2024

EJEL Volume 22, Issue 1

Editors

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Published by Academic Publishing International Limited
Curtis Farm, Kidmore End, Nr Reading, RG4 9AY, United Kingdom
karen.harris@academic-publishing.org

eISSN: 1479-4403

EJEL Volume 22, Issue 1

Contents

EFL University Students' Acceptance and Readiness for e-Learning: A Structural Equation Modeling Approach

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Abstract: The use of information and communication technologies (ICTs) has become essential approach in the field of language learning especially for English as a foreign language (EFL) education. Because ICTs are widely use in higher education, students must be highly digitally proficient and have positive attitudes in order to efficiently manage their classes. Thus, the purpose of this study is to contribute to the literature on EFL university students' perspectives regarding e-learning integration. In this study we extend the technology acceptance model (TAM) to investigate the factors that influence e-learning acceptance and readiness in the context of foreign language learning. Quantitative method was applied in this study, which involved 298 student teachers of English department at a state university in Indonesia. The instrument used in collecting the data was a questionnaire. The collected data were analyzed by using Partial Least Square-Structural Equation Modeling (PLS-SEM) with the SmartPLS3 program. PLS-SEM was used to analyze the proposed hypotheses developed in fulfilling the study objectives. The results indicated the complex relationships between the perceived usefulness, perceived ease of use, perceived enjoyment, motivation, self-efficacy, attitude and actual use of e-learning. Furthermore, the findings revealed that perceived enjoyment and self-efficacy did not have significant influence on actual use of e-learning through the mediating role of perceived usefulness. The findings can help both instructors and students adjust the integration of e-learning in English learning by implementing a learning curriculum and needs that are in line with the user's initial usage objectives, so that users can recognize the importance of e-learning's ease of use and usefulness. This study contributes to educational institutions and e-learning developers to consider developing e-learning apps that support student-centered learning with useful and ease of use to improve students' attitudes towards the use of e-learning. By incorporating e-learning into English language learning, students will have more time to practice and improve their English language skills.

Keywords: e-Learning, EFL University Students, Structural equation modeling, Technology acceptance model (TAM)

1. Introduction

The number of educational institutions offering distance learning has lately increased, owing to the Covid-19 pandemic. University students could not physically participate in the lectures during this period; instead, they attended courses through the distance education system in various nations. Advantages of e-learning in terms of time and space allowed it to come to the forefront. However, adequate attention has not been paid to the individual and technological factors essential for enabling successful learning in higher education institutions (Yavuzalp and Bahcivan, 2021).

E-learning refers to the ability to access learning materials and components in an online environment from any location and at any time (Al-Gahtani, 2016; Sadeghi, 2018). E-learning has pedagogical value in learning a foreign language since it may generate a resource for a learning environment in which learners can practice a new language collaboratively or individually (Rafiee and Naghneh, 2021). To get the benefits of e- learning, EFL university students must have specific technological and educational competencies. The significance of the notion is also tied to the fact that many language learners and teachers are stimulated and motivated by digital technology. As online or internet-based learning has become increasingly popular in recent years, many professional educators have begun to wonder how well distance learning students are equipped to succeed in this setting. EFL Students believe that digital technology can assist them in enhancing their English language skills. As a result, teachers should incorporate digital technological tools into their English language learning (Arif, Armiwati, and Handayani, 2023).

In this context, a number of studies have been conducted that investigate the success of and student satisfaction with e-learning (Hu and AlSaqqaf, 2021; Jiang *et al.*, 2021; Rafiee and Naghneh, 2021; Rahim and Chandran, 2021). It is critical to establish the prior learning experiences of students who have particular expectations from e-learning settings, as well as the degree to which they are prepared for e-learning, so that these environments may be accurately and successfully developed and utilized. As a result, the new concepts of e-learning acceptance and readiness have become crucial and main measures of success of a learning environment. E-

Reference this paper: Al Arif,T.Z.Z. et al., 2024. EFL University Students' Acceptance and Readiness for e-Learning: A Structural Equation Modeling Approach, *The Electronic Journal of e-Learning, 22(1)*, pp 01-16, available online at www.ejel.org

learning acceptance and readiness can be defined as the ability to use digital technology and online resources to improve learning quality (Yavuzalp and Bahcivan, 2021). In reviewing the literature, it is seen that e-learning acceptance and readiness is comprised of elements such as self-efficacy, perceived enjoyment, motivation, perceived usefulness, perceived ease of use, and attitudes (Al-Gahtani, 2016; Mallya, Lakshminarayanan and Payini, 2019; Jiang *et al.*, 2021; Muharam, Zhafira and Lubis, 2021; Hu *et al.*, 2022).

Along with the increased use of e-learning in educational settings, there is growing concern in identifying the important factors that lead to e-learning acceptance and readiness in order to effectively intervene in the relevant circumstances. What is unclear is the acceptance and readiness for e-learning in the context of foreign language acquisition. So far, there has been little discussion on the factors that influence students' acceptance and readiness for e-learning in EFL context. The goal of this study is to investigate the factors influencing EFL university students' acceptance and readiness of e-learning in EFL context. Therefore, the researchers proposed a model based on Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh and Davis, 2000) and related constructs from other theories and models such as Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.*, 2003). The proposed model was then validated by using partial least squares (SmartPLS). The proposed model can examine the relationships between the main variables influencing e-learning acceptance and readiness by EFL university students.

