. Beetham, 2013) as well as design theories and methods (e.g. Kolko, 2010). As important elements of the course, the students were taught sketching, drawing methods and visual facilitation techniques for use in the digital design processes. In his book "Teaching in a Digital Age", Bates (2019) argues that the most important part of both classroom- and online teaching is how we design the learning environment focusing on collaboration. In this exploratory case study, the students were tasked to take the role of learning designers developing digital learning designs targeting different collaborative learning environments for the contexts of e-learning and flipped classrooms. Inspired by Bates' (2019) suggestions for experimenting with new digital opportunities, the students were encouraged to incorporate a range of different media in their digital learning designs such as text, graphics, audio, video and animation. However, as new technologies are developed and incorporated into media systems, old formats and approaches are carried over from older to newer media (Bates, 2019, p. 205). Thus, we investigated how analogue drawing formats can lay a basic foundation for the students to work visually in new digital formats when developing digital learning designs.

2. Research design

The exploratory case study was built on a Design Based Research approach (hereafter DBR) which focusing on both understanding and developing learning contexts. DBR is based on iterative pragmatic perspectives where researchers design and redesign pedagogical interventions, testing these in natural teaching settings (Brown, 1992). The iterative design of these interventions is a key feature of the knowledge production and results of a research project (Anderson and Shattuck, 2012; Barab and Squire, 2004). Thus, in the following the iterative design of interventions in this exploratory case study is described.

The exploratory case study was built on a previous study with other students in the same ILOO Course (Buhl, 2018), which did not teach visual facilitation and drawing techniques. The previous study showed that the students performed both analogue and digital visual practices during their design processes, but after finishing the course, they struggled to recall their use of visualisation when developing ideas, design drafts and prototypes. For instance, they had difficulty explaining their actions between the emergence and selection of design ideas and were able to recall the actual practices documented in their report only when the interviewer persisted in requesting examples. The diversity of visualisations identified in the study supports earlier evidence from elementary school settings (Meyer, 2016) showing how digital media support new visual practices, prompting new uses and representations of existing materialities. That study exposed the limitations of students' ability to articulate and reflect on their own visualisation practices, which were nevertheless identified as learning resources at all phases of the design projects.

In the present study, the same master's course was selected, as the aim was to explore how teaching *visual facilitation and sketching* might enhance students' collaborative processes by directing students' attention to the material aspects of drawing practice as a driver for ideation, collaboration, design and prototyping. Thus, an explicit focus was on drawing practices to promote visualisations as a more active participant in the students' meaning-making processes. To study the impact of *teaching* visual facilitation and sketching, a redesign was made of the course (Barab and Squire, 2004): Two drawing workshops were added to the course where the students and the teacher practiced drawing exercises together. Participatory observations were conducted during the workshops together with photo documentation of the students' and the teacher's drawing processes (Cresswell, 2011). After finalising the course, group interviews were conducted to generate knowledge about the students' drawing experiences. From following the activities in the drawing workshops, it was possible to explore the implications of providing an intensive introduction to drawing as a pedagogical intervention (Brown, 1992) to extend existing oral, writing and digital practices within the humanities. Furthermore, we could investigate how students experienced this intervention and how they reflected on the impact from the intervention after having finalised the course.

As we worked iteratively with researching pedagogical interventions, the investigative process involved producing demonstrable design and changes at the local level and reflecting on the use in other contexts (Barab & Squire, 2004). Thus, the research approach is justified by the way the interventions worked in practice by providing a rich description of context, theory and interventions. Researchers within DBR argue that the rich documentation of interventions provides the readers of the research with a foundation to judge for themselves the possibility of achieving similar—or even better results—from the use of the interventions in their own contexts (Anderson and Shattuck, 2012, p. 17). In the analysis, we aim to give a rich and visual description of empirical examples discussed in relation to theories. Thus, the analysis address practice based consequences of the students' use of visual methods when developing digital learning designs for other educational researchers to judge the use of drawing interventions in their own contexts.

In the next section, the pedagogical intervention revolving the two drawing workshop is presented to give a rich introduction to the teaching context (Barab and Squire, 2004) as a point of departure for analyzing the students' reflective use of visual methods when developing digital learning designs.

2.1 Pedagogical intervention: Drawing workshops

The intervention was implemented during the 8-week course 'IT and Learning Design', in which groups of master's students were tasked to develop a digital learning design based on cases provided by external stakeholders. The work was organised as a design-based research process (e.g. Barab and Squire, 2004), involving iterations that included context research, design development, digital experiments and interventions, as well as theoretical reflection and documentation.

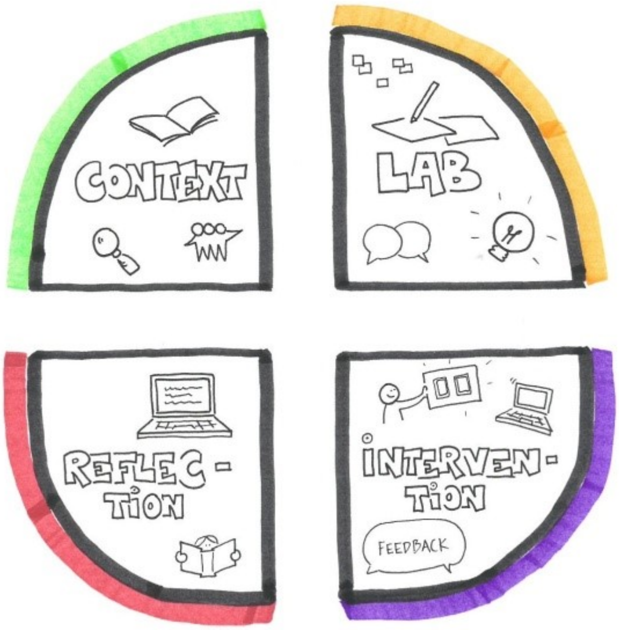

Figure 1: Visual presentation of the four phases in Design-based research (Hautopp and Buhl, 2020)

Thus, the course structure emphasised practice and theoretical knowledge generation as intertwined activities based on the logic of a design process (Buhl, 2016). Seventy students were enrolled in the course at the University's Aalborg and Copenhagen campuses. The drawing exercises were recorded by a document camera and live-projected to a wide screen and through video-conferencing systems at both campuses. To equip the students with tools for the different phases of the design-based research process, the intervention included two workshops introducing the students to *visual facilitation* through drawing exercises, design theories and feedback sessions. The first workshop focused on initial *idea generation* (Schön, 1983; Goldschmidt, 2003; Tversky and Suwa, 2009), while the second workshop focused more on the *presentation* of design ideas (Qvist-Sørensen and Baastrup, 2020). The two workshop designs were based on Olofsson and Sjölen's (2007) mapping of four distinct design genres: *investigative, explorative, explanatory and persuasive.* These describe different modes of entry to the design process. The *investigative and explorative* genres are used to examine the design problem and to share design solutions within the design team. The *explanatory* genre is used to present and communicate a design concept to stakeholders outside the design team, and the *persuasive* genre relates to selling the concept in a marketing context (Vistisen, 2016). In the present study, the teaching intervention prompted students to use drawing in the different genres to gain hands-on experience as active participants by pragmatically testing and reflecting on the potentials and challenges of using visual methods in the design process.

Workshop 1: investigative and exploratory. At the outset, the phrase 'From head to paper—no need for fancy art' was used to emphasise that sketching and visual facilitation are about the act of developing, reflecting and communicating ideas rather than artistry (Valenzia and Adkins, 2009). As design proceeds from pragmatic ways of working (Hansen and Dalsgaard, 2012), the teacher first introduced drawing exercises involving the use of simple icons and elements to illustrate *people, places and processes*, using *speech, text, colours and effects* to highlight key words and elements (Qvist-Sørensen and Baastrup, 2020).

Figure 2: Wide-screen projection of teachers' hand drawings by document camera (left) and students' drawings (right)

Afterwards, the students were asked to *investigate* the design problem through drawings – first as a 10-minute individual assignment and then as a collaborative *explorative* exercise, in which they shared their drawings with each other and discussed ideas, potentials and barriers.

Workshop 2: explanatory and persuasive. As a point of departure, this workshop elaborated different theoretical perspectives on the use of drawings in educational settings, beginning with an introduction to visual facilitation (e.g. Sibbet, 2008) and how drawings and visual methods can be used for knowledge construction and representation (Bowen and Evans, 2015) in university teaching (Bang, Friis and Gelting, 2015). These theoretical concepts were combined with examples from the teacher's own empirical research and teaching in design and the humanities to show how drawings can be used as data collection tools for field notes (Causey, 2016) and interviews to elicit informants' visual imagery (Qvist-Sørensen and Baastrup, 2020). In the present study, the students were guided to use drawings in the different phases of their projects. After the presentation, they were prompted to draw more specific visuals related to aspects of their design problem (e.g. collaboration, digital devices, learning barriers and innovative and creative processes). In both workshops, the students were encouraged to offer feedback and to reflect on their hands-on drawing activities, relating these to the theories and methods of applying visual techniques in academic practices.

2.2 The teacher as a role model for 'actually' drawing

As our educational system has typically declined to use drawings as an acknowledged medium of learning after elementary school (Lyon, 2020), students in higher education may struggle to use drawings as they have unclear expectations of what is perceived as 'good', 'bad', or 'artistic' drawings, for example. Likewise, students may perceive drawings as something 'childlike' or 'childish' (Lyon, 2020, p. 5) due to the socio-cultural environment where they only associate the act of drawing with their childhood and elementary school. Opposite to students' experiences, we wanted to introduce drawing as a collaborative practice and as a crucial actor for designing digital artefacts. In this perspective, the teacher had an important task of being a 'role model' *drawing* together with the students not focusing on 'artistic' drawing, but instead directing drawings to the academic purposes of problem solving and collaboration (cf. the teacher's introduction phrase 'From head to paper — no need for fancy art', which was repeated throughout the course to minimize artistic expectations from the students). Frank and Madsen (2020) also expressed how the teacher's introduction to basic skills within visual facilitation slows down the pace and shows the *process of drawing* for the students to follow. In this paper, the teacher's use of a document camera and video conferencing made it possible for students across the two campuses to follow the drawing process while making their own basic drawings (see figure 2) as inspiration for implementing drawings in their further design processes. Thus, the workshops were not intended to deliver exact instructions for working with drawings, but to introduce a visual repertoire to develop students' skills and awareness regarding the use of visual methods as tools for design and collaboration in higher education. A further aim was to assess whether and how these drawing workshops would impact students' design activities during the rest of the course and to study drawing as an integrated part of digital designs.

2.3 From analogue drawings to digital prototypes

Buxton's (2007) book about sketching user experiences revolve around product design with an emphasis on products that have a dynamic behaviour due to the incorporation of embedded digital technology. Buxton argued for a more experience-oriented design approach instead of an object-oriented one. In the context of this exploratory case study, students were tasked to develop digital designs to spur and support learning experiences among a target group.

Despite the accessibility of analogue drawing techniques (Goldschmidt, 2003) it is emphasized that the act of drawing sketches requires practice (Buxton, 2007), but teachers' introduction of basic drawing techniques is seldom prioritized in education (Edwards, 2012; Lyon, 2020). In this paper, we focus on introducing non-designers –humanities students – to simple drawing techniques to give them a point of departure and inspiration to drawing their ideas in the initial design phases. The purpose of this 8-week course was not to educate them as full-blown designers, but to invite them to materializing their ideas in *designerly* ways (Hansen & Dalsgaard, 2012); that is, producing, reading and redesigning through analogue drawings entangled with digital experiments.

Based on Buxton work (2007), we argue that sketches and prototypes are both instantiations of the students' digital learning design concepts. However, sketches dominate the early ideation phases, whereas prototypes are more concentrated at the later stages where things are converging within the design funnel (Buxton, 2007, p.139). As Olofsson and Sjölen (2007) expressed, design development represents the interplay between different genres where sketches and prototypes serve different purposes. In this exploratory case study, the focus was mainly on the students' development of the digital learning design *concepts* with less focus on the related attributes of cost, timelines, quantity and disposability and so on. which typically are tested through prototypes as more constituted designs (Buxton, 2007). Thus, the empirical data revolves primarily around the initial design phases as a crucial starting point for creating digital learning designs. Hence, this involved the students' reflection about the introduction of drawing techniques as a tool for the early design phases supporting the students' ideations and discussions of digital learning designs. Therefore, to work experience-oriented with different digital media, the students firstly were introduced to analogue drawing techniques (Qvist-Sørensen and Baastrup, 2020) to drive their initial ideation and discussion of different digital opportunities (Bates, 2019) before concretising their ideas in digital prototypes (Buxton, 2007).

After the two drawing workshops, the students were asked to work with different types of digital prototypes to further develop their digital learning designs based on their analogue drawings. Some of their choices included the Marvel app programme, the Sketch programme and Adobe XD. The connection between the analogue drawings as a foundation for developing digital prototypes will be elaborated on in the analysis. Buxton emphasised how prototypes, but also sketches, enable iterative user involvement, participation and testing much earlier in the design process (Buxton, 2007, p. 143). Thus, the analysis will contain examples of how students use different kinds of visual materializations of their digital learning design concepts when testing their ideas with peers and target groups.

3. Theoretical framework

In this section, the theoretical point of departure is outlined in order to analyse and discuss drawing as an academic dialogue tool and to address how this visual practice becomes a part of social learning processes.

3.1 The social function of drawing in education

To challenge academic privilege of the spoken and written word (cf. Mirzoeff, 2000; Bowen and Evans, 2015) we elaborate on why drawing should be acknowledged as an academic tool when students collaborate and acquire new knowledge in higher education. We seek to outline the potential and the research in drawing related to education and how insights should be expanded across disciplines.

In her PhD project "Learning through drawings – investigation into Danish Architecture Education" Inger Louise Berling Hyams (2020) investigated what role drawing plays in architectural education. Drawing has a special role in design and architecture education, since much of the learning and transfer of knowledge passes through drawing rather than regular language (Goldschmidt, 2003; Twersky and Suwa, 2009; Hyams, 2020). Thus, architectural educational discipline can be characterized as a field where the act of drawing is a commonly used practice and can serve as inspiration for other educational domains.

As part of her PhD project, Hyams developed what she calls 'drawing epistemology' (Hyams, 2020, p. 196) which are linked to different historical paradigms of working within architectural education. Hyams explained that she puts 'drawing' first to emphasise that as an architect student, you achieve experiences *through* the act of drawing. Therefore, drawing is set before epistemology, rather than the more grammatically correct form of the 'epistemology of drawing', where epistemology comes first and not as a dependent of drawing. Here, Hyams also clarified the interrelation between the architect and the materials, defined by Donald Schön (1983) as the backtalk and dialogue with materials. Hyams' PhD project concentrated on architectural education and did not link the pedagogical considerations to other fields where particular drawing practices and the relation to thinking might be studied. However, our argument is that the concept of 'drawing epistemology' can be relevant to exploring within other disciplines in higher education.

Primarily, architectural drawings have an end goal of concrete buildings. Even though architects do not build buildings, they do drawings that are built for someone else (e.g. engineers and construction workers) to realise (Robbins, 1994, p.104). In this field, drawings have different functions ranging from abstract ideas to hard-line working drawings, which bridge different aspects of architectural practices (Robbins, 1994 in Hyams, 2020, p. 183). Based on Hyams' empirical work of interviewing architectural students, she concluded that students both see the drawings as an ongoing dialogue with their ideas (cf. Schön, 1983) and at the same time some students emphasise a purpose about that the drawing should be able to speak for themselves (Hyams, 2020, p. 184).

As we investigated the use of drawings when students worked with developing digital learning designs, the end goal was not merely concrete *buildings* (it might be an app or a website), but rather a suggestion for enhancing learning processes and collaboration processes. Thus, some kind of *process* is considered the end goal of the design process, where we consider *visual facilitation* as a relevant drawing genre for this purpose. Visual facilitation is not about depicting reality; instead, it is about representing ideas and icons in relation to other ideas illustrated on the basis of participants' contributions in the dialogue (Valenza and Adkins, 2009). Thus, the purpose of the drawings' self-communications is not as relevant, as drawings are always used and implemented in a dialogue surrounding the drawings (Qvist-Sørensen and Baastrup, 2020).

With their practice-based book *Draw to Learn* (2020), Nanna Frank and Anne Madsen made a teacher's guide for using graphic facilitation in educational settings. They take a point of departure in elementary school but wished to inspire anyone working with learning as a central part of their job. They emphasised the idea that in graphic facilitation, the use of drawings goes from being art or creative expression to becoming a strategic tool to *enhance communication* (Frank and Madsen, 2020). The visuals play an important role in the facilitation of complex contexts which are up for discussion with multiple stakeholders. Thus, the drawings are especially targeted to be a part of a dialogue centring on what the authors express as 'meaningful learning communities' (Frank and Madsen, chap. 1). The cases presented in the book are based on the authors' own experiences of using graphic facilitation, however, presented as fictional narratives. Thus, they present rich practice-based examples from elementary school, yet research is needed as well as examples from other educational contexts.

3.2 Drawing as an academic dialogue tool

In our study, broadening the educational contexts of where drawing practices are taught and being studied as a part of students' academic work was our aim – not least in the disciplines of digital design in the humanities that traditionally are oral and textual. Hyams' (2020) notion of 'drawing epistemology' was considered important in discussing the potential of drawing practices for learning. At the same time, when teaching of drawing was applied to the field of humanities, Frank and Madsen's (2020) notion of creating 'meaningful learning communities' became important to see *drawing as an academic dialogue tool*. Thus, we perceived visual facilitation as a systematic way of drawing together with others (Qvist-Sørensen and Baastrup, 2020) and as an academic driver (Hyams 2020) to enhance communication (Frank and Madsen, 2020) when students develop and present their digital learning design ideas (Olofsson and Sjölen, 2007; Buxton, 2007). As mentioned earlier, the basic drawing exercises were seen as an introduction to a visual repertoire to develop students' skills and awareness regarding the use of visual methods as an academic dialogue tool for design and collaboration in higher education. The social functions of the drawings are further elaborated upon in the next theoretical section.

3.3 Understanding drawing as social and material

As addressed above, our approach to drawing was an academic dialogue tool characterized by being social, communicative and process-related. Understanding the students' visual actions was seen as situations of emerging meaning-making in the social and material interactions with the actual drawing and in dialogue with peers. Thus, visualisation was investigated as part of a the social learning process in which drawings and other materialities – including digital materialities – served as agents of meaning-making. Some scholars (e.g. Fenwick and Landri, 2012) have argued that we must look beyond the dichotomy between human intentionality and non-human objects for a fuller understanding of learning processes. Latour's (2005) actor-network-theory (ANT) prompted some researchers (e.g. Meyer, 2016) to adopt a broader perspective on empirical learning situations as complexes of social and material agency. Fenwick et al. (2011) argued that ANT offers the potential to rethink existing practices and to reframe conventional views of pedagogical practices in the humanities. They contended that learning consists of social material processes involving both human and non-human agency in a continuous flow of events (e.g. schedules, digital access codes, desks, pencils, stories, chewing gum and electricity) that participate in meaning-making. Rather than separate objects in a classroom, these were seen as collections of patterns of materiality that change and interact with human energies. Materialities, such as textbooks, tablets, discourses and learning models, offer different forms for participation in learning for a while, and these practices will in time spread to other learning environments and then later disappear. In this way, learning emerges from a continuous social practice of materialities of 'doing', to which meaning is attributed. Fenwick and Landri proposed the term *hybrid assemblages* to describe 'the continuum of materials, ideas, symbols, desires, bodies, natural forces, etc. that are always active, always reconstituting themselves' (2012, p. 3). In the present study, these hybrid assemblages served as the context for the empirical analysis of visualisations and their role in the design processes, tracing how drawings interact as active participants in the process. From this perspective, teaching, drawings, digital prototyping and the students' acts of drawing are entangled in the hybrid assemblage that constitutes the design process, including reservations towards the status of drawing in academia and the humanities (e.g. Mirzoeff, 2000; Bowen and Evans, 2015) and may be ideas of a requested aesthetic and self-communicative product (e.g. Hyams 2020). Furthermore, the hybrid assemblage may contain ideas of a childish preschool activity (Lyon, 2020). Therefore, investigating drawing as an academic dialogue tool in group processes requires a theory that captures the social dimension of drawing for learning. Our framework incorporated Wenger's (2000) account of social learning, which emphasises that learning happens socially and is negotiated through collaborative processes. This approach enabled us to explore how the students in our study attributed meaning to drawings and the act of drawing in combination with their digital design experiences when we interviewed them after completing the course.

4. Analytical approach and empirical data

Our suggestion of drawing as an academic dialogue tool for meaning-making was based on insights from practices within the professional domains of drawing. Together with sociomaterial and social learning theory, this constituted the framework for analysing the empirical data. Social material theory suggests overcoming the dichotomy between the analogue and digital material by approaching both as entangled actors in the hybrid assemblages. Before presenting our data analysis, it is useful to briefly outline our approach to the empirical material. Visual research is not only *about* the visual but also involves working *through* visuals and visualisations (Pauwels, 2006). For example, while semiotic analysis and content analysis are primarily used to explore visual objects themselves, field research is more appropriate for studying practices, experiences and processes related to the creation and utilization of those objects (Pauwels and Mannay, 2020). By tracing the visualisations as participants in hybrid assemblages, the sociomaterial perspective adopted here primarily focused on the students' practices and experiences rather than any thorough analysis of the *visual artefacts* themselves (e.g. composition and aesthetic qualities). The analysis concentrates on what Pauwels and Mannay (2020) described as *production context* and *utilization context*, tracing the becoming of the drawing and its different uses as an artefact in the four design genres (cf. Olofsson and Sjölen, 2007; Pauwels and Mannay, 2020; Fenwick and Landri, 2012).

The empirical data included participatory observations during drawing exercises, post-course group interviews with 27 students from nine groups of 2–4 students and the visual products of the group design processes. The interview guide was designed and aligned with the *design based research* approach (Barab and Squire, 2004) as the overall structure of the course, inviting the students to reflect upon their design processes and use of visual facilitation and sketching throughout the different design phases. The interview guide was planned by the authors on the basis of their participatory observations of teaching (Cresswell, 2011) and students' visual productions. However, to encourage students to speak more freely about their experiences, the interviews were conducted by a research assistant. The interviews were video-recorded and afterwards analysed by the authors, drawing on thematic analysis (Braun and Clarke, 2006). The following themes were identified in the empirical data which will be elaborated, analysed and discussed in the next sections:

- Drawing used as a driver in students' collaborative group work and theoretical reflections
- The drawings' diverse material agency for students' empirical data collection
- The role of analogue drawings and digital prototypes in students' feedback sessions
- Students' perception of drawing as a new mode of academic work

As part of the DBR approach, we have described the pedagogical intervention where drawing techniques and design theories where introduced to the students in two workshops (Barab and Squire, 2004). The interviews with students function as the primary focus for the empirical analysis on how the students experienced and reflected on the use of these visual methods for meaning making in their collaborative design processes.

5. Analysis

5.1 Drawing used as a driver in students' collaborative group work and theoretical reflections

Echoing previous findings (Buhl, 2018), students talked about how drawings concretised their ideas and functioned as participants in the negotiation of meaning (Wenger, 2000): *'It seemed like we were talking about the same thing, but when we visualised it, it turned out that we were not. It was the tool that helped us'.* The drawings and the act of drawing also participated in group decision-making processes as the design elements became explicit: *'For each input, we talked about it and then sketched it. After it was sketched, one could see whether there was something wrong with it, or, well as soon as it was sketched, then one saw … if it was okay—does it work, or does it look confusing or stupid or something'.* In this way, the students entered an *exploratory* dialogue with the materials (Goldschmidt, 2003; Olofsson and Sjölen, 2007), exemplifying the complex social and material agency of collaborative group processes (Meyer, 2016).

Another group emphasised the importance of drawing *together*: '*We all had the idea, the same idea. But when it came down on paper we realised it was not the same idea. Through the act of drawing together, we acquired a joint understanding, all three of us. It meant a lot for us*'. Here, it can be argued how *through* the act of drawing *together* the students enhance their understanding and communication (Hyams, 2020; Frank and Madsen, 2020) of what seem to be a 'joint idea'. This group further elaborated on how the act of drawing became a significant actor in their idea development of a learning design app: '*Actually, in the beginning we only had ideas of the functions "spin" and "chair". We did not have the idea about "create", we only got that through drawing. Here, we became aware that something was missing* (in the app)'. In this example, the drawings led to new ideas and became an important part in the social negotiation processes (Fenwick and Landri, 2012). Furthermore, the empirical data showed how the students were able to discuss, for example, the technical functionalities in their digital learning designs. A group emphasised how the act of drawing made it possible to discuss details about their digital learning design: '*The drawings created an overview and made it possible to discuss details* (…) *When you make drawings, it becomes evident how many elements and processes which are actually necessary when developing an app*'. Another group explained how the quick drawings made the collaboration about the functions in the learning app more discussable: '*In the sketching phase, you can go into particularly details "Oh yes, we need a button there and what will be needed over here*?"'. Here the student was imitating a group dialogue around the digital learning design, and it can be argued that the quick drawings made it possible to discuss the relation between the digital functionalities and possible user experiences (Buxton, 2007) in different utilization phases (Pauwels and Mannay, 2020). The students' experiences indicated an acceptance of drawing as a meaningful actor, and the interviews reported that it helped to maintain the students' focus in negotiating the multiple aspects regarding, for example, the relation between digital elements and users' learning experiences.

Maintaining a focus on their own drawing experiences enabled the students to reflect on the possibilities of integrating drawings as a modality in developing their learning designs. One group described how they integrated experiences from their own drawing processes into a digital learning design to facilitate teaching about innovation in an online learning context. Their external case related to teacher education; the design question asked how student teachers could be supported when developing teaching materials for innovation. Emphasising the material aspect of learning (Fenwick and Landri, 2012), one student said: '*You can talk about innovation, but how might you make a design about it? How can we make a product that supports [the process* *of innovation]? In other words, we can talk about it, but how should it look visually?'.* The student explained how the group '*went through an innovative process*' in using sketching and visual facilitation, and they later included this in their design of an innovation app for others to use as part of their own learning process. In other words, this group used their own *production* of visuals to reflect on their target group's *utilization* phase (Pauwels and Mannay, 2020). The example show how students reflected on and applied their own experiences of drawing in developing a learning design, and it can be argued that the drawings also prompted pedagogical considerations (Beetham, 2013) when the students took on the role of learning designers.

5.2 The drawings' diverse material agency for students' empirical data collection

In this section, we describe how drawing materialities were traced from group processes to participant involvement in data collection, with examples of how students used their own experiences of visual facilitation in the data collection phase. As mentioned earlier in the drawing workshop, the students were encouraged to use drawing activities both as part of their design processes and for empirical research (e.g. Qvist-Sørensen and Baastrup, 2020). The interviews further revealed that some of the groups used drawing activities in their initial field work, thereby involving their target group in the collaborative design process. One group of students described how they used various digital and analogue means to design prototypes in the exploratory and investigative modes (Olofsson and Sjölen, 2007) and later included drawing as a social activity in their field studies to involve participants in idea generation for the purposes of data collection: '*We had a user participant workshop in which participants made some sketches that we worked on in the Sketch programme later the same day. We included their sketches so that participants could see the process as well*'.

During the process, the students moved between materialities, using hand drawings and the Sketch programme and switching between the four design genres (Olofsson and Sjölen, 2007), beginning with their own exploratory mode when preparing the workshop. Next, they invited participants to draw their ideas, leading later in the day to a more explanatory mode, where different ideas were presented and discussed using the Sketch programme.

From a sociomaterial perspective, the drawings' material agency can be seen as playing an important part in empirical knowledge creation. One student commented on the surprising insights they gained about the target group through the drawing exercises, as the drawing process opened a mutual space for reflection: *'I think that in every process shared with them, in every moment spent with them in a reflection space of some kind, there appeared some sort of groundbreaking new'*. For instance, the group initially thought about including gamification elements in their digital learning design, but the participants' drawings and the subsequent discussion made it clear that the focus should be on accessibility and social activities.

One group commented on the new insights they gained into the elements of their design during a user workshop: *'We found that there were icons we made for the prototype that they could click around in while some of the icons we had used had to be replaced because they sent a different signal'.* On that basis, the students adjusted the design to better suit the utilization context (Pauwels and Mannay, 2020). Another group reflected on how they integrated the participants' ideas in their final prototype*: 'From the physical sketches they made, we talked a lot about how we could include their ideas. (...) The logo we made—actually, one of the young ones from the club made the logo that we chose to take further'.* In this way, a participant's initial drawing achieved agency in the hybrid assemblage (Fenwick and Landri, 2012) that constituted the design concept targeted a blended learning context.

From a sociomaterial perspective, the drawings could be traced from the students' design processes to the participatory workshop, where the design ideas were developed and redesigned on the basis of participants' drawings and joint discussions. In this way, the drawings spread from one learning environment to another (Fenwick and Landri, 2012). In these processes, the student groups showed a flexible approach to the four design genres proposed by Olofsson and Sjölen (2007), with an increased focus on participants' experiences and feedback. This is also an example of how the students balanced the interplay between initial analogue drawings and digital prototyping in the Sketch programme, driving the design process from ideation to a more constituted design based on the participants' experiences (Buxton, 2007).

5.3 The role of analogue drawings and digital prototypes in students' feedback sessions

The above-mentioned examples show how students reflected on their own drawing experiences and how they related these to their development of digital learning designs and conducting data collection. Throughout the interviews, the students also elaborated on how the continuous peer feedback was an important driver for development in their design processes (e.g. feedback exercise from drawing workshop 2).

The visual materials were emphasised as an important actor of both driving the process and presenting ideas in the feedback sessions with other student groups and stakeholders, as the students in the different phases acquired new insights about their learning design (Fenwick and Landri, 2012; Wenger, 2000). One group explained how they went from one initial idea to another, which was largely reduced after a feedback session with fellow students and teachers. In that session, they went into explanatory mode (Olofsson and Sjölen, 2007) using their sketches as a dialogue tool (Frank and Madsen, 2020): '*My goodness, it was a large project. Our second prototype was huge and we could not explain it which we realised at the feedback seminar'.* Due to the experience of not being able to explain their design, the students realised that they had to narrow their focus to create a digital learning design which should inspire a meaningful learning community (Frank and Madsen, 2020). Another group also reflected on receiving feedback on their design ideas: '*It was when we presented our design ideas to another student group that we realised that our design needs to be understandable for others. We know our idea, we know how the app works, or at least it works for us, so it was quite interesting to see what others did not immediately understand*'. The feedback session enabled the students to discuss in more detail the utilization context of their digital learning design (Pauwels and Mannay, 2020), which supported the relation between the materialisation and the academic dialogue.

As the examples below will show, the students used different materialities when presenting their design ideas in the feedback sessions (e.g. analogue drawings as prototypes on paper, the Marvel app Programme, the Sketch Programme and Adobe XD). A group was observed showing how they produced and arranged different drawings as a prototype while presenting their work to the other student groups (opponent group) in a user test session. The user test showed that the drawings framed in a mobile telephone made the user experience explicit and easy for the test group to follow and comment on.

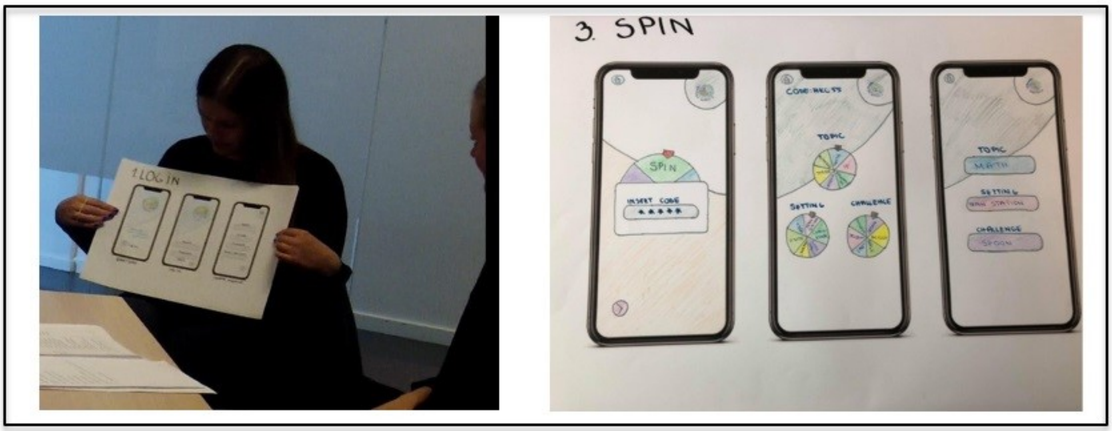

Figure 3: Students' prototype on paper showing a user experience of their digital learning design idea

The opponent group emphasised the following in their feedback: 'It was easy to follow your prototype on paper visualized as a mobile phone (…) I could easy follow from log-in to the different elements and activities in the app'. Another group had chosen to take the insights from their initial drawings phase and made it into a digital prototype in Adobe XD. Their opponent group emphasised the constituted format (Buxton, 2007) of the digital learning design: 'You have designed it very well; it looked like a real website and you explained it well. It was easy to follow your design ideas'. The opponent group addressed the fact that the students could press on the navigation buttons in the prototype in Adobe XD as "a dynamic experience".

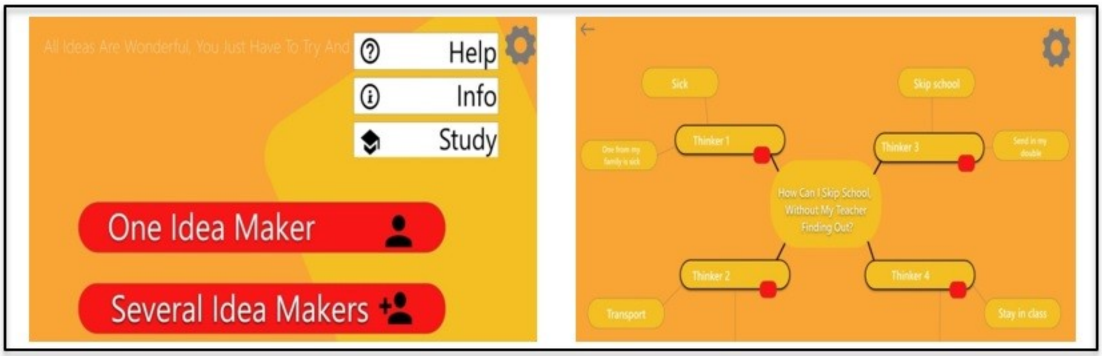

Figure 4: Students' prototype in Adobe XD showing a user experience of their digital learning design idea

The two groups had chosen differently when presenting their design ideas in the explanatory mode (Olofsson and Sjölen, 2007) and further discussed the different affordances of the modalities. Even though the dynamic character of the navigation in Adobe XD was appreciated, limitations were mentioned by the group who made the prototype, because '*you cannot do everything in a prototype programme*'. Moreover, the analogue drawings in the prototype on paper was emphasised as crucial to snow the user experience: '*Your layout with the mobile phone made the user experience evident of what will follow in the next phase*'. The student who had made the Adobe XD prototype explicitly expressed her reflection about the analogue format comparing it with the digital format: '*It think it works just as well as the digital format. I really liked that you have used drawings* (…) *I really enjoy drawing and I would like to become better*'. The above-mentioned dialogue showed the students reflections about working from the analogue drawings in the initial design phases to a more constituted design format in the presentation drawings (Qvist-Sørensen and Baastrup, 2020) and the digital prototypes (Buxton, 2007).

Several groups expressed their appreciation of starting in the basic drawings, which led to further development and concretization of their digital learning design concepts. One group elaborated on how the feedback sessions showed the diversity in digital design solutions among the student groups: '*It was pretty amazing to see how different our design ideas had turned out*' both in regard to the visual layout of the designs but also how the different student groups had solved the task framed by the external stakeholder. Another group elaborated: '*We have got a quite different perception of what the stakeholder needed compared to our opponent group. At the same time the designs have similarities because we still incorporated some of the same points* (in the design). *However, they are completely different; I find that enjoyable*'. The examples showed how the drawings and visual representations became a crucial actor (Fenwick, 2012) when presenting a variety of design solutions. Likewise, the interviews showed the students' reflective experimentation of different analogue and digital media (Bates, 2019). Some students furthermore expressed a wish for more introductions to the different programmes for producing digital prototypes in the explanatory phase (Olofsson and Sjölen, 2007), which could guide a more constituted design presentations (Buxton, 2007). Thus, further studies could have a more specific focus on the production of digital prototypes based on the initial analogue drawings.

5.4 Students' perception of drawing as a new mode of academic work

The final analytical section will revolve around the students' perceptions on drawing as an academic dialogue tool for developing digital learning designs. Several students confirmed observations during the drawing workshop that the taught drawing exercises were meaningful and applicable to their own design processes, as in this example: '*We implemented several things from the teaching, so I think, that this...I think it made a lot of sense'.* Others referred to how the drawings and visual facilitation guided their collaborative group processes: '*We realised that it was probably the lecture that was most beneficial...to guide us in the right direction and on the same path. It was simply an eye-opener as to how one could actually express one's ideas in another way'.* From a sociomaterial perspective, the quotes generally confirmed how the entanglement of teaching exercises, drawings and discussions (Fenwick and Landri, 2012) became meaningful as the students reflected on how the act of drawing supported their collaborative design processes.

Several groups also addressed how the use of drawing was a new way for them to do academic work even though they did not approach the drawing practice theoretically. One group reflected on how they used drawings throughout the design processes and how this tool has been beneficial to learn: '*We have used* *sketching a lot throughout the design process and we think it is a really great tool we have learnt.*' This group also emphasised how they used the drawing workshops as an important space for their design development and group discussions: '*Actually, we have used a part of the teaching to develop our design as we all did some sketching and then talked about our design*'. Three other groups explicitly mentioned how the drawing workshops helped them overcome the barriers of drawing. One student explained, '*In general the two teaching workshops about sketching, it was really good. Because I think many of us had barriers like "fuck, I cannot draw" and "how do we ever get to sketch something?" and then she (teacher's name) showed drawings super simple; that was just really good*'.

As well as providing basic drawing skills and a visual repertoire, the findings indicate that the workshops lowered the students' barriers for drawing in an academic context. Thus, the students' reservations towards drawing (Lyon, 2020) were met by introducing simple drawing techniques (Qvist-Sørensen and Baastrup, 2020; Frank and Madsen, 2020) and by inviting the students to further develop their own visual repertoire suiting their design processes.

When asked directly about whether sketching theories had been a part of the students' design consideration, several groups rejected that it had been a part of their processes. They explained the more practical function of drawing in their group processes: '*getting ideas down on paper*' and '*we probably used it more as a way to get clarity and insights about each other's understanding about the design ideas*'. Even though the drawing exercises in the workshops were combined with theoretical and methodological theories within the field of design and visual facilitation (e.g. Goldschmidt, 2003; Twersky and Suwa, 2009; Qvist-Sørensen and Baastrup, 2020), the students' comments indicated that these combinations were not present in their experiences of the course.

The findings show that students reflected on how drawing as an academic dialogue tool for developing digital learning designs can be beneficial for their group learning processes and their design processes. They acknowledged their initial barriers towards the act of drawing and found the teaching valuable for engaging in the drawing practice. Despite the introduction of theory supporting the visual methods, the students mostly considered drawing, sketching and visual facilitation as practical methods.

6. Discussion

Our findings confirm that teaching visual facilitation and recall of students' drawing experiences helps students to realise the potentials of visualisations for learning as well as to explain their actions and selection of design ideas. The very activity of drawing has the potential to stage processes in which presuppositions can be tested, rejected and replaced by an open mind to address actual problems and serves as a prompt and direct way to share initial ideas and flows. Furthermore, the findings show that the drawing activity is entangled with digital activities as the students balanced the interplay between initial analogue drawings and digital prototyping e.g. in the Sketch programme. Concretisation in the different design phases promoted clarity in the development of ideas, facilitated collaborative processes and supported idea generation and discussion that were tested and further developed in combination with digital prototyping. Based on the initial analogue drawing techniques, a more thorough focus on developing digital prototypes (Bates, 2019) integrating digital sketching tools (Buxton, 2007) is suggested as a future research scope within the humanities.

When asked, the students lacked the theoretical and methodological terminology to specify what their drawing experiences achieved, as they used common language to narrate their actions. However, these narrations drew on the richness and diversity of visual materiality in driving social learning processes forward. For more theoretical reflections on the use of drawings and visual facilitation in academic practice, it can be argued that visual methods should be assigned a more prominent position as material participants on an equal footing with other materialities. This includes an extended knowledge about the theoretical foundation of drawing, which the students had not achieved. A continuous and explicit focus on relating practical drawing activities with theories are crucial to develop a more acknowledged visual learning culture in higher education.

By enlisting drawing as the primary materiality in this sociomaterial framework, this study can be understood as an instance of hybrid assemblage including both analogue and digital materialities. Nevertheless, this approach was found to be productive to the extent that it required us to focus on the actions occurring between the students and the drawings as a valuable encounter between human and non-human actors. In the student interviews, it was demonstrated how the drawing processes drove the design processes and took the collaborative work with the target group in new directions.

These findings also suggest that teaching drawing and visual facilitation as a pedagogical intervention impacts learning outcomes. Despite a lack of emphasis on visual education in Danish schools (Rasmussen, 2017), the students engaged with the workshop exercises and were able to reflect on them. Even though the students were positive towards the use of visual methods throughout their digital design processes, the findings also confirmed that these approaches were unfamiliar based on their previous educational experiences. If visual teaching activities are not continued as an integral part of their future courses, it remains to be seen to what extent students will continue to use drawing as an academic dialogue tool for learning, as the programme does not formally assess visual competences. Thus, curriculum organizers and teachers play an important part in maintaining a focus on drawing as an academic dialogue tool across academic disciplines.

Finally, the study showed that drawing activities became a significant pedagogical consideration, as students seemed more likely to use drawings as a tool for digital learning design and for involving their target group in the participatory workshops. Their flexible use of different design genres (Olofsson and Sjölen, 2007) indicates an interesting direction for further studies of what emerges when design practices enter new interdisciplinary domains (Hansen and Dalsgaard, 2012). As the empirical data in this study were limited, the intention was not to generalise the findings to other settings, but to investigate these students' understanding and use of visual methods in their digital design processes. As mentioned earlier, the results from this the exploratory case study can function as inspiration for applying similar interventions and visual methods to new local contexts in higher education (Anderson and Shattuck, 2012).

7. Conclusion

This paper provides empirical examples of how academic practices in higher education can benefit from a combination of different design methods, visual facilitation and drawing techniques as a means of enhancing students' development of digital learning designs. The study results are suggestive for teachers and researchers teaching design methods to students in educational contexts. From a sociomaterial perspective, the analysis followed students' drawings and the act of drawing through collaborative design processes and showed how these had implications for meaning- and decision-making when designing digital artefacts targeted different online- and blended learning contexts. The paper offers an investigation of *drawing as an academic dialogue tool* when developing digital learning designs, which was seen as playing an important part in students' pedagogical considerations about digital learning designs and data collection. Here, students balanced the interplay between initial analogue drawings and digital prototyping, testing their design concepts with peers and target groups. The present study confirms that visual facilitation has the potential to provide valued and valuable learning experiences, but further research is needed to assess the long-term implications of teaching drawing techniques and visual facilitation in such contexts. To support this research, future teaching in higher education would need a substantial change to fully acknowledge the potential of drawing as an academic dialogue tool on the level with academic reading and writing. Not least in the light of a growing digitalisation involving a range of different media in higher education. In this paper, we have shown the interplay between students' analogue drawing and their development of digital learning designs. Future research could expand the field of how analog practice may enhance digital practice in academic learning in the Humanities.

References

Anderson, T. and Shattuck, J. 2012, Design Based Research: A Decade of Progress in Educational Research? *Educational Researcher*, Vol. 41 (1) pp 16–25 DOI: 10.3102/0013189X11428813

Barab, S. and Squire, K. 2004. Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences*, 13(1). p.1–14.

Bang, A.L., Gelting, A. K. G. and Friis, S. A. K., 2014. Designerly ways to theoretical insights: Visualisation as a means to explore, discuss and understand design theory. In: *Design Research Society Conference*. Umeå, Sweden, 2014. London: Design Research Society. Beetham, H. 2013. Designing for active learning in technology-rich contexts. In: H. Beetham and R. Sharpe, eds. *Rethinking pedagogy for a digital age. Designing for 21st century learning* (2nd ed.). New York: Routledge. pp 26–40.

Bates, T., 2019. Teaching in the digital age: Guidelines for designing teaching and learning. 2. Edition. Available through: https://pressbooks.bccampus.ca/teachinginadigitalagev2/ (Accessed: 29 June 2021)

Betty, E. 2012/1974. *Drawing on the right side of the brain* (4th ed.) New York: TarcherPerigee.

Bowen, T. and Ewans, M. 2015. What does knowledge look like? Drawing as a means of knowledge representation and knowledge construction. *Education for Information*, 31. pp 53–72.

Braun, V. and Clarke, V. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2). pp.77–101. DOI: 10.1191/1478088706qp063oa

Brown, A. 1992. Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of the Learning Sciences*, 2 (2) pp 141–178.

Buhl, M. 2016. Theory-Generating Practice: Proposing a principle for learning design. *Læring & Medier*, 15. pp 1–21.

Buhl, M. 2018. The role of visualizations for digital learning designs in collaborative group work. In I. A. Andreatos, C. Sgouropoulou and K. Ntalianis, eds. *Proceedings of the 17th European conference on e-learning ECEL 2018*. Reading, UK: Academic Conferences and Publishing International. pp.68–73.

Buxton, B. 2007. *Sketching user experiences – getting the design right and the right design.* Burlington, MA: Morgan Kaufmann, Elsevier.

Causey, A. 2016. *Drawn to see: Drawing as an ethnographic method*. Toronto: University of Toronto Press.

Cresswell, J. 2011. *Educational research. planning, conducting, an evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson Education.

Ejsing-Duun, S., & Skovbjerg, H. M. 2019. Design as a mode of inquiry in design pedagogy and design thinking. *The International Journal of Art & Design Education*, *38*(2). pp.445–460. https://doi.org/10.1111/jade.12214

Fenwick, T., Edwards, R. and Sawchuk, P. 2011. *Emerging approaches to educational research. Tracing the sociomaterial.* New York: Routledge.

Fenwick, T. and Landri, P. 2012. Materialities, textures and pedagogies: Socio-material assemblages in education. *Pedagogy, Culture & Society,* 20(1). pp.1–7.

Frank, N. and Madsen, A. 2020. *Draw to learn. A guide for teachers and leaders who aspire to create curious and collaborative learning cultures using Graphic Facilitation.* Copenhagen: Tools for Schools.

Goldschmidt, G. 2003. The backtalk of self-generated sketches. *Design Issues*, 19. pp.72–88.

Hansen, N.B. and Dalsgaard P. 2012. The Productive role of material design artefacts in participatory design events. In: *Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design* (NordiCHI '12), ACM, New York. pp.665–674.

Hautopp, H. and Ørngreen, R. 2018. A review of graphic facilitation in organizational and educational contexts. *Designs for Learning*, 10(1). pp.53–62. https://doi.org/10.16993/dfl.97

Hautopp, H., & Ejsing-Duun, S. 2020. Spaces of joint inquiry through visual facilitation and representations in higher education: An exploratory case study. *Electronic Journal of E-Learning*, *18*(5). pp.373-386.

Hautopp, H. & Buhl, M. 2020. Teaching visual facilitation and sketching for digital learning design in higher education. In: ECEL Conference. Available through: https://vbn.aau.dk/da/activities/presentation-of-paper-at-ecel-conference-teaching-visual-facilita (Accessed 28 February 2021)

Hyams, I. L. B. 2020. *Learning by drawing: Investigations into Danish architecture education*. Roskilde: Roskilde Universitetsforlag.

Kolko, J. 2010. Abductive thinking and sensemaking: The drivers of design synthesis. *Design Issues*, 26(1). pp.15–28.

Latour, B. 2005. *Reassembling the social: An introduction to actor-network theory.* Oxford: Oxford University Press.

Lyon, P. 2020. Using drawing in visual research: Materializing the invisible. In: L. Pauwels and D. Mannay eds. *The SAGE handbook of visual research methods.* London: SAGE. pp.297–308.

Mirzoeff, N. 2000. *An introduction to visual culture.* New York: Routledge.

Meyer, B. T. 2016. Mobile devices and spatial enactments of learning: iPads in lower secondary schools. In I. I. Arnedillo and P. Isaias, eds. *Proceedings of the 12th International Conference on Mobile Learning* (1 udg., Bind 1, s. 3–10), Washington, DC: International Association for Development.

Olofsson, E. and Sjölen, K. 2007. *Design sketching.* Stockholm: KEEOS Design Books AB.

Rasmussen, H. 2017. *Kompleks betydningsfremstilling i digitalt billedarbejde og billedæstetisk kompetenceudvikling i skolen* [Complex meaning-making in digital visual production and visual aesthetic competence development] [Doctoral dissertation, Aalborg University]. Aalborg University Press.

Sibbet, D. 2008. Visual intelligence: Using the deep patterns of visual language to build cognitive skills. *Theory Into Practice*, 47. pp.118–127.

Tversky, B. and Suwa, M. 2009. Thinking with sketches. In: A. Markmann and K. Wood, eds. *Tools for innovation*. Oxford: Oxford Scholarship Online.

Pauwels, L. and Mannay, D. 2020. *The Sage handbook of visual research methods*. London: SAGE.

Pauwels, L. (Ed.) (2006) *Visual cultures of science: Rethinking representational practices in knowledge building and science communication*, Hanover NH/London: Dartmouth*.*

Qvist-Sørensen, O. and Baastrup, L. 2020. *Visual collaboration. A powerful toolkit for improving meetings, projects, and processes.* New Jersey: John Wiley & Sons.

Robbins, E. 1994. *Why architects draw.* Cambridge, MA: Massachusetts Institute of Technology.

Schön, D. A. 1983. *The reflective practitioner: How professionals think in action*. London, UK: Temple.

Sperry, R.W. 1968. Hemisphere disconnection and unity in consciuos awareness. *American Psychologist,* 23. pp.723–733.

Valenza, C. and Adkins, J. 2009. Understanding visual thinking: The History and future of graphic facilitation. *ACM Interactions*, July and August. pp.39–45.

Vistisen, P. 2016. *Sketching with animation. Using Animation to portray fictional realities aimed at becoming factual*. Denmark: Aalborg University Press.

Wenger, E. 2000. *Communities of practice: Learning, meaning, and identity.* Cambridge: Cambridge University Press.

Digitally Assessing Text Comprehension in Grades 3-4: Test Development and Validation

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Abstract: A prerequisite for child reading support at school is adequate assessment. Embedding (repeated) assessment into daily teaching routine is often challenging for teachers in terms of time and organization. The use of digital tools can help teachers in the assessment process (in preparation, evaluation, documentation, etc.). A digital assessment tool (Graz Reading Comprehension test: GraLeV), focusing on assessing reading comprehension skills in Grades 3 and 4 is currently being developed in Austria. This reading assessment covers reading comprehension at the word, sentence, and text level. Text level is assessed via two subtests (Subtest I: presentation of nonsense-stories and corresponding questions, and Subtest II: maze selection). The other levels consist of one subtest each. This paper focusses on the subtests at text level. More specifically, the paper reports the results of two studies. Study 1 describes the development phases and the first piloting of these two subtests (data collection: 10/2019-12/2019). Testing 273 students with preliminary versions of the subtests (Subtest I: 30 items, Subtest II: 60 items) produced information on (a) item difficulty, (b) item discriminatory power, and (c) time limits for future speed testing. Items not meeting the required quality criteria were excluded. The final version of Subtest I consists of 16 questions referring to eight different, short, nonsense-texts. Its testing time (without instructions) is three minutes. The final version of the Subtest II consists of 2 texts each with 15 maze selections (30 items) and testing time is 100 seconds. The internal consistency is found to be good for Subtest I (α=.87) and Subtest II (α=.78 to .80). Study 2 reports on testing for validity and retest-reliability (data collection: 09/2020-11/2020). Student scores in another reading comprehension test, together with teacher assessments of reading comprehension, were used to assess congruent validity. Divergent validity was assessed using teacher assessments of mathematical and socio-emotional skills. As expected, the correlations with the congruent measures were higher than those with the divergent measures. A subsample was tested twice with the GraLeV. Retest-reliability was acceptable for Subtest II. However, the scores obtained at time 2 were higher compared to those at time 1 in both subtests. This is probably the result of increased student familiarity with the digital device and the digital test environment at time 2. The results are discussed in the light of teachers' needs for standardized digital assessments in order to facilitate the tailoring of student reading support.

Keywords: reading skills; text comprehension; digital assessment; test development; quality criteria

1. Introduction

In today's world, reading skills are essential for accessing various forms of media and for the independent acquisition of knowledge. It is therefore no surprise that schools place such a heavy focus on reading ability. Once basic reading skills are acquired, the focus shifts towards gaining speed and improving comprehension so that knowledge may more easily be acquired across all subjects (Chall, 1983). Thus, text comprehension is a crucial ability. As text comprehension remains an essential skill throughout life, it is imperative that students with potential reading difficulties receive timely and adequate support. When assessing student skills, it is frequently the case that teachers use subjective methods and personal judgement rather than rely on standardized tests (Artelt and Gräsel, 2009). This makes it hard to avoid teacher bias, and explains why numerous studies have attempted to measure the accuracy of teachers' judgments (i.e., how well teacher judgement correlates with results obtained in standardized tests). Südkamp, Kaiser and Möller (2012) found in their meta-analysis (including 75 studies) an overall correlation of 0.63 between teacher judgment and student achievement. With respect to reading skills, Paleczek, Seifert and Gasteiger-Klicpera (2017) have shown that certain aspects such as class size or student ability and background may have a negative influence on the accuracy of teachers' judgments. Using standardized tests regularly could therefore enhance judgment accuracy. Thus, in this context, the use of diagnostic procedures to regularly assess reading skills in a simple, straightforward manner during class time plays a crucial role. Such procedures not only aid teachers in identifying students with reading deficiencies, they also ease the regular checking of support measure success.

Some digital tools for assessing German reading skills are only available for purchase (e.g., ELFE II: Lenhard, Lenhard and Schneider, 2020; ProDi-L: Richter et al., 2017; VSL: Walter, 2013), and others (LEVUMI: Mühling and Gebhardt, 2021) are available for free. However, these open access tools are only rarely available in a standardized form. In this paper, we present two subtests from a new standardized, open access diagnostic tool, the Graz reading comprehension test (Grazer Leseverständnistest: GraLeV; Paleczek et al., in prep.). The GraLeV

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focuses on assessing reading skills in Grades 3 and 4. Since it is digital (tablet, notebook, PC), it provides an efficient means of assessing reading skills (with a pure test time of about 10 minutes). Four different subtests provide differentiated information on student reading skills at the word, sentence and text level. So far, the test has been conceptualized, developed, and digitalized, and has also gone through the initial piloting procedures necessary for assessing test quality criteria and usability.

The present paper focusses on the two subtests at the text level (Subtest I and II). First, the different methods for assessing reading comprehension (at text level) are introduced. Second, the advantages and drawbacks of digital assessments are described. We then report on the conception and construction of the digital reading test and follow this with details of study results. Study 1 reports on a piloting study in which we gained insight into (a) item difficulty, (b) item discriminatory power, (c) internal item consistency, and (d) resulting time limits. Study 2 describes subtest validity and reliability.

2. Assessing reading comprehension in primary school

Reading skills generally pertain to a person's ability to successfully cope with certain types of textual or reading-related demands (Artelt et al., 2007, p. 11). This involves various sub-processes of reading, some of which are automatic, and some of which are deliberately controlled (Graesser, Singer and Trabasso, 1994). For most children, the systematic acquisition of reading skills begins with school entry. Initially, basic reading skills (including decoding, reading comprehension at word and sentence level) are acquired. Then, increasingly complex reading and comprehension processes are trained (at the latest from Grade 4 onwards) while reading fluency and speed increase (Klicpera et al., 2017). In particular, the ability to understand texts when reading them is crucial to enabling learning from texts (Schnotz, 1994), a skill which is expected of students at the end of primary school. When reading texts comprehensively, it is necessary to interpret units of meaning across sentences and to establish local and global coherence (Richter and Christmann, 2009).

In primary school in German speaking countries, different test procedures are used to assess reading comprehension skills (for an overview: see Lenhard, 2013; Paleczek and Seifert, 2019). Teachers can use short diagnostic procedures to rapidly gain a rough overview of their class's reading status and to identify students with reading deficiencies (e.g., SLS 2-9: Mayringer and Wimmer, 2014). Some procedures are designed as formative assessment (e.g., VSL: Walter, 2013). Teachers may also use more comprehensive diagnostic tools to test various sub-processes of reading (and especially reading comprehension) (e.g., ELFE II: Lenhard, Lenhard and Schneider, 2020; HAMLET 3-4: Lehmann, Peek and Poerschke, 2006). Word, sentence and text level represent sub-processes and are often dealt with in such tests.

In order to monitor learning progress, teachers need simple procedures capable of measuring reading skills accurately (Guthrie et al., 1974). One way of doing this is to let students answer *questions about a text*. The difficulty of this task, however, varies according to question type (e.g. direct information extraction vs. inference extraction) and answer mode (yes-no questions vs. open questions) (Guthrie et al., 1974). In these procedures in German speaking countries, the answer mode is often a multiple-choice format (e.g., ELFE II: Lenhard, Lenhard and Schneider, 2020). Unfortunately, as students are often already familiar with entities addressed in the texts and questions (animals, plants etc.), their answers also reflect their background knowledge and may not be a pure measure of reading comprehension.

Another possibility of measuring text comprehension is the *maze procedure*, which is often mentioned and used in progress diagnostics of reading comprehension. The maze procedure is a universal means of screening in order to identify weak readers. This procedure has already been extensively tested, especially in English-speaking countries (for an overview: see Wayman et al., 2007). In such a procedure, students are asked to quietly read a section of a text within a certain time limit. In the text, at every seventh word, a target word must be identified out of three presented words (2 distractors, 1 target word). By setting a time limit, the maze procedure is a good way of measuring reading fluency or speed (Muijselaar et al., 2017). By increasing the level of distractor difficulty, the maze procedure can also capture reading comprehension (Conoyer et al., 2017). There are, however, limitations when it comes to measuring reading comprehension. Some researchers argue that the maze procedure assesses comprehension at the sentence rather than the text level (Gellert and Elbro, 2012). In German-language reading tests, the maze procedure is used, for example, in the VSL (Walter, 2013) for Grades 1 to 6.

3. Digital assessments in primary school

In order to provide each student with tailored support, and to regularly check on their learning progress in reading instruction, it is necessary to assess reading (sub-) abilities and individual learning. As this is all rather time consuming, teachers find it difficult to embed such assessment into their daily teaching routine. The use of digital testing procedures can thus support teachers in the diagnostic process, especially with respect to the preparation, implementation, evaluation, and documentation of assessments (Cheung and Slavin, 2012; Neumann et al., 2019). Students can then receive more rapid feedback, teachers save time in follow-up (Ehlers et al., 2013) and spend time on instruction rather than on testing and documentation (Gebhardt, Diehl and Mühling, 2016). Clearly, all such tools need to be easy to use (i.e., to exhibit high usability, as understood by Nielsen (1993)), and schools need to be adequately equipped (e.g., with tablets, reliable class internet, etc.), before such benefits can be realized.

To an increasing extent, standardized reading tests now offer a digital version in addition to the classic paper-and-pencil version. These digital versions facilitate or automate implementation and evaluation. In the area of German reading tests, for example, the ELFE II (Lenhard, Lenhard and Schneider, 2020) is one such hybrid procedure. There are also some tests that can only be performed digitally, such as the ProDi-L (Richter et al., 2017). While studies on these tests examined the scientific reliability and internal validity of the test instruments or looked at the mode effect (Lenhard, Schroeders and Lenhard, 2017; Richter et al., 2017), the question of usability (Nielson, 1993) was not dealt with. A well-designed interface enabling intuitive use is a clear prerequisite for any digital tools. Although usability studies, e.g., the aspect of testing for subjective user satisfaction, have only rarely been part of the educators' research tradition, they have recently become more common in the evaluation of German digital assessment tools. For example, studies have generally shown that digital tests have been very well accepted by primary school teachers (Förster and Souvignier, 2014). For a digital maths tool, Blumenthal and Blumenthal (2020) analysed German fourth graders' opinions on print and digital modes of testing. They state that students found digital testing to be more motivating than testing in print form, and that students perceived digital tests as being faster and easier (although this perception was not corroborated by the test data). Similarly, preferences for digital mode were revealed in assessing vocabulary skills in kindergarten children (Paleczek, Seifert and Schöfl, 2021).

While digital test possibilities appear promising, several variables still require particular attention. For example, not all teachers are used to using digital devices in their lessons (Brandhofer, 2015), and many teachers do not feel competent enough to guide students in their use (Schaumburg, 2015). Student digital competence also needs to be considered. Elementary school students, in particular, often do not have the skills needed to deal with a digital device on their own (Medienpädagogischer Forschungsverband Südwest, 2018). Thus, the evaluation of usability, although long acknowledged as essential with respect to human-computer interaction (Nielsen, 1993), still needs to be specifically addressed in the context of educational assessments.

4. Conceptualising the digital reading comprehension test at text level

Our goal was to design a comprehensive and cost-efficient digital test for assessing reading comprehension, one capable of aiding teacher decision-making and fostering individual student support. To carry this out, we planned subtests for assessing the three different levels of reading comprehension: word, sentence and text level. This paper focusses on text level. The conception and construction of the test and its items took place in summer 2019. The test was installed on a current HTML 5 platform. The exercise contents are stored in xml files which are read and interpreted by the Exercise Viewer using Angular 2 / Typescript. The subtests consist of exercise packages that can be given to students individually or in groups. The test was provided on a self-developed LMS.

For text-level, we decided to develop two different subtest formats, both of which are commonly used to assess reading comprehension on text-level: For Subtest I, we constructed a test that assesses whether students can extract information from short texts. Subtest II uses a maze procedure. The two approaches are described in detail below.

4.1 Subtest I: Questions regarding short nonsense-stories

Subtest I consists of various short texts, each followed by two multiple-choice questions. The texts present information on nonsense-things, creatures (both nouns) or actions (verbs). We used nonsense-content to obviate student use of background knowledge when answering questions.

The texts were constructed either as easy-to-read texts, containing two to three sentences (n=9), or as more demanding texts (e.g., including more sub-clauses, longer sentences) containing four to five sentences (n=7).

In analysing text readability for Grade 3 and 4 students, we applied the readability formula employed in the Regensburg Index (RIX: Wild and Pissarek, 2019). This incorporates characteristic values for readability (e.g., multi-syllabic words, number of sentences) and includes difficulty parameters (e.g., passive forms, sentence complexity). This readability formula has been tested for German texts and provides information on the suitability for certain grades. To determine text characteristics (see Table 1), we used the Regensburg analysis tool for texts (Ratte: Wild and Pissarek, n.y.).

Table 1: Subtest I before first piloting: Characteristics and RIX of texts

Text Type	Text Number	Nonsense-word	Word Type	Word-count	Sentence-count	RIX
short	1	Tinatos Kanat	creatures thing	17	3	2.13
	2	krolken	action	20	2	2.93
	3	Stasmir	thing	20	2	2.94
	4	minnern	action	16	3	2.09
	5	Delliwam	thing	26	3	2.74
	6	Relemis	creatures	14	2	2.44
	7	Rafiza	thing	12	2	2.22
	8	Basati	thing	18	3	2.22
	9	branteln	action	13	3	1.86
M* *(SD)				**17.33 (4.33)**	**2.56 (0.53)**	**2.40 (0.39)**
long	10	Sinalas	creatures	41	4	3.98
	11	Fenati	thing	41	3	4.47
	12	Zünglis	creatures	44	4	4.1
	13	Makentas	thing	38	5	3.54
	14	Wanila	creature	42	4	4.02
	15	Tentaris	creatures	52	5	4.41
	16	frijaben Frijabis	action thing	51	4	4.34
M* *(SD)				**44.14 (5.34)**	**4.14 (0.69)**	**4.12 (0.32)**

The multiple-choice questions corresponding to the texts covered the two important comprehension processes tested in international large-scale studies (e.g., end of Grade 4 in PIRLS: Widauer and Wallner-Paschon, 2017) and in well-established reading tests (e.g., ELFE II: Lenhard, Lenhard and Schneider, 2020). The first process requires retrieving explicitly stated information. The second process requires making straightforward inferences. It thus becomes possible to assess a child's basic level of text comprehension using just two questions for every text.

For the two questions offered, there was one correct answer (target) and three distractors. The distractors were constructed to be at least theoretically possible, thus encouraging students to concentrate on reading and understanding the text. To familiarize students with this type of text (nonsense-texts) and with the task format (two questions on each text), one text (Text 1) was used as an example. Teachers solve the sample questions together with their students to check student understanding of instructions.

In October 2019, we individually offered the texts with their corresponding questions (30 items) to six children (Grade 3: n=3, 2 boys, 1 average and 1 weak reader; 1 girl strong reader; Grade 4: n=1 girl strong reader, Grade 5: n=2 boys, very weak readers). We used observation and the think-aloud method while children conducted the subtests, as well as brief interviews after they finished the test, to obtain information on the solvability of the items and the tool's usability. Afterwards, three texts, questions and/or the answers to the corresponding questions were slightly modified to remove unnecessary ambiguity from the target items. In addition, the digital presentation of text and questions was changed. Initially, the text and both multiple-choice questions were presented on the same screen. This led to small letters and thus resulted in reduced readability, as was revealed by observation and reported by the children. After receiving children's feedback, we decided to present the text and the first question on one screen. On the subsequent screen, we presented the text again, this time with the second question. This also meant that each screen had to load, and thus increased dependence on the internet connection. Furthermore, test instructions were also adapted accordingly. Figure 1 shows the presentation mode of an item in Subtest I after adaptations.

Following these initial adaptations, a pilot test was carried out with a whole Grade 3 classroom (11/2019). A period of observation and classroom discussion after the test revealed that there was no further need for technical or item adjustment (in order to enhance usability).