Considering the global need for developing the learners' digital literacy in the higher education settings, as well as the need for integrating e-learning at the higher education level, not knowing the factors that can contribute to EFL university students' adoption of e-learning may result in depriving learners of the development of students 21st century competences (Zhou, Xue and Li, 2022). The growth of technology and digital learning environments is so quick that students may choose from a variety of e-learning options. This implies that students have the option of using e-learning. Given that e-learning is currently the main trend in education, this study is significant. Knowing that there is a gap between the widespread use of e-learning by EFL university students globally, on the one hand, and the paucity of studies on their e-learning acceptance, on the other, so that this study is focused to examine the attitudes of EFL university students in Indonesia to use e-learning, as well as their actual use of using e-learning in their language classrooms.

This study aims to examine determinants of EFL university students' attitudes as well as the actual use of e-learning in their EFL classrooms at a state university in Indonesia. The research model of this study was an extended of the technology acceptance model (TAM), encapsulating seven constructs: self-efficacy, perceived enjoyment, motivation, perceived usefulness, perceived ease of use, attitudes, actual use. This research aims to answer the following questions; 1). To what extent does the research model (extended TAM) explain EFL university students' attitudes on using e-learning in their EFL classrooms? 2). How well does the study model explain EFL university students' actual usage of e-learning in their EFL classrooms? In addition, this study attempts to answer research hypotheses presented in table 2.

2. Theoretical Frameworks

2.1 E-Learning Integration in English Language Learning

The use of technology in education, particularly language learning, is becoming increasingly popular in today's technological advancements. The growth of technology, along with situations beyond our control, such as the Covid-19 outbreak, has shifted from traditional learning to technology-enhanced language learning, with nearly all of the learning process taking place online. E-learning has expanded rapidly with a variety of technologies and devices to access learning resources, such as laptops, computers, smartphones, and tablets. The advancement of mobile technology is raising more and more attention for autonomous language learning. It is challenging to find appropriate applications in this digital era of rapid technological development and application updating. EFL learners also require extra time and chance to be accustomed to mobile use in the context of learner autonomy (Hui, Liu and Chi, 2023).

There are several factors to be considered while teaching a language online. In contrast to the conventional method, one goal of online language teaching and learning is transitioning from a teacher-centred domain to one shared almost equally by both instructor and students. In addition, there is also the consideration of the tools and materials used. In traditional language classrooms, teachers and students use the whiteboard and a text book. In the teaching and learning of language using e-learning, the main instrument or tool is computing devices and the internet. Computers are seen as having a significant effect on the teaching and learning process, and the Internet provides a wealth of learning resources in a variety of media (e.g., text, pictures, audio, and videos), allowing for self-directed learning and overcoming geographical borders(Al-Fraihat *et al.*, 2020).

Many studies have also highlighted the advantages of incorporating new technology in language education. Rahim and Chandran (2021) highlight the numerous benefits of using technology for foreign language learning. Amongst the advantages are that it help students in improving their learning performance, allows students to experience learning anytime and anywhere, learners can have a variety of integrated assignment and customizable foreign language learning approaches based on their interests and needs, monitoring student engagement in various educational learning activities, enables students to have a flexible learning platform, students can decide what to learn and how to learn, and the last but not least, it allows FL teachers and the learners to decide on the most appropriate contexts and the accurate contents to teach and learn. Nevertheless, what is most important is the assessment of acceptance by students in learning with technology.

Faozi and Handayani (2023) examined the factors that affect the continuance intention of using Mobile-Assisted Language Learning (MALL) applications in the context of language learning. Their research enhances the field of e-learning by shedding light on the factors that influence the continuance intention to use MALL applications. Their study used the expectation-confirmation model and self-determination theory. The study found that users' perceived usefulness of the application, their satisfaction with its usage, and their self-regulation ability significantly influence their intention to continue using MALL. Bernacki et al. (2020), conducted a study on understanding and measuring the role of mobile technology in education. They confirmed that mobile technology can affects the process and products of learning via interactions with other psychological constructs, provide opportunities to directly affect learning process and outcomes, and provide opportunities to improve understanding and modeling of the learning process.

Kessler (2018), stated that language instructors now have so many options for utilizing technology to improve language learning. Even for individuals who enjoy experimenting with new technology, determining which materials, tools, or Web sites are best suited to a certain lesson, activity, or learning's objective. All of these technological resources are available to us for the benefit of our students, and we can engage them in the learning experience in a way that encourages them to practice the language extensively.

Furthermore, Howlett and Zainee (2019) reported their study on the use of technology tools in EFL context. Their findings indicated that students are able to use mobile devices, and agreed that mobile devices increase their learning potential and satisfaction. The use of technology tools provides opportunities for autonomous learning in partnership with their 21st century learning skills. Another study by Khan et al. (2021) examine the college students' perception and readiness about e-learning system. Their findings show that students have positive perception and acceptance towards e-learning. Indeed, e-learning has evolved as a new method of enhancing the learning process, and social media may further increase the learning output. It has enabled educators to incorporate IT solutions for teaching as well as evaluating student coursework fulfilment.

2.2 Technology Acceptance Research

Numerous users' adoption/acceptance theories have been developed over time in an attempt to predict and explain technology acceptance. Some of the most well-studied theories and models are the theory of reasoned action (TRA) (Fishbein & Ajzen, 1975); the technology acceptance model (TAM) (Davis et al., 1989); the theory of planned behavior (TPB) (Ajzen, 1991); the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). The majority of them were empirically examined in various commercial and educational settings. These studies defined or examined technology acceptance as a behavioral intention, attitude, and/or utilization (Abdullah and Ward, 2016).

The technology acceptance model (TAM) is a valid model which includes the perceived usefulness (PU) and perceived ease of use (PEoU) as beliefs on a new technology that affect attitude on the use of that technology (Davis, 1989). TAM is one of the most powerful frameworks for understanding how users adopt technology in education. Its popularity stems from the ease with which it can be applied within structural equation modeling frameworks, as well as its ability to explain differences in actual technology usage or intention to use technology (Sulistiyo *et al.*, 2022). The TAM model consists of three key constructs, i.e., perceived ease of use (PEoU), perceived usefulness (PU) and attitudes towards technology (ATT), explaining behavioral intentions (BI) and the use of technology indirectly or directly (Davis, 1989). The definitions of each variable of this current study are shown in Table 1;

Table 1: TAM Variables and Definitions

Variable	Definition
External variables	
Perceived Enjoyment	The extent to which the activity of using the technology is perceived to be enjoyable in its own right, apart from any performance consequences that may be anticipated (Jiang *et al.*, 2021; Rafiee and Naghneh, 2021; Zhou, Xue and Li, 2022)
Motivation	The inner aspect includes the needs, desires, and wants within the participants in using technology (Pan, 2020; Rafiee and Naghneh, 2021)
Self-Efficacy	a person's belief in his ability to organize and carry out a series of actions needed to complete a particular task using technology (Sumuer, 2018; Pan, 2020; Alfadda and Mahdi, 2021)
Core Variables	
Perceived ease of use	The degree to which the participants believe that using technology would be free of effort (Davis, 1989; Venkatesh and Davis, 2000)
Perceived usefulness	The degree to which the participants believe that using technology would enhance his or her performance (Davis, 1989; Venkatesh and Davis, 2000)
Attitudes	The user's likelihood to use technology (Venkatesh *et al.*, 2003)
Output Variable	
Actual Use	The frequency and the approximate number of times of using technology (Park, 2009; Scherer, Siddiq and Tondeur, 2019)

In different educational contexts the original TAM was extended by including self-efficacy, motivation, and perceived enjoyment as external variable. Alfadda and Mahdi (2021) conducted a study to analyze the correlation of TAM on using Zoom application in language learning. The participants are 75 students taking an online course on the COVID-19 pandemic. The results of the study revealed a strong positive correlation between the actual use of Zoom and the students' attitudes and behavioral intention. In addition, there is a positive correlation between computer self-efficacy and other variables of TAM.

Rafiee and Naghneh (2021) identified the factors affecting e-learning acceptance and readiness in the context of foreign language learning. A number of university students majoring in English education participated to complete the quantitative survey for this study. The data were analyzed using smart partial least squares (smartPLS) software. The results indicated the complex relationships between the perceived usefulness, perceived ease of use, e-learning motivation, online communication self-efficacy and language learners' acceptance and readiness of e-learning.

Yavuzalp and Bahcivan (2021) investigated relationships of readiness for e-learning, self-efficacy, and motivation on students' self-regulation skills. A total of 749 university students from a Turkish state university volunteered to take part in the study. a cross-sectional survey design was implemented in the study. tha data were analyzed by using structural equation modeling with the AMOS software. The research findings revealed that the university students' readiness for e-learning was effective on their self-regulation skills.

Al-Fraihat et al. (2020) explored the determinants of e-learning; perceived usefulness, perceived satisfaction, support system quality, service quality, information quality, learner quality, and instructor quality. The data were collected from 563 students engaged with e-learning in one of the UK universities, and analyzed using a quantitative approach of Partial Least Squares - Structural Equation Modelling (PLS-SEM). The findings indicated that four constructs were found to be the determinants of e-learning use, namely perceived usefulness, educational system quality, learner quality, and support system quality.

Another related study using the TAM model conducted by Ketmuni (2021), his study investigated students' acceptance of online English language learning at a university in Thailand. His study employed the technology Acceptance Model (TAM). N=400 respondents were selected by simple random sampling technique. The findings of his study indicated that the greatest factor affecting the acceptance of online English learning was Perceived Ease of Use. The students suggested that the teachers should have teaching techniques to stimulate students' interests and provide a variety of activities.