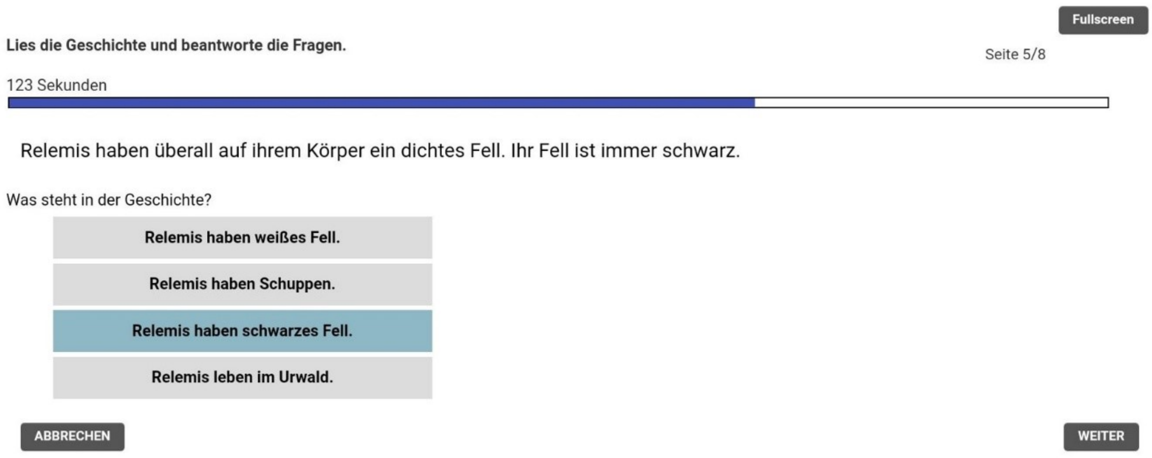

Figure 1: Presentation mode of Subtest I (Short Text 6 with the first question, solved)

4.2 Subtest II: maze selection

For Subtest II, four different factual texts were selected from materials designed to foster Grade 3 students' reading skills (developed in the project LARS from 2012 to 2014, for more information see https://differenzierter-leseunterricht.uni-graz.at/). The topics were deliberately chosen from these materials to cover age-specific interests and to be gender neutral.

After selecting the four factual texts, the text length and the presumed time limit for the test were determined. To ensure that the whole text could be presented on a tablet screen in an appropriate font size without scrolling, we set text length to about 100 words. According to the norms of the SLRT II (Moll and Landerl, 2010), the upper quartile of Austrian Grade 4 students can read approximately 100 words per minute. Studies on maze procedures, however, have shown that higher test reliability goes hand in hand with increased time (Conoyer et al., 2017; Espin et al., 2010) and they suggest a time limit of three minutes (Conoyer et al., 2017). Combining two texts in consecutive screens would have led to students having to click on a "next-button" on the first screen. For us, this option was unsatisfactory as we did not want differences in student scores arising as a result of their ability to click a "next-button". We therefore decided to use texts of about 100 words at different levels of difficulty. In piloting these texts, we wanted to find out whether easy texts, more demanding texts or both would lead to satisfying test reliabilities. Hence, the four selected texts were slightly rewritten and shortened to offer two relatively easy texts (at grade level) and two relatively demanding texts. Two different formulas were applied in order to define readability level. One of them was the gSmog (Simple measure of Gobbledygook - German; Bamberger and Vanecek, 1984), which measures the number of multi-syllable words (more than three syllables) in relation to the number of sentences. The other formula was the RIX (Wild and Pissarek, 2019). Both readability formulas were tested for the German language and they allowed for selection of a suitable text for the grade in question. The tool Ratte (Wild and Pissarek, n.d.) was used to determine text characteristics. Based on these indices, two easier (Texts 1 and 2) and two more demanding texts (Texts 3 and 4) were then designed (see Table 2). Finally, we added questions stating the topic of the text as headings. The use of such headings was intended to arouse student interest and motivate them to read the respective text.

Table 2: Information on the four texts (including text characteristics, gSmog and RIX) in Subtest II

Text Number	Title	Word-count (without distractors)	Sentence-count	gSmog	RIX
1	What can we discover in nature?	104	12	3.48	4.72
2	What do you know about farm animals?	107	15	3.83	3.87
3	How is tomato sauce made?	106	13	5.29	5.29
4	Where do we get our food from?	104	15	6.37	4.45
M (SD)		**105.25 (1.5)**	**13.75 (1.5)**	**4.74 (1.34)**	**4.82 (0.43)**

In accordance with the maze procedure used in English-speaking countries (Fuchs and Fuchs, 1992), every seventh word (not counting the heading) was replaced by a drop-down option that contained the target item (fitting the text) and two distractors. Each text contained 15 drop-down options. As is typical for this task format (see Walter, 2013), we employed one distractor resembling the target word grapheme-phonemically and one distractor resembling the target word in a semantic-syntactical way. We ensured that the distractors (at least as far as the word types nouns, verbs and adjectives are concerned) were (a) grammatically correct, (b) syntactically possible, and (c) related to the context (Ketterlin-Geller et al., 2006). This served to raise the level of distractor difficulty. It has been found that increased distractor difficulty goes hand in hand with higher construct validity in assessing reading comprehension (Conoyer et al., 2017).

To familiarize the students with the task format, we prepared a text consisting of two sentences on "Why is the Earth called the blue planet?”. In this short text, three drop-down options were presented.

Finally, in October 2019, all of the four texts (15 items each, 60 items in sum) were tested in individual settings with six children using observations, the think-aloud method and interviews as described above. As subsequent review of the processing revealed uncertainties concerning five of the items, we adapted the distractors. The children had no difficulty with the test format, nor with its digital presentation, thus usability was given. Again, pilot testing with a whole Grade 3 classroom in November 2019 revealed no further need for technical or item adaptation (in order to enhance usability) for this subtest. Figure 2 shows Subtest II.

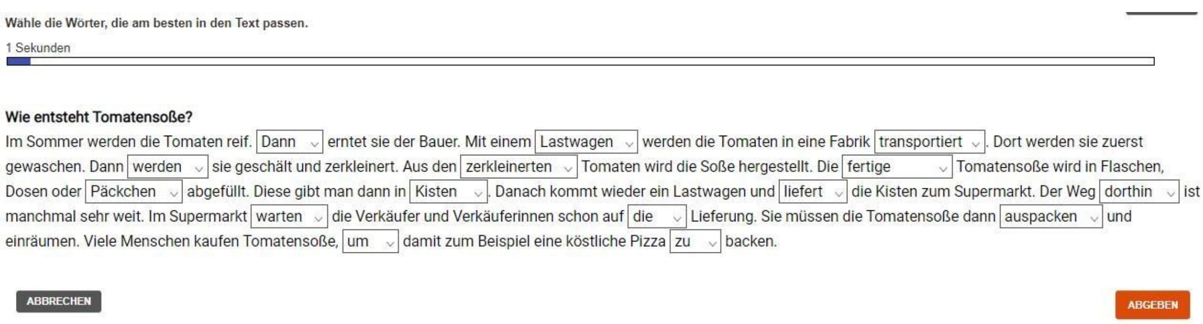

Figure 2: Presentation mode of Subtest II (Text 2, with solutions)

5. Aims and research questions

After undertaking revision and finalizing the construction, we began piloting on the preliminary versions of the subtests to gain insight into the tests’ characteristics (Study 1). More specifically, by using the tests as power tests (excluding a time limit), we gained insight into each single item’s characteristics. Further adaptations were then made based on these insights: Items were deleted/ adapted, a time limit was set, instructions were adapted, and the test’s final length was decided upon. Study 2 was used to test the validity and reliability (the quality criteria) of the final test versions.

6. Study 1: Item analyses and internal consistency

6.1 Procedure

In their final versions, both subtests of the GraLeV are designed to be speed tests. To gain information on item characteristics and internal test consistency, however, it is necessary to conduct the tests as power tests (with no time limit). This enables the students to work on every item of both subtests. To avoid frustration among very weak readers, the test was abandoned once 80% of the students in class had finalized the subtest in question. The power test procedure provided enough information to analyse item difficulty and discriminatory power). The items' difficulty was calculated in Excel as corrected item difficulty, taking account of the number of distractors (Eid and Schmidt, 2014). Item difficulty was intended to be comparably low (with high coefficients of at least 0.6) since the final tests would be conducted as speed tests. The items' discriminatory power was determined by using the reliability analysis in SPSS, which provided a measure of internal test consistency using Cronbach's alpha. To ensure test reliability, an item's discriminatory power needs to be as high as possible, and never below 0.3. A distractor analysis was also conducted to identify any problematic distractors. All items that did not meet the quality criteria were excluded from the original final item set and the internal consistency of the resulting item set (as a measure of reliability) was then calculated. According to Bühner (2011), reliability values of 0.7 are considered as acceptable, and values above 0.8 are considered good.

The time students needed to work on each item was also recorded. This information helped in determining time limits for the speed tests.

Data collection took place in Grade 3 and 4 classrooms from October to December 2019. For each classroom, there were two different testing days (each day spending about one lesson in the classroom) as the preliminary power test version of the GraLeV consisted of a relatively large number of items. On day 1, students worked on the Subtest Word and the Subtest Text II. On day 2, students worked on the Subtest Sentence and the Subtest Text I. Project members (university staff and project interns) conducted the test. They were trained to guide the students through the test procedure. As internet service in Austria is inadequate in many classrooms, in a lot of cases mobile phone internet hotspots had to be used.

Teachers provided relevant information concerning student background.

6.2 Instruments

6.2.1 GraLeV

The GraLeV is a digital test constructed to assess reading comprehension at the word, sentence and text level. Text level is assessed via two subtests (as described above). The Subtest Word consisted in this version of two sample items and 38 test items. Each item consists of three pictures and six words. Students needed to pick the three words that fit the pictures and put them via drag and drop under the pictures (in a box). The Subtest Sentence consisted of 22 items. Each item presented a picture and four sentences below the picture. Students needed to pick the sentence that fit the picture (target sentence). The other three sentences were distractors.

6.2.2 Teachers' questionnaire

The teachers' questionnaire consisted of six questions concerning student background: month and year of birth, first language, special educational needs (SEN; if so: which, and taught by which curriculum) or extraordinary status (this is used in Austria for children who are second language (L2) learners with a very low ability to understand the language of instruction). Teachers filled out the questionnaires in between the testing days.

6.3 Sample

A total of 273 students took part in the study (with their parents' consent), 117 being Grade 3 students. When teachers stated that the student spoke at least one language different from German at home, the student was defined as a L2 learner. Table 3 provides details on the sample.

Table 3: Sample descriptives of Study 1

Grade	N	% female	% L2 learners	% SEN
3	117	49.6	9.4	0.9
4	156	48.7	30.2	2.6
total	273	49.1	21.2	1.8

6.4 Results

In Subtest I, between 235 and 241 students worked on the 30 items (15 stories with two questions each). After analysing items, we identified eight items with a difficulty below 0.6. Additionally, the distractors of three of these items were chosen by more than 20% of the students. Furthermore, one of these item's discriminatory power was below 0.2. These items were not included in the final item set. A text was only retained in the final item set when both corresponding questions met the quality criteria. Thus, seven texts were excluded, resulting in a final set of eight texts (six short texts, two long texts, and each with two questions: 16 items). In terms of Cronbach's alpha (α=0.87), the internal consistency of this final item set was good. Items, were then ordered according to their corrected item difficulty, beginning with the easiest item.

The time students needed to answer both questions for each text was recorded. Based on this, we calculated the average time needed for working on the 16 items of the final item set: 333 seconds (SD=118). The minimum time recorded for working on this item set (72 seconds) was not deemed reliable. We assumed that students had only clicked through answers without having read the text (e.g., needing only 2 seconds for solving both questions referring to Text 12). We thus drew on the time needed by the 25% fastest readers. These needed 258 seconds. Maximum times were also considered to define how long slow readers took for one text with two questions. We wanted students who are weak readers to be able to solve at least one or two questions. This also enables us to differentiate within the group of weak readers. Thus, the maximum time needed for the easiest text in the final item set (short text 6) was analysed. The slowest reader of the sample solved this item in 116 seconds. Based on these findings, we decided to set the time limit to 3 minutes. This limit would prevent the fastest readers from finishing all items, and additionally enable weaker readers to solve at least one item.

In Subtest II, 246 to 251 students worked on the four texts and, hence, on the 60 items. An analysis of the items revealed that Text 1 and Text 4 contained items with corrected item difficulty below 0.6 (two items), or discriminatory power below 0.2 (four items). Text 2 (easy) and Text 3 (more demanding) showed good item characteristics and were included in the final test version. The internal consistencies of Text 2 (Cronbach's α=0.80) and 3 (Cronbach's α=0.78) were satisfactory. Except for one item in Text 3, all items had acceptable values. Separate consideration of the item characteristics in Grade 3 and Grade 4 revealed, however, that in the sample of Grade 3 students, three further items in Text 2 showed discriminatory power below 0.2. Thus, to improve item characteristics in Text 2, one sentence was slightly modified, and three distractors were changed. In one item in Text 3, one distractor was changed.

Looking at the solution times needed by the 172 students revealed that about 167 seconds (*SD*=63.59) were required for Text 2, and 174 seconds (*SD*=62.22) for Text 3. The fastest readers needed 48 seconds for Text 2, and 66 seconds for Text 3. Again, we drew on the time needed by the 25% fastest readers, i.e. about 122 seconds and 130 seconds for solving Text 2 and Text 3, respectively. To ensure that slow readers also had time to work on at least some items, the maximum time recorded for the texts was divided by the 15 items per text. For Text 2, the slowest reader needed about 30 seconds for solving one item. For Text 3, the slowest reader took 29 seconds. Based on these findings, we decided to set the time limit at 100 seconds for reading both texts consecutively. This enables very slow readers to solve at least some items and prevents fast readers finishing both texts before the limit expires.

7. Study 2: Validity and reliability

7.1 Procedure

The final versions of both subtests were performed with students to gain information about the tests' (a) validity (convergent and divergent) and (b) reliability (retest-reliability). Convergent validity measures contained teacher assessment (TA) of student reading skills and student performance on the reading comprehension test ELFE II (Lenhard, Lenhard and Schneider, 2020). According to Bühner (2011), the correlation coefficient of the convergent validity needs to be above 0.5 in order to conclude that the tests assess the same ability.

Divergent validity was calculated based on the TA of students' mathematical and social-emotional skills.

Data collection took place in Grade 3 and 4 classrooms from September to November 2020. Again, we went to the classrooms twice to avoid overwhelming students (Day 1: GraLeV and ELFE II text; Day 2: GraLeV and ELFE II word and sentence). Project members conducted the tests. To be independent of school internet, we brought portable routers to the classrooms. Although this worked better than the hotspots in Study 1, using internet with the whole class still proved challenging. Unfortunately, COVID-19 measures prevented us from going to some classrooms twice. Some results on ELFE II word and sentence subtests are therefore missing. In the subsample tested on both days, we were able to gain knowledge of the GraLeV's retest-reliability. Reliability coefficients above 0.7 are considered as acceptable (Bühner, 2011).

7.2 Instruments

7.2.1 GraLeV

The GraLeV was used in its final version (after Study 1) as a speed test to digitally assess reading abilities on the word, sentence and text level. Text level is assessed via two subtests (as described for Study 1). The Subtest Word consisted of two sample exercises and 12 test exercises (time limit: three minutes). The Subtest Sentence consisted of 22 items (time limit: three minutes).

7.2.2 Teachers' questionnaire

The teachers' questionnaire consisted of the same six questions as in Study 1. Additionally, teachers had to assess students' reading skills (word, sentence and text), their mathematical skills (numerical understanding and spatial-visual skills) and their socio-emotional skills on a Likert-scale, with responses ranging from 1 (weak) to 7 (strong).

Teachers filled out the questionnaires while we were testing the students.

7.2.3 ELFE II

This test was used to measure reading ability at word (75 items), sentence (26 items) and text level (36 items). Reliability values are reported by Lenhard, Lenhard and Schneider (2020) to be r_{tt}=.93 (for retest) and r=.96 (for odd-even-split-half-reliability). We used the paper-pencil version of the test. The subtests had time limits (word: 3 minutes, sentence: 3 minutes, text: 7 minutes). On word level, students needed to choose one of four words that best fit the picture presented. At sentence level, students were presented with a sentence where one word had to be chosen out of five to fit the sentence. At text level, students read short texts and had to answer one to three questions on the text.

7.3 Sample

A total of 534 students took part in the study (with their parents' consent), 333 being Grade 3 students. When teachers stated that the student spoke at least one language other than German at home, the student was defined as L2 learner.

The amounts of test data differ due to the two measuring times used. We gathered information on the two GraLeV-subtest scores (time 1) from 447 (Subtest I) and 451 students (Subtest II). Data on scores in the ELFE II subtests is available for 357 (word level), 364 (sentence level) and 386 students (text level). Teachers' assessment on reading, mathematical and socio-emotional skills was available for 458 students. For a subsample of 169 students, retest data are also available (time 2). Tables 3 and 4 provide further details.

Table 3: Sample descriptives of Study 2

Grade	N	Age *M (SD)*	% female	% L2 learners	% SEN
3	333	8.78 (0.47)	43.0	33.5	0.7
4	201	9.82 (0.46)	54.8	43.4	1.3
total	534	9.14 (0.68)	47.1	37.0	1.0

Note: The information on age, gender, and language spoken at home was only provided for 337, 352, and 356 students, respectively. Percentage calculations are based solely on the data collected. The missing student data was ignored.

Table 4: Subsample retest descriptives

Grade	N	Age *M (SD)*	% female	% L2 learners	% SEN
3	112	8.72 (0.43)	48.2	25.9	0
4	57	9.84 (0.50)	56.1	29.8	1.8
total	169	9.10 (0.70)	50.9	27.2	0.6

7.3 Results

7.3.1 Validity

Table 5 shows the correlations of the two GraLeV-subtests on text comprehension with the ELFE II reading comprehension test and the TA of reading comprehension (convergent validity), as well as the correlations with the TA of mathematical and socio-emotional skills (divergent validity). As expected, the reading comprehension score obtained in the GraLeV's text comprehension subtests correlated highest with the ELFE II reading comprehension scores (.57 to .75). Likewise, the GraLeV scores correlated highly with TA of text comprehension (.40 to .53). Even though there are significant correlations of the GraLeV subtests with TA of mathematical skills (.26 to .40), these are mostly significantly lower than the correlations found for convergent validity (e.g., Subtest I correlates significantly higher with TA of text comprehension than with TA of spatial-visual skills: z = 1.74, p < .05). Only in Grade 4, there is no significant difference between the correlation of Subtest I with TA of text comprehension (convergent validity) and TA of spatial-visual skills (divergent validity): z = 1.36, p = .09). In general, the subtests' scores correlated lowest with TA of socio-emotional skills (.08 to .40, see Table 5).

Table 5: Validity

	ELFE II reading comprehension test			**TA of reading comprehension**			**TA of mathematical skills**		**TA of socio-emotional skills**
Grade 3	**word**	**sentence**	**text**	**word**	**sentence**	**text**	**Numerical understanding**	**Spatial-visual skills**	
Subtest I	.57**	.67**	.61**	.33**	.34**	.40**	.28**	.30**	.08
Subtest II	.63**	.74**	.70**	.38**	.41**	.46**	.26**	.27**	.08
Grade 4									
Subtest I	.61**	.65**	.67**	.43**	.46**	.47**	.34**	.38**	.24**
Subtest II	.69**	.74**	.67**	.50**	.52**	.53**	.33**	.40**	.40**
Total									
Subtest I	.63**	.70**	.69**	.33**	.35**	.40**	.31**	.33**	.16**
Subtest II	.69**	.76**	.75**	.39**	.41**	.46**	.29**	.32**	.21**

Note: ** p<.01

TAs were highly correlated with each other. As expected, TAs of different levels of reading comprehension correlated highly with each other (.87 to .96), as did the TAs of the two mathematical skills (.77). Interestingly, there were also high inter-correlations between the TA of reading skills and the TA of mathematical skills (.51 to .61) and between those of reading skills and socio-emotional skills (.41 to .43). In Grade 4, these inter-correlations were even higher (.47 to .65).

7.3.2 Reliability

Retest reliability was analysed for a subsample of 169 students. As shown in Table 6, for Subtest I, lower values of retest-reliability (r_{tt}=.58) were determined than for Subtest II (r_{tt}=.73). The students scored significantly higher at time 2 compared to time 1, both in Subtest I (T(168)=30.66, p<.01) and in Subtest II (T(168)=28.33, p<.01). The retest-reliability of Subtest II may thus be considered as acceptable (Bühner, 2011).

Table 6: Retest-reliability

Grade	Subtest I		Correlation coefficient	Subtest II		Correlation coefficient
	Time 1 ***M (SD)***	**Time 2** ***M (SD)***	***r***	**Time 1** ***M (SD)***	**Time 2** ***M (SD)***	***r***
3	6.56 (2.86)	8.08 (3.14)	.52**	6.40 (2.78)	8.12 (3.02)	.71**
4	9.25 (3.00)	10.28 (3.35)	.53**	9.54 (3.64)	10.86 (4.75)	.68**
total	7.47 (3.17)	8.82 (3.37)	.58**	7.46 (3.42)	9.04 (3.9)	.73**

Note: ** p<.01

8. Discussion

The present paper has discussed the construction of two GraLeV subtests and associated testing for usability. The paper has also reported upon two studies on piloting and the determination of the test quality criteria (reliability and validity). Both Subtest I and Subtest II were constructed to assess text level reading comprehension. In Subtest I, students read short nonsense-stories and answered two corresponding questions (one extracting explicit information and one making inferences). Subtest II is based on the maze procedure. Students are presented with texts in which every seventh word is replaced by a drop down in which students need to pick the word that best fits the context of the sentence in each case.

Study 1 reported on the piloting of the subtests (N=273 Grade 3 and 4 students) to gain information on item characteristics and test quality (internal consistency as reliability). Internal consistency of the final version of Subtests I was found to be satisfactory (α=.87), and a time limit of 3 minutes was set. The internal consistency of Subtest II was satisfactory for both texts (α=.78 to .80). Due to the speed test character of this subtest, the data from Study 2 could not be used to confirm internal consistency. As we wanted to enhance readability on a tablet screen, we decided against a suggested time limit of three minutes (Conoyer et al., 2017), and set the time limit at 100 seconds. However, by using two texts (one relatively easy, and one relatively demanding), we were able to differentiate assessment in terms of slow and fast readers.

Study 2 analysed test quality of both subtests. The results showed that both subtests fulfil the quality criteria of validity, showing high correlations with the ELFE II reading comprehension test and also with TA of text comprehension, but exhibit lower correlations with TA of mathematical or socio-emotional skills. TAs were also found to correlate highly with each other. Studies have shown that teachers tend to have a rather holistic picture of their students and do not differentiate between various sub-abilities (Paleczek, Seifert and Gasteiger-Klicpera, 2015). This also explains the higher correlations between GraLeV and ELFE II than those between GraLeV and TA of reading skills, as well as the significant inter-correlations between the different TAs. This result highlights the importance of regularly using standardised tests in order to aid teachers in identifying students with reading deficiencies.

Both Subtests I and Subtest II assess text comprehension to a certain extent. However, as can be seen in the correlation values for the ELFE II subtests, both subtests also capture sentence comprehension to a high degree. As the hierarchical reading levels are highly intertwined (Richter and Christmann, 2009), this result is not surprising. Future research will examine whether the implementation of both text level subtests really brings a greater gain in knowledge or whether one subtest at the text level is sufficient.

Retest reliability was found to be satisfactory for Subtest II (r_{tt}=.73), but not for Subtest I (r_{tt}=.58). Analysis also revealed that students scored higher at time 2 than at time 1. This is probably due to the unfamiliarity of the test at time 1. At time 2, students had accustomed themselves to the digital test environment, knew what they had to press, and were therefore faster, i.e. they were able to solve more items in the given time. Particularly in Subtest I, where each item was presented on a separate tablet screen, the time required for items may have acted as a break on students with relatively little digital experience, and thus have led to fewer items being solved. Although usability was evaluated beforehand, as some students might have had only limited prior digital experience (Medienpädagogischer Forschungsverband Südwest, 2018), differences between the students might not have been caused by differences in reading comprehension but by differences in digital competence. This needs to be considered in future studies of digital testing.

Study results suggest that both GraLeV subtests can be used to reliably and validly assess reading comprehension digitally. The manifold advantages of digital tools in learning and assessment (e.g., economic and objective administration, improved scoring and interpretation process; Neumann et al., 2019) justify further developments and evaluations of digital assessments. However, print assessments will remain important for certain classrooms or particular students. For example, internet problems might make it necessary to use the GraLeV in print form. It is thus important to investigate the potential equivalence of the GraLeV print and digital versions in future. Moreover, we are currently developing an app for tablet use that enables us to conduct the GraLeV without relying on the internet. Internet is only needed to upload data, thus enhancing practicability in classroom settings. Retest-reliability can then be analysed again and we are confident that this will lead to better results for Subtest I, where in the current internet-dependent version, the loading of each question on a new screen may have caused delays in students' answers. Standardization of the GraLeV will take place in autumn 2021. The test will then be freely available for teachers. Thus, the GraLeV will soon provide primary school teachers with a valuable digital tool for (a) simplifying differentiated assessment of student text comprehension and (b) easing documentation of learning progress.
Please add:

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References

Artelt, C. et al., 2007. *Förderung von Lesekompetenz. Expertise*, Bundesministerium für Bildung und Forschung, Berlin.

Artelt, C. and Gräsel, C., 2009. "Diagnostische Kompetenz von Lehrkräften", *Zeitschrift für Pädagogische Psychologie*, Vol. 23, No. 34, pp.157–160. 10.1024/1010-0652.23.34.157.

Bamberger, R. and Vanecek, E., 1984. *Lesen-Verstehen-Lernen-Schreiben. Die Schwierigkeitsstufen von Texten in deutscher Sprache*, Jugend und Volk, Wien.

Blumenthal, S. and Blumenthal, Y., 2020. "Tablet or Paper and Pen? Examining Mode Effects on German Elementary School Students' Computation Skills with Curriculum-Based Measurements", *International Journal of Educational Methodology*, Vol. 6, No. 4, pp.669–680. https://doi.org/10.12973/ijem.6.4.669.

Brandhofer, G., 2015. *Die Kompetenzen der Lehrenden an Schulen im Umgang mit digitalen Medien und die Wechselwirkungen zwischen Lehrtheorien und mediendidaktischem Handeln*, unpublished dissertation, Technical University Dresden.

Bühner, M., 2011. *Einführung in die Test- und Fragebogenkonstruktion*, Pearson Studium, München.

Chall, J.S., 1983. *Stages of Reading Development*, McGrawBHill Book Company, New York.

Cheung, A.C.K. and Slavin, R.E., 2012. "How features of educational technology applications affect student reading outcomes: A meta-analysis", *Educational Research Review*, Vol. 7, pp.198-215.

Conoyer, S.J., Lembke, E.S., Hosp, J.L., Espin, C.A., Hosp, M.K. and Poch, A.L., 2017. "Getting More From Your maze: Examining Differences in Distractors", *Reading & Writing Quarterly,* Vol. 33, No. 2, pp.141-154. 10.1080/10573569.2016.1142913.

Ehlers, J.P., Guetl, C., Höntzsch, S., Usener, C.A. and Gruttmann, S., 2013. "Prüfen mit Computer und Internet. Didaktik, Methodik und Organisation von E-Assessment" in Ebner, M. and Schön, S. (eds.) *L3T – Lehrbuch für Lernen und Lehren mit Technologien*. [e-book] Available at <http://l3t.eu/homepage/> [Accessed 15 August 2018].

Eid, M. and Schmidt, K., 2014. *Testtheorie und Testkonstruktion*, Hogrefe, Göttingen.

Espin, C., Wallace, T., Lembke, E., Campbell, H. and Long, J. D., 2010. "Creating a progress-monitoring system in reading for middle-school students: Tracking progress toward meeting high-stakes standards", *Learning Disability Research & Practice*, Vol. 25, No. 2, pp.60–75. 10.1111/j.1540–5826.2010.00304.

Medienpädagogischer Forschungsverbund Südwest, 2018. KIM-Studie 2018. Basisstudie zum Medienumgang 6- bis 13-Jähriger in Deutschland. Available at <https://www.mpfs.de/fileadmin/files/Studien/KIM/2018/KIM-Studie_2018_web.pdf> [Accessed 10 03 2021].

Förster, N. and Souvignier, E., 2014. "Learning progress assessment and goal setting: Effects on reading achievement, reading motivation and reading self-concept", *Learning and Instruction*, Vol. 32, pp.91–100. https://doi.org/10.1016/j.learninstruc.2014.02.002.

Fuchs, L.S. and Fuchs, D., 1992. "Identifying a measure for monitoring student reading progress", *School Psychology Review,* Vol. 21, No. 1, pp.45-58. 10.1016/j.learninstruc.2014.02.002.

Gebhardt, M., Diehl, K. and Mühling, A., 2016. "Online Lernverlaufsmessung für alle SchülerInnen in inklusiven Klassen", *Zeitschrift für Heilpädagogik*, Vol. 66, pp.444-453.

Gellert, A.S. and Elbro, C., 2012. "Cloze Tests May be Quick, But Are They Dirty? Development and Preliminary Validation of a Cloze Test of Reading Comprehension", *Journal of Psychoeducational Assessment,* Vol. 31, No. 1, pp.16-28. 10.1177/0734282912451971.

Graesser, A.C., Singer, M. and Trabasso, T., 1994. "Constructing inferences during narrative text comprehension", *Psychological Review,* Vol. 101, No. 3, pp.371–395. 10.1037/0033-295X.101.3.371.
Guthrie, J.T., Seifert, M., Burnham, N.A. and Caplan, R.I., 1974. "The maze Technique to Assess, Monitor Reading Comprehension", *The Reading Teacher,* Vol. 28, No. 2, pp.161-168.
Ketterlin-Geller, L.R., McCoy, J.D., Twyman, T. and Tindal, G., 2006. "Using a Concept maze to Assess Student Understanding of Secondary-Level Content", *Assessment for Effective Intervention, Vol. 31, No.* 2, pp.39-50. 10.1177/073724770603100204.
Klicpera, C., Schabmann, A., Gasteiger-Klicpera, B. and Schmidt, B., 2017. *Legasthenie – LRS. Modelle, Diagnose, Therapie und Förderung*, 5th edn, UTB, Stuttgart.
Lehmann, R.H., Peek, R. and Poerschke, J., 2006. *Hamburger Lesetest für 3. Und 4. Klassen: HAMLET 3-4*, 2nd edn, Hogrefe, Göttingen.
Lenhard, W., 2013. *Leseverständnis und Lesekompetenz: Grundlagen – Diagnostik – Förderung,* Kohlhammer, Stuttgart.
Lenhard, W., Lenhard, A. and Schneider, W., 2020. *Ein Leseverständnistest für Erst- bis Siebtklässler – Version II: ELFE II*, 4th edn, Hogrefe, Göttingen.
Lenhard, W., Schroeders, U. and Lenhard, A., 2017. Equivalence of Screen Versus Print Reading Comprehension Depends on Task Complexity and Proficiency. *Discourse Processes*, Vol. 54, No. 5-6, pp.427–445. https://doi.org/10.1080/0163853X.2017.1319653
Mayringer, H. and Wimmer, H., 2014. *Salzburger Lese-Screening für die Schulstufen 2-9: SLS 2-9*, Hogrefe, Göttingen. 10.1080/0163853X.2017.1319653.
Moll, C. and Landerl, K., 2010. *Salzburger Lese- und Rechtschreibtest II: SLRT II*, Hogrefe, Göttingen.
Muijselaar, M.M.L., Kendeou, P., de Jong, P.F. and van den Broek, P.W., 2017. "What Does the CBM-maze Test Measure?", *Scientific Studies of Reading,* Vol. 21, No. 2, pp.120-132. 10.1080/10888438.2016.1263994.
Mühling, A. and Gebhardt, M., 2021. LEVUMI. www.levumi.de
Neumann, M.M., Anthony, J.L., Erazo, N.A. and Neumann, D.L., 2019. "Assessment and Technology: Mapping Future Directions in the Early Childhood Classroom". *Frontiers in Education*, Vol. 4, No. 116, pp.1–13. https://doi.org/10.3389/feduc.2019.00116
Nielsen, J., 1993. *Usability Engineering*, Academic press, Boston. 10.1080/0163853X.2017.1319653.
Paleczek, L. and Seifert, S., 2019. "Pädagogische Diagnostik und deren Bedeutung für inklusiven Leseunterricht" in Paleczek, L. and Seifert, S. (eds.) *Inklusive(r) Leseunterricht: Leseentwicklung, Diagnostik und Konzepte,* Wiesbaden, Springer VS, pp.125-147.
Paleczek, L., Seifert, S., Franz, A., Wohlhart, D. and Riedl, S. (in prep.). *Grazer Leseverständnistest: GraLeV*.
Paleczek, L., Seifert, S. and Gasteiger-Klicpera, B., 2017. "Influences on teachers' judgment accuracy of reading abilities on second and third grade students: a multilevel analysis", *Psychology in the Schools*, Vol. 54, No. 3, pp.228-245. https://doi.org/10.1002/pits.21993
Paleczek, L., Seifert, S. and Schöfl, M. (2021). Comparing digital to print assessment of receptive vocabulary with GraWo-KiGa in Austrian kindergarten. British Journal of Educational Technology, 52, 2145-2161. DOI: 10.1111/ bjet .13163
Richter, T. and Christmann, U., 2009. "Lesekompetenz: Prozessebenen und interindividuelle Unterschiede" in Groeben, N. and Hurrelmann, B. (eds.) *Lesekompetenz: Bedingungen, Dimensionen, Funktionen,* 3rd edn, Beltz, Weinheim.
Richter, T., Naumann, J., Isberner, M., Neeb, Y. and Knoepke, J., 2017. *ProDi-L: Prozessbezogene Diagnostik von Lesefähigkeiten im Grundschulalter*, Hogrefe, Göttingen.
Schaumburg, H., 2015. "Chancen und Risiken digitaler Medien in der Schule" in Bertelsmann Stiftung (eds) *Individuell fördern mit digitalen Medien. Chancen, Risiken, Erfolgsfaktoren*, Bielefeld, Verlag Bertelsmann Stiftung, pp.20-94.
Schnotz, W., 1994. *Aufbau von Wissensstrukturen: Untersuchungen zur Kohärenzbildung beim Wissenserwerb mit Texten,* Psychologie Verlags Union, Weinheim.
Südkamp, A., Kaiser, J. and Möller, J., 2012. "Accuracy of teachers' judgments of students' academic achievement: A meta-analysis", *Journal of Educational Psychology*, Vol. 104, No. 3, pp.743–762. 10.1037/a0027627.
Walter, J., 2013. *Verlaufsdiagnostik sinnerfassenden Lesens: VSL*, Hogrefe, Göttingen.
Wayman, M.M., Wallace, T., Wiley, H.Y., Tichá, R. and Espin, C.A., 2007. "Literature Synthesis on Curriculum-Based Measurement in Reading", *Journal of Special Education,* Vol. 41, No. 2, pp.85-120. 10.1177/00224669070410020401.
Widauer, K. and Wallner-Paschon, C., 2017. "Entwicklung und Aufbau der Testinstrumente und Kontextfragebögen" in Wallner-Paschon, C. and Itzlinger-Bruneforth, U. (eds.) *PIRLS 2016. Technischer Bericht*, Salzburg, pp.9-22.
Wild, J. and Pissarek, M., 2019. *Regensburger Analysetool für Texte. Dokumentation*, available at:<https://www.uni-regensburg.de/sprache-literatur-kultur/germanistik-did/downloads/ratte/index.html> [Accessed 25 July 2019].
Wild, J. and Pissarek, M., n.d. *Ratte. Regensburger Analysetool für Texte*, available at:<http://www.uni-regensburg.de/sprache-literatur-kultur/germanistik-did/ratte/index.html> [Accessed 28 August 2019].

A Critical Review of Selected Literature on Learner-centered Interactions in Online Learning

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Abstract: Interactivity, a fundamental aspect of traditional face-to-face teaching, is a central concern in the design planning and organization of technology mediated instructional settings and online learning, because it is crucial in knowledge acquisition and the development of cognitive skills, and is intrinsic to effective instructional practice and individual discovery. The present paper aims to critically review a set of recent representative empirical studies during the period 2010-2019 focusing on the pedagogical expediency of learner-centered interaction in online learning contexts, to identify which aspects of collaborative learning could successfully be integrated within a structured learning management system environment to safeguard high-quality online learning. Searches for the identification of relevant empirical studies were conducted via Science Direct, EdITLib, IRRODL, SpringerLink, IEEE Xplore Digital Library and Scopus using keywords such as learner interactions, online learning, virtual learning environments, student success, e-learner satisfaction and online education. The search yielded 22 key studies focusing on learner-centered types of online interaction in relation to their contribution to student success and satisfaction in virtual learning environments. Our presentation of relevant research is based on five key types of interactive relationships identified in the field of distance education and culminates in a discussion of potential implications for a successful online learning experience and learner satisfaction.

Keywords: interaction, online learning, distance education, interface, presence

1. Introduction

Interaction is one of the most documented and disputed aspects of distance education, serving as a foundational component in many seminal and contemporary approaches to understand the phenomenon of learning (Anderson, 2003). A study examining 35 years of publications in *Distance Education* has shown that interaction was among the major themes of the 515 full articles published from 1980 to 2014 (Zawacki-Richter and Naidu, 2016).Interaction has been characterized as a catalyst in the shift from teacher-directed to learner-centered approaches (Hirumi, 2006; Mayes, 2006), and identified as a central component in the development of thriving learning communities in which participants can communicate and respond to each other's learning needs on intrapersonal and interpersonal levels, or interface with technology agents. In this sense, the formation of a learning community in distance learning contexts has often been found to be associated with (i) social reinforcement, which ultimately results in more group cohesion and less attrition; (ii) information exchange, through collaboration and knowledge building (Moller, 1998); and (ii) greater learner satisfaction with academic programs (Rovai and Barnum, 2003). Yet, the design and support of learning interactions that are both genuinely engaging and conceptually stimulating within online learning contexts remains a significant challenge in contemporary distance education. Therefore, more intensive research efforts in this area are needed.

Interaction is at the core of Moore's description of distance education in terms of his transactional distance theory (Moore and Kearsley, 1996; Wallace, 2003). Moore defines interaction as a pedagogical construct that primarily relies on "the interplay among the environment, the individuals and the patterns of behaviors in a situation" (Moore, 2007: 91). The development of a transaction is influenced by three basic factors: (i) the dialogue developed between the teacher and learner, which Moore (1993) considered to be an element associated with the quality rather than the frequency of communication, (ii) the structure, referring to the degree of structural flexibility of the program in terms of the educational goals of the course, the teaching techniques used and the assessment procedures (learner-content interaction) and (iii) the autonomy related to the extent to which the learner exerts control over learning procedures. Thus, three types of learner-centered interaction in distance education have been established:(i) learner-instructor interaction, (ii) learner-content interaction and (iii) learner-learner interaction. Later, Hillman, Willis and Gunawardena (1994) suggested a fourth type, learner–interface interaction. Transactional distance and autonomy are proportional to each other, because increases or decreases in one parameter result in corresponding increases or decreases in the other (McIsaac Gunawardena, 1996; Giossos, Mauroidis and Koutsouba, 2008). By emphasizing structure, dialogue

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and autonomy as key elements in the resultant communication equation, Moore has highlighted the relativity of the transactional exchange. Moore's focus on learner autonomy was also central to (1989) early work on distance education by Garrison, who postulated that a triad of control, autonomy and responsibility explains the range of communication possibilities among learners and teachers in distance learning.

More recent efforts toward categorization of online interaction systems have primarily followed Moore's (1989) framework elaborating on the notion of learner-centered online interactions leading to the establishment of new interaction types (see Mutalib, Halim and Yahaya, 2016 for a meta-analysis). In their research on asynchronous patterns of interaction within Web-based learning environments, Jung, Choi, Lim and Leem (2002)have discussed learner online interactions of three types: content-centered academic interactions occurring between learners and instructor or between learners and online resources; collaborative interactions among learners; and social interactions between learners and instructors. In contrast, Hirumi (2002; 2009) has classified interactions into four types: learner–self, learner–human, learner–"non-human" (content, interface and environment) and learner–instruction. Chou, Peng and Chang (2010) have proposed a comprehensive five-type categorization of learner interaction in online learning, consisting of (a) learner-interface, (b) learner-self, (c) learner-content, (d) learner-instructor and (e) learner-learner interaction. Chou, Pengand Chang's (2010) learner interaction classification serves the purposes of our discussion of the relationship between learner-centered interactions and students' perceived success and satisfaction in online learning contexts via relevant empirical studies of the past decade.

This review covers relevant empirical studies on online and distance education focusing on the pedagogical expediency of e-learner interaction patterns, to obtain a fuller understanding of the topic and easy integration of this knowledge in the instructional design and effective implementation online education programs. The need for this paper is even more imperative in the context of the recent COVID-19 pandemic, which has forced a temporary disruption in traditional education and led to a notable rise in e-learning for more than 1.2 billion children and adolescents in 186 countries worldwide, whereby teaching is undertaken remotely and on digital platforms (Adnan, 2020; Dhawan, 2020). In this light, this paper seeks to provide answers to the following questions: What are the research methodologies followed in the investigation of different types of learner interactions in online learning environments? What are the results to date, and what research gaps exist?

2. Methodology of the Study

The review follows the Webster and Watson (2002) method combining keyword searching and examination of leading journals. The keywords used for the identification of relevant empirical studies included learner interactions, online learning, virtual learning environments, student success, e-learner satisfaction and online education. Searches were conducted via Science Direct, EdITLib, IRRODL, SpringerLink, IEEE Xplore Digital Library and Scopus. To enhance reliability, separate searches were performed in key journals, including *Distance Education*, *Online Learning*, *Computers and Education* and the *Journal of Distance Education*. The search yielded 22 key studies deemed suitable for inclusion according to the criteria of studies concerning learner-centered types of online interaction in relation to their contribution to student success and satisfaction in virtual learning environments, which were published in English between 2010 and 2019.

3. Student Success and Satisfaction in Online Learning

Many studies in online learning area have widely expressed the importance of student satisfaction as it is associated with student success in learning (Lear, Ansorge and Steckelberg, 2010; Blasco-Arcas et al., 2013). Among various variables influencing student satisfaction in online learning environments, interaction has been identified as a key determinant affecting student satisfaction in online learning in multiple ways (Muzammil, Sutawjaya, A. and Harsasi, 2020; Turley and Graham, 2019). According to Kauffman (2015), student academic success in online learning environments is a multifaceted term determined by a broad range of factors that fall into five interdependent categories: technology-related, user characteristics, course-related, learning approach and support services (Menchaca and Bekele, 2008; Dziuban, Moskal and Thompson, 2015). According to Dabbagh (2007), the quintessential academically successful online student can be described as self-motivated and self-directed, exhibiting an internal locus of control, with above average executive functioning, communication, interaction and technological skills. Learner or student satisfaction, in contrast, is defined as the student's contentment and fulfillment of the expectations and experiences of the subject and/or course (Hom, 2002), as well as overall satisfaction with the course and its specific components or features (Markham, 1999). Student satisfaction is generally considered the crucial and elemental evaluation level to determine the overall quality, success and evolution of online learning environments, because "high levels of student satisfaction with online courses, programs and overall learning experiences are now a frequent occurrence, verifying the effectiveness and legitimacy of online learning" (Senerand Humbert, 2002:4). As with student success, the theoretical delimitation of learner satisfaction in online learning remains a complex and challenging process that is equally affected by several factors including course design, learning community, technology support, program policy and degree of interactivity, which is our main focus herein.

Several relevant studies conducted by investigators seeking to identify the dimensionality of student success and satisfaction in online learning environments have emerged in the past few years. For instance, Song, Singleton, Hill and Koh (2004) have examined factors associated with online learning effectiveness from the graduate student perspective by using a survey generated by researchers to assess learner characteristics, perceived difficulties and beneficial components of online learning. The results have indicated that course design and time management are crucial components in successful online learning, whereas a lack of community and technical problems are most challenging for online learners. Similarly, Eom, Wen and Ashill (2006) have examined factors contributing to perceived student success and satisfaction in university online learning contexts, examining both learner and course design characteristics. The authors' model (composed of the six variables listed above) explained 69% of the variance in learner satisfaction and 63% of the variance in learning outcomes. Course content organization and discipline also appear to play roles in student success and satisfaction, as demonstrated by Rogerson-Revell (2015), who has used e-tivities in an online applied linguistics/TESOL master's program to build critical thinking and practice skills. The e-tivities were designed to promote collaboration and formative assessment (portfolio of written assignments and activities) in an asynchronous manner with the use of an e-moderator (student tutor). Students reported increased motivation, reflection and preparedness for their final module assessment. Similarly,in a study by Jones (2015),who made use of synchronous videoconferencing, service learning (for developing clinical skills) and role playing (with asynchronous video recordings) in online foundational courses, social worker students rated both the online and face-to-face courses favorably. Finally, several learner characteristics such as computer technology self-efficacy (DeTure, 2004), cognitive style (Liu, Magjuka and Lee, 2008), lack of time management skills and motivation (Muilenbergand Berge, 2005), and self-regulation (e.g., Park and Choi, 2009; Yukselturk, 2007) have been found to affect e-learning success and satisfaction to a considerable extent.

Below, we consider the two constructs of e-learner success and satisfaction in relation to the five main types of interaction that may occur in a virtual learning environment, to gain further research perspectives and consider useful pedagogical implications in the area of online education and design.

4. The Role of Interaction in Distance Education in Current Research

4.1 Learner-Instructor Interaction

A subset of recent studies using mixed methodology have investigated the significance of learner-instructor interactions as determinants of successful learner participation, academic achievement and satisfaction in online learning contexts. Learner-instructor interactions are defined as student- or instructor-initiated communications occurring before, during and immediately after instruction. Moore (1989) has characterized learner-instructor interactions as attempts to motivate and stimulate learners and allow for the clarification of misunderstanding by learners regarding the content. Although student–student interactivity has been found to play an important role in online student satisfaction (Russo and Benson 2005; Swan 2001), one of the greatest predictors of student satisfaction is the prevalence, quality and timeliness of student–instructor communication. Kang and Im (2013) have investigated learner interactions and perceived learning in an online environment. A total of 654 undergraduate students responded to a survey regarding learners' interactions with their instructor and their perceived performance. Kang and Im's exploratory factor analysis showed that instruction-related interaction factors had greater predictive power for perceived performance than non-instructional interaction factors (e.g., social intimacy or social exchanges in personal information). Thus, instructional content-related interaction appears to have a more significant effect on learner performance than the other types of interactions.

Similarly, in a quantitative survey of 186 online graduate students, Espasa and Menses (2010) have found a statistically significant relationship between instructor feedback to students after assignments and the learning results, as measured by student satisfaction and final grades. These findings further highlight the important role of student–instructor interactions in student achievement and satisfaction in online learning. However, the findings in Kuo et al.'s (2014) study contradict this picture:learner-instructor interaction was found to be a weak predictor of student satisfaction. The researchers tested a regression model of student satisfaction involving three types of interaction: learner-learner, learner-instructor and learner–content; Internet self-efficacy and self-regulated learning; and class-level predictors in terms of the course category and academic program. Data were elicited via a survey questionnaire from 75 undergraduate and graduate students taking online classes in the College of Education at a US university. Pearson correlation analyses were performed to understand the relationships among three types of interactions: Internet self-efficacy, self-regulation and student satisfaction. The results indicated that learner-instructor interaction had a significant but not particularly strong impact on student satisfaction, as did learner-content interaction; however, this effect became non-significant in the context of class-level–predictors. The authors attributed this finding to student satisfaction being a secondary target of learner-instructor interaction, which may essentially involve criticism, evaluation of student papers, discussion of grades and other instructional activities that may not always be experienced as pleasant.

Learner-instructor interaction has also been researched as a factor contributing to computer-supported collaborative learning. Selles, Munoz-Carriland and Gonzalez-Sanmamed (2019) have conducted a study involving 106 students in the context of five university degree subjects involving work on Computer Supported Collaborative Learning (CSCL) projects. At the end of the projects, the students were requested to fill out a questionnaire including 25 items measuring the five constructs included in the study: student interaction in work groups, intra-group emotional support, teacher-student interaction, use of online collaborative tools and collaborative learning. The results indicated a positive and significant effect of teacher-student interaction in relation to the interaction processes that students developed in their respective groups. Positive and significant relationships were observed for student interaction and the use of online collaborative tools, but with a low and medium effect with respect to team work. These findings clearly indicate the necessity for efficient teacher-student interaction in web-based collaborative learning environments, because the organizational, emotional and educational support provided by the teacher in the early phases of collaboration were deemed key to sustaining group regulation, interaction, communication and individual acquaintance among group members. Teacher presence was also found to significantly affect emerging e-learners' patterns of interaction in online discussion forums, as revealed by qualitative data analysis performed by Park and Choi (2015),on the basis of online discussion transcripts, weekly pre- and post-discussion surveys of student engagement in online discussion and final self-reflective essays in which students described their experiences of the different discussion modes of the class. The study highlights the shifting nature of teacher roles in online learning environments, such that the teacher shares a more symmetrical relationship with students, in contrast to traditional face-to-face instructional contexts. In an earlier study by Suet al.(2005),content-related instructional activities (e.g., summarizing key points, asking/responding to questions and giving feedback) were found to be widely used in asynchronous online programs contributing to the enhancement of interaction among learners, whereas Garrison and Cleveland-Innes (2005) have indicated that qualitative aspects of learner-instructor interaction are important for the promotion of deep approaches to the online learning experience.

In a series of related quantitative studies, learner-teacher interaction has been the subject of further empirical investigation in relation to more affective aspects of the learning process, i.e., e-learners' self-reported autonomy and degree of self-regulation in virtual learning environments. In the Greek educational context of distance education, Fotiadou and associates (2017) have used data gathered at the Hellenic Open University via a four-section questionnaire designed to measure learner autonomy, and student-student and student-tutor interactions, which was completed by 100 postgraduate students. The study used a correlational research design to examine the relationships among the three variables described above and demographic variables (e.g., age, gender, total number of the course module successfully attended and the total number of face-to-face counseling group sessions that the students had attended at the time the study was conducted. Analysis of the results indicated positive but weak correlations between learner autonomy and (i) learner-instructor interaction as well as (ii) one of the three subscales of autonomy examined in this study, i.e., self-awareness, thus indicating an urgent need for a redefinition of the tutor's role in distance learning courses. Although the students in the study had high levels of autonomy in relation to the sub-scale of self-awareness, they still expressed their need to interact with the tutor, because effective tutor-student interaction appears to be perceived by students as a means of continuous academic, emotional and psychological support throughout their studies.

Self-regulation in interactions with others (peers and tutors) as a component of learner autonomy in online learning environments was the focus of Cho and Kim's (2013) study at a Midwestern US university. This notion arose from various views of learning; according to the researchers, SR for interaction with others "involves proactive management of motivation and cognition with others" (Cho and Jonassen, 2009). A total of 407 students participated in the study, and data were elicited from 69 online courses representing 11 departments via a two-part survey questionnaire. The first part focused on students' demographic information, the types of learning tasks in which they participated in the online course they attended and the perceived importance of mastering the content through interaction with an instructor and peers. The second part of the survey asked about online instructors' scaffolding strategies for interaction and their own SR for interaction with others. Hierarchical model regression analysis revealed that all variables significantly contributed to the explanation of students' SR for interaction with others, but instructor scaffolding for the interaction explained the most variance, followed by the importance of mastering content in the course, the importance of interaction with other students and the grade. Most importantly, the study extended self-regulation research in online learning environments to study interaction patterns between learners and between learners and tutors, thus providing a groundwork for further online research in this area.

Finally, in an exploratory study within the Uses and Gratifications Theory framework, which posits that individuals use mass media and other forms of communication to fulfill needs and wants, Sarapin and Morris (2015) have examined learner-instructor interaction patterns via Facebook and the extent to which this type of "digital socialization" (Siemens and Weller, 2011) meaningfully affects learners' academic achievement through the creation of an online community of inquiry. A total of 308 US college faculty members with Facebook profiles were surveyed regarding their expectations of students' perceptions of their credibility, professionalism and approachability in the classroom as well as mutual connectedness with their instructors as a result of out-of-classroom socializing and teacher self-disclosure on Facebook. The instructors who interacted with students on Facebook were more frequently those who had expected to enhance their credibility and relatability in the classroom through the use of a less conventional, out-of-class method of communication—Facebook. However, the study did not analyze or discuss how informal talk between learners and teachers through social media enhances the learning experience. An indication of students' types of online interaction via Facebook has been provided by Jumaat and Tasir (2013), who have noted that students prefer to share their opinions with classmates and convey their judgments in academic-related discussions in terms of responses to instructors' comments and questions rather than moving to a higher level of knowledge construction, such as providing their own examples of their ideas and elaborating on certain topics in learning. Proper scaffolding strategies are deemed necessary to further stimulate meaningful Facebook interactions with students, reflecting their learning process (see for example, Hew and Cheung, 2008; Donmez, 2010; Bosch, 2009).

4.2 Learner-Learner Interaction

Learner-learner interactions occur "between one learner and another learner, alone or in group settings, with or without the real-time presence of an instructor" (Moore, 1989, p. 4). Typically, such interactions ask learners to work together to analyze and interpret data, solve problems, and share information, opinions and insights. The interactions are designed to help groups and individuals construct and apply targeted skills and knowledge. The considerations for effective learner-learner interactions are similar between traditional classroom environments and e-learning environments (e.g., group size, group goals, individual roles and responsibilities, group and individual accountability, contact information and communications and grading). The challenge lies in planning and coordinating such interactions during e-learning (Hirumi, 2009).

In a recent study by Huang et al.(2019), students' interaction patterns in online discussions were quantitatively examined through both content and lag sequential analysis of the learning sentiments of e-learners performing seven types of learning tasks in an asynchronous discussion platform. The research participants were 38 postgraduate students enrolled in a fundamental educational technology theory course in a university in China. All seven learning tasks (four individual-oriented and three group-oriented) were designed to promote thinking and reflection through interactions in online discussions. After the tasks were launched on the learning platform, participants were asked to actively exchange ideas without any form of intervention by the instructor. In general, students participating in group-oriented learning tasks tended to exhibit intense and diverse learning sentiments and to experience more diverse and in-depth interactions (negotiation, testing and modification) that could facilitate meaningful learning. Using a mixed-method analysis, the study considered learners' feelings and disposition as central components in the online learning experience that can either promote or undermine quality interaction and successful cognitive engagement. These findings have various practical implications for online learning educators and designers.

Primarily on the basis of qualitative methodology in the form of social network analysis and thematic analysis, Shuand Gu (2018) have also attempted to investigate differences in student-group interactions between online and face-to-face sessions in a blended learning course. A total of 5090 online posts, 18 thematic groups and 604 classroom conversations were gathered, coded and analyzed to enable further examination of group interaction characteristics on the basis of the relationships among group members. A strong "group-controlling" pattern was found in the online learning component, thus indicating that teachers and students spontaneously produce many interactive behaviors, and the interaction initiative is usually under the control of students when they are learning in the online context. The depth of student interaction increased with the teaching progress and reached a relatively stable state during the middle and later periods in both the online and the face-to-face teaching and learning modes, whereas no significant correlation was found between the depth of the interaction and the number of posts. Compared with the informal environment of online learning, classroom dialogues were more open and required deep thinking, thus echoing the relevant findings in Miyazoe and Anderson's (2010) study.

The quality of online interaction among learners for knowledge construction purposes within a blended learning program was also addressed in another recent study conducted by Diep et al.(2017) in centers of adult education in Belgium. Focusing on adult learners' characteristics, the authors sought to investigate the effect of core self-evaluation when explaining learning performance and online interaction quality on adults' learning performance and also to determine the extent to which online interaction quality and learning performance affect their bonding and bridging social capital. The study used a quantitative approach to data collection, and the data were elicited via a questionnaire using validated scales for the measurement of each of the variables investigated. Path analyses showed that only core self-evaluation significantly predicted adults' learning performance, but,interestingly, online quality interaction quality significantly affected only learners' bonding and bridging capital (cf.e.g., Bernard et al., 2014; Wang, Hsuand Hwang, 2014). Heo, Lim and Kim(2010) have confirmed this result, finding that quality interaction affects communication, mutual support and cohesion among team members in project-based learning, but not the online learners' academic achievement. On the basis of these results, the researchers have concluded that the quality of online interaction accompanied by the support of technologies can foster and bolster social networks that facilitate the collaborative knowledge construction in blended online courses. Moreover, the relationship between online interaction and adults' learning performance appears to be mediated by adults' learning styles and preferences but requires further research. According to Lee, Carter-Wells and Glaeser, (2006), positive teacher-learner and learner-learner interactions contribute to community development but do not correlate with academic achievement. Students' responses to open-ended survey questions have indicated that the instructor's presence in the discussion boards is critical to building community, whereas positive interactions with peers contribute to students' sense of community and meaningful learning. In fact, negative peer-to-peer interactions have detrimental effects on community coalescence.

Knowledge building, student interactions and participation, and the relations among them, have also been investigated in a similar study by Yucel and Usluel (2016) in the context of an online collaborative learning environment with 145 prospective teachers at a private university in Ankara, Turkey. The data were collected from multiple sources, including the log records and the content analysis of Knowledge Forum postings. Interaction development was observed in terms of the use of opinion building and expressing forms and note creation and the students' knowledge building processes in the online collaborative learning environment. Using a convergent parallel design method based on a cross-comparison of separate quantitative and qualitative data analysis, in contrast to Diep et al.'s (2017) study, the authors found an increasing improvement in the quality of student participation and interaction, thus reinforcing learners' knowledge building process throughout the course. Collaboration among students encouraged students to create notes and follow their friends' note creation processes. Students with no information about the course were observed to conduct research and attempt to match their friends' speed after being influenced by those students. To the researchers, such increases in academically related content and quality were considered a function of a dense network of learner-learner interactional patterns and participation in an online collaborative course, thus causing a memorable impact on their learning experiences.

Finally, the relationship between learner-learner interactions and their effect on e-learners' achievement has also recently been re-addressed empirically by Kurucay and Inan (2017) in an online undergraduate course at a southwestern university in the United States. The study also sought to determine the extent to which interactions between online learners affected their perceived learning and satisfaction. A quasi-experimental research design was used: students in the control group were asked to complete their course assignments individually, and students in the treatment group were asked to complete the same assignment collaboratively in groups of three. Data were collected via pre- and post-survey electronic questionnaires and analyzed quantitatively. Overall, the results revealed a significant effect of learner-learner interaction with students' achievement, but no significance in terms of perceived learning and satisfaction. This finding contradicts those from prior relevant studies indicating that learner-learner interaction is a key predictor of student satisfaction (e.g. Chang and Smith, 2008; Sher, 2009; So and Brush, 2008; Young and Norgard, 2006), and it has been attributed to the assumed difficulties encountered in online collaboration or learners' incapability of effectively using the online tools, or to the different natures of collaborative learning in an online learning environment compared with a face-to-face environment. Nevertheless, the frequency of interaction and peer evaluation scores in online group activities were positively associated with students' perceived learning, achievement and satisfaction, whereas students' perceptions of online collaboration (e.g., interest, experience and capability)positively improved after students were involved in online group activities.

4.3 Learner-Content Interaction

Learner-content interactions in online and blended learning (BL) environments have been the subject of two recent empirical studies aiming to fill in the gaps in scientific knowledge by surveying this type of interaction as a determinant of student success and student satisfaction in online courses. The inclusion of studies on BL in this analysis was justified because this teaching method maintains not only the benefits in face-to-face interactions among learners or between instructors and learners, but also the inherent advantages of online teaching methods (Osguthorpeand Graham, 2003). Within the framework of Transactional Distance Theory, Ekwunife-Orakwue and Teng (2014) have investigated the extent to which student interactions in online and blended learning environments affect student learning outcomes, as measured by student satisfaction and their grades. The participants comprised 342 graduate, undergraduate, certificate, non-degree and alumni students enrolled in part time or full time synchronous and asynchronous online or blended courses in the academic areas of Professional Development, Technology and Society, Management and Electrical Engineering at a large US university. Student satisfaction was measured via a survey questionnaire, and the final summative assessment score received in the course reflected the students' academic achievement in the course.

Quantitative data analysis using standard multiple regression indicated that student-content interaction substantially affected student learning outcomes (satisfaction and academic achievement) as opposed to learner-teacher, learner–learner and learner-technology interactions. Sixty percent of the variability in student satisfaction was attributed to the interactions among learners, the content and the technology, whereas the contribution of learner-content interaction (38%) to student grades was almost twice those of other forms of interaction. Females reported slightly higher levels of learner-content interaction than males, and age had a neutral influence on all types of interaction, and did not contribute to online student satisfaction, because the sample included only a higher education population, and its size was limited. This finding appears to be consistent with Rhode's (2009) results from an exploratory study examining the experiences and preferences of adult learners the in terms of various interactions encountered in a self-paced professional development certificate program offered by a private higher education US institution. The authors also found that learner-quality course content and learner-instructor interaction were considered the most important aspects of the program. Participants indicated that quality interaction with the content is indispensable in the self-paced learning environment and cannot be replaced, but that interaction with the instructor could potentially be decreased and compensated for through increased quality interactions with content or learners. Learner-content interaction was found to be the most important predictor of student satisfaction in a study by Kuoet al.(2009) investigating students' perceptions of interaction and course satisfaction in a blended learning postgraduate course via synchronous and asynchronous weekly sessions.

In the same educational context as that of the previous studies discussed above, Zimmerman's (2012) study investigated the relationship between the learner-content interaction and course grades of 185 students in an asynchronous online course at a university in the southwestern United States. Using Blackboard CMS, the students relied completely on materials posted online to complete the requirements. Students were required to complete both a discussion assignment and a five-question quiz each week within a 7-day period, and no make-ups were allowed for either of the two tasks. Data associated with student interaction with course content, including the time spent reviewing online course materials, such as module Power Point presentations and course videos, and the time spent completing weekly quizzes, were collected in three sections of the online course. The results indicated a statistically significant relationship between the amount of time that the learners spent with the content and weekly quiz grades, thus confirming Ekwunife-Orakwue and Teng's (2014) findings concerning the contribution of learner-content interaction to academic achievement. Nevertheless, the generalizability of this study is again compromised by the small sample size as well as the use of strictly quantitative measures that did not capture or enable determination of the full relationship between the heavily under-researched learner-content interaction and course success in online learning contexts. Future research on the topic is imperative, given the implications for online educators and designers in terms of explicit strategy instruction regarding the importance of content interaction in course success as well as the development of course designs that are easily accessible, engaging and motivating for learners to use and learn.

4.4 Learner-interface Interaction

Learner to interface interaction was introduced by Hillman, Willis and Gunawardena (1994) as an additional fourth dimension to the construct of interaction in distance education. The authors have suggested that in online courses, learners must interact with some form of a technology medium as part of the course requirements. According to Hirumi (2002: 147), "learners must possess the skills necessary to operate the delivery system before they can be expected to successfully interact with human and non-human resources," and, if they do not possess such skills, the instructor or supporting staff should provide technological assistance to learners to facilitate learner-interface interaction (Prammanee, 2003). Although the effects of interface and interface design on online student learning have been a focus of growing research, several empirical studies have examined the ways in which e-learners interact and negotiate learning with the technological means of successfully completing their online learning.

To determine the extent to which learner satisfaction in an online graduate higher education course is associated with different types of interaction, Cho (2011) conducted one of the first research projects in learner-interface interaction. The participants were 342 students enrolled in 24 different online courses within a Master of Science degree-accredited online program, who were asked to complete an online learner satisfaction survey questionnaire sent by email after completion of the online course program. The data were analyzed via simple regression analysis to identify each relationship between different types of interaction and learner satisfaction. The results indicated that: (i) Significant positive linear relationships were found between learner-content (.739), learner-instructor (.540) and learner-learner (.770) interactions with learner satisfaction. However, the learner-interface interaction and learner satisfaction were not statistically significant. (ii) Learner-interface interaction also had the least impact on overall learner satisfaction. In contrast, learner-content satisfaction heavily influenced student satisfaction, followed by learner-instructor and learner-learner interaction. Finally, (iii) although significant relationships were observed among learner-content, learner-instructor and learner-learner interactions, learner-interface interaction was correlated with only learner-learner interaction (.206). Given the pivotal role of technology in online courses, Cho attributed the absence of any statistically valid relationships between learner-interface interaction and learner satisfaction to methodological flaws in the study, including (a) the use of general and abstract questionnaire items unable to elicit precise information on the effects of learner-interface interaction on learner satisfaction, (b) response bias, (c) environmental distractions and (d) the use of a single quantitative research method that prevented gathering of more in-depth knowledge data, as are usually afforded in qualitative research paradigms.

In a similar study, Jung and colleagues (2002) have investigated the effects of three types of interaction, i.e., academic (including learner-online resources and task-oriented interaction between learners and instructor), collaborative (or learner-learner interaction) and social (learner-instructor interaction to promote interpersonal encouragement or social integration), on learner satisfaction, participation and attitudes towards online learning in a Web-based instruction (WBI) environment. The participants were 120 undergraduate students from three courses at a university in Seoul, Korea, allocated to three interaction groups. Data were collected via pre- and post-tests measuring learners' prior experience with WBI, their attitudes toward online learning and their motivation levels before and after completing the course. As in Cho's (2011) study, learner satisfaction was measured via a survey questionnaire, and students' learning achievement was calculated in terms of the scores on the five assignments that learners were required to complete during their online course. Overall, social interaction was related more to learning outcomes than to learner satisfaction, whereas collaboration among learners was related more to learner satisfaction than to learning outcomes in WBI. Although learner-interface interaction was not directly addressed as a separate variable in this study but instead was considered part of what the researchers call "academic interaction"—which appears to refer more to learners' access and use of the course content than to the online course design and usefulness of the learning management system in the course—the study concluded that regardless of the type of interaction, WBI experiences result in a more positive view of online learning. However, more extensive qualitative research is necessary to determine the extent to which social and collaborative interactions affect e-learners' achievement, satisfaction and motivation.

Additional focus should be placed on the effect of learner-interface interaction per se and determination of its roles and effects on online learning courses via more sophisticated mixed-method approaches and more sensitive data-gathering instruments in future research (e.g.,Zydney, deNoyelles and Ju-Seo, 2012).

Interaction with technology, an integral part of distance education, has also been addressed in a more recent study by Danesh, Bailey and Whisenand (2015), in relation to instructors. The data were based on 91 graduate and undergraduate college online learners' perceptions of the effects of various interaction methods on the success of the educational outcome of the course. All courses used a mixed-mode, blended learning format combining face-to-face and online classroom discussion, and making use of both asynchronous and synchronous communication technology. Students were encouraged in each course to use both traditional and computer-mediated communication to interact with the teacher and other students, and feedback was routinely provided by the teachers. At the end of the course, the instructors administered a survey questionnaire consisting of a Likert scale, and open ended and agree/disagree questions. According to the questionnaire results, 62% of learners agreed that scheduled synchronous sessions positively influenced their interaction with the instructor, and 56% believed that the scheduled synchronous sessions positively influenced how they interacted with their fellow students, whereas 71% believed that asynchronous technology was the best means of communication with all participants in the course and the instructor. With respect to instructor-interface interaction, 64% of the students agreed that the professor's knowledge and technology use during the synchronous online sessions was critical to the overall success of the class, and they further commented that instructors with highly advanced technological knowledge and skills contributed more effectively to the online course. Although this study has provided further insights into e-learners' perceptions of the instructor-interface relationship in terms of technological expertise and competence while organizing and conducting online learning courses, the nature and characteristics of the interaction with technology, an essential and indispensable pedagogical means of e-learning, remain largely opaque. Therefore, extensive, detailed and interdisciplinary research efforts are needed in the areas of educational technology, distance education and online learning alike.

In a recent study on learner-interface interaction in online environments, Song, Rice and Oh (2019) have investigated learners' participation in online courses, focusing on synchronous learner interaction with a conversational virtual agent. Study data were collected from four graduate asynchronous online courses in an instructional technology program at a mid-sized university in the southern United States, organized into 15 weekly themes and topic modules. Participants were required to complete 13 weeks of asynchronous discussion activity throughout the course term and were also asked to complete seven interaction sessions with a conversational virtual agent throughout the semester regarding instructional topics, through reflection prompts such as "Why do we need to use educational multimedia?" and "Are mobile apps good for teaching?" The conversational agent used was designed and developed to demonstrate the feasibility of the agent in better supporting synchronous interaction in online courses. The agent was an independent online application, rather than being embedded in the course LMS, and was directly accessed by students using a web browser, without logging into the LMS. Learners interacted with the agent through text-based chat, and the virtual agent analyzed their input and replied to their questions and answers. Factor analysis of the results concerning learners' interaction/participation in online courses indicated two factors tied to e-learners achievement: (i)interaction quality, including the quality of discussion forum posts and conversation with the agent and (ii) LMS-oriented interaction, including the frequency and length of course access and the quantity of discussion forum posts. Participants successfully had meaningful interactions with the virtual agent about course topics and materials, and consequently were motivated to further express their opinions and were encouraged to complete tasks throughout the course.

4.5 Learner-self Interaction

Learner-self interaction encompasses the intrapersonal and meta-cognitive skills needed for students to be self-directed distance learners(Northrup, 2002) and is defined as the "learner's reflections on the content, learning process and his new understanding" (Soo and Bonk, 1998). This type of interaction examines learners' reactions to the content and asserts that their reflections and inner-dialogue (called "self-talk") are associated with the learning process. Self-regulation and reflection are critical to online learning, because, according to Northrup (2001), learning ultimately occurs as learners retreat from interaction and focus on individual and internal reflection. Self-regulated learners may have a substantially greater potential for success in distance education than learners with relatively poor self-regulatory skills, because the former may not need as much prompting from an instructor or help from other learners in monitoring, regulating and otherwise facilitating their learning (Hirumi, 2002; Hirumi, 2009).

Notably, this type of interaction has been examined in one recorded empirical study to date by Chou (2010) and associates. The study focused on exploring the interactivity of course-management systems (CMSs). Six commonly used CMSs in colleges and universities in Taiwan were selected for evaluation (Blackboard, e-Campus III, iCAN XP, Moodle, TopLearn and Wisdom Master), and data from 391 online learners in the form of self-reported perceptions of several CMS interactive functions were collected via a survey questionnaire distributed via these platforms. Within the learner-self interaction dimension, students in two of the six groups reported grade status tracking as the most-known function and materials-viewed tracking as the most-frequently used functions, as the top three. Among the most useful functions of the learner-self interaction type were the individualized learning record, assignment-completion tracking, software downloading, system announcements, user guidance for the system and FAQs about the system. Calendar and schedule reminders, a diary and reflection journal, and a report transformer were among the least used functions with respect to the learner-self interaction type. The researchers concluded that although the design of the six investigated CMSs favored most human interactions (learner-learner and learner-instructor), the approximately 50% adoption rates of functions in the learner-interface and learner-self interaction types indicated the existence of substantial room for system improvement and ample research opportunities for qualitative assessment of these interactive functions in computer-mediated learning environments.

5. Summary of Key Findings

On the basis of the review of the most recent empirical studies presented in this paper, the most important findings concerning interaction in online learning environments can be summarized as follows:

- Learner-instruction interactions significantly correlate with learners' academic performance (Kang and Im, 2012) and student satisfaction (Kuoet al., 2014),and significantly affect emerging e-learners' patterns of interaction in online discussion forums (Park et al.2015). Positive and significant effects of teacher-student interaction have also been found in relation to the interaction processes in which e-students engage in online courses (Selles, Munoz and Gonzalez-Sanmamed, 2019), and to e-learners' level of autonomy in the learning process, although these effects are weak (Foteiadou, Angelaki and Mavroudis, 2012). However, instructor scaffolding strategies strongly affect the self-regulation capacity for interactions with others (learners and/or teacher) in online courses (Cho Kim, 2013). Finally, the development of learner-instructor interactions via social media is a useful out-of-class method for university teachers to enhance their credibility and accessibility in conventional classrooms.
- Quality and in-depth learner-learner interactions in online and blended collaborative learning environments are affected by learners' sentiments and dispositions (Huang, 2019) and have a significant effect only on learners' bonding and bridging capital (Diep et al., 2017; Shu and Gu, 2018) and knowledge building processes in online courses (Yucel and Usluel, 2016).However, no significant effect on perceived learning and satisfaction has been found (Kurucay and Inan, 2017; Rovai and Barnum, 2003).
- Interactions with course content are among the most valued types of interaction by learners in self-paced and blended online learning environments. These interactions have been statistically correlated with learner satisfaction and success in course completion (Ekwunife-Orakwueand Teng, 2014; Zimmerman, 2012; Rhode, 2009; Kuoet al., 2009)
- Learner-interface interaction does not statistically correlate with learner satisfaction (Cho, 2011), bearing in fact the least impact on it (Jung et al., 2002). Its effect on learning outcomes in web-based instruction environments is largely superseded by social and collaborative interaction types. However, e-learners believe that online instructors' expertise and knowledge of technology in synchronous online courses is a critical factor facilitating effective online learning (Danesh, Bailey and Whisenand, 2015).
- With respect to learner-self interaction type, the limited research on the topic suggests that e-learners appear to favor certain aspects associated with the individualized learning record, assignment-completion tracking, software downloading, system announcements, user guidance for the system and FAQs about the system(Chou, Peng and Chang, 2010). Because this type of interaction is determined by affective personality traits involving e-learners' self-regulatory behavior, self-efficacy, agency and degree of autonomy displayed during the online learning process, more targeted research is needed to understand and explain the role of this type of interaction in the distance education field.

6. Discussion and Implications for Future Research

As university-level courses are increasingly being developed for online delivery, the pressure to identify the components of online learning environments that contribute to or support learning is increasing. Notably, the issue of the quality and effectiveness of interaction in online learning contexts has also emerged as a major pedagogical challenge in emergency remote teaching, which has been globally enforced as a mandatory educational paradigm as a result of the COVID-19 pandemic (Ferri et al., 2020; Meulenbroeks, 2020). Although much of the research in online education has focused on technical characteristics, technology by itself does not operate independently to create a learning environment. As demonstrated above, student interaction online appears to be a critical component in online learning environments that improves the quality of learning outcomes and facilitates successful course completion. Clearly, a fundamental shift in the culture of research practices is necessary to enable distance educators' and researchers' alike to reach broader and more comprehensive conclusions regarding the processes and conditions that best support learning and interaction in online distance education course design (Abramiet al., 2011). This research agenda should include: (a) further study of the interaction patterns used by learners in a variety of distance education online learning environments, including emergency remote learning contexts, and their effects on learning outcomes and motivational processes; (b) sophisticated research designs and better-quality measures of student learning, higher order thinking and engagement in online learning courses; and (c) more studies in a wide variety of educational contexts, particularly across the grade levels (K-12) and in higher education settings of all types.

References

Abrami, P.C., Bernard, R.M., Bures, E.M. and Tamim, R. 2011. Interaction in distance education and online learning: Using evidence and theory to improve practice. *Journal of Computing in Higher Education,* 23(2-3), pp.82-103.

Adnan, M. and Anwar, K. 2020. Online learning amid the COVID-19 pandemic: Students' perspectives. *Journal of Pedagogical Sociology and Psychology,* 2(1), pp.45-51.

Anderson, T. 2003. Getting the mix right again: An updated and theoretical rationale for interaction. *International Review of Research in Open and Distance Learning,* 4(2), pp. 1-14

Available at: http://www.irrodl.org/index.php/irrodl/article/view/149/230, Accessed Date: 23.01.2021

Bernard, R.M., Borokhovski, E., Schmid, R.F., Tamim, R.M. and Abrami, P.C. 2014. A meta-analysis of blended learning and technology use in higher education: From the general to the applied. *Journal of Computing in Higher Education,* 26(1), pp.87-122.

Blasco-Arcas, L., Buil, I., Hernandez-Ortega, B., and Sese, F.J. 2013. Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, 62, pp. 102-110

Bosch, T.E. 2009. Using online social networking for teaching and learning: Facebook use at the University of Cape Town. *Communicatio,* 35(2), pp.185-200.

Chang, S.-H.H. and Smith, R.A. 2008. Effectiveness of personal interaction in a learner-centered paradigm distance education class based on student satisfaction. *Journal of Research on Technology in Education,* 40(4),pp.407-426.

Cho, M.-H. and Kim, B.J. 2013. Students' self-regulation for interaction with others in online learning environments. *Internet and Higher Education,* 17(1), pp. 69-75.

Cho, M.-H. and Jonassen, D. 2009. Development of the human interaction dimension of the self-regulated learning questionnaire in asynchronous online learning environments. *Educational Psychology,* 29(1), pp. 117-138.

Cho, T. 2011. The impact of types of interaction on student satisfaction in online courses. *International Journal on E-Learning*, 10(2), pp. 109–125.

Chou, C., Peng, H.Y. and Chang, C.Y. 2010.The technical framework of interactive functions for course-management systems: students' perceptions, uses, and evaluations. *Computers & Education*, 55(3), pp. 1004-1017.

Dabbagh, N. 2007. The online learner: characteristics and pedagogical implications. *Contemporary Issues in Technology and Teacher Education,* 7(3),pp.217-226.

Danesh, A., Bailey, A. and Whisenand, T. 2015. Technology and instructor-interface interaction in distance education. *International Journal of Business and Social Science,* 6(2), pp.39-47.

Dhawan, S. 2020. Online Learning: A Panacea in the Time of COVID-19 Crisis. *Journal of Educational Technology Systems,* 49(1), pp. 5-22.

Diep, N.A., Cocquyt, C., Zhu, C., Vanwing, T. and de Greef, M. 2017. Effects of core self-evaluation and online interaction quality on adults' learning performance and bonding and bridging social capital. *The Internet and Higher Education,* 34, pp. 41-55.

DeTure, M. 2004. Cognitive style and self-efficacy: predicting student success in online distance education. *American Journal of Distance Education,* 18(1), pp. 21-38.

Donmez, O., Simsek, O. and Arikan, Y.D. 2010. How can we make use of learner interaction in online learning environments? *Procedia Social and Behavioral Sciences,* 9, pp. 783-787.

Dziuban, C., Moskal, P.D. and Thompson, J. 2015.Student satisfaction with online learning: Is it a psychological contract? *Journal of Asynchronous Learning Network,*19(2), pp. 1-15.

Ekwunife-Orakwue, K.C.V. and Teng, T.-L. 2014. The impact of transactional distance dialogic interactions on student learning outcomes in online and blended environments. *Computers & Education,* 78, pp. 414-427.

Eom, S., Wen, H. and Ashill, N. 2006. The determinants of students' perceived learning outcomes and satisfaction in university online education: An empirical investigation. *Decision Sciences Journal of Innovative Education,* 4(2), pp. 215-235.

Espasa, A., and Meneses, J. 2010. Analyzing feedback processes in an online teaching and learning environment: An exploratory study. *Higher Education*, 59(3), pp. 277-292.

Ferri, F., Grifoni, P. and Guzzo, T. 2020. Online learning and emergency remote teaching: Opportunities and challenges in emergency situations. *Societies,* 10(4), pp. 1-18

Available at: https//:www.mdpi.com/2075-4698/10/4/86, Accessed Date: 10.02.2021

Fotiadou, A., Angelaki, C. and Mavroudis, I. 2017. Learner autonomy as a factor of the learning process in distance education. *European Journal of Open, Distance and e-Learning,* 20(1), pp. 97-111.

Garrison, D. R. and Cleveland-Innes, M., 2005. Facilitating cognitive presence in online learning: Interaction is not enough. *The American Journal of Distance Education,* 19(3), pp. 133-148.

Garrison, D. R. 1989. *Understanding distance education: A framework for the future*. London, UK: Routledge.

Giossos, Y. Mauroidis, H. and Koutsouba, M. 2008. Research in distance education: review and perspectives. *Open Education - The Journal for Open and Distance Education and Educational Technology* 4(1)Available at:

https://ejournals.epublishing.ekt.gr/index.php/openjournal/article/view/9724/0/TurabianCitationPlugin, Accessed Date: 23.02.2021

Heo, H., Lim, K.Y. and Kim, Y. 2010. Exploratory study on the patterns of online interaction and knowledge co-construction in project-based learning. *Computers & Education,* 55, pp. 1383-1392.

Hew, K.F. and Cheung, W.S. 2008. Attracting student participation in asynchronous online discussions: A case study of peer facilitation. *Computers & Education,* 51(3), pp. 1111-1124.

Hillman, D. C., Willis, D. J., and Gunawardena, C. N. 1994. Learner-interface interaction in distance education: An extension of contemporary models and strategies for practitioners. *The American Journal of Distance Education,* 8(2), pp. 30-43.

Hirumi, A. 2009. A framework for analyzing, designing and sequencing planned e-learning interactions. In: A. Orellana, T. L. Hudgins, and M. Simonson (Eds.).*The perfect online course: Best practices for designing and teaching.* Charlotte, NC: Information Age Publishing. pp.201–228.

Hirumi, A. 2006. A framework for analyzing and designing e-learning interactions. In C. Juwah (Ed.). *Interactivity and Interactions in Distance and Online Education*. London, UK. Kogan Page. pp. 46-72

Hirumi, A. 2002. A framework for analyzing, designing, and sequencing planned e-learning interactions. *Quarterly Review of Distance Education,* 3(2), pp. 141-160.

Hom, W. C. 2002. Applying customer satisfaction theory to community college planning of counselling services. *i-Journal,* 2, pp. 3-15

Available at:http://www.ijournal.us/issue_02/ij_issue02_WillardHom_01.htm., Accessed Date: 23.01.2021

Huang, C.-Q., Han, Z.-M., Li, M.-X., Jong, M.S. and Tsai, C.-C. 2019. Investigating students' interaction patterns and dynamic learning sentiments in online discussions. *Computers & Education,* 140, pp.1-18.

Jones, S. H. 2015. Benefits and challenges of online education for clinical social work: three examples. *Clinical Social Work Journal,* 43, pp. 225-235.

Jumaat, N.F. and Tasir, Z. 2013. Students' types of online interaction through Facebook discussion. *Procedia – Social and Behavioral Sciences,* 97, pp. 353-360.

Jung, I., Choi, S., Lim, C., and Leem, J. 2002. Effects of different types of interaction on learning achievement, satisfaction and participation in Web-based instruction. *Innovations in Education and Teaching International,* 39(2) pp. 153–162.

Kang, M., and Im, T. 2013. Factors of learner-instructor interaction which predict perceived learning outcomes in online learning environment. *Journal of Computer Assisted Learning,* 29(3), pp. 292-301.

Kuo, Y.C., Walker, A.E, Schroder, K.E.E. and Belland, B. R. 2014. Interaction, Internet self-efficacy and self-regulated learning as predictors of students' satisfaction in online education courses. *Internet & Higher Education,* 20, pp. 35-50.

Kuo, Y.C., ,Eastmond, J.N., Bennett, L.J. and Schroder, K.E.E. 2009. Student perceptions of interactions and course satisfaction in a blended learning environment. In: G. Siemens and C. Fulford (Eds.), *Proceedings of ED-MEDIA 2009--World Conference on Educational Multimedia, Hypermedia &Telecommunications.* pp. 4372-4380. Honolulu, HI, USA: Association for the Advancement of Computing in Education (AACE).

Kauffman, H. 2015. A review of predictive factors of student success and satisfaction with online learning. *Research in Learning Technology,* 23, pp. 1-13

Kurucay, M. and Inan, F.A. 2017. Examining the effects of learner-learner interactions on satisfaction and learning in an online undergraduate course. *Computers & Education,* 115, pp. 20-37.

Lear, J. L., Ansorge, C., and Steckelberg, A. 2010. Interactivity/community process model for the online education environment. *Journal of Online Learning and Teaching,* 6(1), pp. 71–77.

Lee, J., Carter-Wells, J. and Glaeser, B.2006. Facilitating the development of a learning community in an online graduate program. *The Quarterly Review of Distance Education,*7(1), pp. 13-33.

Liu, X., Magjuka, R. J. and Lee, S. 2008. The effects of cognitive thinking styles, trust, conflict management on online students' learning and virtual team performance. *British Journal of Educational Technology,* 39(5), pp. 829-846.

Markham, S., and Hagan, D. 1999. Student satisfaction – CSSE1202. *CERG Technical Report* 3/99*.*

Mayes, T. 2006. Theoretical perspectives on interactivity in e-learning. In: C. Juwah (Ed.). *Interactivity and Interactions in Distance and Online Education*. London, UK. Kogan Page. pp. 9-26.

McIsaac, M.S. and Gunawardena, C.N. 1996. Distance Education. In: D.H. Jonassen, (Ed.).*Handbook of research for educational communications and technology: a project of the Association for Educational Communications and Technology*. pp. 403-437. New York: Simon & Schuster Macmillan.

Menchaca, M.P. and Bekele, T.A. 2008. Learner and instructor identified success factors in distance education. *Distance Education,* 29(3), pp. 231-252.

Meulenbroeks, R. 2020. Suddenly fully online: A case study of a blended university course moving online during the Covid-19 pandemic. *Heliyon,* 6, pp. 1-7.

Miyazoe, T. and Anderson, T. 2010. The Interaction Equivalency Theorem. *Journal of Interactive Online Learning,* 9(2) ,pp. 94-104.

Moller, L. 1998. Designing communities of learners for asynchronous distance education. *Educational Technology Research and Development,* 46(4), pp. 115-122.

Moore, M. G. 2007. The theory of transactional distance. In: M. G. Moore (Ed.), *Handbook of distance education* (2nd Ed.). Mahwah, NJ: Erlbaum. pp. 32-46.

Moore, M. G., and Kearsley, G. 1996. *Distance Education: A systems view.* Belmont, CA.: Wadsworth.

Moore, M. G 1993. Theory of transactional distance. In: D. Keegan (Ed.), *Theoretical principles of distance education.* New York: Routledge. pp. 22-38.

Moore, M.G. 1989. Three types of interaction. *The American Journal of Distance Education*, 3(2), pp. 1-6.

Muilenburg, L. Y. and Berge, Z. L. 2005. Student barriers to online learning: a factor analytic study. *Distance Education,* 26(1), pp. 29-48.

Mutalib, M.A., Halim, N.D.A. and Yahaya, N. 2016. *Meta-analysis of Interaction in Online Learning*. Conference Proceedings Universiti Teknologi Malaysia.

Muzammil, M., Sutawjaya, A. and Harsasi, M. 2020. Investigating student satisfaction in online learning: The role of student interaction and engagement in distance learning university. *Turkish Online Journal of Distance Education,* 21, pp. 88-96.

Northrup, P.T. 2002. Online learner's preferences for interaction. *The Quarterly Review of Distance Education,* 3(2), pp. 219-226.

Northrup, P. 2001. A framework for designing interactivity into web-based instruction. *Educational Technology,* 41(2), pp. 31–39.

Osguthorpe, R. T., and Graham, C. R. 2003. Blended learning environments: Definitions and directions. *The Quarterly Review of Distance Education,* 4(3), pp. 227-233.

Park, J.H., Schallert, D.L., Sanders, A.J.Z., Williams, K.M., Seo, E., Yu, L.-T., Vogler, J.S., Song, K., Williamson, Z.H. and Knox, M.C. 2015. Does it matter if the teacher is there? A teacher's contribution to emerging patterns of interactions in online classroom discussions. *Computers & Education,* 82, pp. 315-328.

Park, J. and Choi, H. J. 2009. Factors influencing adult learners' decision to drop out or persist in online learning. *Journal of Educational Technology & Society* 12(4), pp. 207-217.

Prammanee, N. 2003. Understanding participation in online courses: A case study of perceptions of online interaction. *Instructional Technology Forum,* 29

Available at: http://it.coe.uga.edu/itforum/paper68/paper68.html, Accessed Date: 09.02.2021

Rhode, J. F. 2009. Interaction equivalency in self-paced online learning environments. An exploration of learner preferences. *International Review of Research in Open and Distance Learning,* 10(1), pp. 1-23.

Available at: http://www.irrodl.org/index.php/irrodl/article/view/603/1179, Accessed Date: 23.01.2021

Rogerson-Revell, P. 2015. Constructively aligning technologies with learning and assessment in a distance education master's programme. *Distance Education,* 36(1), pp. 129-147.

Rovai, A. F. and Barnum, K. T. 2003. Online course effectiveness: An analysis of student interactions and perceptions of learning. *Journal of Distance Education,* 18(1), pp. 57-73.

Russo, T. and Benson, S. 2005. Learning with invisible others: Perceptions of online presence and their relationship to cognitive and affective learning. *Educational Technology and Society*, 8(1), pp. 54-62.

Sarapin, S.H. and Morris, P.L. 2015. Faculty and Facebook friending: Instructor-student online social communication from the professor's perspective. *Internet and Higher Education* 27, pp. 14-23.

Selles, N.H., Munoz-Carril, P.-C. and Gonzalez-Sanmamed, M. 2019. Computer-supported collaborative learning: An analysis of the relationship between interaction, emotional support and online collaborative tools. *Computers& Education,* 138, pp. 1-12.

Sener, J., and Humbert, J. 2003. Student satisfaction with online learning: An expanding universe. In J. C. Moore (Ed.).*Elements of Quality Online Education: Practice and Direction, Volume 4 in the Sloan-C Series.* Needham, MA: Sloan-C.

Sher, A. 2009. Assessing the relationship of student-instructor and student-student interaction to student learning and satisfaction in web-based online learning environment. *Journal of Interactive Online Learning,* 8(2), pp. 102-120.

Shu, H. and Gu, X. 2018. Determining the differences between online and face-to-face student-group interactions in a blended learning group. *The Internet and Higher Education,* 39, pp. 13-21

Siemens, G. and Weller, M. 2011. Higher education and the promises and perils of social network. *Revista de Universidad y Sociedad del Conocimiento,* 8(1), pp. 164-170.

So, H.-J. and Brush, T.A. 2008. Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment. Relationships and critical factors. *Computers & Education,* 51(1), pp. 318-336.

Song, L., Singleton, E.S., Hill, J.R .and Koh, M.H. 2004. Improving online learning: student perceptions of useful and challenging characteristics. *Internet and Higher Education*,7(1), pp. 59-70.

Song, D., Rice, M. and Oh, E.Y. 2019. Participation in online courses and interaction with a virtual agent. *International Review of Research in Open and Distributed Learning.*

Available at: http://www.irrodl.org/index.php/irrodl/article/view/3998, Accessed Date: 23.01.2021

Soo, K.S. and Bonk, C.J. 1998. Interaction: What does it mean in online distance education? Paper presented at the *98 World Conference on Educational Multimedia and Hypermedia & World Conference on Educational Telecommunications*, Freiburg, Germany, pp. 20-25.

Su, B., Bonk, C. J., Magjuka, R., Liu, X. and Lee, S.-H. 2005. The importance of interaction in Web-based Education: A program-level cases Study of online MBA courses. *Journal of Interactive Online Learning*, 4(1),pp.1-19.

Available at :http://www.ncolr.org/jiol/issues/pdf/4.1.1.pdf, Accessed Date: 23.01.2021

Swan, K. 2001. Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education,* 22(2), pp. 306-331.

Turley, C. and Graham, C. 2019. Interaction, student satisfaction, and teacher time investment in online high school courses. *Journal of Online Learning Research,* 5(2), pp. 169-198.

Wallace, R.M. 2003. Online learning in higher education: A Review of research on interactions among teachers and students. *Education, Communication and Information,* 3(2), pp. 241-280.

Wang, S.L., Hsu, H.Y., Lin, S.S. and Hwang, G.J. 2014. The role of group of interaction in collective efficacy and CSCL performance. *Educational Technology & Society,* 17(4), pp. 242-254.

Webster, J., and Watson, R., 2002. Analyzing the past to prepare for the future: writing a literature review. *MIS Quarterly,* 26(2), pp. 13-23.

Young, A. and Norgard, C. 2006. Assessing the quality of online courses from the students' perspectives. *Internet and Higher Education,* 9(2), pp. 106-115.

Yucel, U.A. and Usluel, Y.K.2016. Knowledge building and the quantity, content and quality of the interaction and participation of students in an online collaborative learning environment. *Computers & Education,* 97, pp. 31-48.

Yukselturk, E. and Bulut, S. 2007. Predictors for student success in an online course. *Journal of Educational Technology & Society,* 10(2), pp. 71-83.

Zawacki-Richter, O. and Naidu, S.,2016. Mapping research trends from 35 years of publications in Distance Education. *Distance Education,* 37(3), pp. 245–269.

Zimmerman, T. D. 2012. Exploring learner to content interaction as a success factor in online courses. *The International Review of Research in Open and Distributed Learning,* 13(4), pp. 152–165

Zydney, J.M., deNoyelles, A. and Ju-Seo, K.K.,2012. Creating a community of inquiry in online environments: An exploratory study on the effect of a protocol on interactions within asynchronous discussions. *Computers & Education,* 58, pp.77-87.

Exploring the Motivation of Livestreamed Users in Learning Computer Programming and Coding

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Abstract: This article discusses the emerging presence of online livestreaming programs for computer coding education. The typologies of motivations from a user-gratification perspective were explored from live coding streaming platforms such as "Twitch.tv" and "LiveEdu.tv". Categories of motivations were identified from the literature. Content analysis was used for analyzing the distribution of motivation categories in "Twitch.tv," as well as blog posts on "LiveEdu.tv" guided by Gratifications Theory. From the literature, five types of motivations were identified: 1) Cognitive; 2) Affective; 3) Social Integration; 4) Personal Integration; and 5) Tension release. In live coding streaming communities, the content analysis of 256 streams and twenty six discussion posts indicated that the primary motivation is cognitive related information seeking, followed by social integration such as community outreach, and then personal integration such as personal recognition. Through content analysis, the authors found that the audience's psychological state while watching online livestreaming of coding practice is mainly focused on learning and information seeking, emotional connectedness, and social interactions. Based on the findings, an empirical motivation model in live coding streaming was also developed. The findings for researchers and practitioners alike in programming education can apply respective motivation characteristics in programming education.

Keywords: Live coding, computational thinking, game-based learning, computer science education, online communities, streaming

1. Introduction

With the development of internet technology and the popularization of smart phones, online livestreaming has emerged as a fast-growing method for online media broadcasting in real time. Nearly half of internet users in the US watch live videos at least once a week, and a quarter of them watch live videos at least once a day (Kats, R. 2017). The scale of the video streaming market was estimated at approximately $30 billion in 2016, and it is projected to more than double in growth by 2021, to more than $70 billion (PR Newswire, 2016).

Over 60% of young people (ages 18–34) watch livestreaming content regularly in the U.S. (Emarketer, 2017). As an example, Twitch is one of the biggest live video streaming companies, with about 1 million streamers interacting with more than 100 million viewers each month (Twitch, 2017). Another big livestreaming platform, "Facebook Live," attracts nearly two billion people to watch live videos, with an increase of 50% in 2017 (Fingas, 2018). In China, which has the largest live video streaming market, with 324.8 million Internet users (or 45% of its online users) making use of livestreaming content, more than 200 live video streaming apps are available (Chadha, 2016; Si, 2017; Xiang, 2017). Most of these live video streaming programs are related to video games, live shows, and e-sports.

Livestreaming meets the social requirements of people at different levels, including face-to-face, anywhere, anytime, and interactive. Live video streaming allows people to watch videos on different platforms through the network system at the same time. The emergence of livestreaming platforms has triggered a revolution in communication. Online video livestreaming can be used to produce videos and their related dialogues, metadata, online survey, program evaluations, and other online training materials (Derry et al., 2010).

Livestreaming, however, has a much broader scope than just entertainment and gaming; livestreaming has also emerged in other genres. In recent years, the demand for adding programming and computational thinking into primary school curricula has increased greatly (Repenning, Webb and Ioannidou, 2010); this gives incentive to consider novel approaches such as livestreaming, which have been shown to be used to disseminate programming and coding knowledge. Interestingly, new livestreaming platforms such as "Twitch.tv" and "LiveEdu.tv" (now named: "education-ecosystem") lead a new way on this. "Twitch.tv" is a popular livestreaming platform primarily for entertainment and sports, but also includes streaming for livestream computer programming. "LiveEdu.tv" primarily focuses on computer programming education, which engages a good

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numbers of programming experts as streamers and viewers in a rapidly growing livestreaming multimedia phenomenon.

Live coding benefits programmers by allowing for easy debugging and immediate feedback during the coding process (McDirmid, 2016; Kubelka, 2018); however, little is known about the user motivations underlying streamer and viewer engagement towards using livestreaming for effective and enjoyable coding learning. Unlike other live streaming activities, such as gaming or sports, primarily for recreation purposes, live streamers and participants for coding learning benefit from personal learning experiences and hands-on problem-solving skills. Live coding streaming promotes informal coding education in a variety of ways. Motivational experimentation in a live-stream coding environment sheds light on the growing needs of live streaming-focused programming. Unknown motivations, specifically learning related motivations, can be defined to apply live streaming and re-use different interaction features to deliver a better online learning strategy.

In this research, the empirical motivation model in live-stream coding is built based on the Uses and Satisfaction Theory (Rubin, 2009), with supporting evidence derived from content analysis among live streaming coding platforms. Motivation discovery and modeling articulate the needs of streamer-viewer interaction, which helps to develop motivation-specific learning resources to facilitate information sharing, adaptive data workflow, and cognitive participatory learning environment.

2. Literature Review

Livestreaming demonstrates tremendous user benefits and the potential to grow into an even broader social media trend (Hilvert-Bruce et al., 2018). Uses and Gratification Theory (UGT) has been used to analyze how people engage in different types of social media such as: livestreaming (Sjoblom and Hamari, 2017), online social networking sites (Ku, Chen and Zhang, 2013; West and Turner, 2010; Whiting and Williams, 2013), and video sharing (Chiang and Hsiao, 2015). According to UGT, users seek out their media needs, instead of the media seeking out the user (Wang, Fink and Cai, 2008). UGT supports analysis of how users make choices for online streaming, and the roles users play in media engagement that can fulfill their psychological needs.

Guided by Uses and Gratification Theory (UGT), several motivations were identified for both streamers and viewers in online streaming (Hilvert-Bruce et al., 2018; Sjoblom and Hamri, 2017). UGT helps classify needs in five categories: Cognitive, Affective, Personal Integrative, Social Integrative, and Tension Release (Katz, Blumber, and Gurevitch, 1973; West and Turner, 2010), as presented in Table 1. Online streaming motivators related to the Cognitive need include Learning and information seeking for knowledge acquirement (van der Heijden, 2004; Papacharissi and Rubin, 2000; Sjoblom and Hamari, 2017). Motivators related to the Affective need are Entertainment and Adventure (Venkates, 2000; Sjoblom and Hamari, 2017). Motivators regarding the Personal Integrative need are Emotional connectedness, External support, Social support/recognition, and Social anxiety (Hernandez et al., 2011; Sjoblom and Hamari, 2017). Motivators for the Social Integrative need are Meeting new people, Social interactions, Sense of Community. Tension Release-related motivators are Escape, Relaxation and Distraction (Smock et al., 2011; Sjoblom and Hamari, 2017).

Learning and information seeking has been shown to be an important kind of Cognitive motivation for use in several online media contexts (Hamilton, Garretson and Kerne, 2014; Papacharissi and Mendelson, 2010; Whiting and Williams, 2013). Online video livestreaming enriches knowledge in an intuitive, fast, well-expressed way. It can enable streamers and viewers to interact in real time without any geographical restrictions. Eventually it enhances the effectiveness of the promotion of the broadcasted event. After a livestream is completed, users can continue to provide rebroadcasts and on-demand broadcasts at any time, effectively extending the time and location for livestreaming and maximizing the value of live broadcast content. For online streaming gaming, especially on the Twitch online streaming platform, users can better decide and find which game they want to play based on broadcasts they have watched in the past. Additionally, watching Twitch, users can learn about game strategies, tricks, tactics, and more (Sjoblom and Hamari, 2017).

As for Personal Integrative-related motivators, users can make up for the lack of community engagement in real life by participating in online communities (Miller, 2011). When online streaming users lack external support from family, friends, and local communities, they can seek out online communities with which they can share emotional connections and improve their psychological health by participating in such communities (Bargh and McKenna, 2004). According to reports, online social interaction and participation help reduce user loneliness

(Valkenburg and Peter, 2009). This is especially important to people who find it difficult to communicate socially with others in real life; online communication can help such socially anxious people communicate well due to its abstracted nature (Baumeister and Leary, 1995; Desjarlais and Willoughby, 2010; Mazalin and Klein, 2008). The online streaming environment can provide alternatives to social activities in offline life, eliminating the obstacles that individuals with social anxiety may encounter in physical communities (Hilvert-Bruce et al., 2018).

Social Integration-related motivators (such as meeting new people, social interaction, and sense of community) are important because livestreaming platforms offer a virtual community center, where streamers and viewers can interact, communicate, and make new friends (Hamilton et al., 2014). In livestreaming environments, a sense of community is regarded as pursuing a sense of self-identity in the community (Hamilton, Garretson and Kerne, 2014); sense of community includes senses of community membership, social influence, and a sense of belonging to the livestreaming platform (McMillan and Chavis, 1986). In a livestream, users (including both streamers and viewers) can share the same sense of belonging and connection to each other based upon shared experiences, including: sharing the same dialect, similar social growth experiences and environment, and having the same or similar occupations. Streamers and viewers sometimes share life experience from their outside lives. The streamers might share many similar life and working experiences with viewers in real life. When streamers have similar experiences and/or similar identities in real life, they can more easily narrow the psychological distance between each other by participating in a community.

Tension Release and escape have an important impact on online streaming. Users can forget about their school, work, and other things when participating online. It can be a habit or a way to occupy their time. Watching online streams could also relax them and provide a pleasant form of rest (Sjoblom and Hamari, 2017).

Table 1: **Typology of livestreaming motivators reported from literature**

Motivators	UG need type	Description	Literature
learning and Information seeking	Cognitive	Acquiring information, knowledge, comprehension	Papacharissi and Rubin, 2000; Van der Heijden, 2004; Whiting and Williams 2013; Hamilton, Garretson and Kerne, 2014; Hilvert-Bruce et al., 2018
Entertainment	Affective	Emotionally pleasant, or aesthetic experience	Venkatesh, 2000; Hanson and Haridakis, 2008; Papacharissi and Mendelson, 2010; Cheung and Huang, 2011; Hamilton, Garretson and Kerne, , 2014; Friedländer, 2017; Hilvert-Bruce et al., 2018
Adventure	Affective	Emotionally pleasant, or aesthetic experience	Venkatesh, 2000; Hanson and Haridakis, 2008; Papacharissi and Mendelson, 2010; Cheung and Huang, 2011; Hamilton, Garretson and Kerne, 2014
Meeting new people	Social integration	Enhancing connections with family, friends	Sherry et al., 2006; Chen and Lin, 2011; Scholz, 2012; Pai and Arnott, 2013; Whiting and Williams, 2013; Hamilton, Garretson and Kerne, 2014; Friedländer, 2017; Hilvert-Bruce et al., 2018
Social interactions	Social Integration	Enhancing connections with family, friends	Sherry et al., 2006; Chen and Lin, 2011; Scholz, 2012; Pai and Arnott, 2013; Whiting and Williams, 2013; Hamilton, Garretson and Kerne, 2014; Friedländer, 2017; Hilvert-Bruce et al., 2018
Sense of Community	Social Integration	Enhancing connections with family, friends	Sherry et al., 2006; Chen and Lin, 2011; Scholz, 2012; Pai and Arnott, 2013; Whiting and Williams, 2013; Hamilton,

Motivators	UG need type	Description	Literature
			Garretson and Kerne, 2014; Friedländer, 2017; Hilvert-Bruce et al., 2018
External support	Personal Integration	Enhancing credibility, confidence, and status	Hernandez et al., 2011, Hilvert-Bruce et al., 2018
Social support	Personal Integration	Enhancing credibility, confidence, and status	Hernandez et al., 2011, Hilvert-Bruce et al., 2018
Social anxiety	Personal Integration	Enhancing credibility, confidence, and status	Hernandez et al., 2011, Hilvert-Bruce et al., 2018
Emotional Connectedness	Personal Integration	Enhancing credibility, confidence, and status	Hernandez et al., 2011, Hilvert-Bruce et al., 2018
Escape	Tension release	Escape and diversion	Lin, 2002; Hanson and Haridakis, 2008; Courtois et al., 2009; Papacharissi and Mendelson, 2010; Whiting and Williams, 2013

Motivation can be also characterized as the degree to which persistent effort is focused toward a target (Johns, 1996), and the degree to which persistent effort a student pays toward learning can be perceived as motivation to learn (Law, Key and Yu, 2010). According to situational variables and environmental influences, motivation can be calculated internally by individuals and externally by sources (Amabile, Hill and Hennessy, 1994, Ryan and Deci, 2000, Law et al., 2010). Law, Kee and Yu (2010) indicated that motivation for computer programming in E-learning environment included intrinsic motivation (e.g., individual attitudes and goal), as well as extrinsic environment such as direction, reward, recognition, social pressure and competition.

Live coding is a regular pedagogical practice for teaching computer programming, where teachers write code without planning and project the learning process (Paxton, 2002). Live streaming is informal, which pursues learners' own learning without externally imposed requirements (Hall, 2009). Live streaming focused on entertainment content, such as sports (Hamari and Sjoblom, 2017). However, people also share knowledge through live streaming for interactive visual art (Fraser et al., 2019) and encourage engagement in language learning (Samat, Hashim and Yunus, 2019).

Coding education has been applied in live streaming environments and its implication in the context of computer science education has been discussed (Haaranen, 2018). Kubelka, Robbes and Bergel (2018) indicated that certain liveness features are beneficial to the way developers navigate source code and objects during the coding process. McDirmid (2016) gave out examples of how live coding environments acted as feedbacks or communication tools. In one way, programming training seems boring for some learners, but novice programmers and online learners/viewers have a strong interest in participating in live coding streaming. There is however a lack of a systematic view for motivations that enable users to receive educational and emotional benefits in coding learning. In addition, the analysis of detailed motivations also explains why people enjoy being live coding streamers and viewers, and possibly identify the challenges and prospects of using live streaming for online coding education.

3. Method

Literature analysis was conducted for identifying those reported motivations for livestreaming activities and a typology was developed for motivations for livestreaming coding learning, based on the literature guided by Use and Gratification Theory.

Content analysis (Bloom, 1956; Krippendorf, 2004) was conducted using the motivation categories found in the literature review: Cognitive, Affective, Social Integration, Personal Integration, and Tension Release. Live coding streams were accessed through using the https://www.twitch.tv/directory/, by choosing “Live Channel”, and using any of “programming,” “web development,” and/or “software development” as the search tags. Live coding streams were evaluated by two researchers. A total of 256 streams in a time span of one week, from February 24 to March 2, 2019, were observed. Shortly after watching the stream, the two researchers compared and discussed the streamers’ motivation categories, and one or more motivation categories were assigned if applicable. The coder pairs arrived at consensus on the categorization, therefore, an inter-coder reliability of 100% can be reached.

User feedback/threads and blog posts regarding a live coding platform, LiveEdu.tv (https://blog.education-ecosystem.com/?s=live+streaming), were reviewed and evaluated as selective supporting cases for finding motivation. The blog posts site contained diverse discussion topics posted by the streamers; only those related to perception of motivation for livestreaming were harvested. In total, twenty six discussion posts were harvested and categorized. These data points provide empirical support for the motivation analysis performed by the researchers.

4. Result and Discussion

Livestreaming could offer numerous benefits for those seeking to learn computer coding. Livestreaming for computational programming allows viewers to participate in the programming process; for example, viewers can participate by performing code reviews, suggesting alternative methods, and discovering errors that the streamer may have missed (Haaranen, 2017). There are multiple livestreaming sites for computer coding practice and learning such as Twitch programing and liveEdu.tv.

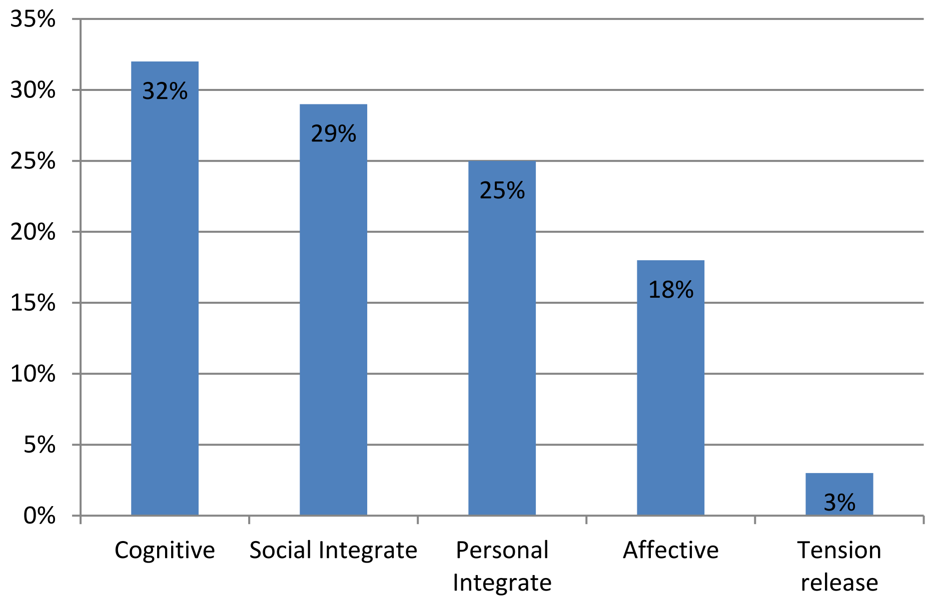

Figure 1: Distribution of motivation categories; sometimes multiple assignments, N=256

Content analysis from 256 live coding streams from Twitch.tv (Figure 1), indicated that the ranking of motivation categories in decreasing order is: Cognitive, Social Integration, Personal Integration, Affective, and Tension Release. Live coding streams were primarily motivated by the purpose of learning and information seeking, followed by meeting new people and community outreach, as well as gaining social and community support. In comparison to other types of livestreaming, such as gaming and sports (Zimmer, 2018), it showed less motivation for entertainment purpose.

Livestreaming with computer programming might be boring to some, only showing a bunch of computer code on the screen. There is no speaking, no joking and singing like other popular event livestreaming. However, it attracts a great number of people to watch and participate for learning and fun. This indicates that live coding demonstrations provide unique motivations for both streamers and viewers.

In a typical live coding experience, the programmer does not speak a word; sometimes they put on some soft music. The programmer can quietly broadcast their live coding practice for several hours without any interaction with the audiences. Every line of code's inputs, along with the programmer's logical flow of coding (including switching, splitting, deletion, addition, modification, etc), are projected on-the-fly on the screen. In general, there is also a webcam in the lower corner showing the programmer's face (Figure 2).

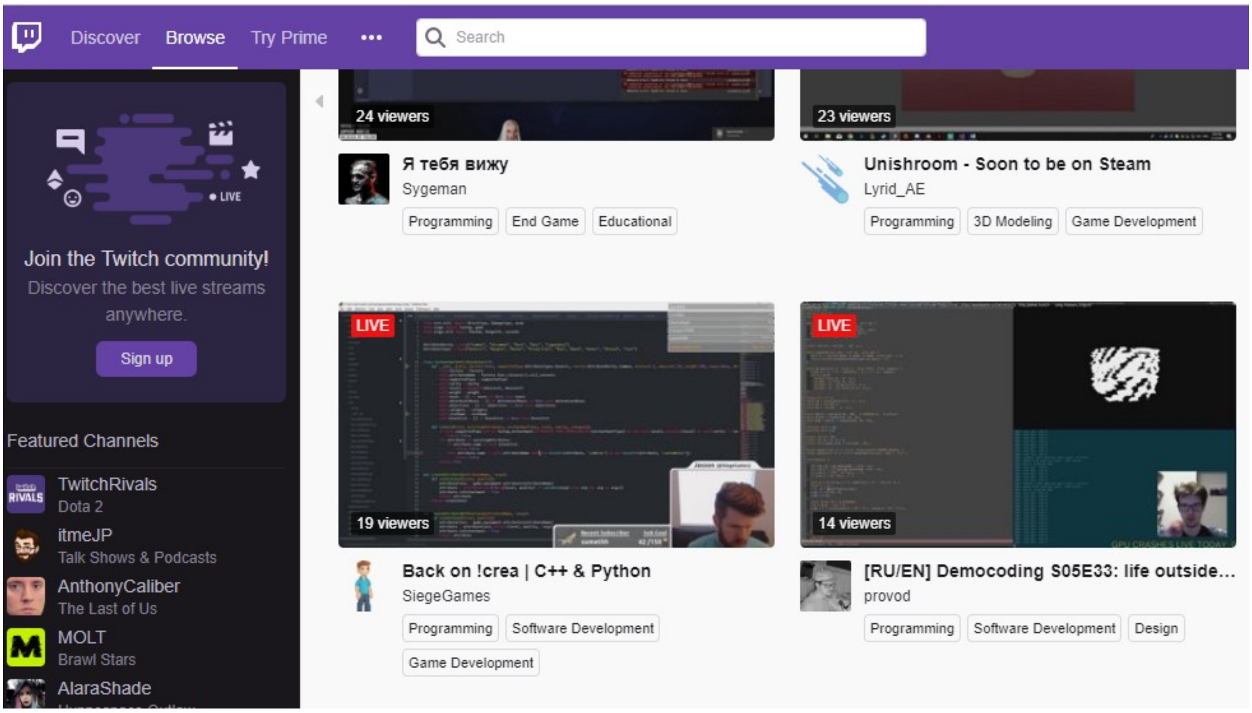

Figure 2: A screenshot of live coding streaming from Twitch.tv

4.1 Cognitive decomposition and thinking aloud

In 1956, Bloom presented his take on cognitive levels. From lowest to highest, they are as follows: recall, comprehension, application, analysis, and synthesis and evaluation (Bloom, 1956). Programmers need to: recognize coding structures, understand programming rules, apply programming tasks, and have debugging skills, as well as advanced programming skills and evaluation capability (Shneiderman and Mayer, 1979; Robins, Rountree and Rountree, 2003). Programming practice is a kind of higher-order learning activity, which requires the full imagination for dynamic features of the program and their all possible execution paths. New programmers usually lack the imagination necessary for expressing their programming ideas into an executable solution, as this develops over time. Live coding displays a complete and unedited view of how experienced programmers apply programming key concepts to produce a fine-tuned program construction process.

Live coding streaming accurately mimics a real coding environment and practice and provides the performance of programming to a live audience. When carrying out a coding project development, firstly, it is important to clearly specify the user requirements in detail; this can be accomplished by defining related data concepts and entities in a clear and unambiguous manner. Next is to begin constructing a general solution. If the problem is relatively large and complex, it may be necessary to decompose the problem into smaller tasks until is small enough to be solved with one or two data structures and algorithms. Live coding allows users to observe such decomposition process in detail and step by step.

> *"It's refreshing and challenging to try to understand how someone else is thinking in code. I'm thinking that at least if whoever is coding is thinking out loud it light be easier."*

Developing proficient skills in computational thinking involves building a variety of problem-solving skills that requires much in the way of coding practice. Live coding facilitates observing the development process, including the pitfalls of programming language design. However, the quality of learning depends on the person who is writing the code. For example, how to abstract a specific solving program into a data structure and the chosen algorithm, or whether they clearly spell out the logic and methods behind the solutions that they demonstrate in real time.

> *"Thought process, I consider myself a relatively proficient developer, but I often struggle with the overall scheme of a program. As in, I know I need X, Y, and Z, but not necessarily the best place to put X, Y, and Z."*

"I've been trying to learn on and off for years now - I know the very basics but putting it all together still eludes me."

The coding process involves taking a big project and breaking it down into smaller, more manageable tasks. This is typically not a one-time deal and it involves continuous refinement. Live-coding can reflect such a process in real time. Finally, it implements specific algorithms to solve a small problem. If the problem is relatively small and simple, it can be easily accomplished. If it is more difficult to tackle, a streamer may look for literature and sources that report a solution. Live coding enables the viewer to observe a refinement process in an easily understood format. A blog discussion reflects a similar idea:

"The streams are not totally polished and bugless (they reflect actual development process but they are educational.)"

4.2 Good habit coding

In traditional programming education, a large amount of autodidactic behavior is required. Live coding can help educate users on how to translate the design of the code into an actual, functioning portion of the code. One solution might involve several designs, and the algorithm requires comparison in coding design for scalability, maintenance, and modularity. Other aspects, such as an algorithm's time and spatial complexity, also need to be given special attention. Blog discussion threads have this to say on the subject:

"How experienced programmers achieve good architecture. Specifically, decoupling/modularization, and the rationale behind their decisions."

"I'm interested in the process people use. I have a colleague who says vim is bad for rails development but I see vim being used all the time in screen casts. It's all down to personal preference but it's still interesting."

"Want to see what best practices, technologies people are using. Want to get better."

Live coding has some advantages in terms of developing debugging skills in programmers, as well as helping them form good habits in terms of appropriate programming language use. Streamers can share their daily experiences of good coding practice live, thus granting their audience a good look at the streamer's workflow. As an example of good programming habits one can consider C++: the C++ programing language (cpp) has some common ways to reduce procedures like "if null == x"; this kind of good-habit code writing can avoid accidentally assigning values in conditional statements, thus granting better program flow. Several blog post threads also comment on this facet of live programming, as can be seen below:

"Real projects, live code are boring, slow pace, lot of debugging, lot of thinking and that was the real spirit."

"I want to see what people do to write more efficiently."

4.3 Information seeking and resources sharing

Live coding, as has been discussed previously in this paper, can benefit users in a multitude of ways; however, the aforementioned reasons are far from the only positive factors to be found in live coding. Another upside to live coding is in how it demonstrates methods for retrieving multiple computational programming resources and synthesizing them together. If a solution to a coding problem exists, then generally speaking there is a corresponding open source library artifact providing an API or an existing algorithm. The problem with the algorithms is finding results that can be referenced in a corresponding field. If a user finds an existing result, there is usually an open source library. Calling an API is a call to an existing algorithm. Online streaming can easily demonstrate such a process by finding the appropriate coding resources and putting them together on the screen. Some blog discussion threads comment on this aspect of live coding:

"I like to see the tools they are using and how they use them."

"I'm self-taught and it's really hard to find resources directed at the intermediate level programmer."
"Yeah this is what I think... It could provide a decent resource for people who're out the 'what's a loop' stages... It's a shame people don't seem to be using 'github' in conjunction with the vids, that'd help the documentation a lot"

> *"Mainly workflow, tools, and dependencies/libraries they are using. There is always someone out there that knows some hidden gem that can make my life much easier."*

4.4 Mutual, impromptu, participative environment

Live coding provides a casual environment for coding practitioners and learners as well as encouragement for mutual learning; in this setting, streamers and viewers can share their computational thinking experience live with each other in a casual way. A blog discussion thread shows this mode of thought to be present in streaming communities:

> *"It attracts a lot of programmers to participate. Other programmers found the live streaming is overcoming the coding programs, but also their own coding challenges or difficulties they experienced. Programmers get together and formed a mutual live learning environment."*

Livestreaming means no preparation, no plan to follow, no polishing content or editing videos. It has the advantage of allowing users to observe and learn the whole computational thinking process in the real life environment. Blog discussion posts provide support for the above idea:

> *"The main idea was for us streamers to just get the stream started, work on whatever we wanted, no plan to follow, no polished or edited video. Things were not even tutorial, they were just real life coding."*
>
> *"Live coding wasn't about educating, it was about sharing ideas and the projects people are working on. That's very different from an educational platform. With live coding people did learn, but the streamers weren't educators. For that they would need some sort of curriculum/plan to follow, and… that is exactly what you're encouraging."*
>
> *"Just for fun. A more passive pair-programming experience."*

4.5 Entertainment

Livestreaming videos offer real and rich content. Computer programming is complex and sophisticated, and as such can be boring. Going to a concert to listen to a live concert is more popular than simply listening to a record. A talk show is more interesting than reading a manuscript seriously. This is because the former is more interactive, authentic, and unpredictable. Everyday news also needs to be watched at a fixed moment, but a live webcast is different. It changes the delay of previous news broadcasts, allows viewers to directly see the actual situation on the scene, and it is a scene without post-processing clips. Compared to reproducible media (such as text), audio-visual media have a far greater abundance of features; an example of such features is the ability to record things, including speech rate, emotions, and gestures, which are all engaging features for audiences. Live coding offers a great deal of entertainment for users, especially compared to other methods of increasing coding experience. Once more, this is supported by discussion posts from live coding communities themselves:

> *"Learning to code can be quite dull,"… "There's not much of a social element. We thought this could be a way for people to learn and also be entertained." "Social elements such as livestreaming can be used to share momentful and live experiences to others that share the same interest."*
>
> *"What I got out of this site was contact with other streamers, programmers and entertainment, I liked the social aspect of checking in on what others were working on. It's easy to see that most live coding style content has a limited shelf-span, typically it's only worth watching live, and you need videos that can be found easily and revisited by old and new users over and over again."*

4.6 Emotional connectedness

Even beyond the underlying logic of mutual learning, there is a far greater demand: in traditional systems of programming, the programmer may feel extreme social isolation; however, if there is a live platform, coders can feel a sense of connection to their audience. They have companions, individuals who are there with them, even if they are hundreds of miles away. If the programmer experiences difficulties, they have a community, people with whom they can work together: problems can be discussed together, and participants can use their talents and experiences for certain unique expertise. Live coding platforms serve as a community center, which can be very valuable to these programmers. Live coding broadcasting touches on a very important psychological phenomenon, a mental state referred to as the feeling of being on the spot; this is where the streamer is, even if they are alone at home, able to feel as though they are in the company of many others, namely, their audience.

A streamer and their viewers can discuss things together, creating a sense of presence that can't be underestimated, brought about by social participation.

> *"As someone who is a hobbyist looking to make it a full time career it's really nice to see how people approach different problems. I like to glean as much information as I can about their workflow and what kinds of tools they use daily in order to be productive."*
>
> *"I observe other coders while wearing a white lab coat and carrying a clipboard. I can inspect the way other specimens program and hopefully assimilate other techniques."*

4.7 Reward and appreciation

Live coding allows streamers to easily share their coding ideas and solutions to a live audience. They want their streaming to be valuable. They love to see others take their solutions or comments into account and see their solutions beneficial others, something which improves their reputation and credibility in the community.

> *"Some streamers might like this but it is not something of value for viewers. If no viewers watch the content being streamed it is of no value…"*
>
> *"Now you want… those 'monetizable' tutorials. A tutorial is straight to the point, bugless, perfectly coded, well edited, no silent thinking moments...."*

4.8 Adventure and curiosity

Maslow (1971) believed that humans have the need to actively explore their environment. They are full of curiosity about everything they can observe, and are fascinated by mysterious, unknown, and unpredictable things. Humans are also irrevocably interested in other human beings; seeing how individuals act and interact with one another is a prime source of intrigue for our species. Livestreams are a source of such interaction which happens in real time, the stream offering a view of the personality of the streamer; this can act as a way of satisfying the viewer's interpersonal curiosity. One blog discussion thread states the following:

> *"I am more curious onto what people are designing."*

4.9 Escape and tension release

Learning to code is a stressful process; it requires high levels of focus and attention for computational thinking. Live coding platforms enable a casual environment for learning to code that allows viewers to relax and lay back away from their boring and stressful working environment to have some fun. Blog discussions state the following corresponding points:

> *"Learning different languages through osmosis because I'm too lazy to study"*
>
> *"Plus it's kind of zen for me. It's really relaxing to watch."*

5. Motivation Model

Content analysis from twenty-six "LiveEdu.tv" forum posts identified motivational needs for live coding from both streamers and viewers. These empirical data combined with the analysis of "Twitch.tv" live streaming data, support the creation of a motivation model based on UGT. It found that motivation focuses heavily on cognitive needs, including information search, cognitive decomposition, thinking aloud, good habit coding, and resource sharing (Figure 3). In such a collaborative learning environment, streamers and viewers achieve mutual advantages and seek personal rewards and emotional relationships. The need for entertainment and curiosity is certainly not insignificant. Both streamers and viewers avoid a stressful coding environment and are more relaxed during the coding process.

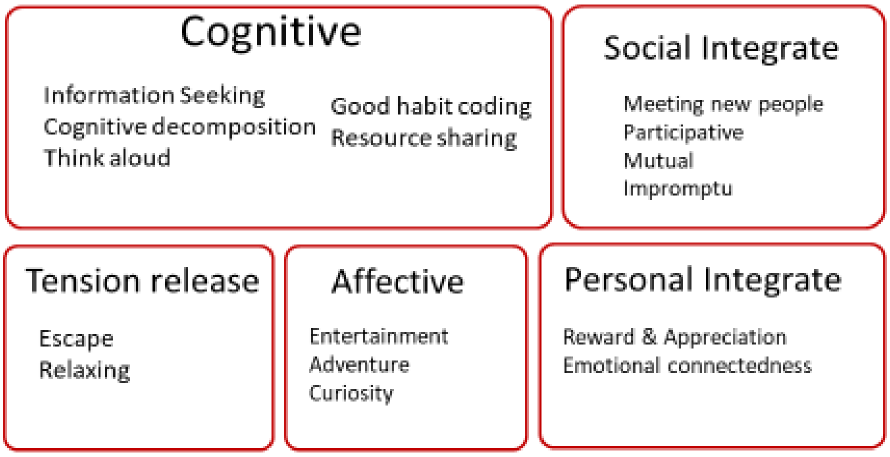

Figure 3. Motivation model in live coding streaming based on UGT

6. Limitations

This study is a preliminary study based on UGT theory as a framework, and the analysis is with a limited sample size. Additional observations can be explored with different coders for further repeated analysis. New surveys and interviews could also be conducted with both viewers and programmers for further exploring their live coding motivations and behind.

Live coding offers new opportunities for the coding education of novice learners. However, evaluating the quality of live coding streams is difficult. Those who determine the quality of a stream cannot just rely on people who watch the stream, as it is felt that viewers of streams are not an accurate enough assessment; after all, the levels of coding capability in viewers varies from person to person. A set of specifications is required to ensure quality and to develop a set of appropriate standards to evaluate the coding quality during the livestream.

If live coding is applied for computational thinking education, there should be specified guidelines for streamers who write code; for example, the concrete computational thinking should be spelled out for solutions to specific problems. Also it is important to ensure that the previous, imperfect work-arounds that had been tried are shared, as well as mistakes that had been experienced during the solving of similar problems.

> *"Value is hard to define..."*
>
> *"They don't understand that it's not necessary to mute/remove the stream. It's a mistake to want 'better quality'."*
>
> *"Silent random uneducational streaming is of no value for viewers."*

The study provided a snapshot of using an emerging online livestreaming program for programming education. As more learners choose online livestreaming for programming education, it is imperative to understand how and why they are motivated to learn through such opportunities. Understanding motivation allows to create more personalized and interactive live streaming tools. The exploration and collection of streaming content can be supported by new adaptive learning modules to enable cognitive decomposition on the fly. Similarly, stress-reduced learning features with incentives and rewards help to create an efficient and equitable learning environment for programming learning.

7. Conclusion

From previous methods of information sharing (such as text, voice, and pictures) to today's innovative livestreaming, information sharing techniques have evolved and been enhanced greatly over the years, changing in terms of quantity, efficiency, and expressive potential. Livestreaming offers a more interactive and presence-based method of communication and maximizes the possibility of maintaining social relationships. Livestream broadcasting content can vary greatly, from original shows to today's diverse live events, including the following: outdoor live activities, news live reports, eating, exploring; education; daily life; and more. Livestreaming can be seen as having significantly impacted many people's daily lives.

Traditional TV or other video media only attracts people through having extremely high-quality content due to its lack of communication. People will recommend content to their friends after they have watched it if they found it to be very good. Unlike watching a movie, however, once people think that an online streamer is even slightly interesting, they may tell others through methods such as online social media platforms; this causes more people to hear about such streams, as they spread much faster than other comparable media sources, and can easily gather crowds of people to join the livestream community.

Since livestreaming can easily reach a large audience, understanding the underlying psychological needs of a live streamer (and their motivation for livestreaming) could shine a light on the audience's motivation. This study took the method of empirical research through content analysis of online livestreaming blog discussions, analyzed the psychological intentions of live coding audiences and streamers, developed a motivation model, and came to the conclusion that the users of live coding mainly focus on the following types of motivation: learning and information seeking, entertainment and adventure, meeting new people and gaining a sense of community, seeking external recognition and support, and seeking escape and relaxation. This indicates that livestreaming can be facilitated as personal learning experience sharing tools for computational thinking training and coding practice demonstration. The findings and motivation model help develop innovative motivation-specific learning tools that support interactive, adaptive, personal, and experience-based computer programming practices and training.

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Reference

Abdous, M. H., and Yen, C. J., 2010. A predictive study of learner satisfaction and outcomes in face-to-face, satellite broadcast, and live video-streaming learning environments. *The Internet and Higher Education*, *13*(4), pp. 248-257.

Amabile, T. M., Hill, K. G., Hennessey, B. A. and Tighe, E. M., 1994. The Work Preference Inventory: assessing intrinsic and extrinsic motivational orientations. *Journal of Personality and Social Psychology*, *66*(5), pp. 950.

Bloom, B. S., 1956. *Taxonomy of educational objectives. Vol. 1: Cognitive domain*. New York: McKay, pp. 20-24.

Blumler, J.G. and Katz, E., 2014. The uses of mass communications: current perspectives on gratifications research. Beverly Hills, CA: Sage.

Chen, C. C. and Lin, Y. C., 2018. What drives live-stream usage intention? The perspectives of flow, entertainment, social interaction, and endorsement. *Telematics and Informatics*, *35*(1), pp. 293-303.

Cheung, G. and Huang, J., 2011. Starcraft from the stands: understanding the game spectator. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* CHI 2011, Vancouver, BC, Canada, May 7-12, 2011(pp. 763-772). DOI:10.1145/1978942.1979053

Chiang, H., and Hsiao, K., 2015. YouTube stickiness: the needs, personal, and environmental perspective. *Internet Research, 25*(1), pp. 85-106.

Chorianopoulos, K. and Lekakos, G., 2007. Learn and play with interactive TV. *Computers in Entertainment (CIE)*, *5*(2), p.4.

Courtois, C., Mechant, P., De Marez, L. and Verleye, G., 2009. Gratifications and seeding behavior of online adolescents. *Journal of Computer-Mediated Communication*, *15*(1), pp. 109-137.

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., Hall, R., Koschmann, T., Lemky, J.L., Gamoram Sherin, M and Sherin, B. L., 2010. Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *The Journal of the Learning Sciences*, *19*(1), pp. 3-53.

Emarketer, 2017. How are internet users watching live streaming? Facebook viewership grew slightly, while other platforms slipped. Available at: https://www.emarketer.com/Article/How-Internet-Users-Watching-Live-Streaming/1015036. [Accessed 27 June 2021]

Fingas J., 2018,. Nearly two billion people have watched Facebook Live broadcasts. April 6th 2018. Available at:https://www.engadget.com/2018/04/06/facebook-live-2-year-statistics/ [Accessed 20 March 2019]

Fraser, C. A., Kim, J. O., Thornsberry, A., Klemmer, S. and Dontcheva, M., 2019. Sharing the studio: How creative livestreaming can inspire, educate, and engage. In: *Proceedings of the ACM Conference on Creativity and Cognition (C&C) 2019* San Diego, CA. (pp. 144-155). New York: ACM. DOI: https://doi.org/10.1145/3325480.3325485

Friedländer, M.B., 2017. Streamer motives and user-generated content on social live-streaming services. *Journal of Information Science Theory & Practice, 5*(1), pp. 65-84.

Haaranen, L., 2017. Programming as a performance: live-streaming and its implications for computer science education. In: *Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education.* Bologna, Italy *June 2017* (pp. 353-358). New York: ACM, DOI:https://doi.org/10.1145/3059009.3059035

Hall, R., 2009. Towards a fusion of formal and informal learning environments: The impact of the read/write web. *Electronic Journal of E-learning*, *7*(1), pp. 29-40.

Hamari, J., and Sjöblom, M., 2017. What is eSports and why do people watch it?. *Internet Research*, 27, 2, pp. 211-232.

Hamilton, W. A., Garretson, O. and Kerne, A., 2014. Streaming on twitch: fostering participatory communities of play within live mixed media. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems,* Toronto, OH, Canada, April 2014 (pp. 1315-1324). New York: ACM,

Hanson, G. and Haridakis, P., 2008. YouTube users watching and sharing the news: A uses and gratifications approach. *Journal of Electronic Publishing*, *11*(3). DOI: https://doi.org/10.3998/3336451.0011.305

Hernandez, D., 2016. Game creator success on Twitch: Hard numbers. Available at: https://blog.twitch.tv/en/2016/07/13/game-creator-success-on-twitch-hard-numbers-688154815817 [Accessed 20 March 2019]

Hernandez, B., Montaner, T., Sese, F. J., and Urquizu, P., 2011. The role of social motivations in e-learning: How do they affect usage and success of ICT interactive tools?. *Computers in Human Behavior*, *27*(6), 2224-2232.

Hilvert-Bruce, Z., Neill, J. T., Sjöblom, M. and Hamari, J., 2018. Social motivations of live-streaming viewer engagement on Twitch. *Computers in Human Behavior*, *84*, pp. 58-67.

Kats, R., 2017. For some, live streaming video is already a constant. Available at: https://www.emarketer.com/Article/Some-Live-Streaming-Video-Already-Constant/1016137 [Accessed 20 March 2019]

Katz, E., Blumler, J. G., and Gurevitch, M., 1973. Uses and gratifications research. *The Public Opinion Quarterly*, *37*(4), 509-523.

Krippendorff, K., 2004. *Content analysis: An introduction to its methodology* (2nd ed.). Thousand Oaks, CA: Sage.

Kubelka, J., Robbes, R. and Bergel, A., 2018. The road to live programming: insights from the practice. In: *Proceedings of the 40th International Conference on Software Engineering* Gothenburg, Sweden, May 2018 (pp. 1090-1101). New York: ACM,.

Law, K. M., Lee, V. C. and Yu, Y. T., 2010. Learning motivation in e-learning facilitated computer programming courses. *Computers & Education*, *55*(1), pp. 218-228.

Lin, C. A., 2002. Perceived gratifications of online media service use among potential users. *Telematics and Informatics*, *19*(1), pp. 3-19.

Maslow, A., 1971. *The farther reaches of human nature*. New York: The Viking Press.

McDirmid, S., 2016. The promise of live programming. In: *Proceedings of the 2nd International Workshop on Live Programming, LIVE,* Rome, Italy (Vol. 16),

McQuail, D., 1993. *Mass communication theory*. Sage: London.