2.3 Research Model and Hypotheses

This current study offered a research model and hypotheses based on the background and literature review, which are shown in Figure 1 and Table 2.

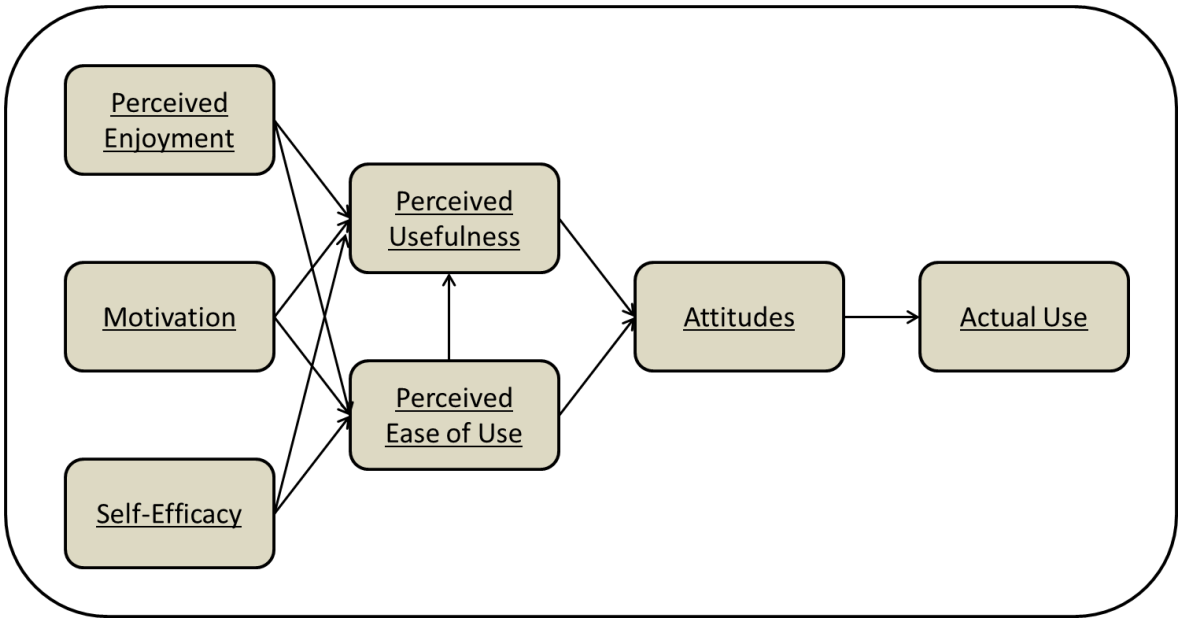

Figure 1: Proposed Research Model

There are seven constructs in this study namely Perceived Enjoyment (PE), Motivation (Mot), Self-efficacy (SE), Perceived Ease of Use (PEoU), Perceived Usefulness (PU), Attitudes (Att), and Actual Use (AU). The research model presented in this study revealed 10 hypotheses as shown in Table 2 below;

Table 2: Hypotheses

No.	Hypotheses
H1	Perceived Enjoyment (PE) will significantly influence Perceived Usefulness (PU)
H2	Perceived Enjoyment (PE) will significantly influence Perceived Ease of Use (PEoU)
H3	Motivation (Mot) will significantly influence Perceived Usefulness (PU)
H4	Motivation (Mot) will significantly influence Perceived Ease of Use (PEoU)
H5	Self-efficacy (SE) will significantly influence Perceived Usefulness (PU)
H6	Self-efficacy (SE) will significantly influence Perceived Ease of Use (PEoU)
H7	Perceived Ease of Use (PEoU) will significantly influence Perceived Usefulness (PU)
H8	Perceived Ease of Use (PEoU) will significantly influence Attitudes (Att)
H9	Perceived Usefulness (PU) will significantly influence Attitudes (Att)
H10	Attitudes will significantly influence Actual Use (AU)

3. Methodology

3.1 Research Design

This current study employed a quantitative method to investigate factors that influence e-learning acceptance and readiness in the context of foreign language learning. This study utilized a survey design since it analyzed data in the form of numbers. A survey design provides a quantitative or numerical description of trends, attitudes, or opinions of a population by studying a sample of that population. From sample results, the researcher generalizes or draws inferences to the population (Creswell, 2014). Furthermore, the extended technology acceptance model (TAM) was used to analyze the proposed hypotheses developed in fulfilling the study objectives. Partial least squares - structural equation modeling (PLS-SEM) approach was used in analysing the data obtained in this study. The Data were analysed using partial least square - structural equation modelling (PLS-SEM) analysis to examine the determinants that influence e-learning acceptance and readiness in the

context of foreign language learning and answer research hypotheses. PLS-SEM is a causal-predictive SEM method that concentrates on creating structural predictions using statistical models. For estimating our model, PLS-SEM outperforms the conventional covariance-based SEM (CBSEM) because it can deal with multivariate normality, measurement level, sample size, model complexity, and uncertain variables (Hair et al. 2019).