Mone G., 2015. Next in live entertainment: watching people code.Communications of the ACM, March 24, 2015Available at: https://cacm.acm.org/news/184758-next-in-live-entertainment-watching-people-code/fulltext [Accessed 20 March 2019]

Pai, P. and Arnott, D. C., 2013. User adoption of social networking sites: Eliciting uses and gratifications through a means–end approach. *Computers in Human Behavior*, *29*(3), pp. 1039-1053.

Papacharissi, Z. and Mendelson, A., 2010. 12 Toward a new (er) sociability: uses, gratifications and social capital on Facebook. *Media Perspectives for the 21st Century*, pp. *212-230*. DOI:10.4324/9780203834077

Papacharissi, Z., and Rubin, A. M., 2000. Predictors of internet use. *Journal of Broadcasting & Electronic Media*, 44(2), pp. 175-196.

Patel N., 2018. Why you should care about live streaming in 2018. Available at: https://neilpatel.com/blog/live-streaming-importance-2018/ [Accessed 20 March 2019]

Paxton, J., 2002. Live programming as a lecture technique. *Journal of Computing Sciences in Colleges*, *18*(2), pp. 51-56.

Repenning, A., Webb, D. and Ioannidou, A,. 2010. Scalable game design and the development of a checklist for getting computational thinking into public schools. In: *Proceedings of the 41st ACM technical symposium on computer science education* Milwaukee, Wisconsin, USA, March 10-13, 2010 (pp. 265-269). New York: ACM,

Robins, A., Rountree, J. and Rountree, N., 2003. Learning and teaching programming: A review and discussion. *Computer Science Education*, *13*(2), pp. 137-172.

Rubin, A. M., 2009. Uses and gratifications. In: R. L. Nabi and M. B Oliver (eds). *The SAGE handbook of media processes and effects*. California, CA: Sage Publications.

Ryan, R. M. and Deci, E. L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), pp. 68.

Samat, N. A. A., Hashim, H.,and Yunus, M. M., 2019. Live streaming: a new platform for ESL learning. *Creative Education*, *10*(12), pp. 2899-2906.

Scholz, T. M.. 2012. New broadcasting ways in IPTV–The case of the Starcraft broadcasting scene. In *World Media Economics & Management Conference*, Thessaloniki, Greece, 23-27 May 2012.

Sherry, J. L., Lucas, K., Greenberg, B. S. and Lachlan, K., 2006. Video game uses and gratifications as predictors of use and game preference. In: P. Vorderer and J. Bryant (eds). Playing video games: motives responses, and consequences (pp.213-224). Mahwah, NJ: Lawrence Erlbaum Associates.

Shneiderman, B. and Mayer, R., 1979. Syntactic/semantic interactions in programmer behavior: A model and experimental results. *International Journal of Computer & Information Sciences*, *8*(3), pp. 219-238.

Sjöblom, M. and Hamari, J., 2017. Why do people watch others play video games? An empirical study on the motivations of Twitch users. *Computers in Human Behavior*, *75*, pp. 985-996.

Smith, T., Obrist, M. and Wright, P., 2013. Live-streaming changes the (video) game. In: *Proceedings of the 11th European Conference on Interactive TV and Video* (pp. 131-138). New York: ACM. DOI:10.1145/2465958.2465971

Smock, A. D., Ellison, N. B., Lampe, C., and Wohn, D. Y., 2011. Facebook as a toolkit: A uses and gratification approach to unbundling feature use. *Computers in Human Behavior*, *27*(6), 2322-2329.

Van der Heijden, H., 2004) User acceptance of hedonic information systems. *MIS quarterly*, 28(4), pp. 695-704.

Venkatesh, V., 2000. Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research*, *11*(4), pp. 342-365.

Whiting, A. &and Williams, D., 2013. Why people use social media: a uses and gratifications approach. *Qualitative Market Research: An International Journal*, *16*(4), pp. 362-369.

Zimmer, F., 2018. A content analysis of social live streaming services. In: Meiselwitz G. (eds) International Conference on Social Computing and Social Media: User experience and behavior, SCSM 2018. Lecture Notes in Computer Science, vol 10913. (pp. 400-414). Cham: Springer. DOI:10.1007/978-3-319-91521-0_29

Perception of e-Learning Among Hungarian Engineering Students

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Abstract: The success of developing e-learning is determined by curriculum quality, the availability of technological requirements and, to an even greater extent, by user response to the technology introduced in the process. Digital enhancement of education through e-learning solutions should also take the unique attributes of the targeted local region, institution, target group and field of expertise into consideration prior to implementation. The paper reports on research conducted to understand the approach of engineering students (n=94) to e-learning supported by Moodle in Hungary, including computer use, evaluation of e-learning materials, systems and online exams. The research used an online questionnaire for exploring the motivation and restrictive factors of using e-learning. Survey findings confirm that e-learning functions primarily in a complementary way to traditional learning. 87.2% of the students in the sample just download the learning materials and use those offline often or regularly. 58% of them find the usefulness of e-learning materials good, but structure or aesthetics is evaluated weak or moderate by more than half of the respondents. Considering the exams, 38% of the students with previous experience in online exams prefer the traditional exams, while 25% prefer the online format. Since access to technological tools and services required for effective e-learning is available, continuous training of the teachers and tutors is necessary both for developing their everyday skills and recognizing the LCMS opportunities.

Keywords: e-learning, attitudes, computer use, ICT, information society

1. Introduction

The transformation of social and economic systems and the frequent changes of the labour market in recent decades brought lifelong learning to the forefront (Jarvis, 2010), and in this context, developing learning capacities became the key to successful learning (McLagan, 2017). In response to the need for adaptability to the accelerated digital world and the growing availability of info-communication tools (ICT), new education models are elaborated (Cobb, 2013). E-learning systems with their flexibility regarding time and place appeared and became widely accepted as new means to provide learning opportunities for students first entering higher education and for students reentering with the need to refresh or supplement their knowledge and acquire new skills and competencies defined by their job requirements. The spread of the internet boosted information flow and it gave e-learning a dual role: it simultaneously acts as a place for the distribution of educational materials and as a tool of communication between teachers, tutors, and students engaged in the educational activity (Dura and Mihăilescu, 2014). Corporate and campus agendas have started to recognize e-learning as having the power to transform the performance, knowledge and skills landscape (Fatsiori, Tsimaras and Zoulias, 2018).

There is a conceptual diversity about e-learning in the literature that makes the interpretation and evaluation of the solutions complicated. Despite the fact that there is an agreement on the concept of e-learning as a teaching method (Peycheva, 2002; Kahiigi et al., 2008), there are several definitions in use. Engelbrecht (2003) or Urdan and Weggen (2000) mention the entire spectrum of electronic media as delivering tools, including internet, intranet, extranet, satellite broadcasts, audio/video, interactive TV and CD-ROMs. Meredith and Newton (2003) limit the medium to online forms, such as the internet and other web-based technologies. Recent trends show the appreciation of MOOC (Massive Open Online Course) (Barak, Watted and Haick, 2016), but these are not to be considered as equivalents of a traditional courses (Hew and Cheung, 2014). Flexibility is a keyword in e-learning development (Khan, 2007; Ollé, 2012) as is blended learning, which is a mix of traditional learning methods and e-learning elements that represent the middle path. E-learning solutions can effectively support flipped education methods (Estrada et al., 2019) or other atypical methods for student-centered learning.

E-learning and related solutions are by now heard of all over the world, yet their utilization isn't spread equally. This also means that there are several frameworks, methods and good practices of application that can be tailored to differing needs. Thus, taking into account local limiting factors, e.g., the paucity of bandwidth, scarcity

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of technical equipment, lack of expertise (Ahmed, Hussain Farid, 2018) as well as the e-learning preparedness of teachers and information technology (IT) competencies of students and the preparedness of both universities and students, are inevitable. An attractive feature of e-learning solutions is cost-efficiency. Studies investigating developing countries frequently highlight this benefit (Alamin and Elgabar, 2014; Hadullo, Oboko and Omwenga, 2017). Although cost-savings are essential for each country and university, the indirect and long-term costs of any misguided efforts may result in them exceeding their current expenses.

The acceptance of new or developed technology is a decisive condition of its application. There are several models and frameworks developed for describing the factors of success during the recent decades. Isaias and Issa (2015) summarize these models as quality evaluation models for information systems. Technology Acceptance Model (TAM) became a popular framework for exploring the attitudes and intentions of using e-learning solutions. In line with other results in the field, Ibrahim et al. (2017) found that computer self-efficacy has significantly affected ease of use, while perceived ease of use significantly affects intention to use e-learning. A comprehensive analysis is difficult to feasible since the local characteristics and cross-cultural differences (Kurdi, Alshurideh and Salloum, 2020) must be kept in mind. However, sharing experience is essential both for researchers and system developers. Critical success factors of e-learning systems within a university environment should be investigated, including the teacher's understanding (Sadeck, Chigona and Cronjé, 2020).

In terms of the analysis content Selim (2017) grouped the key factors of the success and acceptance of e-learning systems into four categories: instructor, student, information technology and university support. Based on an extensive literature review, Alhabeeb and Rowley (2018) identified that key success factors of e-Learning can be divided into five main groups: instructor characteristics, student characteristics, technology infrastructure, learning systems and online learning resources, support and training. The authors also stated that most of the previous studies focused on the student perspective described by Horton (2011). The concept emphasizes that the understanding of the real needs of students can lead to developing powerful applications and making the e-learning system more useful. In this regard, there is a consensus in the literature (Alhabeeb and Rowley, 2018; Lee, Yoon and Lee 2009) that students' characteristics include their experience, habits, trust and concerns regarding computer and internet usage and their attitude toward e-learning. Beyond the availability of well-structured and easy-to-use course materials as an important determinant of students' attitudes toward e-learning, enjoying the benefits of these solutions requires access to well-functioning learning systems and general IT competencies.

E-learning designed to support engineering education comes with unique characteristics and challenges. Beyond the professional skills in engineering work, a well-trained engineer must also face the rapidly changing environment, especially the accelerated information flow in professional communication. Being able to use a new CAD program, programming or simulation software no longer provides a competitive advantage in their field, and having high-level general IT competencies is a must (Pappas et al. 2019). Mallya and Srinivasan (2019) also highlight that the introduction of cloud-based mobile learning in studying an engineering subject is productive and has a positive impact on education competencies of engineering students. As Banday, Ahmed and Jan (2013) stress, engineering education traditionally follows the lecture-tutorial-laboratory paradigm and by being based on science and mathematics, needs higher level of interaction, however, more difficulties can arise in the processes of students' autonomous learning (Tawil et al. 2011). Besides the rapid uptake of ICT-based solutions, multimedia applications and software that reinforce the cognitive and procedural skills in engineering education ensure the nonlinear access to learning materials, and give the students the freedom to proceed at their own pace (Gupta, 2002) the number and accessibility of university-based virtual and remote laboratories is also growing (Banday, Ahmed and Jan 2013). Asenova and Simenov (2018) and Fernández-Rodríguez et al. (2013) show that the main advantages of e-learning in engineering education are 1) improving the quality of university education, 2) removing hindrances and expanding the accessibility to educating various groups of students (including those with special educational needs), 3) shaping professional competencies in the context of person-oriented flexible training, and 4) by performing lab exercises virtually, the reliance upon physical equipment, tools and supporting staff can be reduced. Cornejo et al. (2021) demonstrate that the use of e-learning platforms in engineering education can increase technological speed, allowing the creation of learning spaces on the Internet with a wide range of functionalities. Although the availability of digital and digitalized course materials, learning tools, and virtualized demonstrations via learning management systems can enhance the performance and learning experience of students, platforms and modes of asynchronous and synchronous communication should also be made available.

Earlier research studies have attempted to explore the enormous versatility of e-learning systems and programmes and to address the key challenges and opportunities of e-learning development from the perspective of different stakeholder groups, decision levels, methodological or technical issues. According to our understanding, in order to increase the efficiency of e-learning systems and to support their adaption, it is necessary to align e-learning development goals to the expectations of targeted students as end-users. This study aims to contribute to the existing knowledge base by presenting exploratory pilot research regarding engineering students' perspectives utilizing e-learning systems in a Hungarian university. By doing so, the authors hope to stimulate interest in and provide directions for future research taking into account local circumstances and discipline-specific features in the national context.

2. Problem formulation

2.1 Research goals and background

In the relevant literature sources dealing with the critical success factors of the adaption of e-learning systems, advanced technology infrastructure, i.e. the level of connectivity, broadband and mobile network coverage, the availability of ICT tools and the understanding of users' digital and software skills are the most important prerequisites for the deployment of e-learning systems. The reports of the Hungarian Central Statistical Office (KSH, 2018; KSH, 2019) confirm that internet access was available in 86% of the households in Hungary in 2018, and 59% of all internet subscriptions were cell phone-based connections. 96% of the subscriptions were either 4G or LTE. Data traffic shows a dynamic growth; the traffic of 64 Petabytes in 2018 Q3 is 60% higher than that of in 2017 Q3. Furthermore, 75% of the Hungarian population is an active computer user (the EU average is 79%) and 77% is an active internet user (the EU average is 84%). Online activity exceeds the EU average values in Hungary. Participation in social networks was 86% in 2018 (the EU average is 65%); the upload of own content to the internet is performed by 54% (the EU average is 40%). Business-oriented researches in this field also conclude that expansion of access to ICT tools is also developing, but the integration of digital technology in business remains the most challenging area (EC, 2019; Sasvári, 2013; Aureli, Ciambotti and Sasvári, 2014). Regarding the human capital dimension, only half of the population between 16 and 74 have basic digital skills, which is below the EU average (57%), and 26% of the population has advanced internet user skills (EC, 2019).

Even though access to the internet and the trends of ICT use are encouragingly progressive, only 5% of the population is engaged in market-based e-learning services. Moreover, higher educational institutions have limited room for manoeuvre in using an e-learning system. The notions of e-learning and digital learning are not embedded in the Hungarian legal regulation – except the pressure of the Covid-19 lockdowns –, and the programme accreditation procedure of the Hungarian Accreditation Committee does not allow for national and international courses that are fully dependent on the e-learning system in state-accredited programmes. In this sense, traditional face-to-face approaches supplemented with e-learning materials and platforms, and blended learning solutions are the viable options in Hungary. Although the intention of the university is to increase the role of e-solutions to prepare the engineering students to the modern business environment which received an important boost by the Covid-19 lockdowns. The assessment of benefits and risks are not yet available, hopefully a positive experience will trigger a change in regulation.

The recent situation analysis concerning e-learning in higher education performed by the Hungarian Government in 2016 reveals that while the basic ICT infrastructure and the electronic public services of higher educational institutions are outstanding, the use of e-learning systems and digital education are developing slowly and sporadically, and the digital availability of course descriptions, requirements, contents, library aids and tests is varied in terms of quantity and quality both within and among the higher educational institutions (Hungarian Government, 2016). Although the level of use of e-learning systems by academics and by students seems to be still low and the national strategy on the development of digital education defines goals and actions at the legislative level, there is no clear guidance on the measures to be taken to support the acceleration of the adaption of e-learning systems, and the increase of user satisfaction with the e-learning systems. Thus, targeted investigations considering the unique characteristics of disciplines and programmes, e-learning systems, and the aims, needs and experience of users are needed to be able to improve the effectiveness of e-learning, and through this, to develop higher education.

This paper investigates the case of a Hungarian university (University of Miskolc) using Moodle as a learning management framework for engineering education. As in all Hungarian universities, traditional lectures and seminars are the core tools of education, and e-learning supplements those. In line with the general findings in the literature, the use of face-to-face approaches in most engineering courses is almost still similar to what practiced in the past, meaning that the traditional lecture-tutorial-laboratory paradigm still dominates the engineering education in the university. Improving the teaching-learning process of these courses by the introduction or the more intensive application of the platform and its services depends not only on the technology itself but also on how the students use it and their previous learning experience. Although the platform is able to support and manage teacher-student interactions, including the sharing of learning materials and the submission of homework, several problems arise from misunderstandings in communication, which, consequently, may lead to uncertainty and distrust since:

- students usually ask for downloadable and printable materials,
- after uploading a task to the LCMS (Learning Content Management System), several students also send it by e-mail or ask for an e-mail confirmation to see if the file was received.

Assuming that technical infrastructure is appropriate, it is important to investigate the students' aspects of acceptance of e-learning, including motivations and other influencing factors. Therefore, the goal of our research is to understand the habits and the motivations for using or refusing the usage of e-learning systems, materials and methods by engineering students.

In line with previous research findings, the following three hypotheses were formulated for the research:

- H1: ICT tools and competencies are available in Hungary for supporting successful e-learning.
- H2: Attitudes to e-learning differ by age, gender, level of studies or work experience.
- H3: Experience gained in e-learning increases the trust in it.

2.2 Research design

A questionnaire with short answers and scaled ratings has been designed to investigate the main influencing factors of e-learning systems from the students' perspective. In line with the literature and the research hypotheses, the subject of investigations includes:

- computer use of engineering students,
- opinions about former IT education,
- use of e-learning materials,
- attitude towards e-learning materials,
- trust in e-learning.

Data collection is performed by an online survey managed by the EVASys Survey Automation Software. Data analysis is supported by IBM SPSS statistical software. Beyond descriptive statistics, the analysis of relationships uses cross-tabulation, ANOVA analysis and correlation analysis. A reliability test (Cronbach's Alpha) was applied where available. The test result is good (Cronbach's Alpha=0.87) for the evaluation of the digital learning materials (Section 3.4), and acceptable (Cronbach's Alpha=0.74) for the evaluation of the e-exams (Section 3.5).

The representativeness of the sample is not ensured. Although findings directly support the development of e-learning solutions, the interpretation is limited due to the scope of data collection, especially the territorial limitation. Another limitation is given by the age of the respondents, students between the age of 20 and 30 years old are overrepresented, since learning is becoming increasingly common at an older age.

3. Results

3.1 Sample characteristics

The research sample consists of engineering students at the University of Miskolc, including various study programs and levels. The data collection period covers the autumn of 2018. The sample includes the responses of 94 students. The sample includes 41 female and 53 male respondents. 65 respondents are studying bachelor level programs, and 29 of them are master students. 44 students do not have any work experience. The composition of the sample by age is presented in Figure 1.

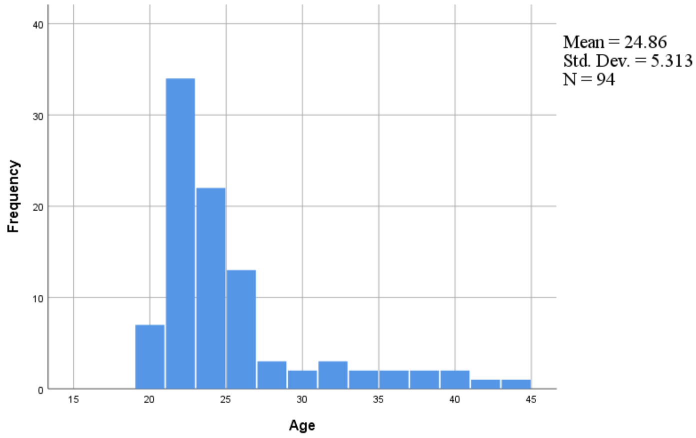

Figure 1: Distribution of age of the respondents (SPSS output)

3.2 Computer use

The respondents spend a considerable amount of time with ICT use. 53 of them use a desktop computer for an average of 4.2 hours per day. A notebook is used by 71 of them, the average time spent on it is 3.5 hours per day. Smartphone use exceeds these values, 90 of 94 students use such devices, the average usage time is 5.4 hours per day. Since work obligations may influence the necessity of computer use, an ANOVA test was conducted. There is a significant difference in the use of desktop computers (x_{no_work}=3.39, x_{work}=4.97 F=4.457, sig.=0.017). Although the difference is not significant, males (4.1 hours per day) spend more time with notebooks than females (2.8 hours per day), but females lead in smartphone use (5.8 hours compared to 5.0 hours per day).

Internet is mostly accessed via Wi-Fi or mobile internet. 39.4% of the respondents frequently connect to free access Wi-Fi networks, while 18.1% prefer mobile internet (even if free Wi-Fi is available) and 4.3% completely stay away from accessing the web this way. Mobile internet access is frequently or continuously used by 79.8% of the respondents (Figure 2).

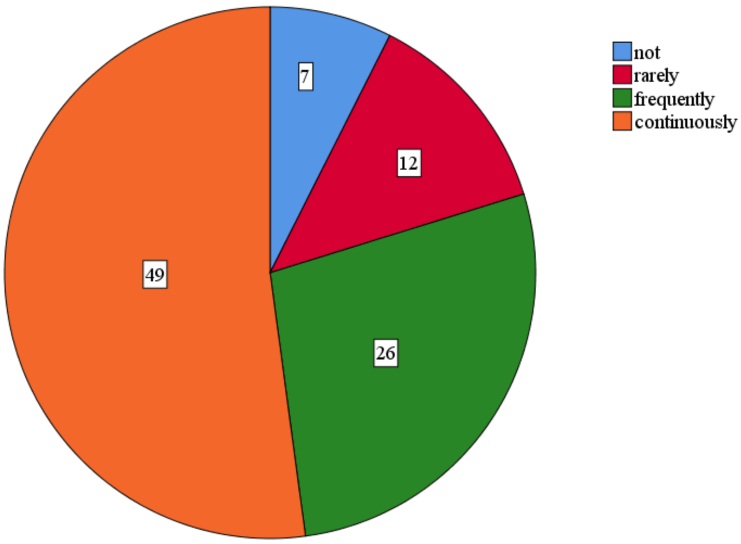

Figure 2: Use of mobile internet access

Cross-tabulation does not show differences in mobile internet or free Wi-Fi use by gender, study level or the level of work experience.

3.3 Evaluation of IT education

IT education is a determining factor for developing general IT competencies and has an impact on the attitude toward the use of ICTs and Internet. The content and the quality of IT courses at the elementary, secondary school level and higher education are difficult to compare due to the diverse goals, concepts and approaches, therefore the survey asks students to mark their level of satisfaction on a 6-point scale (higher value shows higher level of satisfaction). Based on the average values, students are moderately satisfied with the level of IT education (primary school: 3.06, secondary school: 3.54, higher education: 2.91), and are least satisfied with higher education. 43.5% is rather satisfied with the IT education in primary school, this ratio is only 30.8% in the case of higher education (Figure 3).

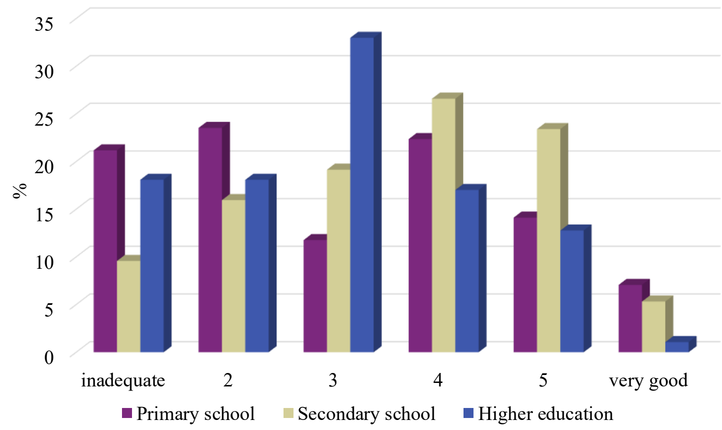

Figure 3: Evaluation of IT education

The non-parametric correlation test shows significant but weak correlations between the results on primary and secondary school levels. There is no significant correlation between the evaluations of IT education at secondary school and higher education levels (Table 1).

Table 1: Correlation between education levels about satisfaction with IT education (Spearman's rho values)

		IT education, primary school	IT education, secondary school	IT education, higher education
IT education, primary school	Correlation Coefficient	1.000	.483**	.137
	Sig. (2-tailed)	.	.000	.187
	N	94	94	94
IT education, secondary school	Correlation Coefficient	.483**	1.000	.194
	Sig. (2-tailed)	.000	.	.062
	N	94	94	94
IT education, higher education	Correlation Coefficient	.137	.194	1.000
	Sig. (2-tailed)	.187	.062	.
	N	94	94	94

**. Correlation is significant at the 0.01 level (2-tailed).

There are no significant differences in satisfaction by gender, age, study level or work experience.

3.4 Evaluation of digital learning materials

The research highlights two forms of digital learning materials and asks the frequency of use in two ways:

- downloadable lecture sketch and notes, slide shows,
- using learning content management (LCMS) systems such as Moodle.

The survey asks to evaluate the digital learning materials by structure, usefulness, aesthetics, actuality, and usability. Downloading materials and using those offline is common, 87.2% of the respondents often or regularly do this. As Figure 4 illustrates, using Moodle for supporting online learning is at lower popularity among the respondents. Most of the students consider the e-learning system as an official storage platform for course materials.

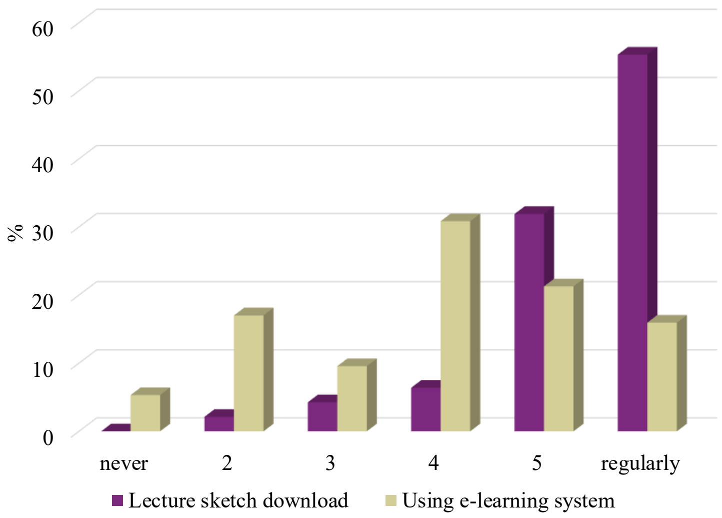

Figure 4: Using digital learning materials (frequency by the % of the respondents)

The usefulness and the usability of e-learning materials are considered rather good by about half of the students, but actuality and formal appearance are considered moderate or weak (Figure 5). Correlations between the answers show significant results. There is a strong correlation between structure and usefulness (Spearman's rho=.708 sig.=.000), structure and aesthetics (Spearman's rho=.728 sig.=.000). A moderate correlation is measured between aesthetics and actuality (Spearman's rho=.636 sig.=.000) as well as structure and manageability (Spearman's rho=.618 sig.=.000). All correlations are significant. These suggest that students have a general opinion about e-learning materials.

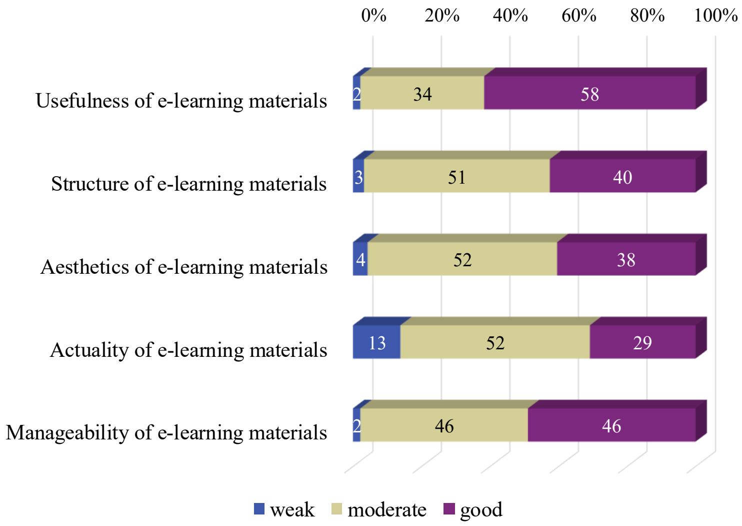

Figure 5: Evaluation of e-learning materials (number of respondents by satisfaction levels)

The H2 hypothesis states that satisfaction with e-learning materials differs by grouping factors of age, gender, study level, work experience or satisfaction with IT education. The statistical tests conducted are not significant; the hypothesis is rejected. Though the results suggest that younger respondents gave a better evaluation, the statistical analysis does not show significant impacts.

Correlation analysis between the ways of using digital learning materials show significant, but moderate or weak relationship (Table 2).

Table 2: Correlation using and evaluation of digital learning materials (Spearman's rho values)

		Using e-learning system	Using e-learning system (of other universities)
Usefulness of e-learning materials	Correlation Coefficient	.349**	.160
	Sig. (2-tailed)	.001	.124
	N	94	94
Structure of e-learning materials	Correlation Coefficient	.266**	.066
	Sig. (2-tailed)	.010	.528
	N	94	94
Aesthetics of e-learning materials	Correlation Coefficient	.294**	.149
	Sig. (2-tailed)	.004	.153
	N	94	94
Actuality of e-learning materials	Correlation Coefficient	.226*	.227*
	Sig. (2-tailed)	.029	.028
	N	94	94
Manageability of e-learning materials	Correlation Coefficient	.186	.048
	Sig. (2-tailed)	.072	.643
	N	94	94
E-exam	Correlation Coefficient	.162	.196
	Sig. (2-tailed)	.118	.059
	N	94	94
Technical reliability of e-exam	Correlation Coefficient	.183	.154
	Sig. (2-tailed)	.077	.138
	N	94	94
Ethics of e-exam	Correlation Coefficient	.247*	.121
	Sig. (2-tailed)	.016	.247
	N	94	94

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

3.5 E-exams

We found that trust in completing an exam online may give relevant information about the attitudes towards e-learning. 54.3% of the respondents have never made an exam online or by the support of software (jointly called e-exam), 28.7% had one e-exam and 17.0% had more.

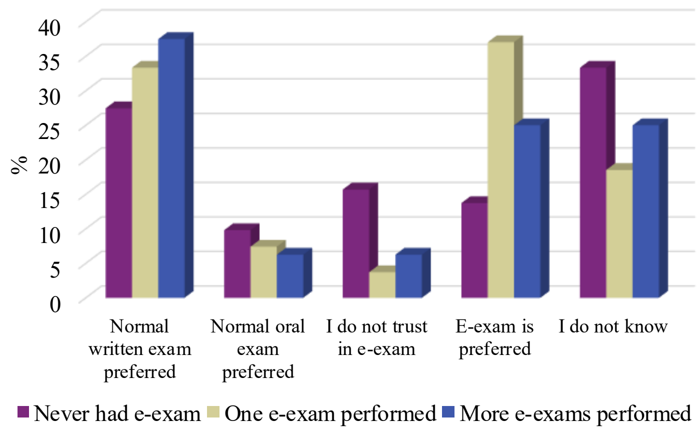

Figure 6: Preferences of e-exams or normal exams

Traditional written exams are clearly preferred by the respondents. However, it is encouraging that trust in e-exams is also observable, especially if a student has participated in one earlier (Figure 6). The refuse rate of oral exams is also observable, and the proportion of uncertain respondents is high.

The analysis of variance (ANOVA) about trust in e-exams shows significant differences by technical reliability (F=15.530, sig.=.000), ethics (F=11.464, sig.=.000) and contribution to effective learning (F=5.031, sig.=.008). Figure 7 summarizes the results on the trust in e-exams.

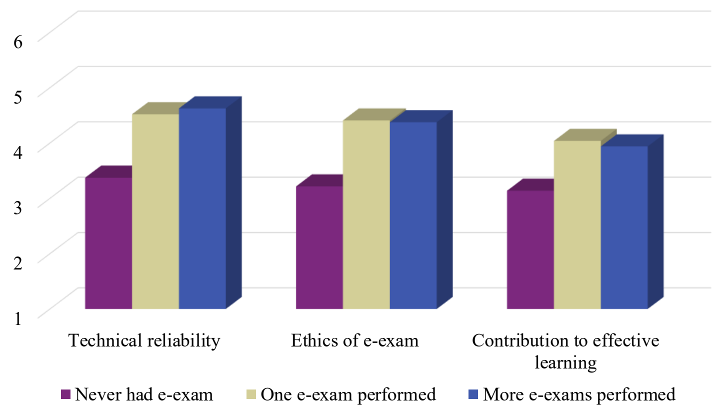

Figure 7: Trust in e-exams (mean value on a 6-point scale, higher value shows greater trust)

Statistical analysis does not confirm relevant differences by age, gender, study level, work experience or satisfaction with IT education.

4. Discussion

Checking the literature about the maturity of e-learning, the development of information society (Servaes, 2003; Buckland, 2017; Kovalchuk, 2020) and the intentions of higher education institutions in curriculum and methodological development (Somogyi and Szendi, 2018), e-learning seems to be the future of education. We believe that blended forms are important parts of graduate courses as well. Based on our experience, the level of utilization lags behind the opportunities, even though there are many opportunities available. According to Arasaratnam-Smith and Northcote (2017), understanding the students' sense can support the development of effective strategies towards a more digitalized and web-based higher education.

The quality of IT education at the former level is considered quite poor by the respondents; they marked mandatory and inadequate answers in the majority. Results related to the IT-based education at the higher education show considerable dissatisfaction that is a clear sign of the need for innovation.

The specific online activities of the respondents are focused on searching and downloading materials, while the utilization of learning and content management systems lags behind. It is to note that we experienced that several teachers and tutors prefer the sharing functions of the systems, while advanced options are unknown to them, which signals the need for education among teachers as well. Since a comprehensive blended learning program is more complex, including several functions of assessment and collaboration (Bentley, Selassie and Shegunshi, 2012), as Pollard and Hillage (2001) highlight, there is an urgent need for developing both teaching and learning styles to support blended learning courses. On the students' side, the main reason for this may be that they are afraid that the materials will no longer be available later. According to the teachers and tutors, the online education forced by the lockdown clearly revealed the lack of knowledge and experience in using an LCMS system including its opportunities.

Asenova and Simenov (2018) pointed out the necessity of well-structured e-learning courses. Our research shows similar results, i.e., structure, aesthetics, and actuality are critical factors. Results also suggest that students are ready to use e-learning, but disappointments in these technical aspects worsen the overall picture.

Exams integrated into the e-learning solutions are not regularly used by the educators, which influences students' opinions about e-exams. The study demonstrated, that more experience may lead to better acceptance of these exams.

Statistical tests show relevant and significant effects of various grouping factors (age, gender, level of studies) only sporadically. Although students were asked from various engineering specializations, the sample of the engineering students seems to be homogenous. An engineering student must be able to react to the challenges that occur in a rapidly changing society. This includes enhanced IT/ICT competencies even beyond the use of professional software as well as access to up-to-date knowledge in a modern form.

According to the hypotheses of the research, the statistical analysis confirmed the following results:

- H1 states that the availability of ICT tools and competencies is given, so the lack of these does not constitute a hindrance to successful e-learning use. The results of the survey presented by Section 3.3 explicitly and Section 3.4 implicitly, clearly show a modern approach to ICT and active use of them. H1 can be accepted.
- H2 says that students' characteristics can be grouped. We conducted cross-tabulation, non-parametric correlation tests (Spearman's rho) and ANOVA, for all of the influencing factors to check the impacts of grouping factors, but no relevant ones were found. Consequently, H2 must be rejected.
- H3 is about the knowledge and experience level in e-learning. The result allows accepting partly the hypothesis; better knowledge and more experience can boost successful utilization by initiating network effects. Correlation test results, described in Section 3.5, are significant, but moderate values suggest that other factors also influence the results. According to results, the experience with e-exams lead to a higher level of trust.

5. Conclusions

Key findings confirm that the engineering students of the University of Miskolc are active computer users and they are online. The access to technological tools and services required to effective e-learning is granted, and the utilization of ICT allows the assumption that the students possess all necessary competencies.

Due to the widespread adoption of fast and ultrafast broadband infrastructure and the high coverage of next-generation access and ICT devices, the technological conditions of online learning are provided. Strategic measures and actions should be taken to improve personal attitudes. Since experience with e-learning leads to better acceptance, a diverse toolset must be applied that gradually shows the available benefits of e-learning to students.

Therefore, teachers and students must be persuaded to use e-learning more accurately. If the utilization of the LCMS system is limited to uploading and downloading lecture notes, efforts are wasted. Continuous training of the teachers and tutors is necessary to develop their everyday skills and show the LCMS opportunities.

6. Suggestions for further research

This study was conducted in a short period of time and investigated one sample student group numbering 94 engineering students. Although this work has some limitations as the small sample size does not provide a complete view of the current situation, it is suitable to demonstrate the importance of future research. It is expected that the paper could serve as a starting point for systemic analyses with newly introduced variables and with a larger scope, especially in Hungary, where e-learning and digital learning are not embedded in the national regulation. In-depth analysis of the knowledge related to the entire service spectrum of Moodle, the frequency and intention of use on both sides would prove critical. Exploring teachers' attitudes to e-learning platforms and the availability, quality and use of IT and e-learning trainings for teachers and students offered by the universities would be gainful to fill the research gap in the Hungarian context and identify the opportunities for improving the teaching-learning process of engineering education.

Conflicts of Interest

The authors declare no conflict of interest.

References

Ahmed, M.U., Hussain, S. and Farid, S., 2018. Factors influencing the adoption of e-learning in an open and distance learning institution of Pakistan. *The Electronic Journal of e-Learning*, 16(2), pp.148-158.

Alamin, H.A. and Elgabar, E.A., 2014. Success factors for adopting e-learning application in Sudan. *International Journal of Soft Computing and Engineering*, 3(6), pp.128-131.

Alhabeeb, A. and Rowley, J., 2018. E-learning critical success factors: Comparing perspectives from academic staff and students. *Computers & Educations*, 127, pp. 1-12.

Arasaratnam-Smith, L. and Northcote M., 2017. Community in online higher education: Challenges and opportunities. *The Electronic Journal of e-Learning*, 15(2), pp.188-198.

Asenova, A. and Simenov, Z., 2018. Design of university e-course in electronics for future engineers. *WSEAS Transactions on Advances in Engineering Education*, 15(2), pp.44-48.

Aureli, S., Ciambotti, M. and Sasvári, P.L., 2014. The Penetration of business information systems in small and medium-sized enterprises in Italy and Hungary: A Comparative Study. *International Journal of Management Science and Information Technology*, 11, pp.64-95.

Banday, M.T., Ahmed, M. and Jan, T.R., 2014. Applications of e-Learning in engineering education: A case study. *Procedia-Social and Behavioral Sciences*, 123, pp. 406-413.

Barak, M., Watted, A. and Haick, H., 2016. Motivation to learn in massive open online courses: Examining aspects of language and social engagement. *Computers & Education*, 94, pp. 49-60. 10.1016/j.compedu.2015.11.010.

Bentley, Y, Selassie, H. and Shegunshi, A., 2012. Design and evaluation of student-focused eLearning. *The Electronic Journal of e-Learning*, 10(1), pp.1-12.

Cobb, J., 2013. *Leading the Learning Revolution: The Expert's guide to capitalizing on the exploding lifelong education market*. New York: Amacom.

Cornejo, C.C., Acasiete, R. C., Quispe, V. A., Valencia, J. M. and Salazar, F. G., 2021. *E-learning System Customized in the Integral Process of Teaching Learning of Engineering Students*. 2021 9th International Conference on Information and Education Technology (ICIET), 2021, pp. 222-226. 10.1109/ICIET51873.2021.9419597.

Dura, C.C. and Mihăilescu, S., 2014. Designing an ANOVA experiment to estimate the impact of e-learning system upon students' performances within the University of Petrosani. *WSEAS Transactions on Advances in Engineering Education*, 11, pp.21-31.

European Commission, 2019. Digital Economy and Society Index (DESI) 2019 Country Report Hungary. Available at: https://ec.europa.eu/digital-single-market/en/scoreboard/hungary [Accessed: 07.05.2020].

Engelbrecht, E., 2003. A look at elLearning models: Investigating their value for developing an e-learning strategy. *Progressio*, 25(2), pp.38-47.

Estrada, M., Vera, G., Ruiz, R. and Arrebola, I., 2019. Flipped classroom to improve university student centered learning and academic performance. *Social Sciences*, 8, 315. 10.3390/socsci8110315.

Fatsiori, A., Tsimaras, D. and Zoulias, E., 2018. Vocational education and training with e-learning tools as a response to the unemployment. *WSEAS Transactions on Advances in Engineering Education*, 15, pp.1-6.

Fernández Rodríguez, J.C., Granados, R., Javier, J. and Muñoz, M. F., 2013. Engineering Education through eLearning technology in Spain. *International Journal of Interactive Multimedia and Artificial Intelligence,* 2(1), pp.46-50. 10.9781/ijimai.2013.216.

Gupta, A., 2002. Content development for elearning in engineering education. *Digital Education Review*, 4, pp.12-23.

Hadullo, K., Oboko, R. and Omwenga, E., 2017. A model for evaluating e-learning systems quality in higher education in developing countries. *International Journal of Education and Development using Information and Communication Technology*, 13(2), pp. 185-204.

Hew, K.F. and Cheung, W.S., 2014. Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges. *Educational Research Review*, 12, pp.45-58. 10.1016/j.edurev.2014.05.001.

Horton, W., 2011. *E-learning by design*. New York: Wiley.

Hungarian Government, 2016. Digital eduational strategy of Hungary. Available at: https://www.kormany.hu/download/0/4b/21000/The%20Digital%20Education%20Strategy%20of%20Hungary.pdf. [Accessed: 07.05.2020].

Ibrahim, R., Leng, N.S., Yusoff, R.C.M., Samy, G. N., Masrom, S. and Rizman, Z.I., 2017. E-learning acceptance based on technology acceptance model (TAM). *Journal of Fundamental and Applied Sciences*, 9(4), pp. 871-889. 10.4314/jfas.v9i4S.50.

Isaias, P and Issa, T., 2015. *High level models and methodologies for information systems*. New York: Springer.

Jarvis, P., 2010. *Adult Education and lifelong learning: Theory and practice*. London: Routledge.

Kahiigi, E.K., Ekenberg, L., Hansson, H., Tusubira, F. F. and Danielson, M., 2008. Exploring the e-learning state of art. *The Electronic Journal of e-Learning*, 6(2), pp.77-88.

Kovalchuk, J., 2020. *Post-Industrial Society. The Choice Between Innovation and Tradition.* Cham: Palgrave Macmillan.

Központi Statisztikai Hivatal, 2019. Távközlés, Internet televízió, 2019. I. negyedév. *Statisztikai Tükör*, 20 June.

Központi Statisztikai Hivatal, 2018. Távközlés, Internet televízió, 2018. III. negyedév. *Statisztikai Tükör*, 10 Dec.

Kurdi, B.A., Alshurideh, M. and Salloum, S.A., 2020. Investigating a theoretical framework for e-learning technology acceptance. *International Journal of Electrical and Computer Engineering*, 10(6), pp.6484-6496. 10.11591/ijece.v10i6.pp6484-6496.

Lee, B-C., Yoon,J-O. and Lee, I., 2009. Learners' acceptance of e-learning in South Korea: Theories and results. *Computers & Education,* 53, pp.1320-1329

Mallya, K. and Srinivasan, D.B., 2019. Effect of Cloud based Mobile Learning on Engineering Education. *International Journal of Mechanical Engineering and Technology*, 10(3), pp.614-621.

McLagan, P.A., 2017. *Unstoppable you: Adopt the new learning 4.0 mindset and change your life*. Alexandria: ATD Press.

Meredith, S. and Newton, B., 2003. Models of e-learning: technology promise vs. learner needs – literature review. *The International Journal of Management Education*, 3(3), pp.43-56. 10.3794/ijme.33.73.

Ollé, J., 2012. *Virtuális környezet, virtuális oktatás*. Budapest: ELTE Eötvös Kiadó.

Pappas, M.A., Demertzi, E., Papagerasimou, I., Koukianakis, L., Voukelatos, N. and Drigas, A., 2019. Cognitive-based e-learning design for older adults. *Social Sciences*, 8(1), pp.1-18. 10.3390/socsci8010006.

Peycheva, R., 2002. *Design of the university course*. Sofia: University Publishing House "St. Kliment Ohridski".

Pollard, E. and Hillage, J., 2001. *Exploring e-learning*. Brighton: The Institute for Employment Studies.

Sadeck, O., Chigona, A. and Cronjé, J., 2020. Understanding e-learning acceptance among teachers: A Grounded-in-Theory Approach. *The Electronic Journal of e-Learning*, 18(6), pp. 575-587. 10.34190/JEL.18.6.009.

Sasvári, P.L., 2013. Usage habits of business information system in Hungary. *International Journal of Engineering and Innovative Technology*, 2, pp.141-147.

Selim, H.M., 2017. Critical success factors for e-learning acceptance: Confirmatory factor models. *Computers & Education*, 49, pp.396-413. 10.1016/j.compedu.2005.09.004.

Servaes, J. ed., 2003. *The European Information Society. A reality check*. Bristol: Intellect Books.

Somogyi, A. and Szendi, A. 2018. E-learning rendszerek a Miskolci Egyetemen és a könyvtári szolgáltatásokban. In: *NETWORKSHOP 2018*. Budapest, Hungary 4-6 April 2018. Budapest: Hungarnet.

Tawil, N.M., Ismail, N. A., Shaari, I., Osman, H., Nopiah, Z. M. and Zaharim, A., 2011. E-learning versus traditional method in teaching mathematics and statistics courses for engineering students in Universiti Kebangsaan Malaysia. In: *Kongres Pengajaran dan Pembelajaran UKM* 2011, Seminar Pendidikan Kejuruteraan dan Alam Bina (PeKA 2011), pp. 18-20.

Urdan, T.A. and Weggen, C.C., 2000. *Corporate e-learning: exploring a new frontier*. San Francisco: WR Hambrecht and Co.

Faculty Engagement in Online Education: Applying the Perceived Characteristics of Innovation to Explain Online Teaching Intention

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Abstract: There exists an increasing demand for online education; however, faculty may question the value of online courses as they grapple with making a connection between the face-to-face classroom and the online learning experience. Much research has focused on factors relating to student engagement, although we posit that faculty engagement represents an important aspect in the online learning context that has been fairly overlooked in the engagement research stream. Therefore, understanding the factors that influence a faculty's intention to teach an OL course in addition to their level of engagement in teaching an online learning course is vital to the growth and success of an OL program. Therefore, in this study, we seek to not only understand the factors that influence faculty's intention to teach online learning courses but also an instructor's level of faculty engagement in online learning courses. We sought a novel lens with which to examine this phenomenon, so this study utilizes the perceived characteristics of innovation (PCI) to examine the relationships between faculty engagement and intention to teach online learning courses. We conducted a survey of 99 instructors from a large public university in order to assess the impact of PCI on faculty engagement and intention to teach online courses. Structural equation modeling (SEM) was employed to analyze the data, concluding that result demonstration, relative advantage, and compatibility influence a faculty's level of engagement in an online learning course, which in turn influences their intention to teach an OL course. We discuss how this research can be utilized in order to more effectively allocate scarce resources by focusing on the relative advantage of online learning, the measurability of online learning, and the way in which it can be compatible with instructors teaching preferences. We present this study to enable the beginning of a new stream of research into faculty engagement.

Keywords: online learning, faculty engagement, perceived characteristics of innovation (PCI), engagement, structural equation modeling, online education

1. Introduction

More than 770 million learners worldwide have been impacted by university and school closures (Zhong, 2020), and many of them are now engaged in online learning (OL). Even before the COVID-19 pandemic, online learning increasingly played an important role in higher education (Freeman and Urbaczewski, 2019) and was expected to grow to a $325 billion market by 2025 (McCue, 2018); we posit that number will now increase. The rise of the Internet has created new ways of delivering courses to students including hybrid and online course delivery methods. There are more technology-related online courses than any other subject (The Chronicle of Higher Education, 2019). As information technology is rapidly evolving, students have become more interested in taking online courses while we are experiencing a digital revolution (Kaplan and Haenlein, 2016).

Students have begun to demand increased online course offerings for several reasons (Palvia et al., 2018, Wolverton, Hollier and Lanier, 2020). One of the reasons is that OL courses provide more flexible access to content, and instruction can be provided anytime and anywhere (Angiello, 2010, Coyner and McCann, 2004). Therefore, OL courses tend to be popular among students with jobs and families (Allen and Seaman, 2016, Lyons, 2004). For most of these students, an OL program represents their only path to a degree. Some OL students live in rural areas, do not have access to reliable transportation, face restricting disabilities, or find themselves with demanding family obligations (Li, Chen and Wu, 2020). An OL education may represent the only method in which the student is able to obtain an education (Palvia et al., 2018). Therefore, over 70% of universities consider online learning as *critical* for long-term educational success (Carraher-Wolverton and Zhu, 2020) and a 'core business' of the university (Stone, 2017).

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Online education has been extensively researched during the last two decades. Many studies on online education have concentrated on students, focusing on topics such as the learners' decisions to accept online learning and their satisfaction with online learning (Ahmed, 2010). Although it is clear that students play role in online learning, we postulate that researchers have neglected the importance of faculty (Meyer and Murrell, 2014, Tanis, 2020, Tanner, Noser and Totaro, 2009). There exists a dearth of studies that examine faculty's role in online programs. As little is known about the faculty who will teach these online courses, we seek to fill this gap in the literature.

Many faculty have expressed skepticism and disinterest in online education (Carraher-Wolverton, 2021, Kebritchi, Lipschuetz and Santiague, 2017, Osika, Johnson and Buteau, 2009). Instructors often face lack of empowerment in development of their online course content, as they are encouraged to adopt predefined content (Kebritchi, Lipschuetz and Santiague, 2017). They also indicate that the responsibility that comes with the OL courses is more, or at least the same, as their counterpart face-to-face courses (Howell, Williams and Lindsay, Kebritchi, Lipschuetz and Santiague, 2017, Schwarz and Zhu, 2015). Furthermore, faculty cite an increase in communication challenges in online courses, as technology inhibits their ability to read non-verbal cues from students (Coppola, Hiltz and Rotter, 2002, Limperos et al., 2015).

As the demand for online course offering increases, teaching online has become an expectation of faulty members in recent years. When the COVID-19 pandemic occurred, essentially all instructors became online instructors overnight. However, Bolliger and Wasilik (2009) indicated that online instruction is a complex undertaking and requires a higher level of commitment from faculty. Many instructors, whether they have taught online courses or not, feel that they did not enjoy it as much as teaching face-to-face classes (Carraher Wolverton and Guidry Hollier, 2019).

Indeed, only 9% of instructors prefer to teach a 100% online course (Darby, 2019, Pomerantz and Brooks, 2017). Some instructors have attempted to teach online but struggled with learning new technology (Osika, Johnson and Buteau, 2009) or were never offered training on the online technology (Kebritchi, Lipschuetz and Santiague, 2017). Moreover, technology can become a distraction in the course when it fails or is unreliable (Chang, Shen and Liu, 2014, Crawley, Fewell and Sugar, 2009). Instructors often grapple with making the connection between the face-to-face classroom and the online learning experience (Carraher Wolverton and Tanner, 2019). Some instructors are concerned about student teaching evaluations, as they are not physically engaging with their students in the same way as a face-to-face classroom. Indeed, less than 30% of faculty members accept the value and legitimacy of online education (Allen and Seaman, 2016).

It is clear that there is a growing unmet demand for online education and on the other hand the level of faculty members' willingness to teach online is relatively low (Kebritchi, Lipschuetz and Santiague, 2017). Therefore, understanding the factors that influence a faculty's intention to teach an OL course in addition to their level of engagement in teaching an online learning course is vital to the growth and success of an OL program. Hence, the purpose of this study is to determine the factors that influence a faculty's level of engagement in teaching an OL course in addition to their intention to teach OL courses. As certain factors influence an individual's decision to adopt a particular innovation, we posit that online classes can represent an "education innovation".

2. Literature Review

2.1 Perceived Characteristics of Innovating (PCI)

Multiple theories are available to explain the diffusion or adoption of technological innovations. These theories include the Technology Acceptance Model (TAM) (Davis, 1989), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003), Diffusion of Innovation (DOI) (Rogers, 1983, Rogers, 2010), Process-based view of information technology (IT) acceptance (Schwarz et al., 2014), and Perceived Characteristics of Innovating (PCI) by Moore and Benbasat (1991). According to Rogers (1983), the rate of adoption is the relative speed with which an innovation is adopted by members of a social system. It is measured by the number of individuals who adopt a new idea in a specified period. The rate of adoption is a numerical indicant of the steepness of the adoption curve for an innovation. Rogers (1983) also demonstrates that the rate of adoption can be strongly dependent on a number of characteristics of an innovation itself such as relative advantage, compatibility, complexity, trialability, and observability.

Studies in the online education research stream have applied well-accepted technology-acceptance models such as TAM (Liu et al., 2010, Ndubisi, 2006, Ndubisi and Chukwunonso, 2004) to predict intention of faculty to participate in online education. Similarly, we seek to apply a well-accepted technology-acceptance model to online education research. However, we are examining the phenomenon from the lens of the faculty, rather than the student, in order to determine the faculty's level of engagement and intention to participate in online education.

We selected the Perceived Characteristics of Innovating (PCI) as studies indicate that it explains substantially more variance than does TAM (Plouffe, Hulland and Vandenbosch, 2001, Poong and Eze, 2008) and it is more robust than TAM (Poong and Eze, 2008). Moore and Benbasat's (1991) PCI has been utilized to predict adoption of technology innovation in different industry settings. For example, Yaacob and Yusoff (2014) employed the PCI to examine the factors associated with the adoption perceived by trainer and trainees in computer-based training. They found that a positive relationship exists between PCI and adoption. Kim, Park and Lee (2017) utilized the perceived characteristics of innovation to investigate consumers' intention to use Buy-Online, Pick-up in Store (BOPS). They found that relative advantage, complexity, compatibility, and risks involved in online shopping are important factors influencing consumers' intention to use BOPS. However, these relationships were significantly moderated by locational convenience and types of product. Hashem and Tann (2007) studied the impact of three groups of factors on the adoption of ISO 9000 standards by manufacturing companies. The three groups of factors are characteristics of innovation, characteristics of the external environment, and organizational characteristics. Their result demonstrates each of the three groups of factors are significantly related to the adoption of ISO 9000.

The application of the Perceived Characteristics of Innovation can also be found in Chung and Holdsworth's (2012) study to investigate the relationship of the determinants of behavioral intent to adopt mobile commerce among the Y Generation. The researchers utilized structural equation modeling to test for construct validity and hypothesis testing. They concluded that Rogers' five perceived characteristics of innovation determined behavioral intent to adopt mobile commerce among the Y Generation. Thus, PCI has been applied in various contexts, and we seek to extend its application to examine the innovation of online learning.

In this study, we seek to apply the PCI to examine the adoption of the innovation of online learning. Specifically, we will employ PCI to determine the factors that influence a faculty's level of engagement in teaching an online learning course in addition to his/her intention to teach online learning courses. The issues surrounding a faculty's intention to teach online learning courses represents an important issue to address as the demand for online learning programs continues to increase (Freeman and Urbaczewski, 2019).

2.2 Faculty engagement

Engagement can be conceptualized by absorption, dedication, and vigor (Schaufeli, 2013, Schwarz and Zhu, 2015). Scholars have studied employee engagement (Saks, 2006, Schaufeli et al., 2002), student engagement (Kahu and Nelson, 2018, Schaufeli et al., 2002), and customer engagement (Prentice, Wang and Loureiro, 2019). Although most pedagogical research on engagement has focused on factors relating to student engagement (Schwarz and Zhu, 2015, Wolverton, 2018), we seek to extend the engagement research stream to address faculty engagement.

Understanding whether certain factors influence a faculty's level of engagement in a course and intention to teach an online course represents an important inquiry. We posit that the addition of the faculty engagement construct adds a related dimension whose importance has been clearly demonstrated on the student side and we postulate will be salient in the faculty decision as well. Therefore, we seek to not only understand the factors that influence faculty's intention to teach online learning courses but also an instructor's level of faculty engagement in OL courses.

3. Methodology

3.1 Survey development

We developed an online survey to collect data for our study, creating items for all the constructs to be studied. We adapted Moore and Benbasat's (1991) characterization of the Perceived Characteristics of Innovating (PCI) concepts to incorporate the OL context. Thus, we extend PCI from evaluating the adoption of technology to include evaluating an instructor's adoption of teaching an OL course.

The items utilized to measure faculty engagement were adapted from Schaufeli et al.'s (2002) established multi-dimensional student engagement measure, including absorption, dedication, and vigor. The behavioral intention (BI) measure was adapted from Venkatesh and Davis (2000). The construct names and items for the constructs are summarized in Table 1.

Table 1: Construct measures

Measures	Anchors	References
Faculty Engagement *Vigor (VI)* 1. When I get up in the morning, I feel like teaching my online course. 2. When teaching my online course, I feel bursting with energy. 3. When working on teaching my online course I always persevere, even when things do not go well. 4. I can continue for very long periods at a time when working on teaching my online course. 5. When working on teaching my online course, I am very resilient, mentally. 6. When teaching my online course I feel strong and vigorous. *Dedication (DE)* 1. To me, working on teaching my online course is challenging. 2. Teaching my online course inspires me. 3. I am enthusiastic about teaching my online course. 4. I am proud of the work that I do to teach my online course. 5. I find teaching my online course to be full of meaning and purpose. *Absorption (AB)* 1. When I am teaching my online course, I forget everything else around me. 2. I get carried away when I am working on teaching my online course 3. It is difficult to detach myself from working on teaching my online course. 4. I get immersed in working on teaching my online course. 5. I feel happy when I work intensely on teaching my online course.	Strongly Agree-Strongly Disagree	Adapted from Schaufeli et al 2002
Intention to teach an online course 1. I intend to teach an online course in the future. 2. I predict that I would teach an online course if I were asked.	Strongly Agree-Strongly Disagree	Venkatesh and Davis 2000
Perceived Characteristics of Innovating (PCI) *Voluntariness* 1. My Department Chair or Dean does not require me to teach online. 2. Although it might be helpful, teaching online is certainly not compulsory in my job. *Relative Advantage* 1. Compared to traditional (face-to-face) teaching, teaching online… 2. takes less time 3. provides a higher-quality teaching experience 4. is easier 5. makes me a more effective instructor 6. gives me greater control over my work *Compatibility* 1. Teaching online is compatible with the way I work. 2. I think that teaching online fits well with the way I like to work. 3. Teaching online fits into my work style. *Image* 1. People at my university who teach online have more prestige than those who do not. 2. People at my university who teach online have a high profile. 3. Teaching online is a status symbol at my university.	Strongly Agree-Strongly Disagree	Adapted from Moore and Benbasat 1991

Measures	Anchors	References
Ease of Use 1. I believe that it is easy to teach online. Overall, I believe that teaching online is easy. 2. Becoming comfortable teaching online was/would be easy for me. *Result Demonstrability* 1. I would have no difficulty telling others about the benefits of teaching online. 2. I believe I could communicate to others the consequences of not teaching online. 3. The benefits of teaching online are apparent to me. 4. I would have difficulty explaining why teaching online may or may not be beneficial. *Visibility* 1. At my university, I am aware that many instructors are teaching online courses. 2. Teaching online is often discussed at the university. *Trialability* 1. Before deciding whether to teach online, I was familiar with what it would involve. 2. I was provided with adequate training about how to teach online.		

3.2 Data collection

In order to test the proposed research model, an online survey was created to collect data for this study. We sent 821 invitations to instructors from seven different colleges, including instructors who currently teach online and those who do not teach online at a large public university in the southeastern United States. We received 99 usable responses for a response rate of 12%. According to the “10 times” rule, the sample size should be at least 10 times the number of incoming paths to the construct with the greatest number of incoming paths (Barclay, Higgings and Thompson, 1995, Chin and Newsted, 1999, Hair et al., 2017). Therefore, the sample size is sufficient.

3.3 Profile of respondents

A greater percentage of the respondents were female (68.69%). As displayed in Table 2, the greatest number of respondents came from the College of Liberal Arts (24.24%), Business (23.23%), and Education (19.19%).

Table 2: Respondent’s college

College	Percentage
Liberal Arts	24.24%
Business	23.23%
Education	19.19%
Nursing	15.15%
Sciences	13.13%
Arts	3.03%
Engineering	2.02%

As displayed in Table 3, most of the respondents (78.79%) designed and taught an online course.

Table 3: Experience of respondents

Experience of Respondents	Percentage
Taught an online course (*only*)	10.10%
Designed an online course (*only*)	0.01%
Designed and Taught an online course	78.79%
None of the Above	11.11%

3.4 Data analysis

We analyzed the data using structural equation modeling (SEM). Given our small sample size (n=99) and the corresponding lack of statistical power in utilizing a covariance-based approach (Westland, 2010), we selected the partial least squares (PLS) approach, specifically Smart PLS 3.0 (Ringle, Wende and Becker, 2015) software. We selected to utilize PLS, because it is the recommended method when the sample size for the data is limited (Barclay, Higgings and Thompson, 1995, Chin, Marcolin and Newsted, 2003, Chin and Newsted, 1999, Gefen, Straub and Boudreau, 2000, Hair et al., 2017).

3.5 Measurement model

The first step in a PLS analysis is the analysis of the measurement (or outer) model. Following the procedures outlined by Wright et al. (2012), our first step was the creation of a first-order measurement model. We began by analyzing the loadings and cross-loadings of all items to ensure that they each loaded on their respective constructs (see Table 4). As some items exhibited a coefficient alpha below the .70 threshold (Nunnally, 1978), they were removed from further analysis. We were thus able to simplify the model while ensuring that the sampling domain had been adequately captured (Churchill, 1979) without including items that make progressively less of an impact on the reliability (Carmines and Zeller, 1979). We then reanalyzed the loadings and cross-loadings of the items, and all loadings were greater on the intended construct than on any other constructs. Consequently, upon determining that none of the remaining items loaded higher on any construct other than the intended construct, we retained all the items.

Table 4: Loadings and Cross Loadings

Loadings and Cross Loadings												
	Intention	Compatibility	Ease of Use	Image	Relative Advantage	Result Demonstrability	Trialabillity	Visibility	Voluntariness	Absorption	Dedication	Vigor
INTENT1	0.923	0.636	0.24	-0.258	0.306	0.255	0.099	0.03	-0.168	0.487	0.514	0.526
INTENT2	0.908	0.555	0.351	-0.242	0.368	0.234	0.141	0.005	-0.141	0.406	0.479	0.521
PCI-COMP1	0.56	0.961	0.375	-0.167	0.623	0.631	0.337	-0.021	-0.115	0.618	0.657	0.677
PCI-COMP2	0.644	0.957	0.384	-0.127	0.633	0.621	0.327	-0.018	-0.164	0.614	0.74	0.699
PCI-COMP3	0.67	0.954	0.377	-0.081	0.59	0.567	0.26	0.061	-0.168	0.539	0.642	0.646
PCI-EOU3	0.32	0.396	1	-0.074	0.317	0.419	0.285	-0.098	-0.045	0.248	0.338	0.355
PCI-IMG1	-0.168	-0.084	-0.02	0.845	0.187	0.054	0.118	0.071	-0.088	-0.04	-0.006	0.042
PCI-IMG2	-0.189	-0.08	0.041	0.922	0.208	0.088	0.174	0.209	-0.069	-0.099	-0.07	-0.041
PCI-IMG3	-0.304	-0.155	-0.153	0.956	0.13	-0.002	0.089	0.042	-0.08	-0.094	-0.036	-0.066
PCI-RA2	0.378	0.605	0.364	0.139	0.898	0.515	0.146	-0.125	-0.124	0.507	0.657	0.678
PCI-RA4	0.305	0.551	0.144	0.131	0.874	0.523	0.073	-0.104	-0.126	0.473	0.665	0.583
PCI-RA5	0.259	0.51	0.324	0.19	0.828	0.473	0.217	-0.069	-0.11	0.384	0.517	0.453
PCI-RD1	0.228	0.531	0.339	0.032	0.517	0.908	0.178	0.062	-0.031	0.527	0.56	0.549
PCI-RD3	0.26	0.624	0.424	0.039	0.545	0.918	0.234	0.043	-0.198	0.555	0.634	0.522
PCI-TRIAL1	0.216	0.249	0.231	-0.06	0.125	0.04	0.724	0.051	-0.059	0.121	0.159	0.197
PCI-TRIAL2	0.023	0.267	0.228	0.23	0.133	0.287	0.863	0.061	0.154	0.164	0.156	0.248
PCI-VIS2	0.02	0.006	-0.098	0.124	-0.117	0.057	0.071	1	-0.014	-0.016	-0.092	-0.091
PCI-VOL1	-0.15	-0.143	-0.072	-0.079	-0.106	-0.141	0.032	-0.025	0.952	-0.203	-0.167	-0.014
PCI-VOL2	-0.174	-0.155	-0.022	-0.073	-0.155	-0.11	0.111	-0.005	0.972	-0.248	-0.207	-0.051
TEACH-ENG-AB1	0.243	0.293	0.081	0.071	0.334	0.333	0.245	0.019	-0.107	0.713	0.351	0.373
TEACH-ENG-AB2	0.338	0.468	0.056	-0.145	0.304	0.489	0.166	0.046	-0.336	0.845	0.54	0.402
TEACH-ENG-AB3	0.281	0.388	0.048	-0.103	0.27	0.304	0.194	0.027	-0.206	0.757	0.357	0.329
TEACH-ENG-AB4	0.45	0.632	0.253	-0.145	0.491	0.58	0.066	-0.059	-0.2	0.842	0.649	0.557
TEACH-ENG-AB5	0.52	0.542	0.428	-0.055	0.586	0.522	0.091	-0.064	-0.08	0.732	0.688	0.587
TEACH-ENG-DE2	0.409	0.634	0.276	-0.031	0.711	0.619	0.281	-0.086	-0.094	0.651	0.923	0.735
TEACH-ENG-DE3	0.53	0.645	0.312	-0.057	0.617	0.594	0.115	-0.163	-0.212	0.628	0.911	0.77
TEACH-ENG-DE4	0.417	0.59	0.286	-0.017	0.539	0.575	0.128	0.018	-0.227	0.553	0.797	0.592
TEACH-ENG-DE5	0.556	0.638	0.316	-0.09	0.64	0.522	0.16	-0.08	-0.17	0.601	0.887	0.672
TEACH-ENG-VI1	0.633	0.711	0.26	-0.116	0.567	0.533	0.176	-0.101	-0.026	0.555	0.694	0.86
TEACH-ENG-VI2	0.428	0.611	0.339	-0.015	0.65	0.541	0.404	-0.052	-0.019	0.566	0.743	0.911
TEACH-ENG-VI6	0.42	0.497	0.324	-0.032	0.513	0.44	0.131	-0.085	-0.051	0.414	0.602	0.822

We next evaluated the reliability, discriminant, and convergent validity of the first-order measurement model. Utilizing the item loadings, we calculated the internal composite reliability (ICR) to evaluate the measure's reliability, finding that all the dimensions exceeded the .70 threshold and were all above 0.78 (Table 5).

Table 5: Composite Reliability and Average Variance Extracted (AVE)

	Composite Reliability	**Average Variance Extracted (AVE)**
Absorption	0.885	0.608
Compatibility	0.971	0.917
Dedication	0.933	0.776
Ease of Use	1	1
Image	0.934	0.826
Intention	0.912	0.838
Relative Advantage	0.901	0.752
Result Demonstrability	0.909	0.834
Trialabillity	0.775	0.634
Vigor	0.899	0.748
Visibility	1	1
Voluntariness	0.962	0.926

Moreover, to estimate convergent validity, we evaluated each dimension's average variance extracted (AVE). Utilizing the threshold value of 0.50 for AVE (Barclay, Higgings and Thompson, 1995), our findings support convergent validity (Barclay, Higgings and Thompson, 1995).

4. Discussion

Our results indicate that certain factors in the PCI model predict intention, while other factors do not exert significant influence. Specifically, compatibility (β = 0.343, t=3.271, p <0.01) measures whether an innovation is consistent with the set of norms, values and other cultural aspects or religious beliefs that predominate in the population. Result demonstrability (β = 0.284, t=3.459, p <0.01) measures the degree to which the results of using an innovation are perceived to be tangible. Relative advantage (β = 0.335, t=3.480, p <0.01) indicates that an innovation will be adopted more widely when it is considered superior to the alternative solution that it replaces. All three above mentioned factors influence faculty engagement. However, image (β = -0.104, t=1.136, ns), ease of use (β = -0.006, t=0.092, ns), trialability (β = 0.038, t=0.658, ns), voluntariness (β = -0.051, t=0.928, ns), and visibility (β = -0.014, t=0.202, ns) do not impact faculty engagement. Moreover, all three of the first order constructs were components of the second order construct of engagement: vigor (β = 0.875, t=30.959, p <0.001); dedication (β = 0.922, t=76.439, p <0.001); and absorption (β = 0.858, t=30.374, p <0.001). Finally, faculty engagement influences intention to teach an OL course (β = 0.602, t=12.145, p <0.001). The results are displayed in the structural model in Figure 1.

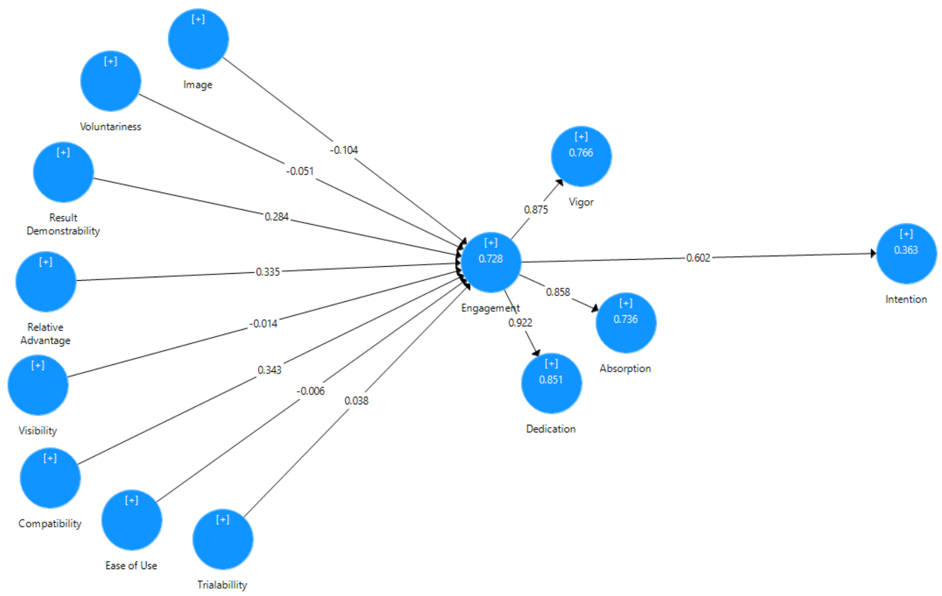

Figure 1: Research model

As the number of online learning courses offered at universities continues to increase, we propose that examining the factors that influence instructor's intention to teach an online course in addition to their engagement in teaching online courses represents an important contribution to the body of knowledge. Knowledge of the significant factors in addition to the unrelated factors enables universities to better target their efforts at motivating and engaging their faculty to teach OL courses. By demonstrating that certain factors do not influence a faculty's level of engagement or motivation, a university can instead focus on the factors with stronger influence.

Specifically, the findings indicate that result demonstrability, relative advantage, and compatibility influence a faculty's level of engagement in an online course, which in turn influences their intention to teach an OL course.

We will now discuss each of the PCI characteristics that influence faculty engagement and intention to teach an OL course.

4.1 Relative Advantage

Relative advantage describes the degree to which an instructor perceives teaching online as being better than teaching face-to-face. Thus, our findings demonstrate the importance of an instructor understanding the benefits of teaching online versus teaching face to face. By explaining the benefits to the faculty, instructors can begin to focus on some of the positive aspects of teaching OL courses. Moreover, explaining how OL courses are desired by students and can benefit some underserved students can assist in strengthening the perceived relative advantage of OL courses. For example, students who work full-time are often required to attend classes after a long day of work. With online courses, the students are able to time shift their coursework, listening to lectures and completing assignments on days when they are not already exhausted from a long workday.

4.2 Compatibility

Compatibility refers to the degree to which teaching online is perceived as being consistent with the existing values, needs, and past experiences of potential instructors. Just as students' schedules have become busier, instructor's time is often split between research, service, and personal activities. Therefore, the benefits that students are seeking from the flexibility of online learning courses can also be found for instructors. Instructors with heavy research, service, or personal responsibilities may value the flexibility that teaching online learning courses offers, as it may correspond with their existing needs and can therefore be compatible with their teaching preferences.

4.3 Result demonstrability

Result demonstrability is characterized as the extent to which teaching online is perceived as having measurable advantages that can be explained by the instructor. Result demonstrability involves the instructor being familiar with the benefits and struggles with online learning. This knowledge should include the ability to communicate both the benefits and difficulties with teaching online. Studies demonstrate the benefits of providing realistic portrayals (Buckley et al., 1998, Schwarz, 2011, Schwarz, 2015, Schwarz and Zhu, 2015, Wolverton et al., 2020). Thus, increasing knowledge of the realistic struggles of shifting their teaching paradigm to support online education, rather than merely marketing the benefits of online learning, can provide the instructor with greater confidence in their level of knowledge. This assurance can also provide the instructors with a greater ability to communicate about their experiences with teaching online. As faculty members tend to listen to their colleagues, this firsthand communication is vital.

4.4 Non-significant factors

Almost as important to consider as the significant factors are the characteristics that do not influence a faculty member's level of engagement in OL courses and their intention to teach online. These include image, voluntariness, visibility, ease of use, and trialability. Therefore, resources invested in increasing the pressure to teach online learning courses or increasing the status of teaching online courses will be ineffective. Furthermore, resources spent to ensure that it is easy to teach online courses or spending resources to provide exposure to online teaching will not influence an instructor's intention to teach online.

Resources are better spent focusing on the relative advantage of online learning, the measurability of online learning, and the way in which it can be compatible with instructors teaching preferences. By focusing on the factors that most strongly influence faculty engagement and intention to teach OL courses, resources can be more efficiently utilized to fulfill the need to offer more online courses. Specifically, we offer a couple of pointers to guide institutional practices:

1. Faculty need to be supported for their OL teaching (Van Wart et al., 2019). Research indicates that millennials, who represent the future of the faculty, seek employment at organizations where they feel valued (Carraher Wolverton, Credo and Matherne, 2021). Therefore, if faculty are needed to teach online courses and be engaged in their teaching, then they should be supported and engaged.
2. Faculty are more likely to devote time to OL practices if they see benefits or receive rewards or recognition for doing so (Van Wart et al., 2019). Due to their heavy workloads, it is very helpful to give the faculty time to experiment with OL teaching (Kumar et al., 2019).
3. Supportive networks can facilitate the diffusion of OL teaching. Training and workshops can encourage adoption of OL teaching (Mansbach and Austin, 2018). IT specialists and library representatives can be important in the OL course design. Students can play an important role in the evaluation of the resources (Khan et al., 2017).

5. Limitations

Although we found some interesting findings and useful results, our study was not without some areas for improvement. First, we utilized PLS for data analysis. Some researchers question the use of PLS for data analysis, claiming that it can allow for mis-specified measurement models based upon the fit indices that are typically reported (Gefen, 2019). However, others argue that PLS is a robust method (Sarstedt et al., 2020), and it has been extensively used in IS research (Kock and Hadaya, 2018).

Others might argue that our sample size was small, with 99 respondents. Therefore, we would encourage other researchers to replicate our study. However, according to the "10 times" rule (Barclay, Higgings and Thompson, 1995, Chin and Newsted, 1999, Hair et al., 2017), the sample size is sufficient to run our model.

6. Opportunities for future research

The researchers postulate that this study enables the beginning of a new stream of research into faculty engagement. The research stream of student engagement is healthy and diverse, yet there is a paucity of studies from the faculty lens. We postulate that if we can understand how to engage our best faculty in online education, then the students will be more engaged. At this point, however, there is no scientific way of knowing this, because it has never been studied; and, until now, we have never had a faculty engagement construct available to conduct these studies. Therefore, we encourage researchers to study the impact of faculty engagement on phenomenon such as student engagement, faculty burnout, and student learning.

With the collection of additional data, other relationships could be examined. For example, by surveying individuals who teach online and those who do not teach online, a researcher could investigate whether differences exist between *continuance intentions* and *intentions to adopt*.

7. Conclusions

As the number of OL courses increase, we must ensure that we have the faculty necessary to teach these courses. Therefore, in this study, the researchers seek to understand how to encourage and motivate more instructors to be involved in online teaching. Specifically, we have extended the perceived characteristics of innovation (PCI) model to examine its influence on faculty engagement and intention to teach online learning courses.

Although student engagement has been rather extensively studied, scant research has investigated the importance of faculty engagement in improving student learning. Through this study, we provide items to measure faculty engagement, which are adapted from an established student engagement measure (Schaufeli et al., 2002). Therefore, this represents a contribution to the engagement literature. We also contribute to the online learning literature by examining the influence of the PCI characteristics on faculty engagement and intention to teach OL courses.

The findings from this study can be utilized to understand the characteristics that engage faculty in OL courses and spur them on to teach OL courses. As demand for OL courses continues to increase, universities will need engaged faculty to provide high-quality education to students from all areas. This study seeks to enhance this effort, as we continue to move into the digital revolution.

References

Ahmed, H.M.S., 2010. Hybrid e-learning acceptance model: Learner perceptions. *Decision Sciences Journal of Innovative Education*, 8(2), pp.313-346.

Allen, I.E. and Seaman, J., 2016. *Online report card: tracking online education in the United States*. Babson Park, MA: Babson Survey Research Group. Babson College.

Angiello, R., 2010. Study looks at online learning vs. Traditional Instruction. *Education Digest: Essential Readings Condensed for Quick Review*, 76(2), pp.56-59.

Barclay, D., Higgings, C. and Thompson, R., 1995. The partial least squares (PLS) approach to casual modeling: personal computer adoption and use as an illustration. *Technology Studies*, 2, pp.285-309.

Bolliger, D.U. and Wasilik, O., 2009. Factors influencing faculty satisfaction with online teaching and learning in higher education. *Distance Education*, 30(1), pp.103-116.

Buckley, M.R., Fedor, D.B., Veres, J.G., Wiese, D.S. and Carraher, S.M., 1998. Investigating newcomer expectations and job-related outcomes. *Journal of Applied Psychology*, 83(3), pp.452-461.

Carmines, E.G. and Zeller, R.A., 1979. *Reliability and validity assessment*. Thousand Oaks, CA: Sage Publications.

Carraher-Wolverton, C., 2021. *Engaging faculty to facilitate student engagement in online courses*: Southeast Decision Sciences Institute Conference (Virtual), February 11, 2021. https://sedsi2021.exordo.com.

Carraher-Wolverton, C. and Zhu, Z., 2020. The importance of faculty engagement in online courses. *Southeast Decision Sciences Institute's 50th Annual Meeting*. Charleston, SC, Decision Sciences Institute.

Carraher Wolverton, C., Credo, K. and Matherne, C., 2021. Development of an organizational coolness concept from an examination of millennial perceptions of cool and uncool employer organizations. *Journal of Organizational Change Management*, 34(3), pp.672-687.

Carraher Wolverton, C. and Guidry Hollier, B.N., 2019. A minimalist design for distance learning. *International Journal of Educational Management*, 33(7), pp.1457-1465.

Carraher Wolverton, C. and Tanner, J., 2019. Teaching public speaking to business students in the digital age: Updating our methods. *International Journal of Education and Development using Information and Communication Technology*, 15(3), pp.22-33.

Chang, C., Shen, H.-Y. and Liu, E.Z.-F., 2014. University faculty's perspectives on the roles of e-instructors and their online instruction practice. *International Review of Research in Open and Distributed Learning*, 15(3), pp.72-92.

Chin, W.W., Marcolin, B.L. and Newsted, P.R., 2003. A partial least squares latent variable modeling approach for measuring interaction effects: results from a monte carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, 14(2), pp.189-217.

Chin, W.W. and Newsted, P.R., 1999. Structural equation modeling analysis with small samples using partial least squares. In: R. H. Hoyle, ed. *Statistical strategies for small sample research*. Thousand Oaks, CA, SAGE Publications, Inc. pp.307-341.

Chung, K.C. and Holdsworth, D.K., 2012. Culture and behavioural intent to adopt mobile commerce among the Y Generation: comparative analyses between Kazakhstan, Morocco and Singapore. *Young Consumers*, 13(3), pp.224-241.

Churchill, G.A., Jr., 1979. A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 16(1), pp.64-73.

Coppola, N.W., Hiltz, S.R. and Rotter, N.G., 2002. Becoming a virtual professor: pedagogical roles and asynchronous learning networks. *Journal of Management Information Systems*, 18(4), pp.169-189.

Coyner, S.C. and McCann, P.L., 2004. Advantages and challenges of teaching in an electronic environment: The accommodate model. *International Journal of Instructional Media*, 31(3), pp.223-229.

Crawley, F.E., Fewell, M.D. and Sugar, W.A., 2009. Researcher and researched: the phenomenology of change from face-to-face to online instruction. *Quarterly Review of Distance Education*, 10(2), pp.165-176.

Darby, F., 2019. *How to be a better online teacher*. [*online*]: The Chronicle of Higher Education. Available at: https://www.chronicle.com/article/how-to-be-a-better-online-teacher/ [Accessed July 10, 2021].

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), pp.319-340.

Freeman, L. and Urbaczewski, A., 2019. Critical success factors for online education: Longitudinal results on program satisfaction. *Communications of the Association for Information Systems*, 44(1), pp.30.

Gefen, D., 2019. A post-positivist answering back.: part 2: a demo in r of the importance of enabling replication in PLS and LISREL. *SIGMIS Database*, 50(3), pp.12–37.

Gefen, D., Straub, D. and Boudreau, M.-C., 2000. Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems*, 4(1), pp.7.

Hair, J.F., Jr., Hult, G.T.M., Ringle, C. and Sarstedt, M., 2017. *A primer on partial least squares structural equation modeling (PLS-SEM)*. 2nd ed. Thousand Oaks, CA: SAGE Publications, Inc.

Hashem, G. and Tann, J., 2007. The adoption of ISO 9000 standards within the egyptian context: a diffusion of innovation approach. *Total Quality Management & Business Excellence*, 18(6), pp.631-652.

Howell, S.L., Williams, P.B. and Lindsay, N.K., Thirty-two trends affecting distance education: an informed foundation for strategic planning. *Online Journal of Distance Learning Administration*, 6(3), pp.1-18.

Kahu, E.R. and Nelson, K., 2018. Student engagement in the educational interface: understanding the mechanisms of student success. *Higher Education Research & Development*, 37(1), pp.58-71.

Kaplan, A.M. and Haenlein, M., 2016. Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster. *Business Horizons*, 59(4), pp.441-450.

Kebritchi, M., Lipschuetz, A. and Santiague, L., 2017. Issues and challenges for teaching successful online courses in higher education:A literature review. *Journal of Educational Technology Systems*, 46(1), pp.4-29.

Khan, A., Egbue, O., Palkie, B. and Madden, J., 2017. Active learning: Engaging students to maximize learning in an online course. *Electronic Journal of e-Learning*, 15(2), pp.107-115.

Kim, E., Park, M.-C. and Lee, J., 2017. Determinants of the intention to use Buy-Online, Pickup In-Store (BOPS): The moderating effects of situational factors and product type. *Telematics and Informatics*, 34(8), pp.1721-1735.

Kock, N. and Hadaya, P., 2018. Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. *Information Systems Journal*, 28(1), pp.227-261.

Kumar, S., Martin, F., Budhrani, K. and Ritzhaupt, A., 2019. Award-winning faculty online teaching practices: Elements of award-winning courses. *Online Learning*, 23(4), pp.160-180.

Li, R., Chen, K. and Wu, D., 2020. Challenges and opportunities for coping with the smart divide in rural America. *Annals of the American Association of Geographers*, 110(2), pp.559-570.

Limperos, A.M., Buckner, M.M., Kaufmann, R. and Frisby, B.N., 2015. Online teaching and technological affordances: an experimental investigation into the impact of modality and clarity on perceived and actual learning. *Computers & Education*, 83, pp.1-9.

Liu, I.F., Chen, M.C., Sun, Y.S., Wible, D. and Kuo, C.-H., 2010. Extending the TAM model to explore the factors that affect intention to use an online learning community. *Computers & Education*, 54(2), pp.600-610.

Lyons, J.F., 2004. Teaching U.S. History online: Problems and prospects. *The History Teacher*, 37(4), pp.447-456.

Mansbach, J. and Austin, A.E., 2018. Nuanced perspectives about online teaching: mid-career and senior faculty voices reflecting on academic work in the digital age. *Innovative Higher Education*, 43(4), pp.257-272.

McCue, T., 2018. *E-learning climbing to $325 billion by 2025; UF Canvas Absorb Schoology Moodle*. [*online*]: Forbes. Available at: https://www.forbes.com/sites/tjmccue/2018/07/31/e-learning-climbing-to-325-billion-by-2025-uf-canvas-absorb-schoology-moodle/?sh=3cb23ea93b39 [Accessed July 9, 2021].

Meyer, K.A. and Murrell, V.S., 2014. A national study of theories and their importance for faculty development for online teaching. *Online Journal of Distance Learning Administration*, 17(2), pp.1-15.

Moore, G.C. and Benbasat, I., 1991. Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research*, 2(3), pp.192-222.

Ndubisi, N., 2006. Factors of online learning adoption: A comparative juxtaposition of the theory of planned behaviour and the technology acceptance model. *International Journal on E-Learning*, 5(4), pp.571-591.

Ndubisi, N.O. and Chukwunonso, N.C., 2004. On-line learning adoption intention: comparing the predictive power of two competing models. Proceedings of HERDSA Conference, Miri, Sarawak, Malaysia, HERDSA.

Nunnally, J.C., 1978. An overview of psychological measurement. In: B. B. Wolman, ed. *Clinical diagnosis of mental disorders*. Springer. pp.97-146.

Osika, E.R., Johnson, R.Y. and Buteau, R., 2009. Factors influencing faculty use of technology in online instruction: a case study. *Online Journal of Distance Learning Administration*, 12(1), pp.1-14.

Palvia, S., Aeron, P., Gupta, P., Mahapatra, D., Parida, R., Rosner, R. and Sindhi, S., 2018. Online education: Worldwide status, challenges, trends, and implications. *Journal of Global Information Technology Management*, 21(4), pp.233-241.

Plouffe, C.R., Hulland, J.S. and Vandenbosch, M., 2001. Research report: Richness versus parsimony in modeling technology adoption decisions—understanding merchant adoption of a smart card-based payment system. *Information Systems Research*, 12(2), pp.208-222.

Pomerantz, J. and Brooks, D.C., 2017. *ECAR study of faculty and information technology, 2017* [*online*]: EDUCAUSE. Available at: https://library.educause.edu/resources/2017/10/ecar-study-of-faculty-and-information-technology-2017 [Accessed July 9, 2021].

Poong, Y.-S. and Eze, U.C., 2008. TAM vs. PCI: An analysis on the theoretical model parsimony and robustness across cultures. *Communications of the IBIMA*, 1(23), pp.198-201.

Prentice, C., Wang, X. and Loureiro, S.M.C., 2019. The influence of brand experience and service quality on customer engagement. *Journal of Retailing and Consumer Services*, 50, pp.50-59.

Ringle, C.M., Wende, S. and Becker, J.-M., 2015. *SmartPLS 3*. [*online*] Bönningstedt. Available at: http://www.smartpls.com [Accessed July 8, 2021].

Rogers, E.M., 1983. *Diffusion of innovations*. 3rd ed. New York, NY: The Free Press.

Rogers, E.M., 2010. *Diffusion of innovations*. New York: Simon and Schuster.

Saks, A.M., 2006. Antecedents and consequences of employee engagement. *Journal of Managerial Psychology*, 21(7), pp.600-619.

Sarstedt, M., Ringle, C.M., Cheah, J.-H., Ting, H., Moisescu, O.I. and Radomir, L., 2020. Structural model robustness checks in PLS-SEM. *Tourism Economics*, 26(4), pp.531-554.

Schaufeli, W.B., 2013. What is engagement. In: C. Truss et al., eds. *Employee engagement in theory and practice* London, Routledge. pp.15-35.

Schaufeli, W.B., Salanova, M., González-Romá, V. and Bakker, A.B., 2002. The measurement of engagement and burnout: a two sample confirmatory factor analytic approach. *Journal of Happiness Studies*, 3(1), pp.71-92.

Schwarz, A., Chin, W.W., Hirschheim, R. and Schwarz, C., 2014. Toward a process-based view of information technology acceptance. *Journal of Information Technology*, 29(1), pp.73-96.

Schwarz, C., 2011. *Understanding the role of expectation disconfirmation theory on IT outsourcing success*. PhD. Louisiana State University.

Schwarz, C., 2015. A review of management history from 2010-2014 utilizing a thematic analysis approach. *Journal of Management History*, 21(4), pp.494-504.

Schwarz, C. and Zhu, Z., 2015. The impact of student expectations in using instructional tools on student engagement: a look through the expectation disconfirmation theory lens. *Journal of Information Systems Education*, 26(1), pp.47-58.

Stone, C., 2017. *Opportunity through online learning: Improving student access, participation and success in higher education*. Perth: (NCSEHE). Curtin University.

Tanis, C.J., 2020. The seven principles of online learning: Feedback from faculty and alumni on its importance for teaching and learning. *Research in Learning Technology*, 28, pp.1-25.

Tanner, J.R., Noser, T.C. and Totaro, M.W., 2009. Business faculty and undergraduate students' perceptions of online learning: A comparative study. *Journal of Information Systems Education*, 20(1), pp.29-40.

The Chronicle of Higher Education, 2019. *MOOC course distribution by subject, 2011-18*. [*online*]: The Chronicle of Higher Education. Available at: https://www.chronicle.com/article/mooc-course-distribution-by-subject-2011-18-246684/ [Accessed July 11, 2020].

Van Wart, M., Ni, A., Rose, L., McWeeney, T. and Worrell, R., 2019. A literature review and model of online teaching effectiveness integrating concerns for learning achievement, student satisfaction, faculty satisfaction, and institutional results. *Journal of Business Research*, 10(1), pp.1-22.

Venkatesh, V. and Davis, F.D., 2000. A theoretical extension of the technology acceptance model: four longitudinal field studies. *Management Science*, 46(2), pp.186-204.

Venkatesh, V., Morris, M., Davis, F. and Davis, G., 2003. Unified theory of acceptance and use of technology (UTAUT). *Management Information Systems Quarterly*, 27, pp.425-478.

Westland, J.C., 2010. Lower bounds on sample size in structural equation modeling. *Electronic Commerce Research and Applications*, 9(6), pp.476-487.

Wolverton, C.C., 2018. Utilizing synchronous discussions to create an engaged classroom in online executive education. *The International Journal of Management Education*, 16(2), pp.239-244.

Wolverton, C.C., Hirschheim, R., Black, W.C. and Burleson, J., 2020. Outsourcing success in the eye of the beholder: examining the impact of expectation confirmation theory on IT outsourcing. *Information & Management*, 57(6), pp.103236.

Wolverton, C.C., Hollier, B.N.G. and Lanier, P.A., 2020. The impact of computer self efficacy on student engagement and group satisfaction in online business courses. *Electronic Journal of e-Learning*, 18(2), pp.175-188.

Wright, R.T., Campbell, D.E., Thatcher, J.B. and Roberts, N., 2012. Operationalizing multidimensional constructs in structural equation modeling: Recommendations for IS research. *Communications of the Association for Information Systems*, 30(1), pp.368-412.

Yaacob, H.F. and Zarir bin Yusoff, M., 2014. Comparing the relationship between perceived characteristics of innovation (PCI) and adoption of computer based training among trainer and trainees. *Procedia - Social and Behavioral Sciences*, 155, pp.69-74.

Zhong, R., 2020. *The Coronavirus exposes education's digital divide*. [*online*]: The New York Times. Available at: https://www.nytimes.com/2020/03/17/technology/china-schools-coronavirus.html [Accessed July 9, 2021].

The Role of the Instructor, Motivation, and Interaction in Building Online Learning Satisfaction during the COVID-19 Pandemic

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Abstract: This study aims to examine the role of instructor, motivation, and interaction in building students' perceptions of and satisfaction with online learning (OL). It proposes a structural model based on data collected from 446 graduate and undergraduate students who attended online courses during the first COVID-19 lockdown. The data analysis was conducted using partial least square structural equation modeling (PLS-SEM). The results reinforced the role of interaction and instructors in strengthening students' motivation, especially highlighting interaction as a facilitator of how instructors motivate their students. Motivation, interaction, and the instructor's role contributed to positive OL perceptions, which in turn generated greater student satisfaction. This study also revealed that interaction is the factor with the highest impact on OL perception. The instructor's role in motivating students was found to be higher if a greater interaction was present in the online platform. However, the students did not derive OL satisfaction directly from their instructors; rather, satisfaction was generated only when motivation, interaction, and positive OL perceptions emerged. Finally, gender differences were identified in the students' OL satisfaction. Females derived a greater level of motivation, OL perception, and satisfaction from interactions with their instructors and peers, while the male students' OL perception and satisfaction were not affected by their instructors.

Keywords: motivation; interaction; instructor; online learning perception; satisfaction; COVID-19

1. Introduction

COVID-19 has exposed higher education institutions (HEIs) to the greatest challenge in the pursuance of their educational mission. In response, HEIs reacted promptly to focus their efforts on building an online learning (OL) infrastructure that supports students as they achieve their academic goals.

However, many universities in less developed countries found themselves unprepared in terms of organization, technology use, faculty training, and psychological preparation for building a smart campus. Skeptics declared that the unplanned move to OL with no training, insufficient bandwidth, and preparation could result in a poor learner experience (WEF, 2020). Others believed in the emergence of a new hybrid education model with significant benefits for the future (Zhaohui, 2020).

The unprecedented COVID-19 crisis necessitated university and student adaptation in many dimensions. The displacement of the traditional campus in favor of an online setting was non-ideal, but necessary not to interrupt the learning process (Hodges, et al., 2020), leading to a debate about OL quality and student satisfaction (Rahman, Uddin and Dei, 2021). Furthermore, this rapid shift changed the central focus of academics to motivation's role as an engagement and knowledge acquisition driver. A recent publication reported that students still prefer in-person over online classes due to the problems they face when taking online classes, such as lack of motivation, understanding the material, decreases in communication with their instructors, and the feeling of isolation caused by online classes (Alawamleh, Al-Twait and Al-Saht, 2020).

Other OL studies addressed mostly students' self-directed learning (Kim, 2004; Simmering, et al., 2009; Bonk, et al., 2015) and self-efficacy (Chang, et al., 2014; Jan, 2015), conceptualizing motivation as students' learned internal skill to engage with the learning environment (Kuo, et al., 2013). In the COVID-19 context, motivation in OL appears hard to achieve since students are socially quarantined and lack the opportunity to interact face-to-face with others (Cho, et al., 2010).

A problematic issue in both online and traditional classroom environments is that most instructors tend to focus on mastering the course subject content, thus neglecting motivation as a learning promotor (Lim and Kim, 2003). Although many studies have attempted to answer research questions about OL from various perspectives in instructional design and technology, few have addressed students' motivational issues (Chen and Yang, 2010; Bekele, 2010), mostly self-motivation (Eom, Wen and Ashill, 2006; Eastman, Aviles and Hanna, 2017). Several

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motivational factors influence learning in general, but Vafa (1999) clarified that these variables are unique to the OL environment.

Satisfaction is a key indicator of success in educational programs. Exploring the factors that influence student satisfaction with OL in the current context can provide input for the appropriate design of learning environments with enough scope to positively influence the OL experience.

Previous studies have primarily discussed satisfaction related to massive online open courses (Khalil and Ebner, 2013; Shrader, Owens and Santa, 2016; Gameel, 2017). Other comparative studies have examined students' performance and satisfaction between on- and off-campus courses to draw the differences between the two experiences (Nortvig, Petersen and Balle, 2018). In turn, the present study concerns overall student satisfaction with OL in the context of compulsory physical isolation for both students and the entire world.

Although there are many dimensions of OL to consider in the pandemic situation, this study assesses an in-depth investigation of the critical factors that motivate students to engage with OL and build a positive experience. More specifically, this study's goal is to examine the relationships between three factors—motivation, interaction, and the instructor's role—and their impact on students' OL perceptions and satisfaction during the COVID-19 pandemic. It is important to emphasize that this research's context reflects the unpreparedness of educational institutions in less developed countries to manage the challenges of building an effective OL environment.

This paper is structured as follows. The literature review presented in the first section addresses the characteristics of online education. In the second section, the theoretical framework provides the basis for the hypotheses' development. The third section describes the method, through which the results associated with the discussions are reported. Lastly, the study's practical implications and some of its potential limitations are discussed.

2. Literature review

OL is defined as "an innovative approach for delivering a well-designed, learner-centered, interactive, and facilitated learning environment to anyone, anyplace, anytime by utilizing the attributes and resources of various digital technologies along with other forms of learning materials suited for open, flexible, and distributed learning environments" (Khan, 2005, p.3).

The slow embrace of OL has revealed the unpreparedness of HEIs in developing countries to deliver knowledge during the COVID-19 emergency. The scalability of OL participation varies across countries and is more critical in less developed education systems (Zhaohui, 2020), even though the digital classroom does not have the constraints of a traditional one.

From a global perspective, online education has removed some of the major limitations of traditional classrooms, such as location, accessibility, transportation, and cost (Cho, Demei and Laffey, 2010). Due to the use of the internet, education applications can reach students anywhere at any time with personalized courses and content. Students have high flexibility and convenience related to increased comfort and the time-saving nature of automated education services, including access to study materials, video lectures, online assignment submission, online interaction, online exams and evaluations, immediate feedback, etc. OL is also recognized for garnering learning goal achievements. According to the Research Institute of America (2013), students increase their material retention rate when learning online by 25–60% due to their ability to determine their own pace, which decreases pressure and accelerates learning acquisition (Gutierrez, 2016).

Yet, OL still has many constraints, such as designing online courses in different subjects; finding and retaining suitable faculty; designing an innovative examination and evaluation model; and checking accreditation and program quality. Mukhtar, et al. (2020) highlighted the inefficiency and difficulty in maintaining academic integrity during the COVID-19 crisis and recommended training faculty to use online modalities and develop lesson plans with reduced cognitive load and increased interactivity.

Moreover, courses that require practice are more difficult even if run through simulations. Another disadvantage of OL may be the sense of isolation and demotivation that students feel, as they lack the opportunity for face-to-face interactions with their instructors and other students. Adnan and Awar (2020) also reported that OL cannot produce desired results in many countries due to poor infrastructure availability and challenges highlighted by students, such as a lack of face-to-face interaction with the instructor, response time, and the absence of traditional classroom socialization.

Several metrics similar to those used in traditional learning have been used to determine success in OL environments (Neuhauser, 2002). The main indicator of performance in OL programs is OL satisfaction. Earlier studies have suggested some factors as key determinants of students' OL satisfaction, such as the quality of online delivery derived from the instructor's role (Bolliger, 2004), interaction (Gray and DiLoreto, 2016), computer self-efficacy (Jan, 2015), motivation (Lim, 2004; Shih, et al., 2013), and social presence (Kim, Kwon and Cho, 2011).

Volery and Lord (2010) similarly identified three critical success factors in online education delivery: instructors, technology, and previous experience using technology. In particular, the instructor plays a central role in online education as a learning facilitator and promoter. Reliance on technology enables knowledge delivery and thus allows students to access any kind of information from the most appropriate sources, and also to become active learners rather than passive recipients of information (Al-Azawei, Parslow and Lundqvist, 2017). Based on a cross-country study in South Korea and India, Baber (2020) found that interaction, student motivation, course structure, instructor knowledge, and facilitation positively influence students' perceived learning outcomes and satisfaction. Furthermore, Chen, et al. (2020) highlighted that user satisfaction with online education platforms differs from the focus on user satisfaction under ordinary circumstances. They included in their study factors such as platform availability, interaction quality, information quality, system quality, service quality, and user personal factors, reporting that platform availability is the most important while user personal factors have little effect on satisfaction.

OL builds upon the collaborative learning principle that addresses the strong socio-affective and cognitive power of learning on the web (Zhang, 2009). Collaborative tools, such as virtual workspaces, provide a good infrastructure for interactions among students with each other and their instructor. However, many studies have dedicated OL's success to students' self-motivation and self-directed learning, which implies that learners assume responsibility for specifying their individual learning needs; goals and outcomes; planning and organizing the learning task; evaluating its worth; and constructing meaning from it (Candy, 1991). Beyond explaining students' motivation through beliefs about their self-efficacy (Bandura, 1988; Shen, et al., 2013), this study is based on the idea that motivation is driven by instructors' ability to improve these beliefs by developing more interactive and engaging environments.

3. Conceptual framework

One of the motivation theories that best supports this study is self-determination theory (SDT) (Ryan and Deci, 2017). This theory was developed based on three fundamental psychological needs that humans seek to fulfill: autonomy (a sense of control and agency), competency (feeling proficient with tasks and activities), and relatedness (feeling included or affiliated with others). Greater individual learning engagement happens in a social environment that supports autonomy rather than that is demanding or controlling. The mastery of knowledge (competency) can be achieved in a challenging environment that simultaneously emphasizes the feeling of being a valued member in a community (relatedness). In an OL environment, once these needs are satisfied, learners become more assured and self-determined, in turn achieving enhanced psychological well-being. However, the deprivation of these three basic needs produces highly fragmented, reactive, or alienated selves. Developing an OL environment that supports flexible learning, computer-mediated communication, and social interaction (Chen and Yang, 2010) can fulfil learners' needs for autonomy, competency, and relatedness. Therefore, SDT can support motivation in OL and explain its impact on OL perceptions and satisfaction.

There are some established models related to OL in the literature. The Community of Inquiry model highlights the presence of social, teaching, and cognitive elements in OL environments (Befus, 2016), while the Cybergogy for Engaged Learning model (Wang and Kang, 2006) explains that the success of learners' online engagement is related to cognitive, emotive, and social domains. As a synthesis of current OL concepts and theoretical frameworks, this study introduces a new model that explains students' OL perceptions and satisfaction as a result of three components and their relationships: motivation, interaction, and the instructor's role. Under the specific circumstances of the COVID-19 crisis, students can perceive greater overall satisfaction with OL if they are extrinsically motivated, feel supported by their instructor, and interact more with their instructor and peers.

3.1 Instructor's role

OL is a relatively new phenomenon for most faculty in developing countries. Although it is no longer considered novel in developed countries, not all faculty members are equally adept at harnessing the necessary technology or managing virtual classrooms (Zhaohui, 2020). Building online coursework can be time-intensive and necessitates distinct instructor skills and roles, such as course designer, profession-inspirer, feedback-giver, and interaction-facilitator (Liu, et al., 2005). Instructor immediacy and presence can affect students' affective learning, cognition, motivation (Baker, 2010), and OL perceptions through their attitude and control of technology (Webster and Hackley, 1997), interactive teaching styles, regular feedback (Volery and Lord, 2010; Cole, et al., 2017), encouragement of interaction with students (Bolliger, 2004), and building a user-friendly online environment (Kritz and Shonfeld, 2018).

Dziuban, Patsy and Joel (2004) reported that when instructors communicate effectively; facilitate, encourage, and motivate learning; organize their courses effectively; demonstrate respect for students; and evaluate students' work accurately, students are more satisfied with online courses. On this basis, this study proposes that:
H1: Instructors positively affect interaction in an OL environment
H2: Instructors positively affect motivation in an OL environment
H3: Instructors positively affect OL perceptions
H4: Instructors positively affect OL satisfaction

3.1 Interaction

Learner interaction has many dimensions, such as learner-content, learner-instructor, and learner-learner interaction, though the instructor's role is to facilitate all types of communications (Kurucay and Inan, 2017).

Frequent and effective student-instructor interaction creates an online environment that encourages students to commit themselves to the course and perform at a higher academic level (Jaggars and Xu, 2016). Indeed, students who continuously interact with instructors are more likely to interact with peers (Bervell, Umar and Kamilin, 2019) and contribute to the online community through proactive strategies, such as writing, responding, and reflecting (Cho and Jonassen, 2009). By enabling and supporting communication, interaction, and collaboration, new knowledge can be constructed. Furthermore, the lack of interactions weakens the classroom's social component and personality development. It associates the feeling of isolation with poor creativity and innovating abilities, resulting in low perceptions of OL and dissatisfaction (Chang and Smith, 2008).

SDT hypothesizes that environments that reinforce social relatedness perceptions enhance motivation and positively influence students' learning behavior (Beachboard, et al., 2011). Students may express themselves more freely and have a better understanding of the usefulness and purpose of online discussions when they perceive a higher social presence (Swan and Shih, 2005). This leads to greater student motivation, emotions, cognitive processes, and learning (Kim, et al., 2013). As a result of instructional and peer support, interaction contributes to optimizing students' learning experiences, developing positive OL perceptions (Gray and Diloreto, 2016; Hunter and Ross, 2019), and generating OL satisfaction (Kuo, et al., 2013). On this basis, it is hypothesized that:
H5: Interaction positively affects motivation in an OL environment
H6: Interaction positively affects OL perceptions
H7: Interaction positively affects satisfaction in an OL environment

3.2 Motivation

Motivation drives human behavior and action. Several researchers have reported learning motivation as the single most important factor that empowers learners and predicts their learning achievements (Hoskins and Van Hooff, 2005) and satisfaction with online environments (Bekele, 2010; Cho and Heron, 2015).

Motivation is a multidimensional construct dependent on situational conditions (Hartnett, George and Dron, 2011). SDT divides human motivation into three categories: intrinsic (doing something pleasurable and gratifying with no apparent reinforcement), extrinsic (doing something because it leads to a separable outcome), and amotivation (the state of lacking the intention to act; Deci and Ryan, 1985). Higher intrinsic motivation may foster students' initial commitment to OL, while extrinsic motivation relates to an external regulation that tends to control students' online engagement.

Motivated students' actions can be driven by instructional rewards, such as grades, instructional feedback, peer support, technical support, interest in the learning content, confidence in self-worth, affect, and control over their learning (Lim, 2004). Motivated students are keen to perceive OL positively and experience higher satisfaction than others. Accordingly:
H8: Motivation positively affects OL perceptions
H9: Motivation positively affects OL satisfaction

3.3 OL perception

Perceived learning is an indicator of student OL engagement (Martin and Bolliger, 2018). In general, online education is perceived as more demanding because of the hard work required due to intensive assignments and deadline pressure. However, OL can be perceived as making it easier for students to complete assignments and more flexible in terms of time, space, content, medium, and access.

To determine students' perceptions of OL, Bhagat, Wu and Chang (2016) developed a multidimensional scale including instructor characteristics, social presence, instructional design, and trust. Wei, Li and He (2019) identified perceived usefulness and ease of use as individual factors that affect willingness to use an OL platform. Due to the advantages of user-friendly platforms, students can find instructional materials online, use many innovative tools, and receive instant feedback from their instructor and peers. Higher positive OL perceptions lead to stronger satisfaction with OL. Consequently, it is hypothesized that:
H10: OL perceptions positively affect OL satisfaction

3.4 Satisfaction

Past research has indicated that SDT predicts a variety of learning outcomes, including performance, persistence, and course satisfaction (Deci and Ryan, 1985). Satisfaction is a key factor in OL (Horvat, et al., 2015) as a determinant of student dropout rate, commitment (Alqurashi, 2019), and performance (Puzziferro, 2008).

Dennen, Darabi and Smith (2007) explained that satisfaction is more likely tied to learners' feelings that their interpersonal communication needs are met. However, it also relates to the evaluation of experience in other dimensions, such as becoming an independent and self-disciplined learner (Kauffman, 2015). In the current study, satisfaction captures the overall satisfaction that students achieve in OL.

Figure 1 shows the study's conceptual framework.

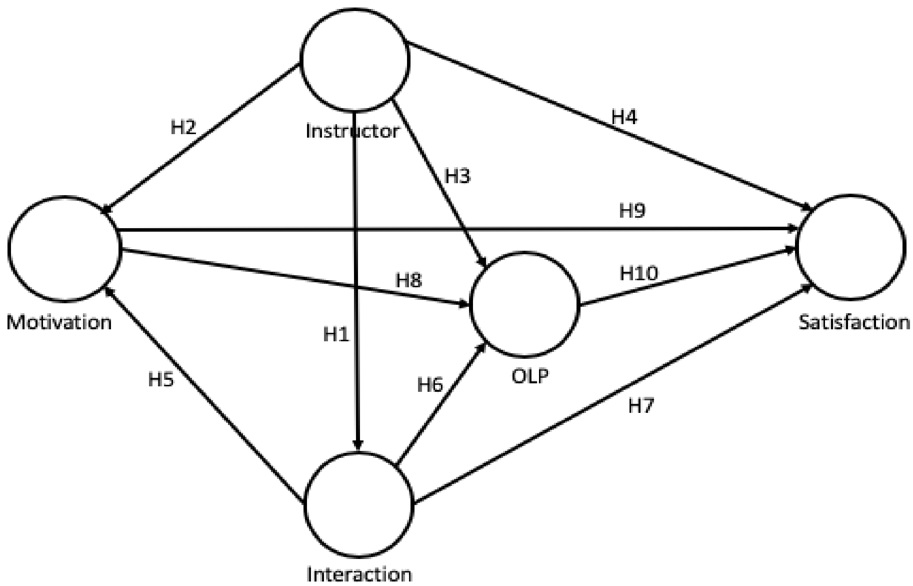

Figure 1: The conceptual framework

4. Method and results

4.1 Data collection and sample description

The data were collected through online surveys in April through May 2020 in Albania. The survey link was randomly distributed to students on Albanian universities' social media (Facebook) sites, and 478 students from 17 universities participated voluntarily. Thirty-two students reported that they did not use any online platform in OL (only social media), so they were excluded from the study. In total, 446 valid questionnaires were obtained. The respondents were informed about the anonymity and confidentiality of their answers.

The sample was predominantly below 22 years of age (80%) and dominated by females (79.4%) and undergraduate students (81.4%; Table 1).

Table 1: Demographic profile of respondents

Demographic	n	%
Gender		
Male	92	20.6
Female	354	79.4
Age		
18-22	357	80.1
23-25	72	16.1
26-	17	3.8
Degree		
Bachelor	363	81.4
Master	83	18.6

The students were asked about their field of study, which was later codified in one of the 10 fields of classification provided by the International Standard Classification of Education (ISCED-F, 2013). No respondents were taking online university courses before the COVID-19 situation.

In total, 60% of the respondents confirmed using only one OL platform, such as Google Classroom (30%), Meet (16%), Zoom (7%), and other platforms (7%), while 40% of them reported using more than one platform in different courses, such as Classroom, Zoom, Meet, and Teams.

4.2 Measurement instrument

A questionnaire was developed to determine the students' overall OL satisfaction based on their perceived motivation, the instructor's role, and interaction on the online platform. Originally, each construct was measured with a set of questions (32 items total) identified from the literature on a five-point Likert-type scale (1 = *absolutely disagree*; 5 = *absolutely agree*). The questionnaire was originally designed in the Albanian language. Forward and backward translation was done in English and Albanian to maintain the questionnaire's equivalence and avoid potential bias.

4.3 Control variables

While modeling relationships between latent constructs, two control variables were introduced to the model to allow more reliable causal inferences, such as field of study and gender.

Each discipline requires unique ways of understanding and inquiring knowledge. In online platforms, it is widely accepted that some disciplines are more difficult than others due to the need for laboratories, experiments, etc. Aristovnic, et al. (2020) told that students from the social sciences have a greater chance of attaining better overall satisfaction compared to their counterparts during the pandemic. Therefore, it was expected for field of study to affect students' OL satisfaction.

Research findings on gender influences on OL satisfaction are contradictory. Some authors have found no significant differences between male and female students on OL satisfaction (Kim, Kwon and Cho, 2011; Harvey, Parahoo and Santally, 2017; Shao, 2020). Other studies have disclosed that females exhibit higher satisfaction with e-learning subjects than males (González-Gómez, et al., 2012). Furthermore, females assign more importance to the planning of learning, as well as being able to contact the instructor in various ways. Horvat, et al. (2015) reported that females place more significance on average waiting time for a response, feedback quality, material thoroughness, material clarity, website user-friendliness, cooperation diversity, and material quantity. They also focus on supplementary online resources to explore topics in greater depth than male students (Martin and Bolliger, 2018).

4.4 Construct reliability and validity

Partial least square structural equation modeling (PLS-SEM) was applied in SmartPLS 3.2.7 (Ringle, Wende and Becker, 2015). One of the advantages of PLS-SEM is the absence of distributional assumptions and the use of small samples (Hair, et al., 2012).

A common rule of thumb suggests that the sample size should be at least 10 times the largest number of independent variables that affect the dependent variable. In the present model, there were 6 independent constructs (including the control variables), indicating that the sample size of 446 records satisfied the threshold.

The independent model factors, as described in the hypotheses, were motivation (MOT), interaction (INT), instructor's role (INST), and OL perception (OLP), while the dependent variable was OL satisfaction (SAT).

Since the model included reflectively measured constructs, the next step of the analysis was checking the indicators' reliability, internal consistency reliability, convergent validity, and discriminant validity (Sarstedt, Ringle and Hair, 2017).

Of the 32 original items, only 20 with factor loadings above 0.7 and that were significant were kept ($p < .05$; Table 2). Higher outer loading factors indicate greater indicator reliability (Hair, Ringle and Sarstedt, 2013).

Table 2: Outer Loadings Statistics

	Item	β
Interaction (INT; α = .77; CR = .85; AVE = .59)		
1. I find it easy to interact with my professor	INT1	0.830
2. I find it easy to interact with other peer students	INT2	0.814
3. I am active during online classes	INT3	0.714
4. I express myself more freely in OL	INT4	0.703
Instructor (INST; α = .830; CR = .90; AVE = .74)		
1 The instructor uses many learning tools to help me understand better	INST1	0.853
2. The instructor helps me be more focused through direct interaction	INST2	0.858
3. The instructor helps me achieve my learning goals	INST3	0.873
Motivation (MOT; α = .78; CR = .86; AVE = .68)		
1. I feel more motivated in OL when interacting with my instructor and other peers	MOT1	0.735
2. My instructor motivates me to get engaged in OL	MOT2	0.896
3. I expect to get high grades in OL courses	MOT3	0.837
OL Perception (OLP; α = .83; CR = .88; AVE = .60)		
1. OL is easier than the traditional one	OLP1	0.801
2. It's easy for me to complete the assignments online	OLP2	0.838
3. OL provides a more flexible time and space for me	OLP3	0.763
4. Many innovative tools that can be used in the online platform	OLP4	0.712
5. I find the OL platform user-friendly	OLP5	0.743
Satisfaction (SAT; α = .88; CR =.91; AVE =.68)		
1. I feel I am becoming an independent learner	SAT1	0.751
2. I feel like I have strengthened my self-discipline	SAT2	0.847
3. I am more satisfied with online classes than with the traditional ones	SAT3	0.839
4. Learning online is exciting	SAT4	0.818
5. My overall experience in OL is great	SAT5	0.859

Composite reliability was measured with Cronbach's alpha, and all indicators were above the 0.7 threshold. Average variance extracted (AVE) was higher than the threshold of 0.5, indicating that the convergent validity of the construct measures was fully established (Henseler, Hubona and Ray, 2016; Table 3).

Table 3: Descriptive statistics, psychometric properties, and correlations.

Variables	M	SD	α	CR	AVE	1	2	3	4	5	6
1. FoS	-	-	-	-	-						
2. Gender	-	-	-	-	-	0.086					
3. Instructor	3.54	0.88	0.83	0.90	0.74	0.005	-0.067				
4. Interaction	3.27	0.88	0.77	0.85	0.59	0.063	-0.063	0.527			
5. Motivation	3.06	0.97	0.78	0.86	0.68	0.020	-0.055	0.602	0.585		
6. OLP	2.99	0.90	0.83	0.88	0.60	0.037	-0.019	0.505	0.613	0.586	
7. Satisfaction	2.66	0.96	0.88	0.91	0.68	0.003	0.013	0.536	0.660	0.657	0.768

Note: SD = standard deviation; a = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted. The numbers in the matrix represent construct correlations.

Further, to assess discriminant validity, the Heterotrait – Monotrait (HTMT) ratio of correlation was used (Henseler, et al., 2014). All values were below the 0.9 threshold, as suggested by Henseler, Ringle and Sarstedt (2015; Table 4).

Table 4: Heterotrait-Monotrait Matrix

	FoS	GE	INS	INT	MOT	OLP
FoS	-					
Gender	0.086					
Instructor	0.019	0.074				
Interaction	0.072	0.074	0.657			
Motivation	0.051	0.071	0.743	0.722		
OLP	0.086	0.048	0.611	0.761	0.678	
Satisfaction	0.035	0.023	0.624	0.797	0.739	0.870

To identify any issue related to multi-collinearity, the collinearity statistics were checked. Multicollinearity is measured by variance inflation factors (VIF) and tolerance. No issues with multi-collinearity were found in the outer model, as the VIF indicators for all variables were below 2.5, with a threshold of 3 suggested in an ideal situation (Hair, et al., 2010).

The reflective measurement model's quality was assessed through the standardized root mean square residual (SRMR = 0.074), which in this case was below the 0.08 threshold recommended by Henseler, et al. (2014). The model explained 46.2% of the variance in MOT, 27.8% in INT, 46.6% in OLP, and 68.6% in SAT.

In addition to R^2 size, the predictive sample reuse technique (Q^2) was used as a criterion for predictive relevance (Stone, 1974; Geisser, 1975). By running a blindfolding procedure, Stone-Geisser's Q^2 values were obtained to show how well the collected data can empirically be reconstructed with the help of the model and PLS (partial least square) parameters (Fornell and Cha, 1993). The indicators showed moderate effects ($.15 < Q^2 < .35$) for MOT ($Q^2 = .291$), INT ($Q^2 = .154$), and OLP ($Q^2 = .259$), while strong effects ($Q^2 > .35$) were identified for SAT ($Q^2 = .435$), establishing satisfactory predictive relevance (Chin, 2010).

4.5 Hypothesis discussion

Evidence emerged in support of nine hypotheses (Table 5), as the path coefficients were significant ($t > 1.96$). The only hypothesis not supported was H4, related to instructors' direct impact on satisfaction.

In total, 46.2% of motivation variance was explained by the role of the instructor and interactions with the instructor and peers. These three factors (MOT: $\beta = 0.285$, INT: $\beta = 0.375$, INST: $\beta = 0.135$) had a direct effect on creating positive OLP ($p < .05$). The coefficients indicated that interaction has the highest impact on OLP. Positive perceptions of OL positively affected OL satisfaction as well ($\beta = .485$, $p < .05$).

Table 5: Hypotheses testing

Hypothesis	Path coefficients	β	T Statistics	P-values
H1	Instructor -> Interaction	0.527	14.539	0.000
H2	Instructor -> Motivation	0.407	8.858	0.000
H3	Instructor -> OLP	0.135	2.848	0.004
H4	Instructor -> Satisfaction	0.048	1.271	**0.204***
H5	Interaction -> Motivation	0.37	8.993	0.000

Hypothesis	Path coefficients	β	T Statistics	P-values
H6	Interaction -> OLP	0.375	7.668	0.000
H7	Interaction -> Satisfaction	0.212	5.124	0.000
H8	Motivation -> OLP	0.285	5.284	0.000
H9	Motivation -> Satisfaction	0.224	5.184	0.000
H10	OLP -> Satisfaction	0.485	12.142	0.000

Note: H4 not supported (p>.05)

4.6 Indirect effects

The most important part of the analysis relied on the indirect effects of exogenous factors in the model. After running a bootstrapping procedure, the moderating effects of interaction were found to enhance the instructor's role in motivating students, improve their perceptions, and increase their OL satisfaction (Table 6).

Table 6: Specific indirect effects

	β	T Statistics	P Values
Instructor -> Interaction -> Motivation	0.195	7.125	0.00
Instructor -> Interaction -> OLP	0.198	6.755	0.00
Instructor -> Motivation -> OLP	0.116	4.136	0.00
Interaction -> Motivation -> OLP	0.105	4.763	0.00
Instructor -> Interaction -> Motivation -> OLP	0.056	4.484	0.00
Instructor -> Interaction -> Satisfaction	0.112	4.812	0.00
Instructor -> Motivation -> Satisfaction	0.091	4.257	0.00
Interaction -> Motivation -> Satisfaction	0.083	4.752	0.00
Instructor -> Interaction -> Motivation -> Satisfaction	0.044	4.408	0.00
Instructor -> OLP -> Satisfaction	0.066	2.705	0.00
Interaction -> OLP -> Satisfaction	0.182	6.39	0.00
Instructor -> Interaction -> OLP -> Satisfaction	0.096	5.858	0.00
Instructor -> Motivation -> OLP -> Satisfaction	0.056	3.897	0.00
Motivation -> OLP -> Satisfaction	0.138	4.618	0.00
Interaction -> Motivation -> OLP -> Satisfaction	0.051	4.315	0.00
Instructor -> Interaction -> Motivation -> OLP -> Satisfaction	0.027	4.138	0.00

The instructor's role affected students' motivation directly (β = .411, p < .05), and when this effect was transmitted through interaction, the total effect increased ($c' = .602$)

Interaction's impact on OLP increased through motivation's moderating effect (t = 3.5, p < .001).

The instructor's role did not have a direct impact on satisfaction. Rather, indirectly it affected satisfaction through MOT (β = .091, p < .05), INT (β = .112, p < .05), and OLP (β = .066, p < .05). These results indicated that the instructor's role can affect satisfaction only if positive perceptions have emerged through increased motivation and interaction on OL platforms.

Regarding the control variables, the model showed no significant control power for field of study (β = -.04, p = .188), while gender (β = .054, p = .049) displayed some significant effects, which were also confirmed from the bootstrapping procedure (t = 1.97, p < .05).

To further explore gender differences, two separate models were run. The results indicated that females were more motivated than male students ($R^2_{females}$ = .493, R^2_{males} = .367). The interaction generated among female students (R^2 = .299) was also higher than in males (R^2 = .195). As a result, females could build higher OLP ($R^2_{females}$ = .493, R^2_{males} = .367) and generate greater SAT ($R^2_{females}$ = .807, R^2_{males} = .667) than males (Table 7).

Table 7: Gender-based differences

	Females			Males		
Paths	M	STDEV	T Stat.	M	STDEV	T Stat.
Instructor -> Interaction	0.549	0.04	13.788	0.452	0.083	5.407
Instructor -> Motivation	0.474	0.05	9.442	0.237	0.095	2.492
Instructor -> OLP	0.116	0.056	2.097	0.153	0.097	**1.666***
Instructor -> Satisfaction	-0.015	0.032	**0.449***	0.061	0.069	**0.994***
Interaction -> Motivation	0.324	0.044	7.347	0.478	0.090	5.281

Paths	Females			Males		
	M	STDEV	T Stat.	M	STDEV	T Stat.
Interaction -> OLP	0.403	0.053	7.523	0.302	0.109	2.824
Interaction -> Satisfaction	0.065	0.031	2.115	0.278	0.114	2.474
Motivation -> OLPerception	0.282	0.058	4.806	0.336	0.124	2.585
Motivation -> Satisfaction	0.152	0.033	4.692	0.245	0.100	2.353
OLP -> Satisfaction	0.766	0.026	29.291	0.412	0.104	3.904

Note: *Nonsignificant path (*p*>.05); STDEV-Standard Deviation; M-Sample Mean

The instructor's impact on interaction and motivation was found to be higher among female students. The instructor's role did not affect male students' OLP and SAT. Furthermore, females derived greater MOT, OLP, and SAT from interactions with their instructor and peers.

5. Conclusions

This study collected student experience data on online education platforms in Albania during the COVID-19 pandemic. It provided empirical evidence on the role of motivation, interaction, instructors, and interfaces on students' OL perceptions and satisfaction.

The study highlighted the importance of student motivation in OL satisfaction, which can be enhanced through social interaction and the instructor's capacity to convey knowledge effectively. The results reinforced the role instructor's role in stimulating interactions with and among students, thereby enhancing motivation to learn and indicating that interaction should be considered a facilitating dimension of how instructors motivate their students.

Motivation, interaction, and the instructor's role positively influenced positive perceptions of OL, leading to satisfaction. Interaction was the factor with the highest impact on creating OL perceptions. Instructors' impact on motivating students was also higher if greater interaction emerged in the OL platform. When students felt motivated, interaction had a stronger effect on building positive OL perceptions.

The instructor's role was insignificant to building OL satisfaction directly and contributed to student satisfaction only when positive OL perceptions were present.

The outcomes of this study are of value for educators and researchers. Instructors can benefit from these research findings to design online courses that improve the quality of learning and satisfaction by particularly emphasizing various tools and methods to enhance students' motivation and interaction.

Finally, the findings confirmed gender differences in perceived OL satisfaction. The satisfaction perceived by female students was greater than the satisfaction perceived by males, confirming the results of existing studies.

6. Research implications

This study examined the roles of motivation, interaction, and instructor factors on student OL perceptions and satisfaction and tested the relationships among these factors. Low OL satisfaction was found among students, as reflected in their attitudes about OL. More concretely, only 28% of students declared they would like to attend online programs in the future and would recommend OL to their friends. This is understandable due to the study context. Nevertheless, the main question raised for educators is how to design online instructions that build learner motivation and generate greater OL satisfaction. To best promote active and engaged student learning, several strategies are recommended.

First, the instructor's role in this study was insignificant to OL satisfaction, but it contributed to positive OL perceptions. This finding implicates instructors to focus on stimulating qualitative interactions with students and find effective alternatives to support them. The level of interaction should be considered a facilitator of how instructors motivate their students. This requires modifying the instructor's academic role from a knowledge conveyer to a learning motivator. Applying collaborative learning principles when designing interactive learning activities that create a sense of commitment (e.g., teamwork, discussions) is also critical. Instructional models employed by faculty that only present online lectures on the platform are less motivating. Animation, virtual reality, audio, video, virtual lab, video conferencing, chat, and discussion forums transform learning into a richer experience. Through diverse learning interactions such as observation, interpretation, construction, contextualization, multiple manifestations, ownership of knowledge, and self-awareness of the learning process, students can achieve a higher degree of learning motivation and involvement (Lim and Kim, 2003).

Although students may prefer text over verbal interaction as a communication mode (Vu and Fadde, 2013), it is crucial to involve them in live discussions and incentivize social interaction. Possible examples to promote social interactions include instructors' direct interaction efforts, such as participating in discussion boards, providing guidelines for social interaction, recognizing students' contributions to the OL community, and monitoring students' social interaction processes (Cho and Kim, 2013).

Adapting action-oriented learning strategies to online environments is critical for profound learning and knowledge transfer. This can be achieved by designing OL to support students to practice learning. Since students have diverse learning styles (visual, auditory, and action-oriented), instructors need to design and integrate assessments, case studies, discussions, and debates to support action-oriented learners. Streaming videos and multimedia can support visual learners, while podcasting can deliver content through audio files in support of auditory learners (Paetzold and Melby, 2008).

The opportunity to meet various students' needs and interests in OL can be exploited by customizing learning content. Additionally, customizing assignments to incorporate student examples and experiences can be beneficial to widening application practices.

Another strategy to generate student motivation is building emotional engagement in the OL process by providing continuous support and immediate feedback via e-mails. Instructors can dedicate office hours and other means of contact for students to support and motivate them. Active interaction with both instructors and classmates can enhance the feeling of being supported and reduce anxiety related to social isolation. Instructors should create a social presence as well to foster a learning community. Student-instructor communication should be productive enough to develop students' desirable social behaviors, improved understanding of concepts, self-esteem, and motivation, all of which stimulate socially desirable interactions.

The findings on gender differences urge instructors to redesign their online courses to improve male students' OL perceptions and satisfaction. This requires a more in-depth investigation of males' learning styles and behavior in OL environments. For instance, Vafa (1999) reported that males prefer auditory modality, indicating the type of learning activities that fit males' learning preferences.

Another issue this study highlights is the use of different platforms in different courses, which may cause confusion and reduce student motivation. Of note, this study was conducted during an initial stage of the OL process for many universities, which are encouraged to develop or adopt a unique platform that assures quality design and support. Furthermore, the impact of COVID-19 on higher education should be analyzed from the perspective of the great opportunity it has provided learners, educators, and HEI managers to experience OL's many dimensions and improve themselves while adapting to the new environment. This experience is expected to bring more diversification and flexibility in the future of the education industry by implementing integrated traditional and online learning, wherein the best features of each learning type can be utilized.

Finally, researchers may test the present model's relationships in other contexts by utilizing the validated instrument, as it possesses acceptable reliability and validity.

7. Limitations and future research

Although intrinsic motivation items were initially included in the model to explain the motivation construct, these items were later removed from the model due to low indicators based on Cronbach's alpha. Still, it is understandable that intrinsic motivation can hardly be achieved among students during the COVID-19 lockdown due to a high stress, low social interaction, and physical isolation. Indeed, 88% of the students who participated in this study reported not feeling self-motivated enough to engage in OL.

Reasonably, the lack of intrinsic motivation in OL (Hartnett, George and Dron, 2011) requires greater focus on extrinsic motivation as a controllable influencer on learners' perceptions of and satisfaction with OL.

A possible limitation of this study can be the research model's exclusion of students' acceptance of computer self-efficacy as an explanatory factor of OL satisfaction. However, computer self-efficacy has changed over the last decade: due to higher internet use, students feel more confident in performing web-based activities (Alqurashi, 2016).

The study was also conducted at an early stage of the pandemic. The introduction and implementation of OL is still a new concept in less developed countries to overcome the COVID-19 crisis. As such, this study's results should be carefully used given the differential contextual influences that might exist at individual and university levels. Other factors such as student characteristics, both students' and instructors' prior OL experience, university management, curriculum, and course structure could be included in future studies to measure OL satisfaction in the post-pandemic context.

References

Adnan, M., and Anwar, K., 2020. Online learning amid the COVID-19 pandemic: Students' perspectives. *Journal of Pedagogical Sociology and Psychology*, 2(1), pp 45-51.

Al-Azawei, A., Parslow, P. and Lundqvist, K., 2017. Investigating the effect of learning styles in a blended e-learning system: An extension of the technology acceptance model, TAM). *Australasian Journal of Educational Technology*, 33(2), pp 1-23.

Alawamleh, M., Al-Twait, L. M., and Al-Saht, G.R., 2020. The effect of online learning on communication between instructors and students during Covid-19 pandemic. *Asian Education and Development Studies*.

Alqurashi, E., 2016. Self-efficacy in online learning environments: A literature review. *Contemporary Issues in Education Research (CIER)*, 9(1), pp 45-52.

Alqurashi, E., 2019. Predicting student satisfaction and perceived learning within online learning environments. *Distance Education*, 40(1), pp 133-148.

Aristovnik, A., Keržič, D., Ravšelj, D., Tomaževič, N., and Umek, L., 2020. Impacts of the COVID-19 pandemic on life of higher education students: A global perspective. *Sustainability*, 12(20), 8438.

Baber, H., 2020. Determinants of students' perceived learning outcome and satisfaction in online learning during the pandemic of COVID19. *Journal of Education and e- Learning Research*, 7(3), pp 285-292.

Baker, C., 2010. The impact of instructor immediacy and presence for online student affective learning, cognition and motivation. J*ournal of Educators Online*, 7(1).

Bandura, A., 1988. Organisational application of Social Cognitive Theory. *Australian Journal of Management,* 13(2), pp 275-302.

Beachboard, M.R., Beachboard, J.C., Li, W. and Adkison, S.R, 2011. Cohorts and Relatedness: Self-Determination Theory as an explanation of how learning communities affect educational outcomes. *Research in Higher Education*, 52, pp 853–874.

Befus, M.K., 2016. A thematic synthesis of Community of Inquiry research 2000 to 2014. Available at: http://hdl.handle.net/10791/190 [Accessed 15 May 2021]

Bekele, T.A., 2010. Motivation and satisfaction in internet-supported learning environments: A review. *Journal of Educational Technology & Society*, 13(2), pp 116-127.

Bervell, B., Umar, I.N. and Kamilin, M.H., 2019. Towards a model for online learning satisfaction (MOLS): re-considering non-linear relationships among personal innovativeness and modes of online interaction. *Open Learning: The Journal of Open, Distance and e-Learning*, pp 1-24.

Bhagat, K.K., Wu, L.Y. and Chang, C.Y., 2016. Development and validation of the perception of students towards online learning (POSTOL). *Educational Technology & Society,* 19 (1), pp 350–359.

Bolliger, D.U., 2004. Key factors for determining student satisfaction in online courses. *International Journal on E-learning*, 3(1), pp 61-67.

Bonk, C.J., Lee, M.M., Kou, X., Xu, S. and Sheu, F.R., 2015. Understanding the self-directed online learning preferences, goals, achievements, and challenges of MIT OpenCourseWare subscribers. *Educational Technology & Society*, 18(2), pp 349-365.

Candy, P.C., 1991. *Self-Direction for lifelong learning. A comprehensive guide to theory and practice.* San Francisco, CA: Jossey-Bass

Chang, C.S., Liu, E. Z. F., Sung, H.Y., Lin, C.H., Chen, N.S. and Cheng, S.S., 2014. Effects of online college student's Internet self-efficacy on learning motivation and performance. *Innovations in Education and Teaching International*, 51(4), pp 366-377.

Chang, S.H.H. and Smith, R.A., 2008. Effectiveness of personal interaction in a learner-centered paradigm distance education class based on student satisfaction. *Journal of Research on Technology in Education*, 40(4), pp 407-426.

Chen, K.C. and Jang, S.J., 2010. Motivation in online learning: Testing a model of self-determination theory. *Computers in Human Behavior*, 26(4), pp 741-752.

Cho, M.H. and Heron, M.L., 2015. Self-regulated learning: the role of motivation, emotion, and use of learning strategies in students' learning experiences in a self-paced online mathematics course. *Distance Education*, 36(1), pp 80-99.

Cho, M.H. and Jonassen, D., 2009. Development of the human interaction dimension of the Self-Regulated Learning Questionnaire in asynchronous online learning environments. *Educational Psychology*, 29(1), pp 117-138.