3.2 Participants

This study involved (n=298) pre-service teachers of the English department at Jambi University, Indonesia. The participants are all pre-service teachers majoring English from the first-year to the fourth-year students enrolled in 2022. The student teachers had formally learned English for three years at secondary school level, three years at high school level, and continue to study English courses as well as receive instruction through the medium of English. Table 3 presents the detailed analysis of participants' demographic information and other data related to their ownership of technology devices, activities in using e-learning, and experience.

Table 3: Demographic Information of Respondents

	Number	Percentage
Gender		
Male	67	22.5%
Female	231	77.5%
Class Enrollment		
1st Year Students	76	25.6%
2nd Year Students	73	24.6%
3rd Year Students	78	26%
4th Year Students	71	23.8%
Computer Ownership	298	100%
Experience of using e-learning		
0-1 year	34	11.3%
1-2 years	89	30.1%
>2 years	175	58.6%

3.3 Instrumentation

In order to investigate factors that influence e-learning acceptance and readiness in the context of foreign language learning, we employed a multiple-item questionnaire. The questionnaires' first part comprised questions on demographic information (i.e. gender, years of student's enrolment, years of e-learning use, and computer ownership). The second part constituted seven variables of TAM, including Perceived enjoyment (two items), motivation (four items), Self-efficacy (two items), Perceived Ease of Use (five items), Perceived Usefulness (eight items), Attitudes (four items), and Actual Use (three items). Table 4 displays the detailed variables and items of the questionnaire. For measuring each item, a four-point Likert scale was used with 1 = strongly disagree, to 4 = strongly agree. The data collected through the online questionnaire (using Google Form) were coded by researchers.

Table 4: Items of Questionnaire

Variables	Items	Adapted references of the survey instrument
Perceived Enjoyment (PE)	I like to use e-learning for English learning	(Jiang *et al.*, 2021; Rafiee and Naghneh, 2021; Zhou, Xue and Li, 2022)
	I find it entertaining to learn foreign language through e-learning	
Motivation (Mot)	I need for using ICT in ELL to improve my English language skills	(Pan, 2020; Rafiee and Naghneh, 2021)
	I want to use ICT for ELL to improve my Academic Achievement	

Variables	Items	Adapted references of the survey instrument
	I use E-learning to study English since many of my friends do	
	I utilize E-learning to study English since the instructor has asked it	
Self-efficacy (SE)	I have knowledge to utilize E-learning for ELL	Alfadda and Mahdi, 2021; Pan, 2020; Sumuer, 2018
	I have skills to utilize E-learning for ELL	
Perceived ease of use (PEoU)	It is easy for me to utilize e-learning for ELL	(Davis, 1989; Venkatesh and Davis, 2000)
	Learning English using e-learning is clear and easy to understand	
	It is easy for me to become skilled using e-learning for ELL	
	It is easy for me to find learning resources using e-learning	
	Overall, the use of e-learning in learning English is easy	
Perceived Usefulness (PU)	By using E-learning, I can learn English quickly	(Davis, 1989; Venkatesh and Davis, 2000)
	The use of E-learning improves my listening skill	
	The use of E-learning improves my reading skill	
	The use of E-learning improves my speaking skill	
	The use of E-learning improves my writing skill	
	The use of E-learning makes me learn English effectively	
	The use of E-learning makes me easy to understand English learning	
	Overall, the use of E-learning is very useful and beneficial for learning English	
Attitudes (Att)	I am interested in using E-learning for ELL	(Venkatesh *et al.,* 2003)
	I feel that adopting E-learning for English study is quite useful	
	The use of E-learning is suitable for learning English	
	The use of E-learning for ELL is a positive thing	
Actual Use (AU)	I use E-learning for ELL on campus and at home	(Park, 2009; Scherer, Siddiq and Tondeur, 2019)
	I use E-learning for ELL regularly every day	
	Overall, I always utilize e-learning to study English	

The questionnaire was distributed among the targeted 415 pre-service teachers in the English department as respondents. The respondents who responded to the questionnaire were 298, thus achieving a response rate of 71.8%.

3.4 Data Analysis

In order to analyse the data, we used the partial least squares - structural equation modelling- (PLS-SEM) approach which first implies testing for the measurement model and then the structural model. PLS-SEM enables the researcher to estimate complex models with many constructs, indicator variables and structural paths without imposing distributional assumptions on the data (Hair *et al.*, 2019). All statistical procedures were conducted with SmartPLS3, and for parameters' estimation minimum likelihood method was used. PLS-SEM, on the other hand, is a causal-predictive approach to SEM that emphasises prediction in estimating statistical models, the structures of which are designed to provide causal explanations (Hair, Howard and Nitzl, 2020).

PLS-SEM was performed to examine the determinants that affect the use of e-learning for English learning purposes. The first step in evaluating PLS-SEM results involves examining the measurement models. Each construct was evaluated using the relevant minimal criterion. If the measurement models meet all the required criteria, researchers then need to assess the structural model. PLS-SEM was performed in order to test the hypotheses with the significant rate 0.05. Before testing the hypothesis, the researchers performed validity (AVE > 0.05) and reliability ($cronbach\ alpha$ > 0.70) tests to fulfil the requirements of analysis using PLS-SEM. The researchers also checked the factor loading's value of each item in the constructs to make sure that the values > 0.70 (Hair et al., 2019).