Cho, M.H. and Kim, B.J., 2013. Students' self-regulation for interaction with others in online learning environments. *The Internet and Higher Education*, 17, pp 69-75.

Cho, M.H., Demei, S. and Laffey, J., 2010. Relationships between self-regulation and social experiences in asynchronous online learning environments. *Journal of Interactive Learning Research*, 21(3), pp 297-316.

Cole, A., Nicolini, K.M., Anderson, C., Bunton, T., Cherney, M. R., Fisher, V. C., Draeger, R., Featherston, M., Motel, L., Peck, B. and Allen, M., 2017. Student predisposition to instructor feedback and perceptions of teaching presence predict motivation toward online courses. *Online Learning Journal*, 21(4), pp. 225-262.

Deci, E.L. and Ryan, R.M., 1985. *Intrinsic motivation and self-determination in human behavior*. New York: Springer.

Dennen, V.P., Aubteen Darabi, A. and Smith, L.J., 2007. Instructor–learner interaction in online courses: The relative perceived importance of particular instructor actions on performance and satisfaction. *Distance Education*, 28(1), pp. 65-79.

Dziuban, C.D., Patsy, M., and Joel, L.H., 2004. Higher education, blended learning, and the generations: Knowledge is power - No more. Available at: https://desarrollodocente.uc.cl/wpcontent/uploads/2020/03/Knowledge_is_power_no_more.pdf

Eastman, J.K., Aviles, M. and Hanna, M.D., 2017. Determinants of perceived learning and satisfaction in online business courses: An extension to evaluate differences between qualitative and quantitative courses. *Marketing Education Review*, 27(1), pp 51-62.

Eom, S.B., Wen, H.J. and Ashill, N., 2006. The determinants of students' perceived learning outcomes and satisfaction in university online education: An empirical investigation. *Decision Sciences Journal of Innovative Education*, 4(2), pp 215-235.

Fornell, C. and Cha, J., 1993. Partial Least Squares (PLS). Unpublished working paper. Ann Arbor: University of Michigan Business School.

Gameel, B.G., 2017. Learner satisfaction with massive open online courses. *American Journal of Distance Education*, 31(2), pp 98-111.

Geisser, S., 1975. The predictive sample reuse method with applications. *Journal of the American Statistical Association*, 70, 350, pp 320-328.

González-Gómez, F., Guardiola, J., Rodríguez, Ó.M. and Alonso, M.Á.M., 2012. Gender differences in e-learning satisfaction. *Computers & Education*, 58(1), pp 283-290.

Gray, J.A. and DiLoreto, M., 2016. The effects of student engagement, student satisfaction, and perceived learning in online learning environments. *International Journal of Educational Leadership Preparation*, 11(1), pp 1-20.

Gutiterres, K., 2016. Facts and stats that reveal the power of eLearning. Shift - Disruptive learning. Available at: shiftelearning.com [Accessed 17 May 2020]

Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. and Tatham, R.L., 2010. Multivariate Data Analysis (7th ed.). New Jersey: Pearson Education Inc.

Hair, J.F., Ringle, C.M. and Sarstedt, M., 2013. Partial least squares structural equation modeling: Rigorous applications, better results and higher acceptance. *Long Range Planning*, 46(1-2), pp 1-12.

Hair, J.F., Sarstedt, M., Ringle, C.M. and Mena, J.A., 2012. An assessment of the use of partial least squares structural equation modeling in marketing research. *Journal of the Academy of Marketing Science*, 40(3), pp. 414-433.

Hartnett, M., St George, A. and Dron, J., 2011. Examining motivation in online distance learning environments: Complex, multifaceted, and situation-dependent. *International Review of Research in Open and Distributed Learning*, 12(6), pp 20-38.

Harvey, H.L., Parahoo, S. and Santally, M., 2017. Should gender differences be considered when assessing student satisfaction in the online learning environment for millennials?. *Higher Education Quarterly*, 71(2), pp 141-158.

Henseler, J., 2017. Partial least squares path modeling. In *Advanced methods for modeling markets* (pp. 361-381). Cham: Springer.

Henseler, J., Dijkstra, T.K., Sarstedt, M., Ringle, C.M., Diamantopoulos, A., Straub, D.W., ... and Calantone, R. J., 2014. Common beliefs and reality about PLS: Comments on Rönkkö and Evermann (2013). *Organizational Research Methods*, 17(2), pp 182-209.

Henseler, J., Hubona, G and Ray, P. A., 2016. Using PLS path modeling in new technology research: updated guidelines. *Industrial Management & Data Systems*. 116(1), pp 2-20

Henseler, J., Ringle, C.M. and Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, 43(1), pp 115-135.

Hodges, C., Moore, S., Lockee, B., Trust, T. and Bond, A. (2020). The difference between emergency remote teaching and online learning. *Educause Review*, 27.

Horvat, A., Dobrota, M., Krsmanovic, M. and Cudanov, M., 2015. Student perception of Moodle learning management system: a satisfaction and significance analysis. *Interactive Learning Environments*, 23(4), pp 515-527.

Hoskins, S.L. and Van Hooff, J.C., 2005. Motivation and ability: which students use online learning and what influence does it have on their achievement?. *British Journal of Educational Technology*, 36(2), pp 177-192.

Hunter J. and Ross, B., 2019. Does increased online interaction between instructors and students positively affect a student's perception of quality for an online course?. *Journal on Empowering Teaching Excellence*, 3(2).

ISCED-F, 2013. International Standard Classification of Education. Available at: http://uis.unesco.org [Accessed 17 May 2020]

Jaggars, S.S. and Xu, D., 2016. How do online course design features influence student performance?. *Computers & Education*, 95, pp 270-284.

Jan, S.K., 2015. The relationships between academic self-efficacy, computer self-efficacy, prior experience, and satisfaction with online learning. *American Journal of Distance Education*, 29(1), pp 30-40.

Kauffman, H., 2015. A review of predictive factors of student success in and satisfaction with online learning. *Research in Learning Technology*, 23, pp 1-23.

Khalil, H. and Ebner, M., 2013. How satisfied are you with your MOOC?-A research study on interaction in huge online courses. In *EdMedia + Innovate Learning* (pp. 830-839). Association for the Advancement of Computing in Education (AACE).

Khan, B., 2005. Learning features in an open, flexible and distributed environment. *AACE Journal*, 13(2), pp 137-153.

Kim, C., Park, S.W., Cozart, J. and Lee, H., 2015. From motivation to engagement: The role of effort regulation of virtual high school students in mathematics courses. *Journal of Educational Technology & Society*, 18(4), pp 261-272.

Kim, J., Kwon, Y. and Cho, D., 2011. Investigating factors that influence social presence and learning outcomes in distance higher education. *Computers & Education*, *57*(2), 1512-1520.

Kim, K.J., 2004. *Motivational influences in self-directed online learning environments: a qualitative case study*. Association for Educational Communications and Technology.

Kritz, M. and Shonfeld, M., 2018. Promoting satisfaction in online courses. In *EdMedia+ Innovate Learning* (pp. 2263-2270). Association for the Advancement of Computing in Education (AACE).

Kuo, Y.C., Walker, A. E., Belland, B. R., and Schroder, K. E., 2013. A predictive study of student satisfaction in online education programs. *The International Review of Research in Open and Distributed Learning*, 14(1), pp 16-39.

Kurucay, M. and Inan, F.A., 2017. Examining the effects of learner-learner interactions on satisfaction and learning in an online undergraduate course. *Computers & Education*, 115, pp 20-37.

Lim, D.H., 2004. Cross cultural differences in online learning motivation. *Educational Media International*, 41(2), pp 163-175.

Lim, D.H., and Kim, H., 2003. Motivation and learner characteristics affecting online learning and learning application. *Journal of Educational Technology Systems*, 31(4), 423-439.

Liu, X., Bonk, C.J., Magjuka, R.J., Lee, S.H., and Su, B., 2005. Exploring four dimensions of online instructor roles: A program level case study. *Journal of Asynchronous Learning Networks,* 9(4), pp 29-48.

Martin, F. and Bolliger, D.U., 2018. Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, 22(1), pp 205-222.

Mukhtar K, Javed K, Arooj M, Sethi A. 2020. Advantages, limitations and recommendations for online learning during COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, *36*(COVID19-S4), S27–S31.

Neuhauser, C., 2002. Learning style and effectiveness of online and face-to-face instruction. *The American Journal of Distance Education*, 16(2), pp 99-113.

Nortvig, A.M., Petersen, A.K. and Balle, S.H., 2018. A literature review of the factors influencing e-learning and blended learning in relation to learning Outcome, Student Satisfaction, and Engagement. *Electronic Journal of E-learning*, 16(1), pp 46-55.

Paetzold, S.P. and Melby, N.J., 2008. Active learning strategies for computer information systems education in online courses. *Journal of Global Business Issues*, pp 13-17.

Palmer, S.R. and Holt, D.M., 2009. Examining student satisfaction with wholly online learning*, Journal of Computer-Assisted Learning*, 25(2), pp 101-113.

Puzziferro, M., 2008. Online technologies self-efficacy and self-regulated learning as predictors of final grade and satisfaction in college-level online courses. *The American Journal. of Distance Education*, 22(2), pp 72-89.

Ringle, CM., Wende, S. and Becker, J. M., 2015. SmartPLS. SmartPLS GmbH, Boenningstedt.

Ryan, R.M., and Deci, E.L., 2017. *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. New York: Guilford Press.

Sarstedt, M., Ringle, C.M. and Hair, J.F., 2017. Partial least squares structural equation modeling. *Handbook of Market Research*, 26, pp 1-40.

Shao, C., 2020. An empirical study on the identification of driving factors of satisfaction with online learning based on TAM. In *5th International Conference on Economics, Management, Law and Education (EMLE 2019)* (pp. 1067-1073). Atlantis Press.

Shen, D., Cho, M.H., Tsai, C.L. and Marra, R., 2013. Unpacking online learning experiences: Online learning self-efficacy and learning satisfaction. *The Internet and Higher Education*, 19, pp 10-17.

Shih, H.F., Chen, S. H.E., Chen, S.C. and Wey, S.C., 2013. The relationship among tertiary level EFL students' personality, online learning motivation and online learning satisfaction. *Procedia-Social and Behavioral Sciences*, 103(26), pp 1152-1160.

Shrader, S., Wu, M., Owens, D. and Santa, A.K., 2016. Massive open online courses (MOOCs): Participant activity, demographics, and satisfaction. *Online Learning*, 20(2), pp 199-216.

Simmering, M. J., Posey, C. and Piccoli, G., 2009. Computer self-efficacy and motivation to learn in a self-directed online course. *Decision Sciences Journal of Innovative Education*, 7(1), pp 99-121.

Stone, M., 1974. Cross validatory choice and assessment of statistical predictions, *Journal of the Royal Statistical Society*, 36(2), pp 111-147.

Swan, K. and Shih, L. F., 2005. On the nature and development of social presence in online course discussions. *Journal of Asynchronous Learning Networks*, 9(3), pp 115-136.

Vafa, S., 2004. Learning style preferences among online university students. In *Society for Information Technology and Teacher Education International Conference* (pp. 736-739). Association for the Advancement of Computing in Education (AACE).

Volery, T. and Lord, D., 2000. Critical success factors in online education. *The International Journal of Educational Management*, 14(5), pp 216-223.

Vu, P. and Fadde, P.J., 2013. When to talk, when to chat: student interactions in live virtual classrooms. *Journal of Interactive Online Learning*, 12(2), pp 41-52.

Wang, M. and Kang, M., 2006. Cybergogy for engaged learning: A framework for creating learner engagement through information and communication technology. In: D. Hung and M.S. Khine (eds) *Engaged learning with emerging technologies* (pp. 225-253). Dordrecht: Springer.

Webster, J. and Hackley, P., 1997. Teaching effectiveness in technology mediated distance learning, *Academy of Management Journal,* 40(6), pp 1282-1309.

WEF - World Economic Forum, 2020. The COVID-19 pandemic has changed education forever. This is how. Available at: https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/ [Accessed 17 May 2020]

Wei, Y., Li, J. and He, Y., 2019. Research on the Influencing Factors of College Students' Use of Online Learning Platform from the Perspective of Customer Perception. In *Journal of Physics: Conference Series* (Vol. 1345, No. 4). IOP Publishing.

Zhang, Y., 2009. Collaborative Learning in a Web-Based Environment: A Comparison Study. In Cognitive and Emotional Processes in Web-Based Education: Integrating Human Factors and Personalization (pp. 343-356). IGI Global.

Zhaohui, W., 2020. How a top Chinese university is responding to coronavirus. World Economic Forum. Available at: https://www.weforum.org/agenda/2020/03/coronavirus-china-the-challenges-of-online-learning-for-universities/ [Accessed 16 May 2020]

An Analysis of Students' Perception of Online Assessments and its Relation to Motivation Towards Mathematics Learning

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Abstract: Assessing student performance is a challenge faced by most educational institutions during this time when conducting in-campus classes is affected by the pandemic. Use of online assessments to determine student performance is gaining wider acceptance over the traditional paper-and-pen type as it allows evaluation of what the students learned despite the lack of physical classroom interaction. Although there are studies that examine student perceptions about online learning in general, only a few focus on assessments especially those that consider its relation to affective aspects of learning. The views of students being the primary beneficiaries of the technology would give relevant information in designing appropriate online assessments and can bring about the success of its implementation. Thus, this present study investigated the usefulness of online assessments according to the perspective of students particularly in their math subject and its relation to their motivation towards mathematics learning. A mixed methods research design was conducted to determine the perception and motivation of 127 second year level engineering students via a questionnaire survey after exposure to a set of online assessments. Results showed that students have a high level of motivation towards mathematics learning and have positive perception about online assessments. Using factor analysis, variations in the perception were found to be explained by 4 factors focused on ease of use and functionality, personal preference, technical considerations, and complementation with other methods. Some of these factors were found to be significantly related with various aspects of motivation. Interview of students also revealed they found taking online assessments a positive innovation in giving assignments and prefer them over traditional assignments. The findings derived from this study give teachers a basis in designing more effective online assessments particularly those that address the needs of today's generation of learners. Further, for a developing country like the Philippines, findings of this study would greatly contribute to the government and academic sector's efforts in capacity building of its online system of education.

Keywords: learning management system, mathematics learning, motivation, online assessment, perception, technology

1. Introduction

Technology enhanced learning has been explored and widely practiced in educational institutions across all class levels in many nations. Indeed, it has completely redefined over the years how the teaching-learning process takes place. It is no longer considered as merely a pedagogical supplement but rather as a staple and integral component of the whole educational set-up. Its increase in relevance is highlighted by the fact that there is an educational revolution wherein acquiring 21st century learning skills must be the goal of every academic institution for its students. Durham Public Schools (DPS) characterizes 21st century learners as students who capably utilize technology and digital media to enhance every aspect of their learning (DPS, n.d.). Aristovnik, et al. (2016) describes them as new generations of students who are very familiar and adept with the latest technologies.

Despite the vast impacts of technology in education, particularly in the design and delivery of curriculum, there is still a need to explore new approaches when it comes to assessments (Crisp, Guardia and Hillier, 2016). Assessment is one area in education where technology can be maximally integrated. It is considered as an essential component in education that promotes learning and measures expected outcomes (Clements and Cord, 2013 as cited in Crisp, Guardia and Hillier, 2016). Baneres, et al. (2019) states that one of the great contributions of technology in education is the evolution of assessments into e-assessments. Online assessment or e-assessment includes a broad range of assessment activities such as online essay and computer-marked online examinations (James, 2016). Guardia, Crisp and Alsina (2017) as cited in Baneres (2016) defined them as the use of information and communications technology in facilitating the entire assessment process starting with the creation of assignments up to checking to as far as conducting statistical analysis. Its effectiveness is stressed by Laine, et al. (2016), claiming that online exams are effective for diagnostic, formative, and summative assessments and provide students with the opportunity of demonstrating performance.

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The use of computers in the Philippines' educational set-up has been present for a long time but mostly for aiding instruction only. Internet technology, on the other hand, is being used primarily for engaging students to search for additional learning references. However, their use as means to administer various forms of assessments to students via learning management systems is somewhat limited. Its utilization as such has also been received with mixed views among teachers due to insufficient evidence that it supports both affective and cognitive learning. Sarmiento, Lapinid and Prudente, (2018) stated that there is scarcity in the literature discussing how online assessments affect performance of Filipino students. Likewise, studies investigating how perception of online assessments can be related to other factors that contribute to learning and engagement such as student motivation are quite limited. Adanir, et al. (2020) mentioned that learner's perceptions of online exams have not been widely studied despite its potential to contribute to more effective use of online exams, particularly among developing countries. Their work further emphasized that investigating learners' perceptions on online exams could reveal factors that would make online examinations more accurate and effective.

The Philippines, like most in the world, has been forced to drastically embrace online learning as the new norm, and along with it is the use of online assessments. The current situation brought by the pandemic has given the country's education sector an imperative to make online learning and online assessments successful. However, the country is still in the stage of building its online learning system capability. Various socio-economic factors and lack of existing policies for an online educational system are issues that the government and education sector are trying to resolve so that students across all economic status can cope with the demands of this set-up. Joaquin, Biana and Dacela, (2020) suggested that teacher capacity, designing efficient learning environment and looking into the student context are factors that must be considered as the country tries to sustain the learning despite the situation. Hence, this current study would be able to contribute to this need to examine perceptions of students about an integral part of the learning process on giving online assessments. The findings would give academic institutions and educators a basis for designing and administering effective online assessments based on students' perspectives, who are considered as end-users and primary beneficiaries of the technology. Additionally, the study determined if there is a relationship between the perception and the motivation of students towards mathematics learning to give some insights about the affective aspects of learning related to use of online assessments. The following are the research objectives of this study:

1. Determine the perception of the students about online assessments.
2. Identify the opinions of students about online assessments.
3. Identify the factors affecting students' perceptions about online assessments.
4. Determine the motivation level of students towards mathematics learning.
5. Determine the relationship between the perception of the students on online assessments and their motivation level towards mathematics learning.

2. Literature review

This section presents related literature to the present study. It is structured presenting four subsections about technology in education and learning management systems, perceptions of online learning, online assessments, and motivation towards mathematics learning.

2.1 Technology in Education and Learning Management Systems

The International Bureau of Education (IBE) defines technology-enhanced education as one that utilizes information and communication technologies (ICT) as mediating devices to support student learning through various applications such as web-based learning, computer-based learning and learning management systems (IBE, n.d.). The bureau further emphasized that using appropriate technologies can support the development of innovative teaching practices that enrich learning experiences. One such technology used to deliver classes online is the learning management system.

Learning management systems (LMS) is an internet-based software application used to carry out e-learning courses, with features that permit virtual correspondence between teachers and students (Proprofs Training Maker, n.d.). Academic institutions can choose from a variety of LMS to carry out fully online or blended learning strategies such as WebCT, Moodle, OLAT, and Sakai (Wilson and Randall, 2012 as cited in Papadakis, et al., 2018). Each LMS offers features that can be customized by users depending on their need, capabilities, resources, and infrastructure. To keep up with these technological advancements in education and to meet the changing learning styles of students, many academic institutions in the Philippines are now setting up their own LMS.

Different components of online learning are gradually being introduced in Philippines schools, mostly at secondary and tertiary levels.

Applying technology in education is seen as an integral component of a teaching-learning environment that addresses the need of 21st century learners. Such students have different learning styles, but they are mostly internet-savvy and uses technology to help them build their knowledge. New technology-driven methods such as flipped classroom, blended learning, massive open online courses (MOOC), and distance learning are deemed the best ways to meet the needs of such learners (Wanner and Palmer, 2015). Such strategies are said to be based on the theory of social learning and constructivism, where students are the active actors in their learning (Young and Jeong, 2020 as cited in Fernandez-Martin, et. al, 2020). Also, these cover three lines of learning namely, individual learning, collaborative learning, and problem-based learning (Vargas and Cordero as cited in Fernandez-Martin, et. al, 2020). Since students assume more active roles in the modern methods of learning, their perception of every aspect of the technology becomes highly relevant as well.

2.2 Perceptions of Online Learning

Higher education institutions need to find ways to improve the implementation of technology and LMS so that it would be viewed successfully by all its stakeholders specially the students (Aristovnik, et al., 2016; Papadakis, et.al., 2018). This can be achieved by determining the perception of students about the technology. Student perception consists of the belief and thoughts of students about the technology used in their course. According to Abdullah, Muait and Ganefri (2019), knowing the perception of students is important because this influences their acceptance of the technology. Many research studies discussed that the effectiveness of applying technology in education can be achieved if factors affecting perceptions of students and teachers in its use and their experience in an online learning set-up are examined (Ssekakubo, Suleman and Marsden, 2013; Aristovnik, et al., 2016; Papadakis, et. al, 2018; Kalogiannakis and Papadakis, 2019; Abdullah, Muait and Ganefri, 2019; Moreno-Guerrero, et. al, 2020).

Aristovnik, et al. (2016) presented an analysis of factors influencing the perceived usefulness of e-courses by students at the Faculty of Public Administration, University of Ljubljana. Findings showed that perception of online courses were connected to demographic data and that consistency with face-to-face teaching and teacher feedback significantly influenced student perception while structure and variety of assignments had no significant impact. A similar study was conducted by Papadakis, et al (2018) which investigated how university students perceive the use of learning management systems. Their work examined the perceptions of students at the University of Crete about mobile access to the LMS Moodle. Findings indicate that students did not find Moodle as an effective learning tool because the mobile access provided only a limited usability and reliability. Ssekakubo, Suleman and Marsden (2013) conducted a study that identified the perception of students from University of Cape Town (UCT) and Makerere University on their appropriate LMS access strategies and their most needed LMS services. Results of their survey indicate that the most desired LMS services by the students are assignments, announcements, resources, course outlines and the chat room.

Some research studies focused on determining the factors that influence the intention of teachers to adopt technology in learning. Kalogiannakis and Papadakis (2019) discussed in their work that attitude toward the usefulness of mobile technology in the teaching process strongly influence pre-service teachers' intention to use mobile learning while students' notion of ease of use had an indirect impact. Papadakis (2018) investigated whether gender and age differences influence the acceptance of mobile devices in education. Results revealed that both factors were not significantly correlated with mobile devices acceptance but emphasized the need for teacher training to successfully incorporate mobile technology into pedagogical practice.

All studies mentioned gave indications that knowing perception of users of the technology would give insights on its proper and effective implementation. One aspect of technology integration in learning that must be explored for effective administration is online assessment.

2.3 Online Assessments

Assessment is an essential and indispensable component of the teaching-learning process which comes in the form of formative and summative types (Adanir, et al., 2020). Baleni (2015) differentiates the two in terms of objectives where formative aims to improve the teaching and learning while summative focuses on relating gathered data to student performance.

Like most subjects, math requires constant use of assessments to give both teachers and students basis to know if course learning outcomes are met. It has been a practice in math classes to provide extra activities, or homework to students with the goal of reinforcing what have been learned in class. These homework activities are formative in nature done beyond class hours and allowing students to work independently or with groups of classmates using available and related resources. Rosario, et.al (2015) emphasized the importance of the teacher's role in designing homework activities with a specific purpose and showed that extension homework brought positive impacts on the mathematics achievement of students. However, the benefits of homework were challenged by others stating that the notion that homework teach study skills and promote responsibility does not pass the test of research, logic, and experience (Kohn, 2006 cited in Booth, 2010).

In math, these homework activities typically come in the form of paper-and-pen exercises consisting of problems that were not solved in class. According to Sarmiento (2017), such kind of activities can be time-consuming for teachers to correct and may cause copying work among students. Baleni (2015) stressed the need to explore diverse techniques of assessing learning in an online set-up of classes. Online homework system or online assessments is an emerging technology applied by some teachers complementing the usual paper-and-pen style of giving assessments whereby students may be given unlimited chances of working on a set of problems that vary in every attempt for self-practice. Under this technology, assignments are given and answered by students through the internet. This potentially addresses the issues on pen-and-paper assessments and more importantly, the concern about continuously assessing student performance despite limited or even lack of physical classes.

Several studies support the effective use of online homework in their mathematics classes using different forms of learning management systems. Sarmiento (2017) conducted a study that determined the perception of students of online homework in mathematics of accounting and finance where a set of homework was administered to students using *MyOpenMath*. Results of this study showed that students found online homework to bring positive impact in their learning. In addition, most students agreed that answering online homework is convenient and that it helped them manage their time. Sarmiento, Lapinid, and Prudente (2018) extended the previous work by determining the effectiveness of online homework in students' performance compared to paper-and-pencil homework. They used a two-group counterbalanced experimental design, where both groups became control and experimental groups and received summative assessments after being subjected to online homework. The results of the summative assessment served as the performance of the participants while their scores in the home-works served as measure of the homework performance. Findings indicated that students performed better than they would by paper-and-pencil.

Adanir, et al. (2020) investigated and compared students' perceptions of online exams at state universities in Turkey and Kyrgyztan via a mixed study research design. Results of the quantitative analysis revealed that Turkish learners found online exams less stressful and more reliable than the traditional mode of taking exams while Kyrgyz learners perceived it otherwise. James (2016) revealed that many students from a regional university in Australia have encountered challenges with having to take major examinations online including technical difficulties and insufficient support. It was also found that ICT infrastructure and reliable connectivity were significant barriers to successful completion of online examinations under secure, proctored conditions. Wanner and Palmer (2015), in their study of flipped courses in a university in Australia, emphasized that attention to assessment practices must be considered to ensure that the learning experience of students is cohesive. Their results further indicated that students preferred blended learning practices over fully online ones stating that they enjoyed clearly structured assessment with wide choices.

Tang and Titus (2002) utilized WebAssign to deliver, collect and grade homework of students in Calculus and General Physics. Students claimed that using the online platform for their homework enhanced their learning of the course content. Most of them preferred WebAssign homework over paper-and-pen homework and the time they spent in engaging with the activities increased significantly. This mode of assessment delivery also promoted cooperative learning and motivated the students to engage and collaborate during activities. Zerr (2007) used Blackboard in administering online homework system, emulating the teacher's presence in the classroom via a sequence of attempt-feedback-reattempt in the assessments. It was found that the participants of the study had a high level of satisfaction in this system. Korkmaz and Karakuz (2009) found that the blended learning model incorporating instruction, homework, individual study, and evaluation contributed more to student attitudes toward geography course when compared to the traditional learning model.

The mentioned studies give insights as to the how taking online assessments enhances learning and increases students' willingness to engage in activities. Motivation towards the learning process can then be a factor contributing to engagement of students with any type of learning activity, whether in class or online. Majority of Philippines schools relied on the traditional mode of giving assessments and used the online system merely as a supplement pre-pandemic. However, in this "forced" online or remote set-up, assessments remain a vital component of the learning process and thus, the motivation of students to engage on such activities must be considered. Hence, this study investigated this affective aspect and related it with perception of students on online assessments.

2.4 Motivation Towards Mathematics Learning

Various studies have emphasized that the affective component of learning and student emotion are as much vital as it is for cognition and that academic success as well as active learning is linked with the affective dimension such as higher degrees of motivation (Booth, 2010; Fared, Jdaitawi and Sheta, 2018; Jeong, Canada and Gomez, 2018, Jdaitawi, M., 2020). Students' attitudes including their motivation play a role on how they involve themselves in the learning process.

Motivation is the reason why one performs a certain activity. In class, students become motivated to engage in learning activities once they perceive its importance and if they can derive benefits from doing such (Pintrich and Schunk, 1996 cited in Tuan, Chin and Shieh, 2005). Tuan, Chin and Shieh (2005) developed a questionnaire that measured the motivation of students towards science learning. In their work, motivation was categorized according to six factors that include self-efficacy, active learning strategies, science learning value, performance goal, achievement goal and learning environment stimulation. Each represents what drives the student to participate in science learning activities. Self-efficacy denoted the belief of students in one's ability to do a task. Active learning strategies focused on the role of students in constructing their own knowledge. Science learning connected motivation to the students' finding relevance of the subject in their daily lives. Performance goal focuses on the desire to out-perform others. Achievement goal was about motivation derived from gaining more competency. Lastly, learning environment stimulation denoted the role of curriculum and set-up in class (Tuan, Chin and Shieh, 2005).

Bhowmik (2014) in his take on constructivism stated that by theory, it is the learner that establishes how he comes to know a concept and that interactive and problem-centered teaching approaches should be considered in mathematics classes. It was also suggested that for student engagement to be established, there should be a broad set of learning activities including those bringing in out-of-school experiences (Denzine and Brown, 2014). These out of school problem-centered activities can materialize in the form of assignments. It may then be logical to consider that to make students engaged in the learning process, they must find motivation towards the process itself. The activities given in and out of class to support learning should then be designed well enough to ensure students perceive their value so that meaningful engagement may be realized.

The studies reviewed provide a framework that serves as a basis for this study where the perception of online assessments can bring about the effective use of technology, and that students' perspectives about the learning process can influence how well motivated they are to take part in the learning activity. Thus, this present study investigates the connection between student perceptions on technology-based and online assessments delivered via learning management systems and their motivation towards math learning.

3. Methodology

For the methodology, this paper gives a description of the participants and some demographic profile, particularly their gender, and degree program in the university. Next, the research design is discussed followed by the development of the questionnaires used in the study and how the data were analyzed. Lastly, the research procedure was outlined.

3.1 Participants of the Study

The participants of the study were second year engineering students from a university in Cavite, Philippines who were chosen via a convenience sampling method. Out of the 432 engineering students enrolled during the semester and taking integral calculus, only 127 (29.4%) belonging to 5 intact sections were selected as they were the only ones to complete all the online assessments and answer the survey questionnaires. These students have been previously exposed to the learning management system of the university during their first year in college and were already familiar with its features including online assessment. Tables 1 and 2 show the demographic profile of the participants in terms of gender (32.3% female and 67.7% male participants) and degree program in the university. The degree programs of the students were civil engineering (CEE, 39.4%), computer engineering (CPE, 20.5%), electronics engineering (ECE, 19.7%) and mechanical engineering (MEE, 20.5%).

Table 1: Frequency distribution of students according to gender

Gender				
	Frequency	Percent	Valid Percent	Cumulative Percent
FEMALE	41	32.3	32.3	32.3
MALE	86	67.7	67.7	100.0
Total	127	100.0	100.0	

Table 2: Frequency distribution of students according to degree program

Degree Program					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CEE	50	39.4	39.4	39.4
	CPE	26	20.5	20.5	59.8
	ECE	25	19.7	19.7	79.5
	MEE	26	20.5	20.5	100.0
	Total	127	100.0	100.0	

3.2 Research Design

A mixed methods research design was utilized where a combination of qualitative and quantitative data is obtained and analyzed to provide answers to the problems in this study. The qualitative data obtained were the opinion of the students about taking online homework or assessments. The quantitative data consisted of the level of motivation towards mathematics learning and perception on online assessments of students obtained via the 4-point scale opinion questionnaire surveys.

3.3 Instrument and Statistical Analysis

The instrument used to measure the motivation towards math learning (MTML) was based on the Students' Motivation towards Science Learning (SMTSL) questionnaire developed by Tuan, Chin and Shieh (2005). The researchers asked for the approval of the developer of the questionnaire to allow them to utilize the material but with some modifications to meet the objective of measuring the motivation towards mathematics learning of the students. The modification involved changing the context of the questionnaire from science to mathematics learning. Some negatively stated items from the original were also reversed as per suggestion by the evaluators consulted by the researchers during content validation. Some of the changes adapted by the researchers included the following: "Whether the science content is difficult or easy, I am sure that I can understand it" was changed to "Whether the math content is difficult or easy, I am sure I can understand it"; and "I am willing to participate in this science course because the teacher uses a variety of teaching methods" was changed to "I am willing to participate in this math course because the teacher uses a variety of teaching methods". The rest of the items in the SMTSL questionnaire were changed in a similar manner.

The instrument to measure the perception on online homework was based on the material used by Sarmiento (2017). A few items in the questionnaire were reworded to indicate that the perception was directed towards the students' online homework in calculus. The 24-item questionnaire included 21 items that measure the perception score and 3 items that determined if the students utilized their unlimited attempts to answer each online homework to prepare for summative exams, the techniques they used to solve the given problems and if they found the online assessments useful.

The students responded by rating each item in the questionnaires using the 4-point scale: 1-strongly disagree, 2 – disagree, 3-agree, and 4-strongly agree. Initially, the questionnaire was designed to use a 5-point scale but based on the comments of the evaluators of the questionnaire, it was suggested to exclude the neutral option to get a clearer inference on the inclination of the students in terms of their motivation towards math and their perception on online assessments. Also, following the work of Sarmiento (2017), the researchers opted to use only a 4-point scale in both questionnaires, whereby the "neutral" or "no opinion" option was not included to ensure that the respondents would specify their level of agreement on each of the propositions in the questionnaires. Using an even number of options is said to eliminate the middle choice which gives respondents a means not to show their actual preference and thus providing researchers with little useful data (University at Buffalo, 2019). Table 3 shows the interpretation of the results obtained from the instrument for measuring the motivation towards math of the students and perception.

Table 3: Interpretation of student responses for motivation and perception instrument

Rating	Verbal Interpretation	Level of Motivation	Level of Perception
1.00-1.49	Strongly disagree	Very low motivation	Highly Negative
1.50-2.49	Disagree	Low motivation	Negative
2.50-3.49	Agree	High motivation	Positive
3.50-4.00	Strongly agree	Very high motivation	Highly Positive

A reliability analysis using 30 samples was used to verify the consistency of the instrument where a Cronbach's Alpha of 0.927 was obtained indicating reliability of the test. Factor analysis was used to identify the factors or components that possibly caused the variation on the students' perception of online learning. A Kaiser-Mayer-Olkin Measure of Sampling Adequacy (KMO) test was conducted to determine if the sample is adequate to perform factor analysis. A KMO value of 0.893 and p-value of 0.000 were obtained indicating adequacy. Lastly, a multiple correlation analysis via the Pearson r Correlation Coefficient was applied to determine if there were significant relationships between the factors extracted from the students' perception survey and the factors that constitute the students' motivation towards math.

3.4 Research Procedure

Initially, the researchers prepared the online assessments and ensured that the level of difficulty of the items were similar. These items were taken from previous assessments made by the researchers during their traditional pen-and-paper assessments in the previous school years. A total of 4 online assessments were prepared for this study one each for the sub-topics of techniques of integration, namely: integration by parts, trigonometric integrals, trigonometric substitution, and partial fraction decomposition. These assessments were all multiple-choice type of assessment involving different problems that students needed to answer online via the LMS of the university. Each online assessment was due for a week, with students given an unlimited number of attempts and their best scores among attempts were given credit. Students may get a different set of 10 questions in each attempt. The students got to see their scores right after submission and they were provided with a summary of what items they answered incorrectly. The students were given opportunities to submit clarifications about the homework via the chat and forum feature of the LMS for immediate feedback. Once all the assessments were completed, the students answered the instruments for perception and motivation through the LMS.

4. Results

The results of the survey and statistical analysis are presented in the following sequence: perception of students, factors affecting students' perception obtained using factor analysis, motivation level of students and correlation analysis.

4.1 Students' Perception of Online Assessments

Table 4 shows the mean responses on each item in the students' perception questionnaire. Generally, the students claimed they had a positive experience taking online assessments. They strongly agreed that this kind of assessment should be done not just in calculus but also in other math courses. Among the items in the perception survey, the item "*Doing online homework helps me practice answering exercises in Calculus*" had the highest mean of 3.65, followed by "*Getting immediate result and feedback from online homework motivates me*" with a mean of 3.62 and the third highest is "*I like doing online homework*" with a mean of 3.57. Based on standard deviation, these three items were among the 5 having lowest variation on the responses of the students indicating that they are mostly in agreement with the use of the online assessments in helping them prepare for their subject, the immediate feedback function gives them motivation and that they generally like doing online homework.

Table 4: Students' perception of online homework in integral calculus

	Perception of Online Homework	Mean	Std. Deviation
P1	I like doing online homework.	3.5748	.62386
P2	Doing online homework is a positive innovation to the way homework is administered.	3.4803	.67671
P3	Online homework has to be spread out to other math courses besides Calculus.	3.4961	.74401
P4	Doing online homework has disadvantages for me.*	2.6929	.98005
P5	I prefer paper-and-pencil homework to online homework in Calculus.*	2.5906	.97878
P6	Technical computer problems reduce my online homework grade.*	2.5039	.96670
P7	Online homework helps me manage my time in answering homework.	3.3150	.74216
P8	Getting immediate result and feedback from online homework motivates me.	3.6220	.58998
P9	Doing online homework helps improve my performance in my Calculus class.	3.4409	.69754
P10	Along with online homework, paper-and-pencil homework should also be given to students.	3.2520	.80641
P11	Answering online homework scares me.*	3.1575	.83023
P12	I want to continue doing online homework.	3.4488	.67505
P13	I am more comfortable doing homework online compared to paper-and-pencil.	3.1181	.80291
P14	I encountered difficulties accessing the online homework.*	2.8425	.95473
P15	The online homework environment is appropriate and convenient for users.	3.3858	.63054
P16	Doing online homework is a positive experience.	3.5039	.58924
P17	Doing online homework helps me practice answering exercises in Calculus.	3.6535	.56874
P18	The online homework platform is easy to use and is user friendly.	3.4724	.66460
P19	I do not want to take any online homework.*	3.4961	.73327
P20	Online homework does not help me prepare for quizzes and examinations.*	3.4803	.77511
P21	Online homework increases the amount of time I spent studying.	3.2677	.81112

4.2 Opinion of Students about Taking Online Assessments

The opinion of students about taking online assessments were obtained via open-ended questions in the perception survey. There were 72 students (56.7%) who preferred taking online assessments compared to the paper-and-pen form. There were 116 (91.3%) students who responded that taking the online assessment helped them prepare for their major exam in calculus. The instrument also identified how the students answered their online assessments. There were 15 (11.8%) who said that they solved the problems independently by referring to their lecture notes, 3 (2.4%) responded that they solved using only sources from the internet or math softwares while the majority (109 - 85.8%) utilized various sources including their notes, internet available references and math softwares. They also collaborated with their classmates via group studies.

4.3 Factors Affecting the Students' Perception of Online Assessments

Factor analysis was conducted to understand what aspects of perception on online assessments mostly explains the variation in the responses of students. Based on the Scree plot generated in the analysis, 4 factors or components were extracted from the set of 21 questions on perception. The eigenvalue greater than 1 was considered to decide on the number of factors. This is shown in Figure 1.

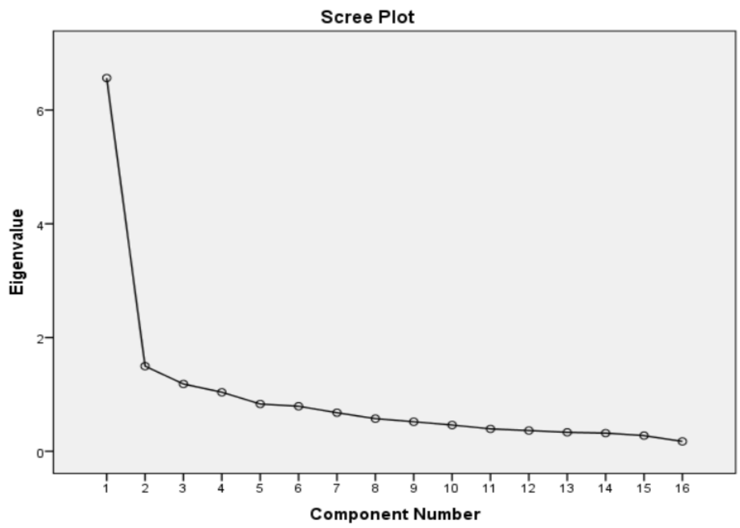

Figure 1: Scree plot on the factor analysis of the students' perception of online homework

Table 5 shows the summary of the results of the factor analysis where 64.255% of the variation of students' perception can be explained by the 4 factors or components extracted from the data. The remaining 35.745% was not captured. Based on the analysis, Factor 1 explains the largest variation on the students' perception, with a variance of 41.015%.

Table 5: Factor analysis results

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.562	41.015	41.015	6.562	41.015	41.015	5.428	33.925	33.925
2	1.497	9.357	50.372	1.497	9.357	50.372	1.892	11.825	45.75
3	1.183	7.396	57.768	1.183	7.396	57.768	1.581	9.882	55.632
4	1.038	6.487	64.255	1.038	6.487	64.255	1.38	8.623	64.255

Extraction Method: Principal Component Analysis.

Table 6 enumerates the items in the questionnaire on students' perception that are closely related and are clustered as one component or one factor that explains the variation in the results. Analysis revealed that only 16 items were left because some of the items are highly correlated to factor 1. Referring to the actual items in Table 4, we find that P3, P7, P8, P9, P12, P15, P16, P17, P18 and P21 are highly correlated thus are clustered as factor 1. P19 and P20 are clustered as factor 2, P6 and P14 are clustered as factor 3, and P5 and P10 are clustered as factor 4.

Table 6: Component matrix of the students' perception of online homework

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
P3	0.728			
P5				0.592
P6			0.721	
P7	0.675			
P8	0.8			
P9	0.693			
P10				-0.801
P12	0.586			
P14			0.744	
P15	0.784			
P16	0.865			
P17	0.716			
P18	0.721			

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
P19		0.754		
P20		0.86		
P21	0.583			

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Descriptive information shown in Table 7 about the items shows that factors 1, 2, 3 and 4 have means of 3.4628, 3.4882, 2.6732 and 2.9213. This gives an over-all perception mean of 3.2982 which is interpreted as positive perception on online assessments.

Table 7: Descriptive statistics of the factors extracted

Item	Mean	Std. Deviation
P3	3.4961	0.74401
P7	3.315	0.74216
P8	3.622	0.58998
P9	3.4409	0.69754
P12	3.4488	0.67505
P15	3.3858	0.63054
P16	3.5039	0.58924
P17	3.6535	0.56874
P18	3.4724	0.6646
P21	3.2677	0.81112
Factor1	**3.4628**	**0.50059**
P19	3.4961	0.73327
P20	3.4803	0.77511
Factor2	**3.4882**	**0.67101**
P6	2.5039	0.9667
P14	2.8425	0.95473
Factor3	**2.6732**	**0.75692**
P5	2.5906	0.97878
P10	3.252	0.80641
Factor4	**2.9213**	**0.5507**
Overall Perception	**3.2982**	**0.43267**

The four factors were identified as ease of use and functionality, personal preference, technical considerations, and complementation with other methods. The items P3, P7, P8, P9, P12, P15, P16, P17, P18 and P21 found to be highly correlated and clustered as factor 1, all focus on the ease of use of the technology. These pertained to items were the respondents agreed that the delivery of online assessment was user-friendly, convenient and gave them a positive experience. Likewise, the items targeted functionality of the online assessments, where students agreed that it helped them study in their subject, gave their needed results and feedback, and contributes to improving their performance in class. Factor 2 is explained by the items P19 and P20, which focuses more on the personal preference of students on the type of activity, whether online or not, they want to experience in class. Items P6 and P14 are clustered as factor 3, which focused on technical considerations such as difficulties encountered while doing their online assessments. Finally, P5 and P10 are clustered as factor 4 where the responses of student focused on complementing online and paper-and-pen type of assessments in their classes.

4.4 Motivation of Students towards Math Learning

The motivation level of the engineering students was determined after their exposure to the online assessments in Calculus. The motivation level was categorized according to 6 factors, namely self-efficacy, active learning strategies, math learning value, performance goal, achievement goal and learning environment stimulation. Table 8 summarizes the results obtained from the questionnaire.

Table 8: Motivation levels of students towards math learning

Motivation Factors	Mean	Std. Deviation	Interpretation
Self-Efficacy	3.15	.422	High level of motivation
Active Learning Strategies	3.46	.380	High level of motivation
Math Learning Value	3.50	.418	Very high level of motivation
Performance Goal	3.16	.447	High level of motivation
Achievement Goal	3.48	.455	High level of motivation
Learning Environment Stimulation	3.32	.447	High level of motivation
Over-all Motivation	3.35	0.279	High level of motivation

Self-efficacy accounted for the confidence of students in dealing with math concepts in their class. This measured the students feeling of self-sufficiency and belief in themselves to perform well in the subject as well as solving difficult math problems. Results in Table 8 show that the students have high level of self-efficacy with over-all mean rating of 3.15 implying that students strongly believed in their capacity to do well in math. The next factor is active learning strategies which measured the students' motivation to engage in activities particularly when presented with new math concepts. This determined if students connected their past learnings with the new concepts and if they find reasons for their mistakes. The motivation of the students based on this factor is 3.46, implying that students still engage in math activities even if they commit mistakes and find concepts difficult to understand. Math learning value focused on motivation emerging from knowing the importance of math. Table 8 reflects a mean rating of 3.50 which implies that students believed that math is useful in their daily life and in their field of study. The fourth factor measures motivation arising from students desire to out-perform others. Results showed that the mean performance goal is 3.16 which indicates that students get motivated by getting good grades. Achievement goal denotes motivation derived from seeing progress in their math performance.

The mean achievement goal rating is 3.48 which meant that students were highly motivated when they see better performance and when they can solve more difficult math problems. Lastly, learning environment stimulation showed a mean rating of 3.32. This indicated that students are motivated by the set-up of their class such as having enough class interaction and experiencing different teaching strategies that pose challenges to them. The students agreed that the set-up of class as well as dynamic and new activities make them more willing to participate in class. The over-all motivation of the students towards math learning is 3.35 which indicates that students have high level of motivation.

4.5 Relation between the Students' Perception of Online Homework and Motivation towards Math Learning

Multiple correlation analysis was done to determine the relationship of the factors arising from the perception of students on online assessments with the motivation level of students. Further, it was determined to which aspects of motivation are the factors significantly correlated to. As reflected in Table 9, factor 1 was found to be correlated to the motivation aspects of active learning strategies (r=0.247), math learning value (r=0.281), and learning environment stimulation (r=0.314) at 0.05 level of significance. The p-values corresponding to these are all less than 0.01 indicating high level of statistical significance of results obtained. Factor 2 was found to have significant correlation with self-efficacy (r=0.205, p=0.021) and active learning strategies (r=0.206, p=0.02) at 0.01 level of significance and have high significant correlation with math learning value (r=0.236, p=0.007) at 0.05 level of significance. Factor 3 was found to have high level of significance with self-efficacy (r=0.265, p=0.003) at 0.05 level of significance while it is significantly correlated with active learning strategies (r=0.204, p=0.022) at 0.05 level of significance. Finally, factor 4 was found to be significantly correlated with active learning strategies (r=0.208, p=0.019) as well as math learning value (r=0.206, p=0.02) at 0.05 level of significance.

The over-all students' perception of online assessments has a highly significant correlation with the over-all motivation level (r=0.388, p=0). These observations indicate that as the perception scores of students on online assessments increase, the level of motivation also increases and vice versa. This could be an indication that perception influences motivation or motivation influences perception in the same direction.

Table 9: Correlation analysis between students' perception and motivation towards math learning

Factors derived from the Perception of Students on Online Assessment		Self-efficacy	Active Learning Strategies	Performance Goals	Math Learning Value	Learning Environment Stimulation	Ovel-all Motivation
Factor1	Pearson Correlation	0.133	.247**	-0.067	.281**	.314**	.324**
	Sig. (2-tailed)	0.135	0.005	0.453	0.001	0	0
	N	127	127	127	127	127	127
Factor2	Pearson Correlation	.205*	.206*	0.158	.236**	0.123	.276**
	Sig. (2-tailed)	0.021	0.02	0.076	0.007	0.169	0.002
	N	127	127	127	127	127	127
Factor3	Pearson Correlation	.265**	.204*	0.097	0.15	0.084	.265**
	Sig. (2-tailed)	0.003	0.022	0.276	0.092	0.35	0.003
	N	127	127	127	127	127	127
Factor4	Pearson Correlation	0.157	.208*	-0.139	.206*	.197*	.244**
	Sig. (2-tailed)	0.077	0.019	0.12	0.02	0.027	0.006
	N	127	127	127	127	127	127
Over-all Perception	Pearson Correlation	.218*	.300**	-0.019	.309**	.308**	.388**
	Sig. (2-tailed)	0.014	0.001	0.832	0	0	0
	N	127	127	127	127	127	127

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

5. Discussion and conclusion

The discussion of the results along with their implications are presented such that the discussion for problems 1 and 2 are given together, followed by the discussion for problem 3 and lastly, the discussion of problems 4 and 5 are given together.

1.1.5 *Research Problems: (1) Determine the perception of the students about online assessments and (2) Identify the opinions of students about online assessments.*

Results of the study showed that students have a positive perception on the use of online assessments. They agreed that the integration of technology in the way they take their assessments is a good innovation that allows them to get immediate feedback and results in their assessments. Also, majority of the students utilized the online assessments to prepare for their exam. They find that having unlimited attempts to take the online assessments exposes them to different types of problems useful for practice in problem-solving. The findings of this study are in line with the results of Adanir, et al. (2020) which mentioned that Kyrgyz students find the potential of online exams to improve learning through the provision of immediate feedback. This is further supported by the works of Sarmiento (2017) and Baleni (2015) where both studies emphasized that doing online assessments gave students opportunities to view their results and use the feedback to study further as final preparations for their summative tests.

In this study, the students also found that the use of online assessments provided them new and a variety in the teaching-learning strategies done in class. The results adhere to the suggestion by Lawson and Lawson to provide students with a broad set of activities (Lawson and Lawson, cited in Denzine and Brown, 2014) and by the results of Wanner and Palmer (2015) stating that students enjoyed the wider choices in learning and assessment they experienced in flipped classroom.

1.2.5 *Research Problem (3) Identify the factors affecting students' perceptions about online assessments*

Based on the factor analysis conducted, there are 4 factors that explains the variation on the perception of students on online assessments. The perception of students is generally explained by the first factor, ease of use and functionality, which explained 41.015% of the variation in the responses of students. This implied that the perception of students is focused on the convenience in the use of technology and if they find that it serves its purpose. Students tend to become more accepting of a new strategy or technology if they feel that it helps them achieve their learning goals. The online assessments were meant primarily to provide additional exercises for students thus they find that doing multiple attempts serve the purpose of helping them practice and learn more. This is supported by the work of Kalogiannakis and Papadakis (2019) whose results ranked usefulness of mobile learning in the teaching process strongly influenced the attitude of pre-service teachers in adopting a certain technology followed by ease of use. The work of Sarmiento (2017) also backs up the results of the study pointing out that students found taking online exams convenient because it can be accessed anytime within the allotted period.

The other factors derived from this present study are personal preference (9.357%), technical considerations (7.396%) and complementation with other methods (6.487%). The students found that online assessments can be an effective complement to doing paper-and -pen assessments and that most prefer it over the use of purely traditional means. This is supported by the work of Laine, et. al (2016) who despite giving positive feedback about taking electronic examinations also mentioned that pen-and-paper assessment is still an essential component for math assessments that can work together with the electronic exam. The technical difficulties are emphasized in the work of James (2016) where many students shared that their challenges in taking online examinations are due to technical difficulties, ICT infrastructure and internet connectivity. Reliable internet connection and lack of efficient gadgets that support online activities are common concerns among Filipino students. Thus, technical difficulties often arise and is a major issue that must be taken into consideration by academic institutions so that the learning experience remain positive for all students.

1.3.5 *Research Problems (4) Determine the motivation level of students towards mathematics learning and (5) Determine the relationship between the perception of the students on online assessments and their motivation level towards mathematics learning.*

The motivation level of students towards mathematics learning was found to be of high level, with a mean of 3.35. This motivation level is explained by 6 factors namely self-efficacy, active learning strategies, math learning value, performance goal, achievement goal, and learning environment stimulation. Multiple correlation analysis revealed that perception on online assessments is significantly correlated to motivation, on all its aspects except performance goals. This is in line with the results of the study of Abdullah, Muait and Ganefri (2019) where use of technology as part of teaching tools was shown to influence student motivation for the enhancement of student's overall learning experience. It is important to note that the high level of motivation of students after the exposure to online assessments maybe attributed to the type of student participants in the study. Since the students are enrolled in engineering programs, they have many subjects in mathematics in their curriculum or those subjects applying mathematics principles. This explains why the students acknowledge that math is important to their field of study and that they want challenging math problems so they can improve their understanding and knowledge of the subject. However, they are also dynamic students who require variety in their classes and tend to be competitive as well. Hence, the use of online assessments where they can answer different sets of problems in every attempt engages them more. They want to be exposed to different problems so that they can practice solving and they are encouraged to get better results in every attempt that they take. This is supported by the findings of Korkmaz and Karakuz (2009) where in Geography courses, the use of blended learning model contributed positively to students' attitudes towards their course.

The results of this present study support the effectiveness of online homework and the positive reception of students on this kind of assessment strategy. Like the results of Tang and Titus (2002), Zerr (2007) and Sarmiento (2017), the participants in this study also generally preferred online homework system over paper assignments, even though all research studies utilized different platforms for administering the online assessment. The participants became more motivated as reflected in their agreement that online homework increased their amount of time spent in studying and that most of them collaborated with their classmates in working on the different assessments. This coincides with the results of Tang and Titus (2002) where in their study, a significant increase in time of engagement was found. In the work of Sarmiento (2017), perception on online homework for her students in mathematics of accounting and finance was also of high level like the results of this paper.

This study also reflected what was found in her research and that is for students, taking online homework had a positive impact on learning.

This paper was able to highlight the key aspects needed in the effective use of online assessments and was able to show how it can influence the motivation level of students toward mathematics learning. In conclusion, knowing the perception on online assessments can give educators insights as to how to carry out the technology in the most effective way. This study emphasizes that design should focus on functionality, wherein the online assessments must provide opportunities for students to practice and prepare for their summative or major exams. The variety in problems and the multiple attempts can help address this aspect. It should also focus on ease of use with clear structure and guidelines. A well-designed online assessment can influence the motivation level of students and increase their engagement in class. Over-all, the use of online homework is a welcome addition to the different strategies that teachers employ to encourage active engagement among students. The benefits including ease of task of grading student works and being able to provide them with varied activities for practice and self-learning far outweigh the somewhat meticulous stage of preparing relevant materials.

6. Recommendation and limitations

This study was limited to the experience of students in their math subject during the semester. Hence the perception was directed only towards perception on online assessments within the context of their mathematics class. Likewise, this study did not investigate effectiveness of the online assessment on improving the motivation of students to engage more in their mathematics classes but focused on their correlation only.

The main challenges encountered by the researchers were the limited means to verify whether the students answered the assessments without resorting to guessing because the assessments were of multiple-choice type and the likelihood that the students utilized softwares to solve the problems instead of solving them. The researchers tried to discuss some problems from the online assessment during the face-to-face meeting asking students to explain their solution to determine if they knew the solution to the problems. The students were reminded that during their major exam, the questions will be based from the online assessments, but their solutions will be required for submission. This way they are encouraged to work on the solutions to the problems they encountered.

Considering the current situation in most countries, the use of online assessments in evaluating students and enhancing the learning process is now a requirement. Academic institutions in the Philippines must double their efforts in setting up infrastructure and learning management systems, formulating policies, and training teachers in the use of ICT and designing online materials including online assessments. Hence, studies that focus on how it can be carried effectively and accurately must be done. Future research can explore best practices in the delivery of online assessment to maximize its utility and benefits. It is also recommended to study its impact on student performance and come up with structural models that identifies what other factors contribute to acceptance of both teachers and students of online assessments.

References

Abdullah, R., Muait, J., and Ganefri. 2019. Students' perception towards modern technology as teaching aids. *Asian Journal of Assessment in Teaching and Learning*. 9(2), pp. 37-42. DOI:10.37134/ajatel.vol9.no2.5.2019

Adanır, G., İsmailova, R., Omuraliev, A. and Muhametjanova, G., 2020. Learners' perceptions of online exams: a comparative study in Turkey and Kyrgyzstan. *International Review of Research in Open and Distributed Learning* [online] Available at: < http://www.irrodl.org/index.php/irrodl/article/view/4679/5331> [Accessed 10 April 2021].

Aristovnik, A., Keržič, D., Tomaževič, N. and Umek, L., 2016. Determining factors of students' perceived usefulness of e-learning in higher education. Paper presented at the International Association for Development of the Information Society (IADIS) International Conference on e-Learning, Madeira, Portugal, Jul 1-4, 2016, Part I, pp. 3–10. .Available at: https://eric.ed.gov/?id=ED571462 [Accessed 11September 2021]

Baleni, Z. 2015. Online formative assessment in higher education: its pros and cons. *The Electronic Journal of e-Learning*, 13(4), pp. 228-236.https://academic-publishing.org/index.php/ejel/article/view/1730 [Accessed 11 September, 2021]

Baneres, D., Whitelock, D., Ras, E., Karadeniz, A., Guerrero-Roldan, E., and Rodriguez, M., 2019. Technology enhanced learning or learning driven by technology. *International Journal of Educational Technology in Higher Education*, Available at: <https://educationaltechnologyjournal.springeropen.com/articles/collections/telleteditorial> [Accessed 10 April 2021].

Bhowmik, M., 2015. Constructivism approach in mathematics teaching and assessment of mathematical understanding. *Basic Research Journal of Education Research and Review*, 4(1), pp. 8-12.

Booth, G., 2010. *The effects of homework assessment on student motivation and achievement.* [pdf] Available at: <https://pdfs.semanticscholar.org/2876/38f3e2c772636337488c62f337fd0fb6fb60.pdf> [Accessed 26 August 2017].

Carnegie Mellon University, n.d. *Student lack of interest or motivation*. [online]. Available at:<https://www.cmu.edu/teaching/solveproblem/strat-lackmotivation/lackmotivation-02.html> [Accessed 20 August 2017]

Crisp, G., Guàrdia, L. and Hillier, M., 2016. Using e-Assessment to enhance student learning and evidence learning outcomes. *International Journal Educational Technology in Higher Education*, [e-journal] 13(18). https://doi.org/10.1186/s41239-016-0020-3.

Denzine, G. and Brown, R., 2015. Motivation to learn and achievement. In: R. Papa (ed) *Media rich instruction*. Cham: Springer. https://doi.org/10.1007/978-3-319-00152-4_2.

Durham Public Schools (DPS), n.d. Characteristics of 21st Century Learners. [online] Available at: < https://sites.google.com/a/dpsnc.net/dps-literacy-framework/21st-century-literacy/characteristics-of-21st-century-learners> [Accessed 10 April 2021].

Fared, J., Jdaitawi, M., and Sheta, H., 2018. Fostering positive adjustment behavior: Social connectedness, achievement motivation and emotional-social learning among male and female university students. *Active Learning in Higher Education*, [e-journal] 19 (2), 145-158. doi.10.1177/1469787417731202.

Fernández-Martín, F., Romero-Rodríguez, J., Gómez-García, G. and Navas-Parejo, M., 2020. Impact of the flipped classroom method in the mathematical area: a systematic review. [online]. http://dx.doi.org/10.3390/math8122162.

Guàrdia, L., Crisp, G., and Alsina, I., 2017. Trends and challenges of e-assessment to enhance student learning in higher education. *Innovative Practices for Higher Education Assessment and Measurement*, [e-journal] (pp. 36–56). Abstract only. Available through: Semantic Scholar website < tps://www.semanticscholar.org/paper/Trends-and-Challenges-of-E-Assessment-to-Enhance-in-Guàrdia-Crisp/bcf946fb3df8c405b17033230b6ccb12f2264506> [Accessed 10 April 2021].

International Bureau of Education (IBE), n.d. Technology-enhanced learning. [online] Available at: <http://www.ibe.unesco.org/en/glossary-curriculum-terminology/t/technology-enhanced-learning> [Accessed 10 April 2021].

James, R., 2016. Tertiary student attitudes to invigilated, online summative examinations. *International Journal of Educational Technology Higher Education,* [e-journal] 13(19). https://doi.org/10.1186/s41239-016-0015-0.

Jdaitawi, M., 2020. Does flipped learning promote positive emotions in science education? A comparison between traditional and flipped classroom approaches. *Electronic Journal of e-learning*, [e-journal]. 18(6), pp. 516-524. doi: 10.34190/JEL.18.6.004

Jeong, J., Canada, F., and Gomez, D., 2018. The study of flipped classroom for pre-service Science teachers. *Education Science,* [e-journal] 8(163). doi:10.3390/educsci8040163.

Joaquin, J., Biana, H,, and Dacela, M., 2020. *The Philippine higher education sector in the time of COVID-19*. [online] Available at: < https://www.frontiersin.org/articles/10.3389/feduc.2020.576371/full> Accessed [15 September 2021].

Kalogiannakis, M., and Papadakis, S., 2019. Evaluating pre-service kindergarten teachers' intention to adopt and use tablets into teaching practice for natural sciences. *International Journal of Mobile Learning and Organisation*. 13. doi: 10.1504/IJMLO.2019.096479

Korkmaz, O. and Karakus, U., 2009. The impact of blended learning model on student attitudes towards geography course and their critical thinking dispositions and levels. *The Turkish Online Journal of Educational Technology*, 8(4), pp. 51-63.

Laine, K., Sipilä, E., Anderson, M., and Sydänheimo, L., 2016. Electronic exam in electronics studies. Paper presented at the SEFI Annual Conference 2016: Engineering Education on Top of the World: Industry University Cooperation. Tampere, Finland. Available at: http://sefibenvwh.cluster023.hosting.ovh.net/wp-content/uploads/2017/09/laine-electronic-exam-in-eletronics-studies-9.pdf [Accessed 11 September 2021]

Moreno-Guerrero, A., Aznar-Diaz, I., Caceres-Reche, P. and Alonoso-Garcia, S., 2020. E-learning in the teaching of mathematics: an educational experience in adult high school. *Mathematics 2020*. doi:10.3390/math8050840

Papadakis, S. 2018. Evaluating pre-service teachers' acceptance of mobile devices with regards to their age and gender: A case study in Greece. *International Journal of Mobile Learning and Organisation.* 12. doi: 10.1504/IJMLO.2018.095130

Papadakis, S., Kalogiannakis, M., Sifaki, E. and Vidakis, N., 2018. Access Moodle using smart mobile phones. a case study in a Greek university. In: A. Brooks, E. Brooks and N. Vidakis (eds) *Interactivity, Game Creation, Design, Learning, and Innovation.* ArtsIT 2017, DLI 2017. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 229. pp. 376-385. [online] http://dx.doi.org/10.1007/978-3-319-76908-0_36

Proprofs Training Maker, n.d. *What is an LMS*? [online]. Available at: <https://www.proprofs.com/training/lms-software/> [Accessed 21 August 2017]

Rosario, P., Nunez, Vallejo, G., Cunha, J., Nunes, T., Mourao, R and Pinto, R., 2015. Does homework design matter? the role of homework purposes on students' mathematics achievement. *Contemporary Educational Psychology,* [e-journal] 43, pp. 10-24. doi: 10.1016/j.cedpsych.2015.08.001

Sarmiento, C., 2017. Student perceptions of online homework in mathematics of accounting and finance. *Advanced Science Letters*, 23, pp. 1122-1125.

Sarmiento, C., Lapinid, M., and Prudente, M., 2018. The effect of online homework in the performance of mathematics of accounting and finance students. *Advanced Science Letters*, 24(11). 7956–7960. DOI:10.1166/asl.2018.12465

Ssekakubo, G., Suleman, H. and Marsden, G., 2013. Designing mobile LMS interfaces: learners' expectations and experiences. *Interactive Technology and Smart Education*, 10(2), pp. 147-167 [online] Available at: <https://core.ac.uk/download/pdf/232196429.pdf> [Accessed 17 April 2021].

Tang, G. and Titus, A., 2002. *Increasing students' time on task in calculus and general physics courses through WebAssign. Proceedings of the 2002 American Society for Engineering Education Annual Conference & Exposition.*[pdf] Available at: <https://www.semanticscholar.org/paper/Increasing-Students'-Time-on-Task-in-Calculus-and-Tang-Titus/ef9f1de1babd7124eed0c651560424087ca29de8> [Accessed 26 August 2017].

Tuan, H., Chin, C. and Shieh, S., 2005. The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education*, 27(6), pp. 639-654.

University at Buffalo, 2019. *Strongly agree: the number of response options matter when using a Likert scale: psychologist's research suggest that a response format should be given as much thought as the test itself* [online] Available at <www.sciencedaily.com/releases/2019/04/190423114033.htm> [Accessed 28 May 2020].

Wanner, T. and Palmer, E., 2015. Personalising learning: Exploring student and teacher perceptions about flexible learning and assessment in a flipped university course. *Computers & Education*. 88, 354-369. https://doi.org/10.1016/j.compedu.2015.07.008.

Zerr, R. 2007. A quantitative and qualitative analysis of the effectiveness of online homework in first-semester calculus. *Journal of Computers in Mathematics and Science Teaching*, 26(1), pp.55-73.

Recommendation Systems on E-Learning and Social Learning: A Systematic Review

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Abstract: E-learning is renowned as one of the highly effective modalities of learning. Social learning, in turn, is considered to be of major importance as it promotes collaboration between learners. For properly managing learning resources, recommender systems have been implemented in e-learning to enhance learners' experience. Whilst recommender systems are of widespread concern in online learning, it is still unclear to educators how recommender systems can improve the learning process and have a positive impact on learning. This paper seeks to provide an overview of the recommender systems proposed in e-learning between 2007 and the first part of 2021. Out of 100 initially identified publications for the period between 2007 and the first part of 2021, 51 articles were included for final synthesis, according to specific criteria. The descriptive results show that most of the disciplines involved in educational recommender systems papers have approached e-learning in a general way without putting as much emphasis on social learning, and that recommender systems based on explicit feedbacks and ratings were the most frequently used in empirical studies. The synthesis of results presents several recommender systems types in e-learning: (1) Content-based recommender systems, (2) Collaborative-filtering recommender systems, (3) Hybrid recommender systems and (4) Recommender systems based on supervised and unsupervised algorithms. The conclusions reflect on the almost lack of critical reflection on the importance of addressing recommender systems in social learning and social educational networks in particular, especially as social learning has particular requirements, the weak databases size used in some research work, the importance of acknowledging the strengths and weaknesses of each type of recommender system in an educational context and the need for further exploration of implicit feedbacks more than explicit learners' feedbacks for more accurate recommendations.

Keywords: E-learning, social learning, content-based recommender systems, collaborative-filtering recommender systems, hybrid recommender systems, algorithms

1. Introduction

E-learning, a developed learning approach, allows a learner to study at his own pace, from any destination, with a variety of teaching resources at his disposal. The purpose remains to improve their knowledge and enable them to learn remotely (Ntshwarang, Malinga and Losike-Sedimo., 2021). Among the most widespread types of web-based learning are social learning. Unlike traditional e-learning, which consists of simply transmitting information from the trainer to the learners, social learning promotes interaction and collaboration between learners. In the presence of a wide variety of educational content, social environments are faced with the need to adopt an approach to manage these different resources, it is due to the significant amount of learning objects learners are confronted with (Chen-Huei and Shih-Ming, 2015). The recommendation system adopted in several disciplines is an imperative tool in online learning environments as it promotes distance learning and grants the opportunity to individual learners for managing their time and focusing on the learning process (Sikka, Dhankhar and Rana, 2012). It is thus more appropriate to offer learners materials that meets their needs and requirements according to their profiles, activities and orientations. In this regard, several researchers approached recommendation systems in terms of e-learning and social learning by referring to several known techniques, including content-based techniques, techniques based on collaborative filtering, hybrid systems, etc. Researchers are adapting content-based recommendation systems to assist learners (Ghauth and Abdullah, 2011), (Tewari, Saroj, and Barman, 2015). Other researchers propose collaborative filtering-based recommendation systems focusing on the preferences of all learners (Tan, Guo and Li., 2008). Machine learning has likewise been addressed to increase the performance of recommendation systems (Dahdouh et al., 2019).