4. Results

4.1 Descriptive Statistics

We examined the descriptive statistics of each item and presented them in Table 5. The mean scores were over the midpoint 2.00 of the scale, showing mainly positive responses to the models' constructs. The shape of a normal distribution is determined by the mean and the standard deviation. The standard deviation is a statistic that indicates how closely all of the samples in a collection of data are clustered around the mean. It measures the spread of scores within a set of data. The standard deviation of the data is within 1 standard deviation of the average (from μ-1σ to μ+1σ), it indicates a normal distribution. An inspection of the skewness as well as the kurtosis showed them to be within |-1| and |1|, hence the data is normally distributed.

Table 5: Descriptive Statistics

	No.	Missing	Mean	Median	Min	Max	Standard Deviation	Excess Kurtosis	Skewness
PE1	1.000	0.000	3.744	4.000	2.000	4.000	0.444	-0.133	-1.240
PE2	2.000	0.000	3.576	4.000	2.000	4.000	0.508	-1.415	-0.463
Mot1	3.000	0.000	3.559	4.000	2.000	4.000	0.503	-1.706	-0.318
Mot2	4.000	0.000	3.431	3.000	2.000	4.000	0.515	-1.478	0.057
Mot3	5.000	0.000	3.064	3.000	2.000	4.000	0.696	-0.931	-0.087
Mot4	6.000	0.000	2.660	3.000	1.000	4.000	0.793	-0.347	-0.210
SE1	7.000	0.000	3.684	4.000	2.000	4.000	0.472	-0.955	-0.889
SE2	8.000	0.000	3.502	4.000	2.000	4.000	0.533	-1.172	-0.343
PEOU1	9.000	0.000	3.350	3.000	1.000	4.000	0.555	-0.023	-0.217
PEOU2	10.000	0.000	3.327	3.000	1.000	4.000	0.530	0.084	-0.022
PEOU3	11.000	0.000	3.175	3.000	1.000	4.000	0.553	0.528	-0.067
PEOU4	12.000	0.000	3.478	3.000	1.000	4.000	0.545	-0.100	-0.478
PEOU5	13.000	0.000	3.333	3.000	1.000	4.000	0.574	-0.032	-0.286
PU1	14.000	0.000	3.172	3.000	2.000	4.000	0.587	-0.290	-0.053
PU2	15.000	0.000	3.421	3.000	2.000	4.000	0.570	-0.789	-0.345
PU3	16.000	0.000	3.286	3.000	2.000	4.000	0.565	-0.530	-0.061
PU4	17.000	0.000	3.091	3.000	1.000	4.000	0.688	-0.019	-0.370

	No.	Missing	Mean	Median	Min	Max	Standard Deviation	Excess Kurtosis	Skewness
PU5	18.000	0.000	3.118	3.000	1.000	4.000	0.669	0.238	-0.412
PU6	19.000	0.000	3.172	3.000	1.000	4.000	0.575	0.295	-0.127
PU7	20.000	0.000	3.253	3.000	2.000	4.000	0.592	-0.501	-0.141
PU8	21.000	0.000	3.556	4.000	3.000	4.000	0.497	-1.963	-0.225
Att1	22.000	0.000	3.572	4.000	2.000	4.000	0.521	-1.034	-0.580
Att2	23.000	0.000	3.569	4.000	2.000	4.000	0.528	-0.888	-0.623
Att3	24.000	0.000	3.428	3.000	1.000	4.000	0.565	-0.076	-0.445
Att4	25.000	0.000	3.633	4.000	2.000	4.000	0.509	-0.578	-0.860
AU1	26.000	0.000	3.370	3.000	2.000	4.000	0.572	-0.736	-0.238
AU2	27.000	0.000	2.724	3.000	1.000	4.000	0.700	-0.285	-0.033
AU3	28.000	0.000	3.061	3.000	1.000	4.000	0.689	-0.071	-0.328

4.2 Factor Analysis

Figure 2 shows the factor analysis. The factor loadings and average variance extracted (AVE) were the two procedures to establish convergent validity. Convergent validity was assessed by item factor loading onto the underlying construct. The factor loadings were all greater than the threshold of 0.50 (Hair et al., 2010), demonstrating acceptable convergent validity at the item level. On the other hand, at the construct level, AVE is commonly employed indicators of convergent validity. As shown in Table 6, the AVE-values are acceptable (greater than the threshold of 0.50). The score of factor loadings of each item >.50 and the count of average variance extracted (AVE) > .50. It means that the entire items are valid.

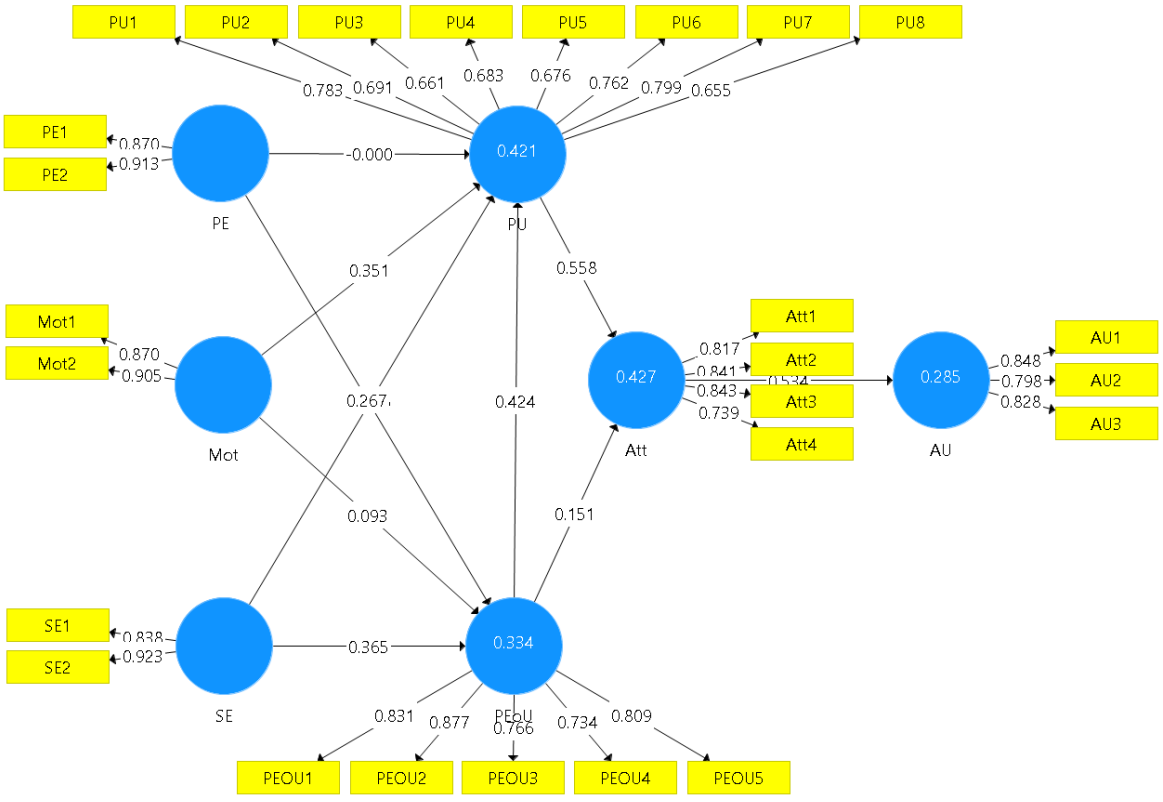

Figure 2: Factor Analysis Results

4.3 Evaluation of the Measurement Model

A confirmatory factor analysis (CFA) was used to evaluate the measurement model with uncorrelated errors. Higher values generally indicate higher levels of reliability and validity. Reliability of the data was established by the use of the Cronbach's Alpha (which are regarded to be adequate if they equal or exceed 0.70.), rho_A (> 0.70), Composite Reliability (> 0.70) as well as Average Variance Extracted (AVE) in assessing convergent validity, An acceptable AVE is 0.50 or higher indicating that the construct explains at least 50 per cent of the variance of its items (Hair *et al.*, 2019). Furthermore, standardized estimates of the items were consulted likewise. The Cronbach alpha, rho_A, CR, and AVE of the constructs were within the acceptable ranges, as shown in table 6 below.

Table 6: Construct Validity and Reliability

	Cronbach's Alpha	rho_A	Composite Reliability	Average Variance Extracted (AVE)
AU	0.768	0.785	0.864	0.680
Att	0.826	0.832	0.885	0.658
Mot	0.732	0.743	0.881	0.788
PE	0.745	0.764	0.886	0.796
PEoU	0.863	0.865	0.902	0.648
PU	0.863	0.867	0.893	0.512
SE	0.721	0.784	0.875	0.777

The next step we assessed discriminant validity, which is the extent to which a construct is empirically distinct from other constructs in the structural model. Discriminant Validity (Fornell-Larcker Criterion) was used to determine that each construct's AVE should be compared to the squared inter-construct correlation (as a measure of shared variance) of that same construct and all other reflectively measured constructs in the structural model. The shared variance for all model constructs should not be larger than their AVEs, as displayed in table 7.

Table 7: Discriminant Validity - Fornell-Larcker Criterion

	AU	Att	Mot	PE	PEoU	PU	SE
AU	**0.825**						
Att	0.534	**0.811**					
Mot	0.417	0.483	**0.888**				
PE	0.367	0.414	0.384	**0.892**			
PEoU	0.457	0.459	0.314	0.451	**0.805**		
PU	0.569	0.641	0.495	0.340	0.552	**0.716**	
SE	0.322	0.407	0.322	0.405	0.504	0.363	**0.882**

Table 8 shows the goodness-of-fit of the model. Several goodness-of-fit indices were used to assess the measurement model's fit, including the standardised root mean residual (SRMR) with a value of < 0.08 considered optimal (Hu & Bentler, 1999). SRMR was used to quantify the PLS-SEM divergence between the observed and estimated covariance matrices, should be considered with extreme caution. From the results of CFA, the measurement model in this study has a good fit to the sample data (SRMR = 0.078).