Many researchers have therefore addressed recommender systems to improve the quality of recommendations provided to learners. The learner is always the main component when it comes to distance learning. The learner's level of motivation and interest in the online courses is also of paramount importance to the success

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of the learning process. It is within this perspective that researchers are constantly seeking to develop more effective and relevant recommender systems and to improve the quality of the recommendations provided. Researchers are attempting to act on sophisticated techniques to be adduced and existing techniques to be improved. Hence, we constantly need to address the ongoing development to study the real needs of learners, especially in terms of recommendations. Although a large number of scientists have proposed high-performance recommendation systems for learning recommendations, there are still several aspects that need to be questioned and enhanced in order to propose more performing systems. The objective of this work is to outline a general view of some works performed between 2007 and 2020, including some studies conducted in 2021 as well. A general descriptive study on the techniques deployed, the data analysed and the final results is carried out. The selected works are then divided based on several aspects: the approach used, the geographical affiliation, the size of the databases concerned, distribution according to e-learning and social learning, and by type of publication. The main intention is to recognize the added value of the selected works in terms of online learning, and then to highlight the aspects still to be addressed, which will be the subject of forthcoming research work. Several research questions are raised concerning the added value brought by the selected works in distance learning, but also the shortcomings identified, whether they are general shortcomings or specific shortcomings for each type of approach proposed in the selected works. In this study, we focus on several aspects, including: (1) identifying the techniques involved in each type of recommendation, namely content-based approaches, collaborative filtering-based approaches, and hybrid approaches, (2) the size of the databases considered in the evaluation of the recommendation systems, (3) the ability of the proposed recommendation systems to generate relevant recommendations, (4) identifying the most covered techniques in terms of recommendations. 51 articles were selected from 100 works carried out from 2007. We opted to undertake this selection from 2007 onwards, since this was the year when recommendation systems started to gain momentum in e-learning. And since then, the number of works carried out in this direction is growing steadily.

The paper is divided into several parts. The first part defines the research questions and outlines a general vision of the major types of existing recommendation systems. The second part consists in defining the research methodology considered. The following part conducts a descriptive analysis of the selected works by classifying them according to the types of recommendations. Then, a statistical analysis is performed to partition the selected works according to several parameters: the size of the database, the type of publication, etc. Finally, we propose practical answers to the research questions we raised previously.

1.1 Context and work purposes

Our study is situated within the context of recommender systems supporting distance learning. Learners are the primary beneficiaries of recommender systems as long as these systems seek to provide high-quality recommendations. To this extent, our work tends towards a comprehensive study on the type of recommender systems that have been proposed in the field of distance learning, on the points that have been addressed, on the aspects that remain to be addressed in future work and on their contribution to the learning process and education in general. In this sense, we propose in the following section a set of research questions that we aim to answer through the analysis performed.

1.2 Research questions

Our present analysis is carried out with the aim of scrutinizing the situation of recommendation systems in e-learning, and to study the main aspects that have not been adapted in these studies. The research questions we aim to answer are:

1. What are the general gaps and missing points not addressed in these studies?
2. What are the main similarities and contradictions of the reported studies?
3. What are the particular gaps to mention for each type of educational recommender system?
4. What is the impact of selected recommender systems on learners?
5. How the results and findings contribute to online learning?

2. Background

2.1 Recommendation systems

A recommendation system is defined as a system that makes proposals to the user (films, music, different types of content) that are likely to interest him (Park and Kim, 2011). In our context of social learning, the intention is to filter information for learners or scientists in order to help them discover new contents or elements. A recommendation system can take many forms based on many concepts:

2.1.1 Content-based approach (Mobasher, 2007; Wang et al., 2018)

This type of recommendation system is mainly based on content analyzing documents, resources and objects previously evaluated by users. This analyzis allows to build a recommendation model based on the interests of different users. It is by referring to the profiles of the various users that the recommendations are calculated.

2.1.2 Collaborative filtering approach (Nilashi et al., 2013; Sharma and Mahajan, 2017)

This kind of recommendation system has been widely exploited in several fields and its application is widespread. In contrast to content-based recommendation systems, recommendation systems based on collaborative filtering consider the assessment made by all users in order to recommend items to a specific learner. Typically, the collaborative filtering approach is divided into two main collaborative approaches:

- Memory-based collaborative filtering:

This type of collaborative filtering essentially relies on the set of user profiles to calculate similarity between users. In this case, it is the similarity parameter between users that will be invoked to calculate recommendations to the different users.

- Model-based collaborative filtering:

This type of collaborative filtering is based on the calculation of similarity between the different items in order to calculate the recommendations for the individual users.

2.1.3 Hybrid approach (Geetha et al., 2018 ; Ignat'ev et al., 2018 ; Zhang et al., 2015)

Hybrid approaches aim to combine the qualities of the various existing approaches and mitigate their limitations. The best-known hybrid approach in terms of recommendations is the one that combines the content-based approach and the collaborative filtering approach. However, there are other types of hybrid approaches with other aspects, the main point is to integrate or combine several techniques simultaneously to be able to discuss a hybrid system.

2.1.4 Approaches based on supervised and unsupervised machine learning (Gannod et al., 2018)

Nowadays, machine Learning is considered as one of the most widely used tools in terms of recommendations in all areas, particularly for prediction, classification, clustering, etc. Several algorithms have been developed in terms of Machine Learning to improve system performance. Thus, the two most frequent types of machine learning in terms of recommendation systems are supervised learning and unsupervised learning:

- Supervised learning: The algorithm or learning is made to be supervised when the input data is already classified and it is necessary to predict the outputs based on the input elements.
- Unsupervised learning: This type of learning makes it possible to analyse data that are neither classified nor labelled with the objective of classifying and categorizing them according to predefined attributes and criteria.

2.2 E-learning and social learning

E-learning is one of the fastest growing of learning styles due to rapid technological development. It's about acquiring diverse knowledge in a wide range of fields and to enable learning for a large part of the community. Some of the outstanding advantages of e-learning include:

- Ease of use and accessibility by computer, telephone (...).
- Online monitoring and organized controls.
- Considering the rhythm of learning.

Many researchers have likewise emphasised the various factors influencing e-learning in general, including: the cost of the Internet, the technology used (Ahmed, Hussain and Farid, 2018), the design of the course, the role of educators (Nortvig, Petersen and Balle, 2018), etc. The purpose is thus to maximize learning by engaging learners in the learning process (Khan et al., 2017).

It is thus important to assume the social dimension in the learning process and learners must be able to learn in an interactive and collaborative environment. Thus, social learning emerges as a key factor in the interaction of learners with each other to foster collaborative work. The concept of community turns out to be very relevant to social learning (Arasaratnam-Smith and Northcote, 2017).Today, with the possible and easy access to different social networks and social environments in general, it is possible for a learner to interact easily with other learners. Thus, social networks bring many advantages in terms of learning:

- Foster interaction between learners.
- Encourage interaction between learners and the instructor.
- Facilitate communication among different members of the learning environment.
- Express themselves and help each other easily and freely.

3. Research methodology

3.1 Data collection

In order to collect conferences and journal papers, we relied on a collection of journals, conferences and electronic databases, including IEEE, Science Direct, RECYS conference, ResearchGate, Scopus,etc. We collected 51 papers from the databases mentioned above.

Conferences	Journals
1- IEEE. 2- Springer. 3- ACM	1- Elsevier. 2- Springer. 3- DBLP. 4- Tandofline.

3.2 Search terms

The search terms used for this article can be divided into two groups. The first group includes terms related to e-learning: e-learning, e-learning, distance learning, learners, online education. The second group includes terms that refer to recommendation systems and their different types: recommendation system, recommendation, content, collaborative filtering, hybrid system.

3.3 Selection of articles to be included

To be regarded as suitable for this study, research articles must meet the following criteria:

- The article must be published in journals or conferences published between 2007 and the first part of 2021. The objective is to include recent studies in terms of recommendation systems and e-learning.
- All articles must be written in English.

The figure 1 summarizes the general steps of our research methodology.

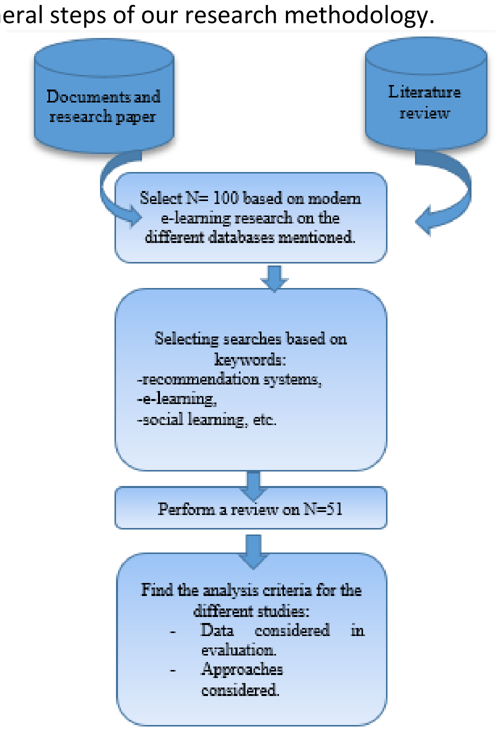

Figure 1: Illustration of aspects to be addressed within hybrid recommendation systems

4. Description of the studies selected in terms of the different recommendation approaches

When addressing the development of online learning environments, the learner is faced with a diversity of information and educational resources, whether on traditional learning platforms or in social learning environments. In this respect, it is crucial to consider an optimal way to manage the different pedagogical resources within learning environments and to enable the learner to better acquire knowledge in a specific domain. Recommendation systems are therefore the best way to manage the different resources and to enable the learner to target his needs and objectives in a more concrete way. In the literature, many works have been proposed in this direction, and those considering learners' personal information, preferences, activities, actions taken by instructors, etc., have been developed. In our study, we will classify the systems of recommendations proposed in terms of E-learning and social learning into 4 categories:

- Content-based recommendation systems.
- Recommendation systems based on collaborative filtering.
- Hybrid recommendation systems.
- Recommendation systems based on Machine Learning algorithms.
- Other recommendation approaches.

4.1 Content-based recommendation systems

Numerous studies have been carried out on the level of recommendation systems based on E-learning content as well as social learning. (Ghauth and Abdullah, 2011) outline a recommendation system approach based on the content and grades of particularly good learners. The test database of 95 students is spread over the different tests carried out, of which only 24 students are selected to test the proposed approach. (Kandakatla and Bandi, 2018) propose a recommendation system that emphasizes content-based semantic filtering as well as negative evaluations in order to recommend messages that are adapted to the needs and profiles of learners. The database consists of N > 1000 learners and 57153 assessments. (Soualah-Alila et al., 2013) propose a recommender system architecture aiming to combine three essential models in an m-learning context:

- The first model aims at studying teaching knowledge.
- The second model involving the learner profile and the learning context.
- The third model including the rules for combining the learning modules.

(Souali et al., 2011) highlight a recommendation system capable of processing learners' requests and, based on these requests, providing them with the most appropriate support. (Tewari, Saroj and Barman, 2015b) suggest a recommender system that analyzes learners' opinions on content and then, based on these opinions, recommends to teachers to modify the hardest parts according to the learners. (Kowald et al., 2018) highlight AFEL-REC, a recommendation system in social learning and based on social data in the form of effective social labels to improve the recommendation system. The database considers 1274858 users, 35346 educational resources and 1879761 interactions. (Basagoiti and Arenaza, 2015) propose a recommendation system based on the preferences of previous students on a content. (Morsomme and Alferez, 2019) propose a course recommendation system developed at University College Maastricht, Netherlands for liberal arts degree students. This recommendation system is intended to encourage students to make choices that fit their program. The approach is based on a sparse predictive model of grade based on students' past academic performance and level of academic expertise. The study was carried out on the transcripts of 2526 students of the liberal arts program between 2008 and 2019 with a total of 79,245 course enrolments.

The first database only considers a total of 95 learners for testing, while the second database tests a set of more than 1000 learners. Another database examines 1274858 learners, which is estimated to be a very high number capable of proving the performance of the system. It therefore appears that there is a significant difference in the volume of data involved in the tests, and that using a large database proves that the system is more reliable.

The content-based recommender system contributes hugely to e-learning. It allows the integration of all learner data, including profile, preferences, by collecting all information related to the learner. Hence, this model does not need data from all learners to recommend items to a specific learner, i.e. to calculate recommendations for a specific learner, we only need his personal data and characteristics. The content-based approach system is capable of capturing the data and preferences specific to each learner, and recommending the most appropriate items for that learner's data and preferences, even if these items are generally not too recommended or not too common in the learning environment. In addition, a learner can receive recommendations based solely on his personal data without the need for further interaction with the learning environment.

However, few researchers addressed social learning as a meaningful terminology in their work. When searching for social learning as a keyword related to content-based recommender systems, we found only one paper (Kowald et al., 2018).

4.2 Recommendation systems based on collaborative filtering

On the other hand, a number of studies have been carried out on recommendation systems based on collaborative filtering, either based on traditional collaborative filtering or combining other aspects with collaborative filtering.

(Tarus, Niu and Mustafa, 2018) propose an approach based on ontology and a decision algorithm. It is divided into 4 parts:

- Creation of the ontology.
- Measuring the similarity of evaluations.
- Generating the best items.
- Apply the decision algorithm on the proposed items.

(Bobadilla et al., 2009) highlight a recommendation system focuses on the learners with the highest scores to model the recommendation approach. The database was extracted from MovieLens due to the lack of an e-learning database that meets the requirements of the proposed approach. (Tarus, Niu and Khadidja, 2017) propose a recommendation system based on collaborative filtering and ontology as well. A database of 300 learners and 450 pedagogical resources was used to evaluate the performance of the recommender system. (Tan, Guo and Li., 2008) The proposed system is mainly based on collaborative filtering and four key modules:

- Recommendation template database.
- Recommendation system database.
- Recommendation management.
- Data management.

(Manouselis, Vuorikari and Van Assche, 2010) developed a collaborative filtering service for a community of teachers in Europe. The study relied on 2554 evaluations related to 899 learning resources. (Hu and Zhang, 2008) propose a recommendation system based on learner community structures and collaborative filtering. The approach was evaluated by considering 500 users with 300 elements. (Brik and Touahria, 2020) discuss the analysis of activities in collaborative filtering within the educational field. This work aims to use ontology and the semantic web to provide efficient recommendations. (Chen et al., 2020) focuse on collaborative filtering with the intention of recommending courses to students to help them in their course selection. The history of students' course selection records is exploited to compute the improved cosine similarity. This paper evaluates 18457 records from 2022 students and actual data from 309 courses.

Recommendation systems based on collaborative filtering have a particularity of making the learner reliant on other learners. In other words, based on the existing similarity between two or more learners, recommendations are generated. This creates a certain connection between the different profiles and considers all learners instead of considering each learner individually in spite of the others. This will help to study the set of similar learners and to get an idea of the commonalities and differences between one learner and another. From another point, in collaborative filtering, we don't need a large amount of data as is the case with the content-based system. It’s then possible to offer recommendations that are based mainly on the preferences of the learners closest to the learner in question, and therefore the system tends to study the preferences of learners who have, for instance, points in common with the learner in question with the aim of better satisfying his needs. On the other hand, by generating recommendations based on similar profiles, the learner will feel more involved in the learning process, and therefore more interested and motivated by the content offered.

Regarding our research on collaborative filtering, social learning has not been identified in any of the selected papers. Researchers still address distance learning in a general way without focusing specifically on social learning.

4.3 Hybrid recommendation systems

Among the systems that have proven their high performance are hybrid systems. A hybrid system consists of combining and merging many recommendation approaches simultaneously to create a more efficient approach. Several scientists have proposed hybrid recommendation systems with respect to distance learning by explaining the process involved and the different techniques used. The purpose of this section is to highlight some work carried out in terms of hybrid systems in e-learning.

(Bourkoukou and Bachari, 2018) provide a Learningfitll recommendation system that can be adapted to the learner's different dynamic preferences. The goal is in fact to merge the two aspects of Data Mining: K-nearest neighbors and association rules. The test was carried out on a database of 163 learners. (Tarus, Niu and Kalui , 2018) implement a recommendation system that will allow the contextual data of learners to be exploited using both the SPM algorithm and collaborative filtering techniques. The evaluation database contains 1200 learners and 57153 evaluations. (Salehi and Kmalabadi, 2012) consider the attributes of the learning material to give recommendations to learners. The database is formed by 676 learners, 16345 assessments and 3763 resources. (Klašnja-Milićević et al., 2011) suggest a recommender approach that group similar learning styles and then apply the AprioriAll algorithm. The evaluation database is containing 440 learners against 6 contents. (Wan and Niu, 2019) tend towards the establishment of a system that takes into consideration the creation of clusters based on the influence of learners and the propagation of information. The analysis was made on a database of 119 learners from 6 universities. (Tahmasebi Fotouhi and Esmaeili,, 2018) make it possible to exploit learning styles with the various functionalities of the web page to incorporate all the data present at the web page level and create a more efficient system. (El Mabrouk, Gaou and Rtili, 2017) propose a recommender system which is mainly based on the exploitation of data. The three main steps of this approach are the collection of implicit and explicit data, the processing of collected data, the measurement of similarity between learners and content, and finally the creation of a recommendation log with the purpose of organizing the recommendations by learner.

The study was conducted on a database of 700 learners, 70512 assessments and 1000 resources. (Turnip, Nurjanah and Kusumo, 2017) suggest a recommendation system based on content, collaborative filtering and good learners. A database of 43 learners and 4644 assessments was used as an evaluation database. (Ansari et al., 2016) propose A CodERS recommendation system as part of an interactive programming learning platform. The test was performed on only 12 users. (Zhuhadar et al., 2009) combine recommendations based on the content of the ontology and recommendations based on the rules of the ontology by testing it on a HyperManyMedia platform. The analysis was conducted on 10 user profiles. (Niyigena and Jiang, 2020) guide learners in developed countries to select more appropriate resources. Calculations are based on developed knowledge and rating predictions for 1237 students. A hybrid recommendation system is proposed by a group of researchers (Bhaskaran, Marappan and Santhi,, 2021), which consists in analyzing and learning automatically the styles and characteristics of learners. Thus, learning styles are handled by clustering based on several strategies.

In the case of hybrid recommendation systems, the databases used range from 43 learners to 1200 learners. The database with 43 learners remains the weakest database compared to the others, while only one database exceeds 1000 learners.

What makes hybrid recommender systems distinguishable in online learning from other types of recommenders is the hybrid aspect of combining several approaches simultaneously. Learners will get more versatile and interesting recommendations incorporating their characteristics, preferences and many other parameters. The fact of considering all these aspects in a single recommendation system is a huge asset for the learner as he will get access to more adapted recommendations.

4.4 Recommendation systems based on supervised and unsupervised learning

Machine Learning is regarded as one of the most widely used tools in all fields, including economics, industry, education and forecasting, as well as in recommendation systems. In terms of recommendation systems, Machine Learning is exploited to provide more relevant recommendations and to be able to respond to different learner requirements. Many researchers have addressed Machine Learning algorithms in educational recommendation systems, including k-means, neural networks, etc., and the use of Machine Learning algorithms in educational recommendation systems has been discussed by many researchers. The table 4 summarize the different proposals of researchers at this level and their proposed approaches and algorithms:

Table 4: Some recommendation systems based on supervised and unsupervised learning

Paper	Used algorithms	Synthesis	Data
(Aher and Lobo, 2013)	➢ Clustering. ➢ K-means. ➢ Association rules.	This article proposes the combination of several algorithms: ➢ Clustering. ➢ K-means. ➢ Association rules.	No test performed
(Khanal et al., 2019)	A multitude of Machine Learning approaches.	This article discusses a general overview of the different existing approaches to recommendation systems in the field of E-learning.	No test performed
(Aher and Lobo, 2012)	➢ Association rules. ➢ Clustering. ➢ Classification.	The study proposes several combinations of algorithms in terms of recommendations: ➢ Classification and association rules. ➢ Association rules and clustering. ➢ Association rules for classified data. ➢ Clustering and classification in association rules. ➢ Association rules only.	Database of 45 learners for 15 resources
(Dahdouh et al., 2018)	Association rules	The proposed recommendation system draws on the history of learners' behaviour and activities in order to provide them with a set of recommendations appropriate to their needs.	Database made up of certain elements and learners.
Dwivedi and Rawat, 2017)	K-means	This work proposes a recommendation system based on the learner's profile with reference to the k-means algorithm.	Database of 100 learners
(Dahdouh et al., 2019)	Association rules	This proposed recommendation system aims to provide learners with the right courses based on the application of association rules to all transactions within the learning environment.	Database of 1218 learners
(Fazeli et al., 2018)	➢ KNN ➢ Graph based algorithm ➢ Matrix Factorisation	Within the social learning platform, recommendation system techniques were evaluated through user-centred and data-centred evaluations.	A study based on 60 students in several countries
(Fazeli et al., 2014)	Graph based approach	This approach develops a recommendation system based on the study of graphs and taking into consideration the social interactions between learners.	Three databases: *631 users *331 users *941 users
(Chaudhary and Gupta, 2019)	SVM, KNN, Random Forest, Naïve Bayes	This article suggests a recommendation system based mainly on two primary steps: pre-processing and prediction.	Database based on keywords and URL links.
(Masethe et al., 2021).	KNN	The proposed JCOLIBRI system is exploited to build a case-based reasoning recommender system providing an interface to a non-expert user to define a query based on the problem domain.	
(Yanes et al., 2020)	Classifier algorithms	This work draws on machine learning algorithms to propose a recommender system for predicting actions based on course specifications and evaluations. The recommendation system developed is applied in the context of a College of Computer and Information Sciences, Jouf University, Kingdom of Saudi Arabia (KSA).	The dataset collected from 127 scientific courses within three departments during the two academic years 2018 and 2019.

For recommendation systems based on supervised and unsupervised learning, three databases with more than 1000 learners. The other databases include only a limited number of learners not exceeding 100. The figure 2 configures the distribution of some Machine Learning algorithms in the studies mentioned at the level of recommendation systems. It turns out that association rules and classification algorithms, including decision trees, are the most propagated in the mentioned studies. For machine learning based recommender systems, there has not been much emphasis on social learning. (Fazeli et al., 2018) focused on supervised learning algorithms to support a social learning environment.

The application of machine learning algorithms is of major importance to learners, including the use of association rules, k-means algorithms, and classification. This will result in more accurate prediction of recommendations and better performance. Since the ultimate goal is to meet the needs of learners, the use of machine learning algorithms has a tremendous impact on learner satisfaction.

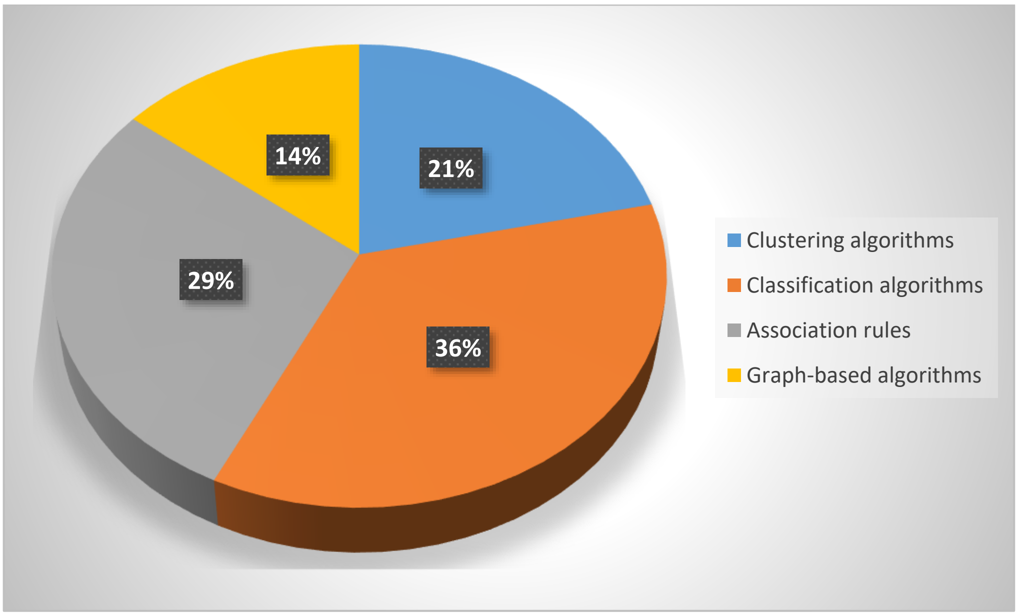

Figure 2. The distribution of algorithms for supervised and unsupervised learning at the level of recommendation systems.

4.5 Other recommendation systems

In this section, we present alternative recommendation systems based on other approaches and concepts.

(Ouadoud et al., 2017) propose a recommendation system that suggests free e-learning platforms that meet the needs of different institutions and learners according to their objectives and specifications. (Hsu, Hwang and Chang, 2010) propose a reading recommendation system that is based on experts' knowledge of English and their opinions. The evaluation data was performed on 25 learners. (Hsu, Hwang and Chang, 2013) implemented a personalised recommendation system based on the preferences and level of knowledge of the learners. The experiment was conducted on 3 groups:

- Group 1: 42 learners.
- Group 2: 33 learners.
- Group 3: 33 learners.

(Lavbič, Matek and Zrnec, 2017) propose a new approach to help users learn SQL easily. The analysis was performed on a database of 93 learners. (Hinz and Pimenta, 2018) propose a recommender approach based on the concept of reputation to ensure personalized recommendations. The recommender system was evaluated based on a questionnaire for 30 learners. (Di Mascio, Laura and Temperini, 2018) present a solution to support learners participating in a programming context by recommending the next problem to undertake. (Chaudhary and Gupta, 2017) carried out a study on the work carried out between 2001-2017 and concerning the different application software developed for learning as well as the evaluation parameters used. (Liu, 2008) proposes a self-assessment system with a recommendation system to adapt the platform to the needs of the learners.

(Buncle, Anane and Nakayama , 2013) combine the two approaches, personalized and non-customized. The personalized approach is based on two implicit and explicit profiles, while the non-customized approach is based on the characteristics of the objects. The experiment is carried out on 943 users for 1682 items (MoviLens). (Agbonifo and Akinsete, 2020) develop a personalized recommendation system based mainly on ontology using the java programming language. 100 learners was considered during the evaluation. (Sunil and Doja, 2019) address learning style and level of knowledge in their recommender approach. The approach contains four modules relating to courses and learners, and consider 612 reports. (Singh et al., 2020) propose an ontology-based solution to multiple challenges such as cold start. To overcome this problem, the user has to give a sequence of scores and assign them to a set of k factors. The proposed system achieves a 95% accuracy. The study was conducted on 118 students.

5. Results discussion

5.1 Papers classification

The table 6 sets out the different types of articles involved: articles proposing approaches with experimentation, articles in the form of a survey, articles proposing approaches without experimentation. F Figure 3 summarizes the distribution according to whether experiments were performed or not. According to our analysis, we note that most of the articles included in our study fall within the framework of articles proposing approaches with experimentation, since the experimentation and validation of approaches with recommendations is essential in order to show the performance and reliability of their proposals. On the other hand, questionnaire-based articles exhibit the lowest percentage because the evaluation of a recommender system through questionnaires remains the most underperforming and underutilised tool in recommender systems research.

Table 6: Papers divided according to the presence or absence of tests carried out

Paper type	Number	%
Articles with experimentations	37	72,5%
Survey articles	1	1,9%
Articles without experimentations	13	25,6%

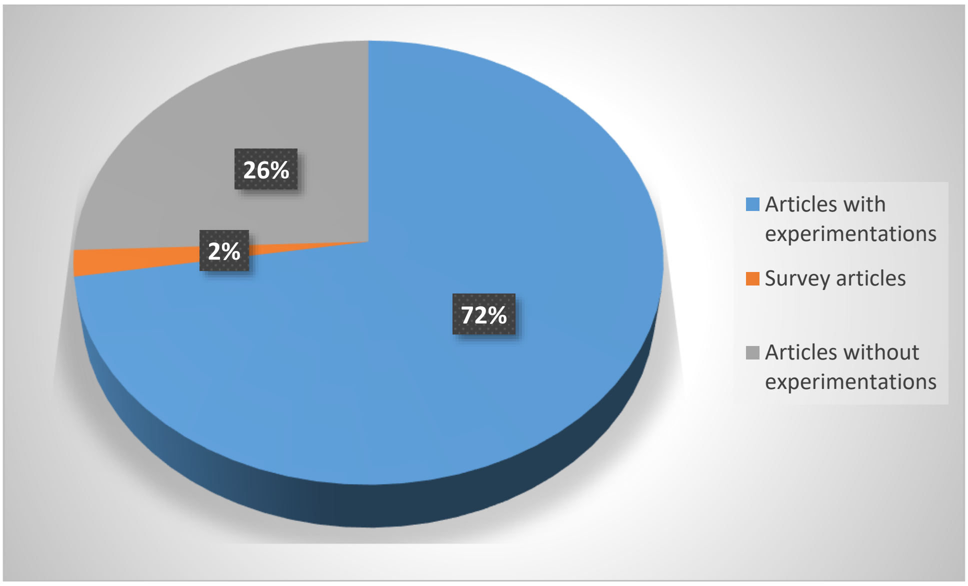

Figure 3: Distribution of selected papers according to the type of article

5.2 Papers by year

In this section, we will present all of those we have cited in our study according to the years of implementation from 2007 to 2020 in the table 7 and figure 4. We recognise that during the period between 2017 and 2020 is the most active period in terms of research carried out on e-learning recommendation systems. This is a reflection of the major evolution in recommendation systems over the last few years. Beyond 2009, recommendation systems are increasingly gaining importance in e-learning. It was only after 2010 onwards that researchers started to orient recommendation systems towards improving e-learning environments. We also note that recommendation systems based essentially on supervised and unsupervised algorithms have been among the most propagated approaches from 2013 to 2019 since most scientists are beginning to move towards Machine Learning algorithms.

Table 7: The recommendation systems according to the completion year of the article

Year interval	Number of publications
2007-2009	5
2010-2016	15
2017-2021	31

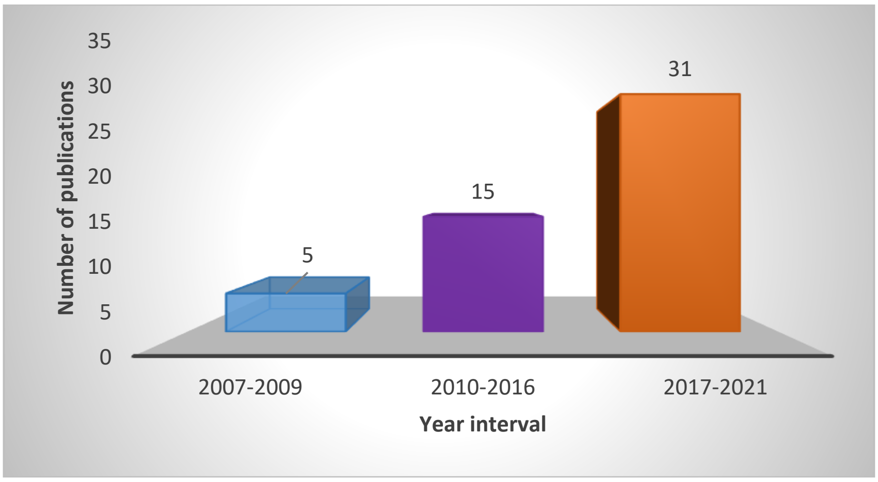

Figure 4: Distribution of selected papers according to the year interval

5.3 Classification by approaches

In this section, we will describe the distribution of the different approaches to recommendations in our study in the table 8 and figure 5. Based on the analysis performed, we note that the strongest responses are hybrid approaches and approaches based on supervised and unsupervised learning. This comes back to the fact that hybrid approaches and approaches based on Machine Learning algorithms have shown their great performance, and that Machine Learning algorithms have become the most widely used at all levels and in all disciplines.

Table 8: Distribution of the recommendation systems proposed in this article by approaches

Recommendation approach	Number	%
Content-based approaches	8	15,68%
Approaches based on collaborative filtering	8	15,68%
Hybrid approaches	12	23,52%
Approaches based on supervised and unsupervised learning	11	21,6%
Other recommendation approaches	12	23,52%

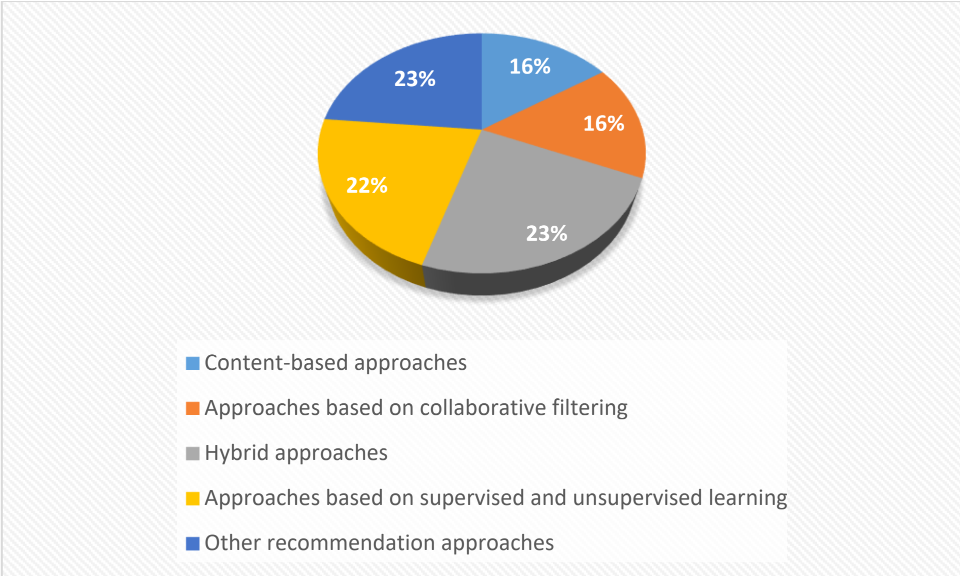

Figure 5: Distribution of selected papers according to the type of recommender system

5.4 Classification by e-learning and social learning

According to the table 9 and figure 6, we notice that studies conducted on distance learning that promote collaboration and interaction between learners show a very low percentage of studies compared to studies conducted on traditional learning platforms that do not address the social or interaction aspect in their work.

Table 9: Distribution of papers according to e-learning and social learning

Learning style	Number	%
E-learning	48	94,11%
Social Learning	3	5,89%

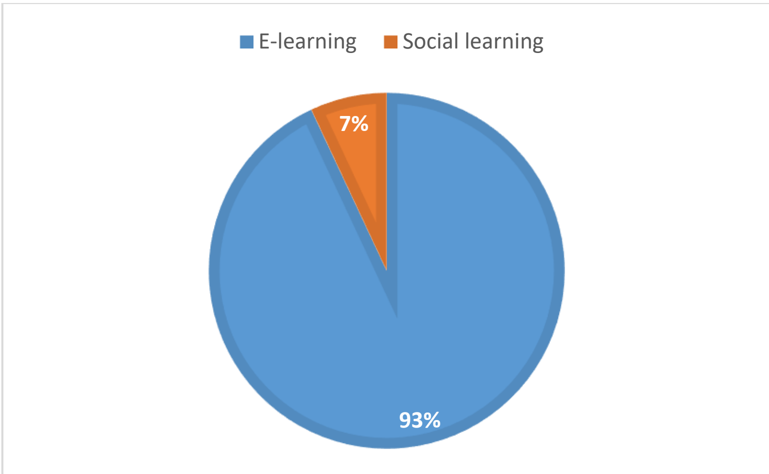

Figure 6: Distribution of papers regarding e-learning and social learning based on papers collected

5.5 Database volume classification

Based on the table 10 and figure 7, we notice that the majority of studies do not go beyond a test database of 1000 learners, and many of the researches carried out are satisfied with a total number of no more than 100 learners We have not included all studies since they do not all cite the volume of data tested. We can note that most studies focus only on a number that is considered limited to prove the performance and reliability of the proposed approach. On the other hand, a significant number of studies have conducted tests on large databases (>1000).

Table 10: Distribution of recommendation systems according to the volume of the test databases

Database volume	Number	%
≤ 100	11	36,66%
$100 < \quad \leq 1000$	11	36,66%
> 1000	8	26,68%

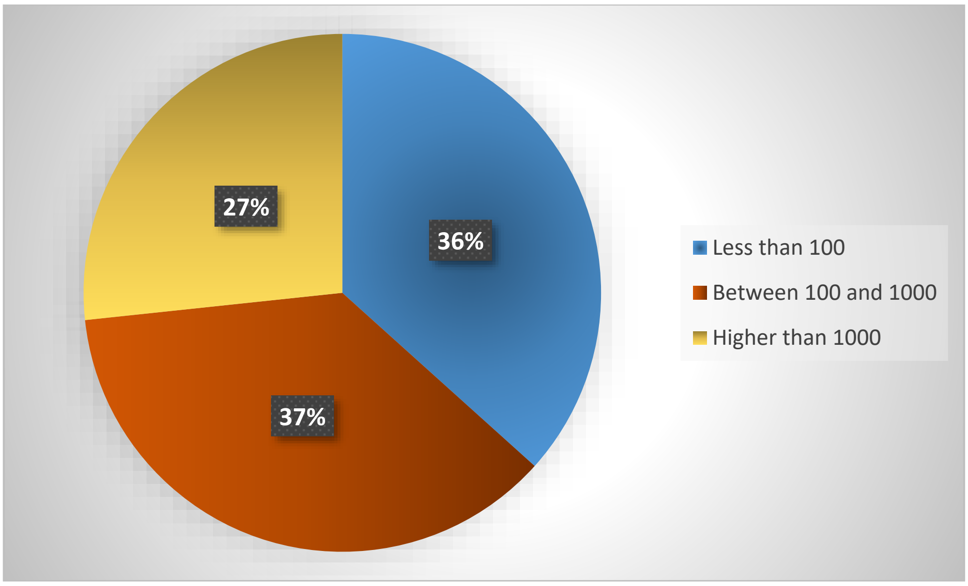

Figure 7: Distribution of selected papers according to the database size

5.6 Demographic classification

In this section we discuss the demographic distribution of the selected studies, focusing on the continents. The dominating continent in the selected research is ASIA (Figure 8). The Asian countries are noticeably involved, especially China and India. As for the European continent, it stands in second place with a significant contribution from Netherlands. Africa is also distinguished by the presence of the maghrebian countries such as Morocco. However, not many papers have been selected in America.

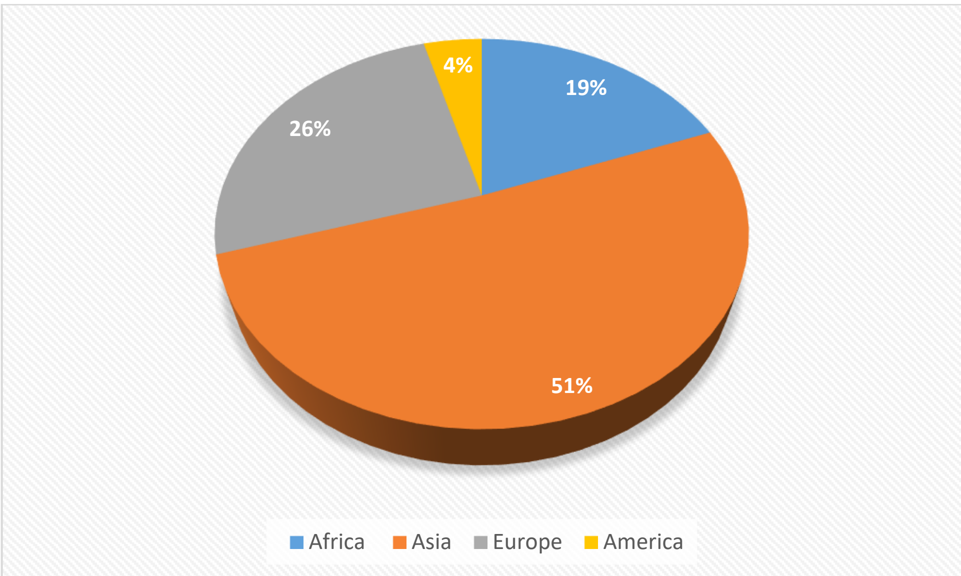

Figure 8: Distribution of selected papers according to location of the research laboratory

5.7 Classification by type of publication

The selected works in this article are partitioned between journals and conferences with a slight difference making the number of journals exceed the number of conferences (Figure 9). The journals are characterized by a high involvement of Elsevier as an editorial group, then the MDPI and DBLP databases, as well as springer and IEEE. As for conferences, most of them are supported by IEEE, Springer and then ACM in terms of scientific publications.

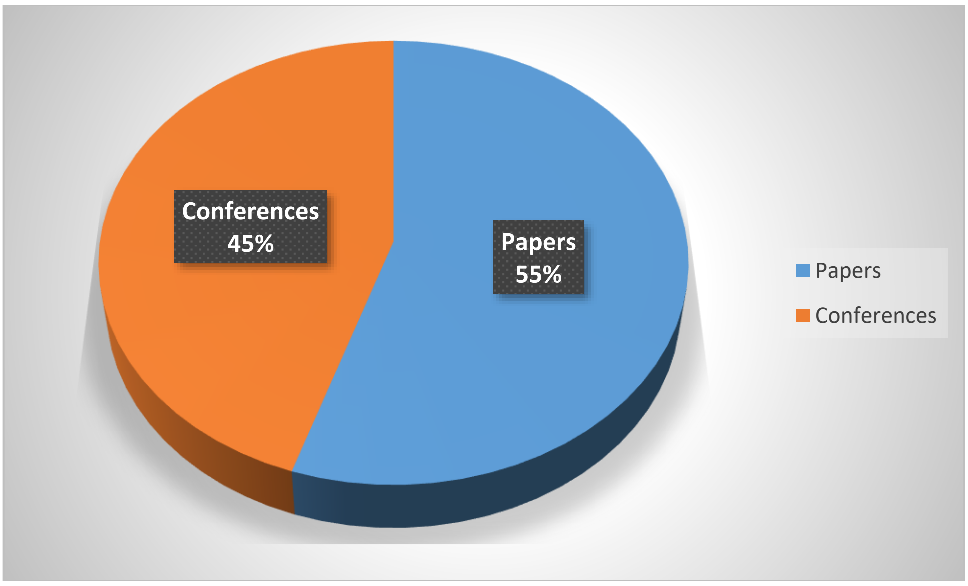

Figure 9: Distribution of selected papers by type of publication

6. Discussion

At the outset, it was mentioned that the purpose of this study is to analyse the recommendation-based approaches used in terms of e-learning and social learning. By making the appropriate selection, we were able to obtain a significant number of studies for analysis and to answer the questions we asked at the beginning. In the following section, we will develop our proposed answers in response to the questions we asked.

6.1 Question 1: What are the general gaps not addressed in these studies?

However, although the recommendation systems mentioned were able to deal with several aspects to better manage teaching resources and adapt them to the needs of learners, our analysis revealed that there are several points that were not covered:

- Social learning has not been sufficiently addressed in research studies regarding recommendation systems, particularly for social networks that can have a broad impact on learning. Most of the proposed recommendation approaches have been dedicated to traditional online learning environments. The figure 3 shows the distribution of articles dedicated to E-learning vs. articles dedicated to social learning, the difference is significant: 3 research studies carried out at the level of social learning vs. 39 studies carried out at the level of E-learning learning environments.
- Learners carry out a large number of activities and events within learning environments, especially in social environments as it promotes learner interaction and collaboration. It is therefore important to envision an enduring aspect that has not been mentioned in these articles which is the aspect of existing relationships between these different events, and how these connections may affect the performance and quality of the recommendations provided.
- The cold start problem: We can encounter this problem on two levels. First, for a new learner on whom we have virtually no information about, it would be difficult to recommend resources to him since we have no information about him. Second, when we have new resources, no information is yet available about it.
- Problems of missing data at the matrix level: When we do not have enough data collected about learners, such as their activities, logs, events performed or ratings for resources or items, this will be a challenging task for calculating recommendations.
- Increasing input data: The recommendation system must always remain efficient and reliable even as the number of learners or learning resources in the learning environment increases.
- New teaching resources or elements: Need to integrate new teaching resources into the recommendations despite the lack of information on these resources.

- Problem of erroneous data: Sometimes learners may give arbitrary ratings or ratings that are not based on their true personal opinion, or perhaps they do not even have access to a given learning resource to annotate it.
- Isolation problem: Sometimes a learner may have a taste or preference that is not like any other learner, so in collaborative filtering, this may cause a problem in the calculation of recommendations.

6.2 Question 2: What are the main similarities and contradictions of the studies carried out?

After our analysis carried out on several types of recommendation systems: content-based, collaborative filtering-based, hybrid and Machine Learning-based, we illustrated many advantages and disadvantages according to our interpretation of the mentioned studies. The mentioned research carried out on recommendation systems in E-learning and social learning has highlighted several aspects concerning the recommendations given to learners:

- Many techniques were examined, including content-based techniques, collaborative filtering, Machine Learning and hybrid techniques.
- The different types of data related to learners, including their interactions, personal information, characteristics, activities performed, etc.
- The level of performance of the proposed approaches and their evaluation.

6.3 Question 3: What is the impact of selected recommender systems on learners?

Recommender systems in Computational Environments for Human Learning intend to develop a recommendation strategy based on the characteristics of the learning context. The goal is to support learners in their learning process to achieve their learning goals. Recommender systems in HIEs recommend a wide variety of items such as learning resources, software, courses, tips, peer learners and learning sequences and activities. The work discusses the existence of several positive effects that recommender systems can exert on learning such as learning performance, learner performance and motivation to learn. The results of selected works confirm these positive effects. Thus, recommender systems can help improve learners' effectiveness and motivation. The main objective in the deployment of recommender systems in the learning context is to guide users to appropriate resources to achieve the learning objective in a minimum amount of time. According to the selected studies, the proposed recommender systems are found to have a significant impact on education:

- Learner performance: Regarding learners, the main benefit is to identify better quality resources and achieve the learning objective. The proposed learning recommendation systems can also identify students with particular difficulties. Thus, learners navigate in the knowledge hyperspace and get good feedback. This is beneficial for adjusting the content of the learning resources found in the learning platform. The proposed content-based recommendation systems can thus help promote personalized learning. It is about adapting the content to the needs of the learners based on what the system knows about them.
- Motivation: Selected educational recommender systems impact positively on the motivation of learners by maintaining their interest. In addition, these systems improve the atmosphere of the learning environment as well as the interaction between learners and with the learning contents within the learning environment.
- Learning enhancement: Selected recommendation systems based on collaborative filtering promote interaction and social navigation. This helps to find willing learners with similar ideas and preferences and to enhance the experiences within the existing communities.

6.4 Question 4: How the results and findings contribute in e-learning and social learning?

The papers we selected for this analysis were tremendously fruitful in order to identify in which direction these papers have contributed to remote e-learning. Each proposed recommender system is characterized by its specific features and refers to its own machine learning techniques or algorithms for example. Hybrid recommendation systems and those based on machine learning provide the opportunity to hybridize several techniques simultaneously and above all to use multiple algorithms concurrently in order to improve the quality of the recommendations generated. Moreover, researchers are not restricted to using one algorithm but generally combine several algorithms, such as association rules, k-means and KNN. This continuous improvement of the recommendation systems in terms of e-learning is the main reason why the quality of the recommendations is remarkably increasing.

On the other hand, we performed an analysis according to several parameters:

- The geographical distribution of the selected works.
- The classification of the studies according to the type of the recommendation system.
- Classification according to the size of the used database.
- Classification by publication period

In this regard, we were able to highlight several points from the selected work and the analysis performed in the article:

- The importance of combining several recommendation approaches to improve the quality of recommendations.
- The diversity of approaches used in recommender systems.
- The identification of the most active period in terms of proposed recommender systems.
- The identification of the most prevalent approaches used.
- Identify the most active continents in terms of research on recommender systems in online learning.
- Comparing the frequency of works addressed in traditional e-learning vs. social learning.

7. Conclusion and outlook

In this article, we explored a few studies carried out in terms of recommendation systems in e-learning. The method consists in selecting a number of researches based on well-defined criteria and on several article databases. Each work is part of a specific type of recommendation. On this basis, we divided the selected works into several types of recommendations: content-based approaches, collaborative filtering-based approaches, hybrid approaches and supervised and unsupervised learning-based approaches.

The most active period in terms of research work lies between 2017 and 2021. This is due to the ongoing development of e-learning recommender systems and the increasing interest of researchers in this area. On the other hand, the percentage of hybrid recommender systems and approaches based on supervised and unsupervised learning is the highest compared to other types of approaches. This reflects the high performance of hybrid and machine learning based approaches.

It is also worth mentioning that the size of the database is of great importance in the evaluation of a recommender system. For the selected works, there are studies where the size of the concerned database is not significant enough, which can lead to less reliable results. Another important point to mention is the type of data involved in the recommender systems. The majority of studies address the learners' explicit data and their evaluations, which is a point to be improved in future studies. It is worth investigating other more reliable types of data in recommender systems, such as actions performed by learners.

Focusing on the actions performed by learners will generate more relevant recommendations according to the learners' own learning pace. It is always necessary to ascertain whether the proposed recommendation system is capable of providing recommendations that are likely to steer learners and improve their skills and motivation. The concern in e-learning to date is that learners may lack motivation. Generating recommendations corresponding to their expectations will automatically boost their motivation, and thus their interactivity within the e-learning experience.

On the other hand, there is still a noticeable lack of studies dedicated to social learning, especially recommendation systems adapted to social learning networks. That said, there is a more urgent need to focus on this side and propose recommender systems incorporating community detection, since social networks are characterized by communities of friends, communities of similar learners, and other types of communities. Community detection in recommender systems can be performed in several ways, such as detecting communities of friends, detecting communities of similar learners in terms of preferences. This allows to treat each community separately to generate recommendations that are adapted to the characteristics of each community.

The research we discussed deals with several types of recommendations regarding distance learning. However, they do not address the concept of communities, bearing in mind that this is a highly crucial aspect of recommendations that can actually contribute to making a difference. It will be worth digging in this direction and focusing on the discipline of community detection in recommendations. The majority of the research included in this systematic review focuses solely on distance learning in general without addressing social networks in learning or graph analysis in recommender systems. This kind of research is now possible since social networks have spread to learning as well and because of the amount of interaction that exists between learners. This interaction allows to generate very large graphs, and thus large communities as well. It is more appropriate to divide learners into communities before addressing the recommendations than to consider learners as a whole community.

References

Agbonifo, O. C. and Akinsete, M., 2020. Development of an ontology-based personalised e-learning recommender system. *International Journal of Computer (IJC)*, 38(1), pp. 102-112.

Aher, S.B. and Lobo, L.M.R.J., 2013. Combination of machine learning algorithms for recommendation of courses in E-Learning System based on historical data. *Knowledge-Based Systems*, 51, pp. 1–14.

Aher, S.M.D. and Lobo, L.M.R.J., 2012. Best combination of machine learning algorithms for course recommendation system in e-learning. *International Journal of Computer Applications*, 41, pp. 1–10.

Ahmed, M.,U. Hussain, S., and Farid, S., 2018. Factors influencing the adoption of e-learning in an open and distance learning institution of Pakistan. *The Electronic Journal of E-learning*, 16(2), pp.148-158

Ansari, M.H., Moradi, M., NikRah, O. and Kambakhsh, K.M., 2016. CodERS: A hybrid recommender system for an E-learning system, In: 2016 2nd International Conference of Signal Processing and Intelligent Systems (ICSPIS). Presented at the 2016 2nd International Conference of Signal Processing and Intelligent Systems (ICSPIS), Tehran, Iran: IEEE, pp. 1–5.

Arasaratnam-Smith, L.A. and Northcote, M.T., 2017. Community in online higher education: challenges and opportunities. *Electronic Journal of E-learning*, 15, pp. 188-198.

Basagoiti, R., Arenaza, I., 2015. Personalizing access to e-learning content based on their preferences. International Technology, Education and Development Conference 2015 (INTED), Mondragón, Spain, pp.7.

Bhaskaran, S., Marappan, R., Santhi, B., 2021. Design and analysis of a cluster-based intelligent hybrid recommendation system for e-Learning applications. *Mathematics*, 9(2), pp. 197-218. https://doi.org/10.3390/math9020197

Bobadilla, J., Serradilla, F., Hernando, A., 2009. Collaborative filtering adapted to recommender systems of e-learning. *Knowledge-Based Systems*, 22(4), pp. 261–265.

Bourkoukou, O., Bachari, E.E., 2018. Toward a hybrid recommender system for e-learning personalization based on data mining technique. *International Journal on Informatics Visualization*, 2(4), pp.271-278.

Brik, M., Touahria, M., 2020. Contextual information retrieval within recommender system: case study "e-learning system". *Technology, Education, Management, Informatics (TEM Journal)*, 9(3), pp. 1150–1162. https://doi.org/10.18421/TEM93-41

Buncle, J., Anane, R., Nakayama, M., 2013. A recommendation cascade for e-learning, In: 2013 IEEE 27th International Conference on Advanced Information Networking and Applications (AINA). Presented at the 2013 IEEE 27th International Conference on Advanced Information Networking and Applications (AINA), Barcelona: IEEE, pp. 740–747.

Chaudhary, K., Gupta, N., 2017. Recommendation for learners in e-learning system, In: 2017 International Conference on Next Generation Computing and Information Systems (ICNGCIS). Presented at the 2017 International Conference on Next Generation Computing and Information Systems (ICNGCIS), Jammu: IEEE, pp. 58–63.

Chaudhary, K., Gupta, N., 2019. E-learning recommender system for learners: a machine learning based approach. *International Journal of Mathematical, Engineering and Management Sciences*, 4, pp. 957–967.

Chen, X., Yue, X.-G., Li, R.Y.M., Zhumadillayeva, A., Liu, R., 2021. Design and application of an improved genetic algorithm to a class scheduling system. *International Journal of Emerging Technologies in Learning,* 16(1), pp. 44-59. https://doi.org/10.3991/ijet.v16i01.18225

Chen-Huei, C. and Shih-Ming, P., 2015. The effectiveness of Facebook groups for e-learning. *International Journal of Information and Education Technology (IJIET)*, 5(7), pp. 477-482

Dahdouh, K. Oughdir, L. Dakkak A. and Ibri A., 2018. Smart courses recommender system for online learning platform. 5th International Congress on Information Science and Technology (CiSt), Marrakech, Morocco: IEEE, 2018, pp. 328-333, doi: 10.1109/CIST.2018.8596516

Dahdouh, K., Dakkak, A., Oughdir, L., Ibriz, A., 2019. Association rules mining method of big data for e-learning recommendation engine, In: M. Ezziyyani, (Ed.), Advanced intelligent systems for sustainable development (AI2SD'2018), Marrakech, Morocco, Advances in Intelligent Systems and Computing. Cham: Springer, pp. 477–491.

Di Mascio, T., Laura, L., Temperini, M., 2018. A framework for personalized competitive programming training, In: 2018 17th International Conference on Information Technology Based Higher Education and Training (ITHET). Presented at the 2018 17th International Conference on Information Technology Based Higher Education and Training (ITHET), Olhao: IEEE, pp. 1–8.

Dwivedi, S.K., Rawat, B., 2017. An architecture for recommendation of courses in e-learning. *International Journal of Information Technology Convergence and Services (IJITCS)*, 9(4), pp. 39–47.

El Mabrouk, M., Gaou, S., Rtili, M.K., 2017. Towards an intelligent hybrid recommendation system for e-learning platforms using data mining. *International Journal of Emerging Technologies in Learning (iJET)*, 12(6), pp. 52-76.

Fazeli, S., H. Drachsler, M. Bitter-Rijpkema, F. Brouns, W. Van der Vegt, and P. B. Sloep. 2018. User-centric evaluation of recommender systems in social learning platforms: accuracy is just the tip of the iceberg. *IEEE Transactions on Learning Technologies*, 11, pp. 294–306.

Fazeli, S., Loni, B., Drachsler, H., Sloep, P., 2014. Which recommender system can best fit social learning platforms?, In: C., Rensing, S. de Freitas, T. Ley, P.J. Muñoz-Merino (Eds.), Open learning and teaching in educational communities. Cham: Springer, pp. 84–97. https://doi.org/10.1007/978-3-319-11200-8_7

Gannod, G., Abbott, K.M., Van Haitsma, K.S., Martindale, N., Heppner, A., 2018. A machine learning recommender system to tailor preference assessments to enhance person centered care among nursing home residents. *Innovation in Aging*, 2, pp. 43–43.

Ghauth, K.I. and Abdullah, N.A., 2011. The effect of incorporating good learners' ratings in e-learning content-based recommender system. *Journal of Educational Technology & Society*, 14(2), pp. 248-257.

Geetha, G., Safa, M., Fancy, C., Saranya, D., 2018. A hybrid approach using collaborative filtering and content based filtering for recommender system. *Journal of Physics: Conference Series*, 1000, pp. 012101.

Hinz, V. T. and Pimenta, M. S.., 2018. Integrating reputation to recommendation techniques in an e-learning environment. 17th International Conference on Information Technology Based Higher Education and Training (ITHET), Olhao: IEEE, 2018, pp. 1-6.

Hsu, C.-K., Hwang, G.-J. and Chang, C.-K., 2010. Development of a reading material recommendation system based on a knowledge engineering approach. *Computers & Education*, 55, pp. 76–83.

Hsu, C.-K., Hwang, G.-J. and Chang, C.-K., 2013. A personalized recommendation-based mobile learning approach to improving the reading performance of EFL students. *Computers & Education*, 63, pp. 327–336.

Hu, J., Zhang, W., 2008. Community collaborative filtering for e-learning, In: 2008 International Conference on Computer and Electrical Engineering. Presented at the 2008 International Conference on Computer and Electrical Engineering (ICCEE), Phuket, Thailand: IEEE, pp. 593–597.

Ignat'ev, V.Yu., Lemtyuzhnikova, D.V., Rul', D.I. and Ryabov, I.L., 2018. Constructing a hybrid recommender system. *Journal of Computer and System Sciences International*, 57(6), pp. 921–926.Kandakatla, D.M. and Bandi, K., 2018. A content based filtering and negative Rating Recommender System for E-learning Management System. Conference: International Conference on Intelligent Computing and Sustainable System (ICICSS 2018), Coimbatore, India: IEEE, pp. 167-172.

Khairil Imran, Ghauth; Nor Aniza, Abdullah, 2011. The effect of incorporating good learners' ratings in e-learning content-based recommender system. *Journal of Educational Technology & Society*, 14(2), pp. 248-257.

Khan, A., Egbue, O., Palkie, B., Madden, J., 2017. Active learning: engaging students to maximize learning in an online course. *Electronic Journal of E-learning*, 15(2), p107-115.

Khanal, S.S., Prasad, P.W.C., Alsadoon, A., Maag, A., 2019. A systematic review: machine learning based recommendation systems for e-learning. *Education and Information Technologies*, 25, pp. 2635–2664. https://doi.org/10.1007/s10639-019-10063-9.

Klašnja-Milićević, A., Vesin, B., Ivanović, M., Budimac, Z., 2011. E-Learning personalization based on hybrid recommendation strategy and learning style identification. *Computers & Education*, 56, pp. 885–899.

Kowald, D., Lacic, E., Theiler, D. and Lex, E., 2018. Afel-rec: a recommender system for providing learning resource recommendations in social learning environments. *ArXiv*, Available at: https://arxiv.org/pdf/1808.04603.pdf [Accessed 26 July 2021)

Lavbič, D., Matek, T., Zrnec, A., 2017. Recommender system for learning sql using hints. *Interactive Learning Environments*, 25(8), pp. 1048–1064.

Liu, F.-J., 2008. Design of self-directed e-learning material recommendation system with online evaluation. International Conference on Convergence and Hybrid Information Technology, Daejeon, Korea (South): IEEE, pp. 274-277, doi: 10.1109/ICHIT.2008.184.Manouselis, N., Vuorikari, R., Van Assche, F., 2010. Collaborative recommendation of e-learning resources: an experimental investigation: collaborative recommendation. *Journal of Computer Assisted Learning*, 26(4), pp. 227–242.

Masethe, M.A., Ojo, S.O., Odunaike, S.A., Masethe, H.D., 2021. Framework of recommendation systems for educational data mining (edm) methods: Cbr-rs with knn implementation, In: S.-I., Ao, H.-K Kim,., M.A Amouzegar,. (Eds.*)*, *Transactions on Engineering Technologies*. Springer, Singapore, pp. 87–98.

Mobasher, B., 2007. Data mining for web personalization, In: P., Brusilovsky, A., Kobsa, W. Nejdl, (Eds.), *The adaptive web: methods and strategies of web personalization*. Springer, Berlin, Heidelberg, pp. 90–135. https://doi.org/10.1007/978-3-540-72079-9_3

Morsomme, R., and Alferez, S.V., 2019. Content-based course recommender system for liberal arts education. *International educational data mining society*, Paper presented at the International Conference on Educational Data Mining (EDM), Montreal, Canada.

N. Yanes, A. M. Mostafa, M. Ezz, S. N. Almuayqil, 2020. A machine learning-based recommender system for improving students learning experiences. *IEEE Access,* 8, pp. 201218–201235. https://doi.org/10.1109/ACCESS.2020.3036336

Nilashi, M., Bagherifard, K., Ibrahim, O., Alizadeh, H., Nojeem, L.A., Roozegar, N., 2013. Collaborative filtering recommender systems. *Research Journal of Applied Sciences, Engineering and Technology*, 5(16), pp. 4168–4182. https://doi.org/10.19026/rjaset.5.4644.

Niyigena, J-P. and Jiang, Q., 2020. A hybrid model for e-learning resources recommendations in the developing countries. In: Proceedings of the 2020 4th International Conference on Deep Learning Technologies (ICDLT) (ICDLT 2020). New York, NY, USA: Association for Computing Machinery, pp. 21–25. DOI: https://doi.org/10.1145/3417188.3417211

Nortvig, A.-M., Petersen, A.K., Balle, S.H., 2018. A literature review of the factors influencing e-learning and blended learning in relation to learning outcome, student satisfaction and engagement. *Electronic Journal of E-learning*, 16(1), pp. 46-55.

Ntshwarang, P.N., Malinga, T., Losike-Sedimo, N., 2021. ELearning tools at the university of Botswana: relevance and use under covid-19 crisis. *Higher Education for the Future*, 8(1), pp. 142–154. https://doi.org/10.1177/2347631120986281

Ouadoud, M., Chkouri, M.Y., Nejjari, A., El Kadiri, K.E., 2017. Exploring a recommendation system of free e-learning platforms: functional architecture of the system. *International Journal of Emerging Technologies in Learning (iJET)*, 12(2), pp. 219-226.

Park, D.H., Kim, H.K., 2011. A literature review and classification of recommender systems on academic journals. *Expert Systems with Applications*, 39(11), pp. 10059-10072.

Salehi, M., Kmalabadi, I.N., 2012. A hybrid attribute–based recommender system for e–learning material recommendation. *IERI Procedia*, 2, pp. 565-570

Sharma, S., Mahajan, A., 2017. A collaborative filtering recommender system for github, *International Journal of Emerging Technologies in Engineering Research (IJETER)*, 5(8), pp. 57-62

Sikka, R., Dhankhar, A., and Rana, C., 2012. A survey paper on e-learning recommender system. *International Journal of Computer Applications*, 47(9), pp. 27-30.

Singh, P.K., Sinha, M., Das, S., Choudhury, P., 2020. Enhancing recommendation accuracy of item-based collaborative filtering using Bhattacharyya coefficient and most similar item. *Applied Intelligence*, 50, pp. 4708–4731. https://doi.org/10.1007/s10489-020-01775-4

Song, B., Gao, J., 2014. The enhancement and application of collaborative filtering in e-learning system, In: Y., Tan, Y Shi,., C.A.C. Coello, (Eds.), *Advances in swarm intelligence, lecture notes in computer science*. Cham: Springer., pp. 188–195.

Soualah-Alila, F., Mendes, F., Cruz, C., Nicolle, C., 2013. Recommender system for combination of learning elements in mobile environment. IADIS International Conference Mobile Learning, Berlin, Germany, Mar 2012, pp. 309-314.

Souali, K., El Afia, A., Faizi, R., Chiheb, R., 2011. A new recommender system for e-learning environments, In: 2011 International Conference on Multimedia Computing and Systems. Presented at the 2011 International Conference on Multimedia Computing and Systems (ICMCS 2011), Ouarzazate: IEEE, pp. 1–4.

Soude Fazeli, Babak Loni, Hendrik Drachsler and Peter B. Sloep, 2014. Which recommender system can best fit social learning platforms?, In: C., Rensing, S. de Freitas, T. Ley, P.J. Muñoz-Merino (Eds.), Open learning and teaching in educational communities. Cham: Springer, pp. 84–97. https://doi.org/10.1007/978-3-319-11200-8_7

Sunil, Doja M.N., 2020. An improved recommender system for e-learning environments to enhance learning capabilities of learners. In: P.Singh, B.Panigrahi, N.Suryadevara, S.Sharma, A.Singh (eds) Proceedings of ICETIT 2019. Lecture Notes in Electrical Engineering, New Delhi, India: Springer, 605, pp. 604-612. https://doi.org/10.1007/978-3-030-30577-2_53

Tahmasebi, M., Fotouhi, F. and Esmaeili, M., 2018. Hybrid adaptive educational hypermedia recommender accommodating user's learning style and web page features. *Journal of AI and Data Mining*, 7(2), pp. 225-238. doi: 10.22044/jadm.2018.6397.1755

Tan, H., Guo, J., Li, Y., 2008. E-learning recommendation system, In: 2008 International Conference on Computer Science and Software Engineering. Presented at the 2008 International Conference on Computer Science and Software Engineering, Wuhan, China: IEEE, pp. 430–433. https://doi.org/10.1109/CSSE.2008.305

Tarus, J., Niu, Z., and Khadidja, B., 2017. E-learning recommender system based on collaborative filtering and ontology. *World academy of science, engineering and technology, International Journal of Computer, Electrical, Automation, Control and Information Engineering*, 11(2), pp. 256-261.

Tarus, J.K., Niu, Z., Kalui, D., 2018. A hybrid recommender system for e-learning based on context awareness and sequential pattern mining. *Soft computing*, 22, pp. 2449–2461.

Tarus, J.K., Niu, Z., Mustafa, G., 2018. Knowledge-based recommendation: a review of ontology-based recommender systems for e-learning. *Artificial Intelligence Review*, 50, 21–48.

Tewari, A.S., Saroj, A., Barman, A.G., 2015. E-learning recommender system for teachers using opinion mining, In: K.J. Kim, (Ed.), *Information science and applications, Lecture notes in electrical engineering*. Berlin, Heidelberg: Springer, pp. 1021–1029.

Turnip, R., Nurjanah, D., Kusumo, D.S., 2017. Hybrid recommender system for learning material using content-based filtering and collaborative filtering with good learners' rating, In: 2017 IEEE Conference on E-Learning, e-Management and e-Services (IC3e). Presented at the 2017 IEEE Conference on e-Learning, e-Management and e-Services (IC3e), Miri, Sarawak, Malaysia: IEEE, pp. 61–66.

Verlani Timm Hinz; Marcelo Soares Pimenta, 2018. Integrating reputation to recommendation techniques in an e-learning environment. 17th International Conference on Information Technology Based Higher Education and Training (ITHET), Olhao: IEEE, 2018, pp. 1-6.

Wan, S., Niu, Z., 2019. A hybrid e-learning recommendation approach based on learners' influence propagation. *IEEE Transactions on Knowledge and Data Engineering*, 32(5), pp. 827-840, doi: 10.1109/TKDE.2019.2895033.

Wang, D., Liang, Y., Xu, D., Feng, X., Guan, R., 2018. A content-based recommender system for computer science publications. *Knowledge-Based Systems*, 157, pp. 1–9.

Yanes, N., Mostafa, A. M., Ezz, M.and Almuayqil, S. N., 2020. A machine learning-based recommender system for improving students learning experiences. *IEEE Access,* 8, pp. 201218–201235. https://doi.org/10.1109/ACCESS.2020.3036336

Zhang, H.-R., Min, F., He, X., Xu, Y.-Y., 2015. A hybrid recommender system based on user-recommender interaction. *Mathematical Problems in Engineering*, 2015, 145636. https://doi.org/10.1155/2015/145636

Zhuhadar, L., Nasraoui, O., Wyatt, R. and Romero, E., 2009. Multi-model ontology-based hybrid recommender system in e-learning domain, In: 2009 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology. Presented at the 2009 IEEE/WIC/ACM International Joint Conference on Web Intelligence and Intelligent Agent Technology, Milan, Italy: IEEE, pp. 91–95.

Driving Value Creation in the New Economy Following the COVID-19 Crisis. Data-mining Students' Satisfaction from Online Teaching in the Virtual Academic Climate

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Abstract: This study examines the advantages of online teaching from the perspective of students at eleven institutions of higher education, universities, and colleges in Israel. The study was conducted at the end of the second semester of their academic studies, after students had experienced "face to face" studies, and they were asked to reply freely to an open question on how they evaluate the benefits of transitioning to online teaching. Students were forced to cope with a new reality, where they were compelled to study in a digital classroom. The academic-social climate, lecturer-student relations, and the relations among the students themselves changed instantaneously, with no preparation by any of those involved. The research findings can illuminate the strengths of online teaching with a view to the future. Was the impact of teaching and learning during the coronavirus era a one-time event for the students or one from which it is possible to examine and embrace new ways of learning as they see them? Based on 1,937 fully completed surveys, a mixed methods research design was employed. Major themes were manually tagged, and an empirical model was developed. Structural Equation Modeling (SEM) was utilized to test the model's goodness-of-fit. Findings present a host of parameters that have a significant positive influence on students' positive perception of the transition to online teaching. This study is the first to thoroughly examine the advantages of switching to online teaching among a large group of students from several different academic institutions, and it presents both qualitative and empirical results. Ethical implications of the findings are discussed.

Keywords: Online teaching, COVID-19, Virtual academia, Students

1. Introduction

The COVID-19 pandemic, which broke out about a year ago, required educational institutions to reorganize their manner of teaching, in particular by transitioning to e-teaching, so that studies could continue in times of lockdown. This generated a need for adjustment, by both faculty and students, but many advantages are also evident. Several studies have discussed the benefits of e-teaching; however, this is the first comprehensive study to examine the benefits of e-teaching as perceived by 1,937 students from 11 educational institutions, both empirically and qualitatively.

Mukhtar and colleagues (2020) explored and analyzed the benefits of and reactions to e-learning. They sampled about 12 students and 12 instructors from the medical college and university of dental medicine in Lahore, Pakistan, qualitatively and during the COVID-19 pandemic. The main advantages raised emerged first among the instructors, who claimed that the lesson had become "easy to manage", as it is possible to control the audio and see and examine listening more comfortably, while the system helps by providing access to insecure students who can contact the instructor by using the "chat". Another important parameter that arose as a meaningful advantage is lecture recordings, which helped the students review the information, follow it easily, and of course take notes and improve their understanding more comfortably. Other results emerged from the study by Velichová, Orbánová and Kúbeková (2020) regarding the advantages of e-learning during the pandemic. They sampled some 2,824 participants by questionnaires, where the sample included students of business administration and hostelry and high school students in a range of disciplines. The main advantage indicated by their study was the significant change in the toolbox in the educational environment, where students and instructors were on one hand required to rapidly develop significant technological skills, but on the other they enjoyed advanced interactive search engines, real time collaborations, that contributed significantly to students' involvement in the lesson.

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Kasai and colleagues (2021) presented additional evidence of the significant advantages of e-learning during the pandemic, by exploring some 42 medical students in a qualitative and quantitative study in order to estimate their weaknesses and strengths side by side with quantitative evaluation of the effect of e-learning (Kasai et al., 2021). The main advantages raised were that it is possible to easily determine and specify the students' learning goals and be flexible with them. In addition, medical students could devote more time to urgent cases, to their analysis, and to generating more precise records, while their organizational skills improved throughout their studies and particularly during the pandemic and e-learning. Khalid, Bashir and Amin (2020) also presented the advantages of the association between e-learning and autonomous learning and academic achievements as advantages that evolved during the pandemic and were credited to e-learning (Khalid, Bashir and Amin, 2020). In a study that sampled 2,948 students, basic analyses were used without building a model in order to conclude that there is a more significant positive association between use of e-learning and improvement in autonomous learning and high academic achievements, than when compared to conventional learning, namely, all the students sampled in the "e-learning" group were found to have a higher self-capacity for learning and higher academic achievements (Khalid, Bashir and Amin, 2020). The advantages of e-learning were also investigated in the period that preceded the COVID-19 era. For example, the quantitative study by Dumford and Miller (2018), which included data on 300,543 American students and adults, claimed that e-learning is capable of encouraging different types of involvement in class than traditional learning, and even of improving the student's quantitative thinking (Dumford and Miller, 2018). Thus, also Mbuva (2015), who presented the advantages of e-learning methods through the success of the faculty in meeting students' learning needs and improving students' critical thinking via technology. In addition, authors emphasized the containment and acceptance of e-learning for the academic present and the ability to rapidly adapt to technological learning, such that this type of learning is accepted positively by the students (Mbuva, 2015).

Zhang and Han (2012), who conducted a quantitative study in a medical university in China, indicated a significant improvement in students' language skills. They found that of the 40 students divided into trial and control groups in the pre-pandemic period, the group that studied language in a mixed online and traditional learning model reached better achievements than their peers who studied language traditionally. In addition, the former formed a better basis for developing their autonomous and shared learning. Cristescu and Iordache (2017) indicated the interactional advantages. In their qualitative study they surveyed some 302 people and claimed that the interaction among the students and between the students and the instructors improved, as did the relations between individuals in different social groups (Cristescu and Iordache, 2017).

An interesting perspective on the advantages of e-learning was presented in the qualitative study conducted by Greener (2010), which surveyed teachers in universities in the pre-pandemic period. This study focused on e-learning and showed that the learning environment is no longer controlled by the instructor and that there is little control, as well as that the learning environment is adapted to the student's needs in real time. The learning environment has changed from one determined by the teacher's outlook regarding the student's environmental needs, whereby the teacher conducts the lesson, to one determined by the student, who perceives the environment as a personal learning domain, creates professional adaptations, and changes it to one that is familiar and convenient for his personal development, within the options provided by technology and with no environmental disturbance.

The research literature relates to three generations of online teaching (Wadmany, 2017, 2018; Almog and Almog, 2020):

- **The first generation** was aimed at benefiting humanity on a global level: at elite universities and free of charge.
- **The second generation** was aimed mainly at achieving the goals of the academic institutions on a global level: as a means of recruiting students from around the world to programs on campus, contributing to the institution's reputation as a leading innovative school, and excelling in unique aspects of the school, as well as maintaining a global presence. E-teaching also serves as a channel for fundraising and for increasing revenues by granting study certificates, diplomas, and awarding degrees at a low price to a large number of students.
- **The third generation** of online teaching was aimed at achieving local goals of the academic institutions: improving teaching by means of pedagogical network models (such as the backward course design), teaching courses with a high demand such as large introductory courses, preparatory, and/or supplementation courses. These courses are open free of charge to students from all over the world

who do not need a diploma or a degree. There is also a possibility of studying for a fee and receiving a diploma.

- Are we in the fourth generation?

The COVID-19 pandemic generated a substantial change in academic teaching in Israel as around the world, by transitioning from "face to face" teaching to online teaching and learning. This transition involves breaching barriers and challenges encountered by the students as well as by the faculty, which require an immediate response. Students who registered for academic studies based on their familiarity with the traditional study experience received, unexpectedly, a completely different experience: an experience of digital "distance learning" where it is possible to keep the microphone and camera off and thus become unseen and unheard.

This study is the first to examine the advantages of online teaching from the perspective of students at a variety of academic institutions after experiencing an unexpected semester. These advantages are manifested in open access for learners through digital tools, learner-centered teaching, the potential for independent learning anytime and anyplace, and interaction between students (Salmon, 2019). The following is an inspection of the typical academic climate in "face to face" teaching versus online teaching.

1.1 The academic climate in face-to-face teaching

The academic climate is the area or environment in which learning takes place. Traditionally, the academic climate describes the atmosphere in the classroom. This atmosphere is a product of interrelations between the physical elements in the classroom and the interpersonal student-lecturer relations (Smith, Smith and de Lisi, 2001). Some define the climate as the product of interrelations between students' views and perceptions and the relationship among them (Moos, 1979). Anderson saw the climate as a product of interrelations among the learners on one hand and between the students and lecturer on the other (Anderson, 1970, 1979). The different definitions are associated with the dynamic nature of the academic climate and the sense of a vital and lively setting: "The classroom is anchored in space and time and comprises several autonomous components that purposefully maintain mutual relations with each other" (Smith, Smith and de Lisi, 2001, p. 7).

The academic climate is comprised of two dimensions:

1. **The contextual dimension** includes the physical space, which encompasses chairs, desks, study material, interpersonal interactions, as well as the administrative/ institutional element and the psychological element (Schubert, 1986).
2. **The teaching dimension** includes all the factors that affect the lecturer and students' performance.

Many studies have examined the classroom climate and its psychological components (Fraser, 1982, 1986, 1989; Fraser and Waldberg, 1991). These psychological components include the academic climate, which comprises aspects that concern mutual social relations within the academic environment. This aspect of the academic climate is called the "academic-social climate".

The academic-social climate has much significance for teaching and learning processes in all educational settings. This issue has been neglected to a large degree with regard to institutions of higher education (Hativa, 2002), where the value of research is greater than that of teaching (Iram, 1978). Occupation with the academic-social climate was neglected in academic teaching despite the changes that occurred in higher education around the world. The year 2020 marked a huge transformation in teaching and learning in general and in academic teaching in particular.

Measures of academic-social climate relate both to learning and teaching and to the classroom social climate in the students' department and organization (support for the student, involvement by the lecturer, operating his authority as a teacher, order and organization when teaching, varied teaching methods, creating a sense of connection between the learners, and goal orientation). Research (do Nascimento, Porto and Kwantes, 2018) indicates that students' perceptions of the academic-social climate might vary substantially. In institutions and departments with strong interpersonal interaction students appear to show higher evaluation of the teacher's involvement and support and less with regard to competition, order, and organization. In contrast, students at institutions and departments not characterized by strong interpersonal interaction evaluate academic aspects more strongly.

The social dimension of learning constitutes an inseparable part of the academic climate and has also been found to have considerable weight in one's academic success (Samdal et al., 1998; Katz and Aspden, 1999). Joint learning in a group setting inevitably creates mutual relations and a sense of cohesion (Hiltz, 1995). The social relations formed within a study group constitute an important part of learning, as social interaction affects the quality of the interaction in the overall learning process as well as learning outcomes (Anderson and Kanuka, 1997; Springer, Stanne and Donovan., 1999; Hammond, 1999). Social relations within the learning group may improve mutual relations among the group members and thus enhance the efficacy of academic collaboration (Henri, 1999). Good social relations make it possible to form an efficient learning discourse, successful conflict management, and increase the involvement of group members in the discourse (Anderson and Kanuka, 1997).

The social atmosphere within the learning group is formed gradually, as the group members become familiar with each other. Over time, social interactions and friendships are formed, and their intensity might dictate motivation to share information with group members (Haythornthwaite, 1997). In time, a sense of belonging to the group emerges and it too affects the student's degree of involvement, satisfaction, and success in the course (Haythornthwaite, 1997; Katz and Aspden, 1999; Gatfield, 1999). The sense of belonging to the group is a measure that affects the student's transition from the status of observer to that of participant. This belonging affects the performance of tasks and involvement in the course, and hence also success in the course (Haythornthwaite, 1997). In general, most studies note the significance of students' attitudes and feelings towards the social environment of their studies, which constitutes a meaningful predictor of their achievements (Fox, Luszk and Schmuck, 1966).

1.2 The academic-social climate in the online expanse

The academic-social climate in the online expanse is currently in its first stages of research in the context of academic instruction. One major study conducted in Israel centered on courses at Tel-Aviv University. Sherry-Steinberg (2000) examined how the social atmosphere was formed in two online university courses. The researcher sought to explore whether and to what degree an academic-social climate is formed independent of face-to-face encounters. The research results showed that students in an online course who participated in discussion groups developed a strong academic-social atmosphere over time. The discussion groups generated a type of "coffee shop atmosphere" and facilitated topical discussions.

Nachmias and colleagues investigated the effect of combining online courses with classroom teaching on the social atmosphere (Nachmias, Mioduser and Shemla, 2000). The research results show that use of online courses significantly affects the teaching and learning process, by increasing students' involvement and participation. Moreover, an online course supported by classroom teaching enhances the group's academic-social climate and its joint work.

Several studies examined the evolvement of the academic-social climate in online courses by the nature of discussion groups that develop in the virtual dimension. Some claim that the virtual discourse might pose barriers for students due to the lack of face-to-face interaction. The distance and the absence of nonverbal cues generate social inhibitions that prevent an open attitude to learning and to constructing new ideas (McLoughlin and Luca, 2000). Nevertheless, students are able to feel part of an online learning group. This feeling depends on the form of discussion and interaction between the participants, the course structure, the role of the facilitator, and the technical features of the media.

During technology-assisted courses students, as a learning community, undergo a learning experience that includes learning about how to work together from a distance and how to use the media to complete their assignment. It is important to form a sense of community among the students in order to enhance efficient use of online courses (Sherry-Steinberg, 2000). The sense of belonging and of comfort in the technology-assisted media forms a sense of "flow". This is typical of discussion groups among students who use web-based study activities as part of classroom studies. The study also found that a sense of comfort and flow was typical of groups that had been previously acquainted (Sherry-Steinberg, 2000). This helps advance study aims as it helps students form purposeful activity, with feedback and the sense of an achievable challenge.

Aside from the study group, which constitutes an important element in the development of the academic-social climate, the course lecturer in the online course may also constitute a key factor in encouraging the formation of this climate. The lecturer can determine the level of the discussion and its boundaries, while striving to advance the study process (Wolcott, 1995; Anderson and Kanuka, 1997). If the lecturer assumes the role of "social host" this might increase the level of participation by providing feedback, presenting examples, and encouraging the participants to undergo a productive learning procedure (McLoughlin and Luca, 2000). A technology-assisted course that takes place concurrent with classroom encounters requires the lecturer to implement insights from the classroom dynamics, with specific attention to the students (Ohara et al., 2000). The course lecturer might, through proper leadership and management of the online course, form a suitable climate for joint work and for the emergence of an intellectual debate (Davie, 1989; Salmon, 2000; Collison et al., 2000).

1.3 The online environment and the act of teaching

Technological changes are formed, by nature, to serve human beings and meet their needs, however they often have the effect of changing society and people. Technological inventions are assimilated in the social order and become an inseparable part of the new social existence. The manner in which technology is assimilated is indicated by research focusing on the effects of new technology versus its predecessors. For instance, in the 1950s and 1960s, following the invention of television, its efficacy as a teaching medium was explored relative to traditional teaching methods. Similarly, in the 1970s and 1980s a large range of computer-assisted teaching methods were explored, in the 1980s and 1990s multimedia was the focus, and from the late 1990s until the present technology-assisted and distance learning methods are being explored comparatively in order to check their relative efficacy (Bernard et al., 2004).

In recent years the use of technology for purposes of teaching and learning at institutions of higher education around the world has gradually grown (Jones and O'Shea, 2004). A great deal of effort is invested in constructing an online environment, since technology is considered to offer flexible time, space, and learning pace (Inglis, Ling and Joosten, 2002). In addition, there are advantages that are identified with technology, such as the significant improvement in utilizing time for learning, reducing the learner's dependency on a physical learning site, expanding the study setting and information sources, cancelling the dependence on textbooks as the single source of knowledge, and constructing an active knowledge environment while enhancing the academic dialogue (Hiltz, 1998).

1.4 Information technologies for learning

Despite the many advantages, use of information technologies for learning has not yet proven itself unequivocally. For instance, a study conducted by Bernard and colleagues included a meta-analysis with data from 232 studies on distance learning from the years 1985-2002 (Bernard et al., 2004). The researchers compared distance learning to classroom learning on three dimensions: achievements, attitudes, and dropout rates. They found that in aspects of synchronous learning, classroom teaching resulted in better achievements, while in asynchronous learning, distance learning resulted in better achievements.

Lou and colleagues examined the use of computer technology in group learning versus individual learning (Lou, Abrami and D'Apollonia, 2001). The findings showed that computer-assisted learning in small groups is more efficient than learning with a computer alone. The researchers concluded that the efficacy of using a computer as a learning tool depends to a large extent on the learner's features. On this point a distinction was also made between students who prefer an independent learning environment and students who need a learning environment that includes human interaction. The former will have more success in individual distant learning; the latter will have more success in group learning (Diaz and Cartnal, 1999). Turney and colleagues examined the benefits of teaching by means of hybrid courses, as manifested in improved student achievements (Turney, 2009). The researchers found that assimilating use of computers might significantly improve students' achievements, but only if the learning goals are compatible with their assimilation in the study program. According to the researchers, hybrid courses let students revisit the study material and thus the student is accountable for his own learning, which is adapted to his learning pace. In addition, the computer gives the student feedback and guides the learning, enabling him to enhance his achievements. Nevertheless, this learning method, which combines technology with traditional teaching, is not suitable for everyone – quite a few students miss the "campus atmosphere" as well as the unmediated contact with their peers and with the lecturer (Keith, 1999).

In any case, it seems that information and communication technologies (ICT) lose their force when they lack proper facilitation. In such cases the technology-assisted course is perceived by students as a tool that enables convenience, communication, and management of the class activity (Meister, 2002; Kyavik et al., 2004), while they lack thorough understanding of the learning possibilities it contains. In addition, active participation in discussion groups does not necessarily attest to expanded knowledge. Davies and Graff explored the relationship between participation in online debates and students' final grades in the course (Davies and Graff, 2005). The researchers found that active participation in the course website and in discussions does not necessarily lead to higher grades. Assimilation of technology might indeed constitute a stimulus for learning, but it requires a paradigmatic change that shifts the emphasis from teaching to learning (Rogers, 2000). Indeed, technology has influenced and is still deeply influencing the style of teaching and access to information (Connolly, Jones and O'Shea., 2005), but it cannot yet be said for certain that the technological changes and assimilation of technology-assisted courses in teaching lead to better learning outcomes.

The research indicates a high degree of dichotomy with regard to the efficacy of technologies in learning. Some see technologies as an efficient tool that improves instruction and learning outcomes (Pifarré, 2007; Salpeter, 1998; Wodecki, 2006; Wenglinsky, 1998). Then again, others claim that studies that support technology-assisted learning are unique to a certain context and hence are not generic and cannot be generalized (Healy, 1998). Yet others argue that technology does not improve learning and knowledge at all compared to the traditional non-technology assisted learning procedure (Wright, 2008).

1.5 Difficulties of learning and technology

One of the difficulties that emerges with regard to learning and technology relates to how learning is treated. Learning can be seen as a simple act of acquiring knowledge, a type of transition from absence to presence. Another more complex outlook sees learning as a process aimed not only at acquiring knowledge but also an activity that contributes to the development and enrichment of the individual (Vygotzky, 1978). This type of learning is perceived as a factor that helps widen one's horizons and enrich one's inner world (Renshaw, 1992). This is learning that opens a sociocultural dimension for the learner, above and beyond the concrete level of knowledge.

Grasping learning in a wide context emphasizes its social dimension. Some claim that the social dimension might disappear in technology-assisted courses that allegedly neglect this aspect of the learning procedure (Felix, 2005). This part of technology-assisted teaching has hardly been explored systematically and raises the question of the contribution of technology-assisted courses to learning in its wide meaning, as enriching, expanding, and enhancing the learner's inner world, including the social and sociocultural aspect.

As evident from the literature review, technological developments have created a revolution, and they are challenging the educational system in general and higher education in particular (Leung and Ivy, 2003). The new tools require rethinking the methodologies we use for academic teaching (Passig, 2003), particularly since the system of higher education is absorbing students for whom academic education has become more accessible than in the past (Offir et al., 2004). This change process requires examining the effectiveness of technologies in learning and teaching (Mioduser et al., 1999). The huge increase in the number of online courses at academic institutions in Israel since 1999 is ascribed mainly to a national strategic initiative by the Council for Higher Education and its executive arm, Meital, the inter-university center for e-learning. The Council for Higher Education's call for a new pedagogy to accompany the new technological tools, has mostly remained unanswered (Tel Aviv University, 2003).

Preliminary exploration of online academic courses in Israel indicates that technology has advanced rapidly, leaving pedagogy lagging behind. In higher education there is a shortage of methodologies, guidelines, and manners of evaluation related to constructing online courses anchored in well-based theories, objective principles, and research findings. Most online courses are built on the personal intuition or personal experience of the faculty or of the developers (Nachmias and Mioduser, 2001; Saba, 2001). Although conclusions were reached based on "local" evaluation studies, there is no database of rules based on the aggregated conclusions regarding the effectiveness of technology-assisted courses in higher education (Guri-Rosenblit, 2003; Naveh, Tubin and Pliskin., 2003; Shelma and Nachmias, 2004; Soffer et al., 2004). Also, there are only few studies on the evaluation of online courses, a fact stressing that technologies were embraced before pedagogical developments adapted to this change in tools (Nachmias et al., 1999; Nachmias and Segev, 2003).

This situation is evident not only in the "how" of online learning environments but rather also in the "what" – What do we want to teach our students in order to prepare them to be knowledgeable practitioners, each in their own field, and responsible 21st century citizens? Such questions were not addressed when developing study programs in general, and in particular when planning the process of embracing technology (Dyson, 1998).

The faults of online teaching in academia are based on the following principles, as evident from the research literature (Wadmany, 2017, 2018): A low percentage (about 7%) of learner's complete online courses, students are concerned that their communication skills and interpersonal relations will be harmed, online courses are unsuitable for students who do not have the skills of independent learners and for students with low motivation to learn. As stated, in 2020 both lecturers and students inadvertently found themselves in a new reality – a dramatic change. Initial examinations were held of students' attitudes to this change.

1.6 The effect of online teaching on the satisfaction of students in Israel

A survey at Tel Aviv University (Cohen, Barot, Hagit, and Ezra, 2020) examined students' attitude to the efficacy of online teaching. The survey was completed by 183 students from Tel Aviv University. The findings concern the facilitators of distance teaching and learning as well as the difficulties and inhibitors, from the perspective of the students. The findings indicate that online learning affords the students the flexibility to manage their time according to their personal needs, lets them carry out other daily tasks while learning, and also allows them to maintain a routine. In addition, the online teaching pattern grants them flexibility in the pace of learning as it is possible to listen to recordings of lectures whenever and wherever convenient. Moreover, learning at home has an advantage as students do not have to come to the campus, saving them significant time and financial costs. Finally, the transition to online teaching made it possible to continue the semester and prevented its cancellation, which might have been detrimental to their course of studies in particular and to their life in general. Notably, the option of recordings contributed to the quality of teaching during this time on several spheres; in addition to being an efficient tool for students to make up missed lessons, they also helped lecturers improve the quality of teaching, as for the first-time lecturers could observe how they conduct lessons in order to improve their practice (Crane, 2020).

This innovative study aims to address an acute global problem. Several studies have attempted to understand the effect of the academic system, for instance Mayo's qualitative study (Mayo, 2020). However, no comprehensive study has examined the phenomenon extensively, both empirically and qualitatively, in several institutions. The current study is the first to examine the advantages of online teaching from the perspective of students at eleven institutions of higher education in Israel, both universities and colleges. The study was conducted at the end of the second semester of their academic studies, after the students had experienced "face to face" studies, and they were asked to freely answer an open question on their evaluation of the advantages of transitioning to online teaching.

2. Methodology

2.1 Initial Sample

A survey was distributed online using Google Forms to students from eleven academic institutions. Respondents were asked to freely answer the open question: "What are the advantages following the transition to online learning? How is this manifested for you?" and a Likert-type closed-ended question (from 1- completely disagree, to 5- completely agree): "In my opinion the transition to online teaching improves my study capacity" (symbolized as *IMP* in the model).

The number of fully completed questionnaires collected was 1,937. The majority of the respondents were from Ariel University (923), Sami Shamoon College (405), and Tel-Hai College (145). Of all respondents, 53.1% were female and 46.9% male. Respondents' age range was 18-28 (74.3%), 29-52 (24.4 %), and 53-67 (1.3 %).

2.2 Analysis

A mixed methods research design was employed (Terrell, 2012). First, answers to the open-ended question were manually reviewed, identifying major themes. Each response was binary coded regarding belonging to any of the themes, i.e., 0 (does not belong) or 1 (belongs) (Eckhaus and Sheaffer, 2018). Correlations were placed in the model between the variables, as they all belong to the same question. Table 1 details the themes. Notably, the respondents did not address all the themes rather only several that seemed to them important, such that it is logical to have only several dozen tags for each category.

Table 1: Main themes

	Variable	Theme	N
Lesson recordings	*T1*	Possibility of making up missing studies when the lecture is recorded	689
	T2	Possibility of learning at a suitable pace for me when the lecture is recorded	95
Students learn better during lessons	*T13*	Description of classroom problems unrelated to teaching (temperature, disruptive students)	18
	T14	There is no noise in class	88
	T16	Better concentration on the lesson	64
	T17	It is much easier to see the lecturer	31
	T18	It is not necessary to copy from the board	10
	T19	More material is learned in a shorter time	21
	T20	Makes it easier to cope with caring for children	33
	T21	I feel more comfortable asking questions during the lesson	14
	T23	**Enables** independent learning	25
	T24	**Requires** developing independent learning capacity	32
The lecturer teaches better	*T28*	The material is conveyed better	46
	T29	The lecturer is more attentive to the students during the lesson	20
	T30	The lecturers are more available via e-mail	25

Next, Structural Equation Modeling (SEM) was employed to test the model's goodness-of-fit (Eckhaus, 2019; Levy and Eckhaus, 2020). Model fit was estimated using CFI, NFI, RMSEA, SRMR, and minimum discrepancy, divided by their degrees of freedom (CMIN / DF). Values that indicate good fit are CFI and NFI > .95, RMSEA values < 0.05 (Ivzori-Erel, Bar-Sela and Cohen), the ratio CMIN / DF < 2 (Ohara et al., 2017), and SRMR< .08 (do Nascimento, Porto and Kwantes, 2018).

SEM is considered a second generation data analysis technique (Bagozzi and Fornell, 1982), which follows first generation statistical tools such as regression. Regression shows the direct effect of one variable on the other, however showing an effect in isolation of other effects, concluding that such causation occurred would be misleading (Cook and Campbell, 1979). We therefore used SEM to develop a model that combines the effects, so that no effect is isolated.

3. Results

First, we explored possible differences between the academic institutions regarding capacity for improvement in one's studies due to the move to the online environment (*IMP)*. An ANOVA test was performed, showing a significant statistical difference ($F(11,1884)=6.70$, $p<.001$). A statistically significant difference was found between the Orot Israel College and the three major institutions investigated - Ariel University ($p<.05$), Sami Shamoon College ($p<.001$), and Tel-Hai College ($p<.001$). Means and standard deviations of *IMP* in the four institutions are presented in Table 2. Between the three major institutions investigated there was no significant statistical difference.

Table 2: N, Means, and SD of the four institutions regarding IMP

	N	Mean	SD	Kruskal-Wallis mean rank
Orot Israel	77	3.56	1.31	1244.83
Ariel University	923	2.73	1.53	952.19
Sami Shamoon College	405	2.5	1.52	871.02
Tel-Hai College	145	2.21	1.30	772.73

In Table 2 we observe that Orot Israel has the highest mean of improvement perception (*IMP)*. However, since the Levene test of homogeneity of variances was significant, an a-parametric test was needed. We therefore performed a Kruskal-Wallis test, which confirmed a significant statistical difference ($\chi^2(11) = 71.96$, $p<.001$). Kruskal-Wallis mean ranks are presented in Table 2. In Table 2 we observe that Orot Israel has the highest mean rank, compared to the other three.

Next, we investigated IMP differences among disciplines. Students' disciplines were distributed over a wide range; however, five disciplines were dominant: Social Sciences and Humanities, Computer Science, Education, Accounting and Economics, and Electrical Engineering. An ANOVA test was performed, showing a significant statistical difference between these disciplines ($F(4,630)=3.47$, $p<.01$). Means and standard deviations of *IMP* in the four institutions are presented in Table 3. Results show a significant difference between Education and Social Sciences and Humanities ($p<.05$), and between Education and Computer Science ($p<.05$). In Table 3 we observe that the Education discipline has the highest perceived improvement in learning due to the move to an online environment (*IMP*).

Table 3: N, Means, and SD of the dominant disciplines with regard to *IMP*

	N	Mean	SD
Electrical Engineering	175	2.65	1.56
Education	125	3.06	1.51
Accounting and Economics	92	2.55	1.49
Social Sciences and Humanities	115	2.45	1.45
Computer Science	128	2.45	1.56

In the next step, we present the correlations matrix, followed by the development of the model and the SEM results.

Spearman's correlations, means, and SD are presented in Table 3. Figure 1 illustrates the model and results.

Table 4: Correlation matrix: Means, SD

	T1	*T2*	*T13*	*T14*	*T16*	*T17*	*T18*	*T19*
T1	-							
T2	.12***	-						
T13	.01	.003	-					
T14	.074***	.008	.211***	-				
T16	.030	.012	.042	.306***	-			
T17	.050*	.028	.116***	.269***	.161***	-		
T18	.051*	-.016	.068**	.088***	.188***	.106***	-	
T19	.015	-.001	-.010	.193***	.036	-.013	062**	-
T20	.001	-.030	-.013	-.010	-.002	.015	.046*	-.014
T21	.012	-.019	-.008	.069**	.052*	.038	-.006	.050*
T23	-.057*	.016	-.011	.019	.030	-.015	-.008	-.012
T24	-.080***	-.029	-.013	-.028	-.024	-.017	.047*	-.014
T28	-.025	-.012	-.015	.031	.009	-.020	-.011	.049*
T29	-.002	0	-.01	.002	-.02	.03	-.01	-.01
T30	.019	-.005	-.011	.019	.056*	.095***	.056*	-.012
Gender	-.028	-.036	.017	-.011	.006	-.021	.033	-.028
IMP	.19***	.14***	.09***	.16***	.2***	.08***	.08***	.09
Mean	.36	.05	.01	.05	.03	.02	.01	.01
SD	.480	.216	.096	.208	.179	.126	.072	.104

*p<.05, **p<.01, ***p<.001

Table 4: Cont.

	T20	*T21*	*T23*	*T24*	*T28*	*T29*	*T30*	*Gender*	*IMP*
T21	.083***	-							
T23	-.015	-.010	-						
T24	.014	-.011	.021	-					
T28	-.021	-.013	.012	-.020	-				
T29	.03	.11***	-.01	-.01	.02	-			
T30	-.015	-.010	-.013	-.0.15	.102***	.35***	-		
Gender	-.052*	-.044	.012	.024	-.024	*.02	-.052*	-	
IMP	.06**	.07**	.06**	.05*	.09***	.07**	.1***	-.09***	-
Mean	.02	.01	.01	.02	.02	.01	.01	.47	2.7
SD	.129	.085	.113	.127	.152	.1	.113	.499	1.51

∗∗$p < .01$. ∗∗∗$p < .001$. ł $p=.05$ ---- dotted line implies mediation.

Note: T29 is exactly on the cusp of significance, however, since it is part of the same content world it is logical to consider it significant.

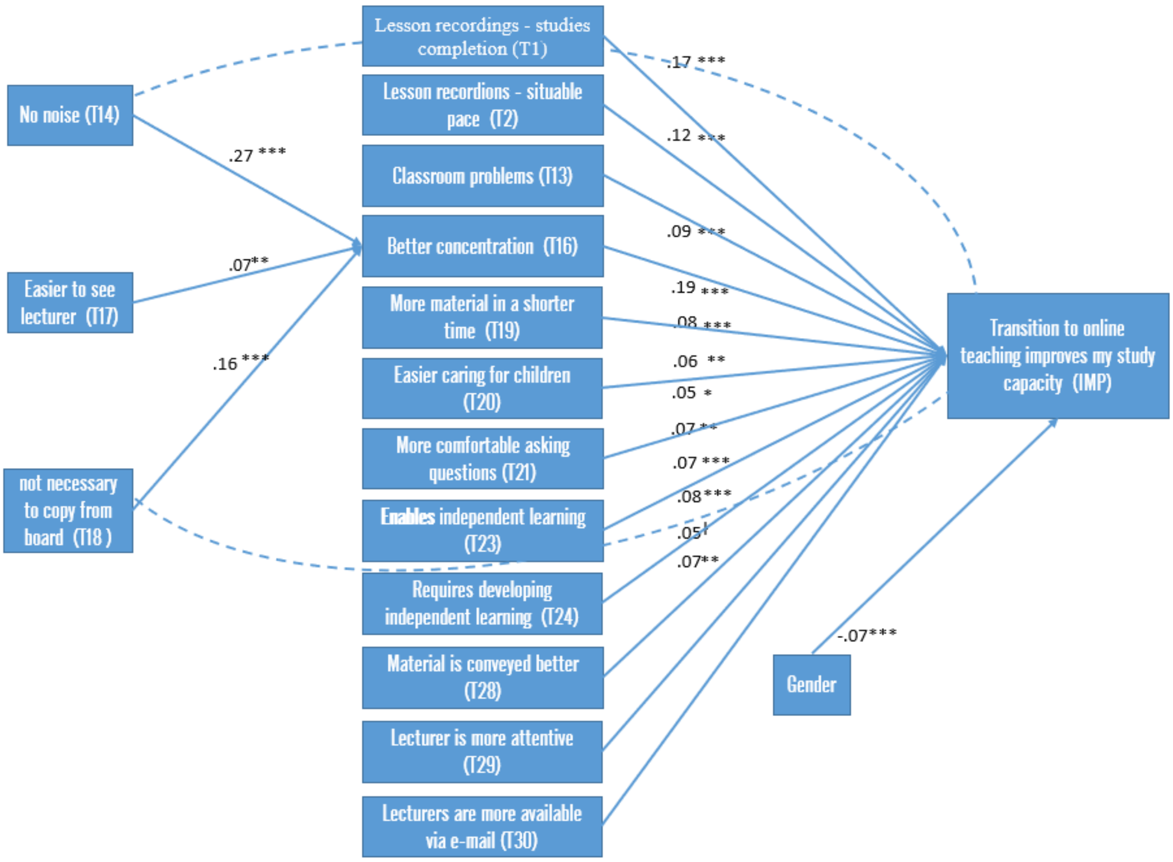

Figure 1: Model and standardized coefficients

The hypothesized model showed a very good fit: CMIN/DF = 1.95, CFI = .99, NFI= .98, RMSEA = .02, SRMR=.01. All the theme variables except T14, T17, and T18, had a direct positive effect on *IMP* – the perception that the move to online teaching improved personal study capacity. However, we found that the three variables positively affected T16, and that T14 and T18 had an indirect effect on *IMP* mediated by T16, as follows:

T16 mediation of the indirect effect of T14 on *IMP* was significant (β=.05, $p<.001$). Bootstrapped Confidence Interval (CI) ranged from [.03, .07]. T16 mediation of the indirect effect of T18 on *IMP* was significant (β=.03, $p<.01$). Bootstrapped Confidence Interval (CI) ranged from [.03, .07]. Bootstrap size for both mediations was 5000.

Finally, gender had a negative effect on *IMP* (β=-.07, $p<.001$). Since gender was coded as 0=female and 1=male, a negative effect implies that females had a more positive attitude to online learning than males.

4. Discussion

This study examines students' evaluation of the advantages of moving to online teaching. Students were "forced" to accept a new reality of learning in a "digital study environment". The academic-social climate, the conduct of lecturer-student relations, and relations among the students changed instantaneously, with no preparation by any of those involved. Hence, the research findings can illuminate the strengths of online teaching, with a view of the future. Was the effect of teaching and learning in the COVID reality a one-time event for students or one that can form a perspective for examining and embracing new manners of study for them? Teaching and learning – where are they headed?

The findings show that all of the investigated parameters have a positive and significant effect on students' positive perception of the transition to online teaching. Of these, the study found that use of lecture recordings was addressed the most, as a substantial advantage of online teaching in students' perception, and students grasp recordings as enhancing their academic capacity. Hence, with regard to the benefit of improved teaching for students, the current research findings urge lecturers to consider recording their lectures. This topic is not a simple one and it involves challenges that have not yet been clearly resolved, for instance how to maintain rights to material when it is easily recorded, copied, and distributed, infringing on the copyright and harming the lecturer's livelihood. There is room to investigate this topic and to suggest viable solutions that will enable lecturers to record lectures with no concern and to grant students this important tool to improve their studies.

This finding of the current study constitutes a significant contribution to one well-known problem of the younger generation – lack of concentration, and suggests that online teaching might improve concentration, a topic stressed by the current research results. According to the results, reducing classroom noise, the ability to clearly see the lecturer, and eliminating the need to copy from the board, improve students' concentration during lessons. These improvements lead to higher satisfaction with online teaching, and the higher concentration they generate significantly enhances satisfaction with online teaching. Moreover, improved concentration mediates between reducing classroom noise and eliminating the need to copy from the board, and higher satisfaction with online teaching, namely, enhancing concentration is the reason that reducing noise and eliminating the need to copy from the board improve students' satisfaction with teaching.

The importance of these variables is highlighted through the mediation analysis. Mediation analysis is more than a statistical approach, but rather a highly complex and integrated methodology composed of research, conceptual, and analytic components (Walters and Mandracchia, 2017). Mediation analysis is becoming increasingly popular in psychological research (Li, 2019). This analysis is more informative than simple multivariate regression since it allows considering an additional type of variable, a mediator, which can help determine how an independent variable influences the dependent variable (Dondé et al., 2019).

While we have successfully presented key advantages of the move to the online teaching medium based on a large sample of respondent from different institutions, the respondents are all from the same country. Future studies may extend this research by investigating the findings in other cultures.

Another interesting finding is the difference between the Orot Israel College, which is an education college, and the three major academic institutions investigated - Ariel University, Sami Shamoon College, and Tel-Hai College, which are academic institutions. These results are further supported by the findings showing that education practice has the highest learning improvement perception due to the move to the online environment. This indicates a change in the pedagogic outlook, resulting from the COVID era. The fact that it is precisely in the field of education that the transition to the online medium is perceived as more efficient constitutes a issue for consideration regarding changes in pedagogic policy in the near future as well as an area for future research.

A supportive academic-social climate, while harnessing technology to the needs of teaching in order to benefit students, might make the learning experience more comfortable and convenient. It is necessary to recognize the fact that the new technologies created a paradigmatic change, and therefore new technologies that are uniquely adapted to the new educational technologies should be actively discovered and assimilated. In order to improve lecturers' performance as teachers, the pedagogical aspects of the new technological tools should be enhanced. A program that assimilates the new tools should be offered as an inseparable part of teaching practice rather than as an external aide for the teaching and learning process. The authors of the current article are of the opinion that computers will never replace teachers; nevertheless, lecturers with good command of the pedagogical aspects of computers and who harness them to improve the quality of teaching and learning – will replace those who do not do so.

References

Almog, T. and Almog, O., 2020. *All the lies of the academy.* Rishon Letzion: Yedioth Ahronoth Books. [Hebrew].

Anderson, G. J., 1970. Effects of classroom social climate on individual learning. *American Educational Research Journal*, 7, pp. 135-152.

Anderson, T. and Kanuka, H., 1997. Online forums (1): *New platforms for professional development and group collaboration*. Journal of Computer-Mediated Communication, 3: 0-0. https://doi.org/10.1111/j.1083-6101.1997.tb00078.x

Bagozzi, R. P. and Fornell, C., 1982. Theoretical concepts, measurement, and meaning. In C. Fornell (Ed.), *A second generation of mulivariate analysis, vol. 2* (pp. 5-23). New York: Praeger.

Bernard, R., Abrami, P., Lou, Y., Borokhovski, E., Wade, A. and Wozney, L., 2004. How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research*, *74*, 379-439.

Cook, T. D. and Campbell, D. T., 1979. *Quasi experimentation: Design and analytical issues for field settings*. Chicago

Cohen, A., Barot, O., Hagit, G. and Ezra, O., 2020. Student perceptions of online teaching in higher education in light of the Corona crisis: Promoting and inhibiting factors. School of Education, Tel Aviv University. (Hebrew)

Connolly, M., Jones, N., and O'Shea, J., 2005. Quality assurance and e-learning: Reflections from the front line. *Quality in Higher Education*, *11*, 59-67.

Collison, G., Elbaum, B., Haavind, S., and Tinker, R., 2000. *Facilitating online learning.* WI: Atwood.

Crane, C., 2020. Transforming our perspectives as language professionals during COVID-19. *Second Language Research and Practice,* 1(1), pp. 168–173.

Cristescu, I. and Iordache, D., 2017. Learning tools offered by online social networks - a qualitative approach. *Romanian Journal of Human - Computer Interaction*, 10(4), pp. 271-284.

Davies, J. and Graff, M., 2005. Performance in e-learning: Online participation and student grades. *British Journal of Educational Technology,* 36, pp. 657-663.

do Nascimento, T. T., Porto, J. B., and Kwantes, C. T., 2018. Transformational leadership and follower proactivity in a volunteer workforce. *Nonprofit Management and Leadership,* 28(4), pp. 565-576. doi:10.1002/nml.21308

Diaz, D.P., and Cartnal, R.B., 1999. Students' learning styles in two classes. *College Teaching*, *47*(4), pp. 130-135.

Dondé, C., Silipo, G., Dias, E. C., and Javitt, D. C., 2019. Hierarchical deficits in auditory information processing in schizophrenia. *Schizophrenia Research,* 206, pp. 135-141.

Dumford, A. D. and Miller, A. L., 2018. Online learning in higher education: Exploring advantages and disadvantages for engagement. *Journal of Computing in Higher Education*, 30(3), pp. 452-465.

Dyson, F. J., 1998. *Imagined worlds*. Cambridge, MA: Harvard University Press.

Eckhaus, E. 2019. *How to be happy*. Blog section on http://www.artistila.com/. Available at: http://www.artistila.com/how-to-by-happy/ [Accessed 29 May 2021]

Eckhaus, E. and Sheaffer, Z., 2018. Happiness enrichment and sustainable happiness. *Applied Research in Quality of Life,* 14(4), pp. 1079–1097. doi:https://doi.org/10.1007/s11482-018-9641-0

Felix, U., 2005. E-learning pedagogy in the third millennium: The need for combining social and cognitive constructivist approaches. *ReCALL: The Journal of EUROCALL,* 17, pp. 85-100.

Fox, R., Luszk, M. B., and Schmuck, S., 1966. *Diagnosing classroom learning.* Chicago: Environments. Science Research Associates.

Fraser, B. J., 1982. Development of short forms of several classroom environment scales. *Journal of Educational Measurement*, 19, pp. 221-227.

Fraser, B. J. 1986. *Classroom environment*. London: Croom Helm.

Fraser, B. J., 1989. Twenty years of classroom climate work: Progress and prospect. *Journal of Curriculum Studies*, 21, pp. 307-327.

Fraser, B. J. and Waldberg, H. J. (Eds.), 1991. *Educational environments: Evaluation, antecedents, consequences*. London: Pergamon.

Gatfield, T., 1999. Examining student satisfaction with group projects and peer assessment. *Assessment and Evaluation in Higher Education*, 24(4), pp. 365-369.

Greener, S. L., 2010. Plasticity: The online learning environment's potential to support varied learning styles and approaches. *Campus-Wide Information Systems*, 27(4), pp. 254-262.

Guri-Rosenblit, S., 2003. *A top-down strategy to enhance information technologies into Israeli higher education*. Available at: www.irrodl.org/content/v2.2/rosenblit.html Accessed January 2009.

Hammond, M., 1999. Issues associated with participation in online forums – the case of the communicative learner. *Education and Information Technologies,* 4, pp. 353-367.

Hativa, N. 2002. First class in the course. *Al Hagova,* 1, pp. 14-15. [Hebrew]

Haythornthwaite, C., 1997. *A social network study of the growth of community among distance learners*. Available at: http://www.shef.ac.uk/~is/publications/infres/paper49.html Accessed October 2009.

Healy, J. M., 1998. *Failure to connect*. New York, NY: Simon and Schuster.

Henri, F., 1991. Computer conference and content analysis. In A. R. Kaye (Ed.), *Collaborative learning through computer conferencing* (pp. 17-136). Heidelberg: Verlag-Springer.

Hiltz, S. R., 1995. *Teaching in a virtual classroom*. In *Proceedings:* International conference on Computer Assisted Instruction (ICCAI 95), Taiwan. March 1995.

Iram, Y., 1978. The influence of higher education traditions on the academic path of the Hebrew University of Jerusalem, *Studies in Education*, 28, 123–130 (in Hebrew).

Inglis, A., Ling, P., and Joosten, V., 2002. *Delivering digitally*. London: Kogan Page.

Ivzori-Erel, A., Bar-Sela, G., and Cohen, M., 2020. Introducing the concept sense of place: A mediator between place of care and emotional distress of patients with cancer at the end of life. *Psycho-Oncology,* n/a. doi:10.1002/pon.5530

Jones, N., and O'Shea, J., 2004. Challenging hierachies: The impact of e-learning .*Higher Education, 48*, pp. 379-395.

Kasai, H., Shikino, K., Saito, G., Tsukamoto, T., Takahashi, Y., Kuriyama, A.,Tanaka, K., Onodera, M., Yokoh, H., Tatsumi, K., Yoshino, I, Ikusaka, M., Sakao.S. and Ito, S., 2021. Alternative approaches for clinical clerkship during the COVID-19 pandemic: Online simulated clinical practice for inpatients and outpatients. *BMC Medical Education*, 21(3), pp. 1-13.

Katz, J.,E., and Aspden, P., 1999. *Friendship formation in cyberspace analysis of a national survey of users*. Available at: http://www.iaginteractive.com/emfa/friendship.html [Accessed October 23, 2009]

Keith, H., (Ed.), 1999. *Higher education through open and distance learning*. New York, NY: Routledge.

Khalid, M., Bashir, S., and Amin, H., 2020. Relationship between self-directed learning (SDL) and academic achievement of university students: A case of online distance learning and traditional universities. *Bulletin of Education and Research*, 42(2), p. 131.

Leung, Y. and Ivy, M., 2003. How useful are course websites? A study of students' perceptions. *Journal of Hospitality, Leisure, Sports and Tourism Education*, 2(2), pp. 15-25.

Levy, I. and Eckhaus, E., 2020. Rape narratives analysis through natural language processing: Survivor self-label, narrative time span, faith, and rape terminology. *Psychological Trauma: Theory, Research, Practice and Policy*. doi:10.1037/tra0000587

Li, Y., 2019. *A simulation study to check the consequences of violating assumptions in mediation analysis*. New Orleans, LA: Louisiana State University Health Sciences Center.

Lou, Y., Abrami, P., and D'Apollonia, S., 2001. Small group and individual learning with technology: A meta-analysis. *Review of Educational Research*, 71, pp. 449-521. https://doi.org/10.3102/00346543071003449

Mayo, P., 2020. The Corona challenge to higher education. *Culture e Studi del Sociale*, 5(1, Special), pp. 371-376.

McLoughlin, C. and Luca, J., 2000. Developing professional skills and competencies in tertiary learners through on-line assessment and peer support. In J. Bourdeau and R., Heller (Eds.), *Proceedings of ED-MEDIA 200* (Vol. 1, pp. 633-638). Montreal: Association for the Advancement of Computing in Education.

Mbuva, J. M., 2015. Examining the effectiveness of online educational technological tools for teaching and learning and the challenges ahead. *Journal of Higher Education Theory and Practice*, 15(2), pp. 113-127.

Meister, J., 2002. *Pillars of e-learning success*. New York, NY: Corporate University Exchange.

Mioduser, D., Nachmias, R., Lahav, O., and Oren, A., 1999. Web-based learning environments: Current pedagogical and technological state. *International Journal of Research in Computers in Education,* 33(1), pp. 55–76.

Moos, R. H. 1979., *Evaluating educational environments*. San Francisco, CA: Jossey-Bass.

Mukhtar, K., Javed, K., Arooj, M., and Sethi, A., 2020. Advantages, limitations and recommendations for online learning during COVID-19 pandemic era. *Pakistan Journal of Medical Sciences*, 36(4), pp. 27-31.

Nachmias, R. and Mioduser, D., 2001. Integrating the internet in education. *Eureka – Journal for the Instruction of Sciences and Technology in Elementary Schools,* 14, pp. 6–16 [Hebrew].

Nachmias, R., Mioduser, D., Oren, A., and Lahav, O., 1999. Taxonomy of educational websites – A tool for supporting research development and implementation of web-based learning. *International Journal of Educational Telecommunications,* 6(2), pp. 141–158.

Nachmias, R., Mioduser, D., and Shemla, A., 2000. Internet usage by students in an Israeli high school. *Journal of Educational Computing Research*, 22(1), 55-73.

Nachmias, R. and Segev, L., 2003. Usage of content in web-supported academic courses. *Academic Exchange Quarterly,* 7(1), pp. 5–15.

Naveh, G., Tubin, D. and Pliskin, N., 2003. *Critical success factors of e-learning implementation at university*. Available at: www.biu.ac.ul/bar-e-learn/success.pdf [Accessed January, 28 2006]

Offir, B., Lev, Y., Barth, I. and Shteinbok, A., 2004. An integrated analysis of verbal and nonverbal interaction in conventional and distance learning environments. *Journal of Educational Computing Research, 31*(2), pp. 101–118.

Passig, D. 2003. A taxonomy of future higher thinking skills. *Informatics in Education – An Internation,al Journal,* 2(1), pp. 79–92.

Pifarré, M. 2007., Scaffolding through the network: Analysing the promotion of improved online scaffolds among university students. *Studies in Higher Education*, 32, pp. 389-408.

Renshaw, P. D., 1992. On the experimental context: Parents' interpretations of the education motive during teaching. In J. Valsiner (Ed.), *Children's development within social context* (pp. 53–74). PA: Lawrence Erlbaum Associates*.*

Rogers, D. L., 2000*.* A paradigm shift: Technology integration for higher education in the new millennium*. Educational Technology Review,* 20, pp. 19-33*.*

Saba, F., 2001. *Distance education: Covering distance education since 1995*. Available at: http://www.distance-educator.com/portals/research_dintro.html [Accessed May 3, 2007].

Salmon, G., 2000. *E-moderating: The key to teaching and learning online*. London: Kogan-Page.

Salmon, G., 2019. *E-moderating: The key to online teaching and learning*. New York: Routledge, Taylor and Francis Group.

Salpeter, J., 1998. Taking stock: What's the research saying? *Technology and Learning*, 18, pp. 24–40.

Samdal, O., Nutbeam, D., Wold, B. and Kannas, L., (998. Achieving health and educational goals through schools – A study of the importance of the school climate and the students' satisfaction with school. *Health Education Research, 13*(3), pp. 383-397.

Schubert, W. H., 1986. *Curriculum: Perspective, paradigm and possibility.* New York: Macmillan Pub. Co; London : Collier Macmillan Publishers.

Shelma, A. and Nachmias, R., 2004. *Current state of web-supported courses in higher education*. Available at: www.biu.ac.il/bar-e-learn.shmla_anat_2004.doc [Accessed January, 30th 2006]

Sherry-Steinberg, O., 2000. *The development of social climate in discussion forums integrated in different models of distance learning courses.* Unpublished M.A. Thesis, School of Education, Tel Aviv University. [Hebrew]

Smith, J. K., Smith, L. F., and de Lisi, R., 2001. *Natural classroom assessment: Designing seamless instruction and assessment*. Thousand Oaks, CA: Corwin Press, Inc.

Soffer, T., Nachmias, R., Raban, Y. and Ram., J., 2004. *Diffusion of web-supported academic instruction*. Available at: www.biu.ac.ul/bar-e-learn/tal_sofer_2004.doc [Accessed October, 2009}

Springer, L., Stanne, M.E. Donovan, S.S., 1999. Effects of small-group learning on undergraduates in science, mathematics, engineering and technology: A meta-analysis. *Review of Educational Research*, *69*(1), pp. 21-52.

Tel Aviv University, 2003. *Activity report on academic online learning at Tel Aviv University 2001–2002* [Hebrew].

Terrell, S. R., 2012. Mixed-methods research methodologies. *Qualitative Report,* 17(1), pp. 254-280.

Velichová, Ľ., Orbánová, D., and Kúbeková, A., 2020. The COVID-19 pandemic: Unique opportunity to develop online learning. *TEM Journal*, 9(4), pp. 1633-1639.

Vygotzky, L. S., 1978. *Mind in society*. Cambridge, MA: Harvard University Press.

Wadmany, R., 2017. *Digital pedagogy – from theory to practice*. Tel Aviv: Mofet, Kibbutzim College. [Hebrew]

Wadmany, R., 2018. *Digital pedagogy – opportunities for different learning*. Tel Aviv: Mofet, Kibbutzim College. [Hebrew]

Walters, G. D. and Mandracchia, J. T., 2017. Testing criminological theory through causal mediation analysis: Current status and future directions. *Journal of Criminal Justice,* 49, pp. 53-64.

Wenglinsky, H., 1998. *Does it compute? The relationship between educational technology and student achievement in mathematics*. Princeton, NJ: Policy Information Center, Educational Testing Service.

Wodecki, A., 2006. Why e-learning at university? *Dialogue and Universalism*, 16, pp. 81-87.

Wolcott, L., 1995. The distance teacher as reflective practitioner. *Education in Technology*, 34(3), pp. 49-55.

Wright, J., 2008. Web-based versus in-class: An exploration of how instructional methods influence postsecondary students' environmental literacy. *Journal of Environmental Education*, 39, pp. 33-46.

Zhang, W. and Han, C., 2012. A case study of the application of a blended learning approach to web-based college English teaching platform in a medical university in eastern China. *Theory and Practice in Language Studies*, 2(9), pp. 1961-1970.

Appendix

Qualitative examples

The following are the major themes, with examples of each theme.

The themes are numbered T1 to T30, but the numbers are not continuous since during the manual classification process of such a large number of respondents, themes are often dropped or changed.

1. Recorded lessons

1. Possibility of making up missing studies when the lecture is recorded T1
"Recorded lessons can be watched again"
"The lessons are recorded and it is always possible to review the material when there is a discrepancy or when I did not concentrate or was not present during the lecture"

2. Possibility of learning at a suitable pace for me when the lecture is recorded T2
"The lecturers speak slowly, I see recordings at double speed"
"It is possible to follow recorded lectures, to stop when necessary in order to understand the materia, and then continue".
"When there are lessons where I wish to review the material studied at my own pace, it is possible to review the lesson several times and that's good"
"The option of recorded lectures and exercises also makes it possible for each student to learn at his own pace of understanding".

2. Students learn better during lessons

1. Description of classroom problems unrelated to teaching (temperature, disruptive students) T13
"The ability to combine work and studies because the lectures are available all the time, and there are no distractions as in class such as latecomers, noise"
"The advantage is the quiet, meaning that it is possible to concentrate better without the background noise of the class, and also to finally see the board well – in class it is often very hard to find a seat first and this makes it hard to understand the material and to study in general"
"Spares having to come to the university (significant), learning in crowded classrooms, there is no need to find a place in the first row (otherwise I don't see all parts of the board")
"There are no distractions by other students in the class, it is not too hot or too cold and there is no backache (as I get from the university chairs)"

2. There is no noise in class T14
"There is no noise and surroundings that can compromise concentration"
"You can hear the lecturer well and you can see the 'board' well, there is no noise made by other students, and in general it is more pleasant to study in this way for someone like me who prefers quiet"
"There is no noise like in class and there are much less comments and questions"
"A second advantage is that the lecturer can silence all the students. Usually students make lots of noise during lessons in a regular classroom but on Zoom it is possible to silence everyone and that helps me listen significantly better"

3. Better concentration on the lesson T16
"It is easier for me and I manage to stay much more concentrated than in class"
"It lets me learn much better and more thoroughly at hours when I am free, concentrate better, and maintain the pace"
"I manage to concentrate better because there is no noise around me and I concentrate only on what the lecturer is saying without background noise"
"It feels like sitting in the first row so the ability to concentrate increases, there is no need to make an effort to come to the university, classes do not drag out beyond the necessary time"

4. It is much easier to see the lecturer T17
"The knowledge that it is only me versus the lecturer without other people around me"

"Everyone can see and hear on the same level, not like in frontal when some people sit in front and others in back"
"I suffer from an attention disorder. And when I hear a lecturer via headphones on a screen with no class, the amount of disruptions is drastically reduced and I concentrate better"
"You can see any lecturer you wish with no place restrictions"
"The convenience of not having to find a seat in class, to sit far, to hear people talking"

5. It is not necessary to copy from the board T18

"It lets me listen better to the lesson and not be busy taking notes, and the notes are better"
"Online learning provides many files that lecturers wouldn't have provided if it was a classroom with a board, and this makes learning much easier"
"The possibility of reviewing lessons and taking notes even after the class is over (from recordings). Saves time – you don't copy from the board so the lesson is more concise"
"It is not necessary to copy the material that the lecturer conveys in the lecture and this saves much time during the lecture (another advantage for me specifically is that it is easier for me to absorb the material studied this way)"

6. You learn more material in less time T19

"More material is learned"
"The lecturer manages time more efficiently"
"You get more done"
"The lecturers do it as clear and lucid as possible and this forms a meaningful learning continuity as well as getting a lot done"

7. Makes it easier to care for children T20

"You can record and watch later (certainly for parents, who can time it better with feeding children and putting them to sleep)"
"I had just given birth and I could both be with the baby and care for him comfortably"
"In case you miss something, especially in circumstances when parents are caring for their children. Students are occupied with things that are no less important, communication problems, etc. It is possible to easily make up missed studies and not lag behind. It's wonderful when the material is saved and accessible! Because even if I missed something during the lesson itself it is always possible to review it"
"Availability for the children"

8. I feel more comfortable asking questions during the lesson T21

"There is room for more individual expression versus the lecturer – I can express myself much more and in such a way that the lecturer is responsive"
"The possibility of talking to the lecturer takes an organized form. Each [student] speaks in turn, not like in class where everyone talks at once"
"The questions are matter-of-fact only"
"I ask what I want to, not like in class where I'm embarrassed"
"The possibility of being more involved in class, asking questions"

9. Enables independent learning T23

"The convenience of self-study (that does not suit everyone)"
"People who can study from afar or learn at home on their own"
"More time for self-study, more convenient time planning"
"As a student of electrical engineering to begin with, even in a regular semester, lots of the learning is autonomous since there is a limit to how much a lecturer can impart understanding and deep insights of the material in a frontal lecture, so not having to come to class gives me more time for self-study and rest"

10. Requires developing independent learning capacity T24

"Requires more effort by the students. This is manifested in the self-study required in order to understand the study material"
"The online learning compelled me to develop my computer and programming skills and self-study, which I will need in my professional life after university studies"

"The advantages are thorough experience with independent studying"
"Requires much more self-discipline"

3. The lecturer teaches better

1. The material is conveyed better T28

"The assignments are more creative"
"Some courses are given excellently online and it is not necessary to hold them in a physical form"
"It is easier to understand the material"
"Learning with another lecturer for whom you did not sign up but who conveys the material better"
"More focused"

2. The lecturer is more attentive to the students during the lesson T29

"I can express myself much more and in such a way that the lecturer is responsive"
"In workshops where the lecturer wants to know how each student has advanced there is no need to come to Ariel for that purpose"
"Lecturers are more considerate and explain each topic at more length"
"More consideration by the lecturers"

3. The lecturers are more available via e-mail T30

"Lecturers are willing to be available after class as well"
"A response and individual attention"
"I notice that the lecturers are available and answer different questions during class and at other times, more than in frontal lessons"
"Lecturers with high availability"

Editorial for EJEL Volume 19 Issue 5

Dear readers of the EJEL,

As we are approaching the third year of the global pandemic, online learning is gaining in maturity, quality and the level of adoption across the world. And this is also having a positive impact on widening the range and quality of e-learning research. This trend is evident in this new issue of EJEL, the last of 2021, which includes 11 research papers written by authors from 12 nations: Thailand, UK, Denmark, Austria, Greece Cyprus, USA, China, Hungary, Kuwait, Philippines, Morocco and Israel.

Athitaya Nitchot, Lester Gilbert and Wiphada Wettayaprasit, from Prince of Songkla University, Thailand and University of Southampton consider knowledge maps as a pedagogical tool and introduce an experimental tool (Mytelemap) in their design science study. The evaluation shows that the students who engaged with the tool have achieved better final results. The findings are limited to web design courses and will need to be validated in other subject area as a part of the future work.

Another design-based research study by Heidi Hautopp and Mie Buhl from Aalborg University in Copenhagen, focuses on the importance of drawing and sketching in designing digital artefacts and supporting learning designs in humanities. The findings from the paper suggest that drawing as a means for developing ideas, collaborating, presenting and discussing design ideas is equally important as the more traditional means of academic discourse such as reading and writing. Teaching (of drawing) was important for students' engaging in the drawing practice and for overcoming some initial barriers with the new method.

Assessment, although one of the most important areas for a university's standing and students' engagement and satisfaction continues to be under-represented in e-learning research in general, and in EJEL in particular. One of the rare contributions in this area comes from Susanne Seifert and Lisa Paleczek from University of Graz. The focus of their study is the evaluation of a specific digital assessment tool (Graz Reading Comprehension test: GraLeV) that measures reading comprehension skills in primary schools in Austria. In addition to contributing to standardising national comprehension assessment the authors offer some other interesting findings that require further investigation, such as the increasing impact of digital competences on student performance.

The fourth article in this issue is by Eirene Katsarou and Paraskevi Chatzipanagiotou from Democritus University of Thrace, and European University Cyprus. The aim for their systematic review was to identify the impact of various types of interactions in the learning environment to the success of learning. They report that learner-instructor interactions significantly (positively?) correlate with learners' academic performance, and that the quality of learner-learner interactions in online and blended collaborative learning environments are affected by learners' sentiments and characters. The latter will need to be considered when designing collaborative (online) learning tasks.

The next article is by Hong Huang and Yongji Li from University of South Florida, and AsiaInfo Tech, (China) respectively. Their focus is on online livestreaming programs for computer programming education. Based on the content analysis of 256 streams and twenty-six discussion posts they found that the primary motivation is cognitive and related information seeking, followed by social integration such as community outreach, and social capital through personal recognition.

In the sixth article in this issue, the Hungarian authors László Berényi (University of Miskolc), Nikolett Deutsch (Corvinus University of Budapest), Bernadett Szolnoki (University of Miskolc) and Zoltán Birkner (University of Pannonia) study views and opinions of engineering students in Hungary on their e-learning practice. The analysis of survey results from 97 students, indicates that more experience can boost successful utilisation of digital learning practices by initiating network effects.

The study by Colleen Carraher-Wolverton and Zhiwei Zhu from University of Louisiana at Lafayette, USA, examines the level of instructor engagement in online courses using the Perceived Characteristics of Innovation (PCI) instrument. The factors resulting from the application of structural equation modelling on the data collected, such as result demonstration, relative advantage, and compatibility were found to be instrumental in

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engagement, which in turn affects the level of engagement. Consequently, the paper discusses various measures that could be used to promote these factors.

In the eighth paper, Marsela Thanasi-Boçe from the American University of the Middle East, Kuwait, investigates the influence of instructors on student satisfaction with online learning. The statistical model that they developed from the data collected shows that instructors exert a high influence on the motivation of students through interactions, who as a result develop positive perceptions of online learning. Moreover, the positive impressions result in higher satisfaction of the students. A further result of the study is that female students develop a higher level of satisfaction, while for male students, instructors had no influence on the perception of and satisfaction with online learning.

The following paper presents a mixed method study by Ma. Theresa Christine C. Valdez and Lea D. Maderal from De La Salle University-Dasmariñas (Philippines). They investigate students' attitudes towards online assessments in mathematics which are more commonly administered in the context of digital teaching. The results show that students hold positive attitudes toward online examinations. Based on the factor analysis, they conclude that the differences in attitudes could be attributed to factors such as ease of use and functionality, personal preference, technical considerations, and complementation with other methods. The interviews confirmed the results of the quantitative analysis of data.

A systematic literature review about e-learning recommender systems is discussed in the tenth paper by Sonia Souabi, Asmaâ Retbi, Mohammed Khalidi Idrissi and Samir Bennani from Mohammed V University in Rabat, Morocco. From a total of 51 articles published between 2007 and the first half of 2021, it emerges that recommender systems based on feedback and explicit ratings are predominant. Overall, the literature review reveals some deficiencies, such as the rather limited coverage of recommender systems in social learning contexts, the commonly rather small database sizes on which recommendations are based, the lack of emphasis on strengths and weaknesses of different recommender system categories, and especially the negligence of implicit feedback, e.g., user behavior recorded as a data source in recommender systems.

The final paper in this issue, written by Eyal Eckhaus and Nitza Davidovitch from Ariel University, Israel, explores the advantages and disadvantages of online teaching experienced by students as a result of the increased use of digital learning tools imposed by the COVID crisis. They conducted an open-ended survey at 11 Israeli higher education institutions, in which the impressive amount of over 1900 students participated. Structural equation modeling was applied to identify major factors that have a positive impact on students' perceptions of the transition to online teaching, even beyond the COVID induced pressure.

We believe that this issue of EJEL again gives a solid and stimulating overview of current activities in e-learning research and practice. We would like to wish all readers an inspiring and fruitful time reading this issue.

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