Table 8: Model Fit

	Saturated Model	Estimated Model
SRMR	0.065	0.078
d_ULS	1.467	2.854
d_G	0.613	0.675
Chi-Square	1.087.173	1.159.923
NFI	0.720	0.701

4.4 Evaluation of the Structural Model (Hypotheses Testing)

Table 9 shows the hypotheses testing. Seven of the ten hypotheses proposed in this study are accepted, while three others are rejected. The researcher uses the t-statistic and P-Value to determine the result of hypothesis testing. If t-statistic > 1.96 and P-Value < .05, H_0 was rejected and H_a is accepted. This indicated that there was a significant effect among variables.

Table 9: Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Decision
PE -> PU	-0.000	0.001	0.051	0.008	0.993	Not Supported
PE -> PEoU	0.267	0.269	0.060	4.453	0.000	Supported
Mot -> PU	0.351	0.354	0.051	6.838	0.000	Supported
Mot -> PEoU	0.093	0.096	0.059	1.592	0.112	Not Supported
SE -> PU	0.036	0.036	0.056	0.652	0.515	Not Supported
SE -> PEoU	0.365	0.364	0.066	5.496	0.000	Supported
PEoU -> PU	0.424	0.424	0.060	7.032	0.000	Supported
PEoU -> Att	0.151	0.154	0.069	2.205	0.028	Supported
PU -> Att	0.558	0.557	0.057	9.848	0.000	Supported
Att -> AU	0.534	0.536	0.045	11.845	0.000	Supported

The results revealed that EFL students' actual usage of e-learning in learning English was significantly influenced by Attitude (*P*-value = .000), while PU and PEoU significantly influenced Attitude (*P*-value = .000 and .028 respectively). PU, however, was significantly influenced by PEoU (*P*-value = .000). The extended variable, PE had a significant influence on PEoU (P-value = .000) but not on PU (*P*-value = .993). Motivation had a significant influence on PU (*P*-value = .000) but not on PEoU (*P*-value = .112). SE had a significant influence on PEoU (P-Value = .000) but not on PU (P-value = .515).

5. Discussion

The purpose of this study was to examine the factors that influence EFL university students' attitudes and actual usage of e-learning in English learning. We developed a research model based on the technology acceptance model (TAM) as the core framework, extended with three external variables (perceived enjoyment, motivation, and self-efficacy). Using PLS-SEM, we confirmed that the suggested research model fits the data well. This study advances the field of e-learning by shedding light on the factors that influence the attitude and actual usage of e-learning. By uncovering the importance of perceived enjoyment, self-efficacy, motivation, perceived usefulness, perceived ease of use, and attitude, the study contributes to the understanding of user behaviour and decision-making in the context of e-learning usage. The findings can inform the adoption and integration of e-learning, leading to more engaging and effective language learning experiences in online and remote settings. This study contributes to the advancement of e-learning practices by providing evidence-based insights into the factors that drive user attitude and adoption of e-learning in English language learning.

5.1 EFL University Students' Attitudes Towards e-learning

This study investigated the extent to which attitudes influence EFL students' actual usage of e-learning by determining the significant indirect and direct predictors of Actual Use (AU) and evaluating the amount of variance in AU explained by PE, Mot, SE, PU, PEoU, and Att. Using PLS-SEM, this study found that three main variables of TAM, namely PU, PEoU, and Att, significantly influence the students' actual usage of e-learning in English learning. These findings emphasize the importance of these factors in influencing users' attitude and actual use of e-learning for English language learning. Understanding the factors that influence users' attitude and actual usage of e-learning allows educational institutions and application providers to develop and adjust their offerings and tailor them to meet the requirements and expectations of language learners.

This study shows that Attitude has a direct positive effect on the actual use of e-learning, suggesting that EFL students with positive attitudes towards the use of e-learning are likely to use them for English language learning. The results show that attitude mediated the influence of PU and PEoU on actual use of e-learning.

When students in Indonesia find e-learning easy to use and beneficial, their attitudes towards e-learning are likely to be positive, and these positive attitudes contribute to a higher likelihood of utilizing e-learning. These findings, consistent with previous studies on the use of e-learning (Rafiee and Naghneh, 2021; Yavuzalp and Bahcivan, 2021), supported the significant roles that PU, PEoU and attitude played in determining EFL students' usage of e-learning. The findings indicate that when teachers develop a positive attitude towards the use of e-learning in teaching EFL, they are willing to utilize it regularly in their practice. This can be facilitated by their experience with the use of e-learning.

The significant influence found for PU on Attitude in this study is in line with studies that examined the underlying reasons for students' usage of e-learning (Zhou, Xue and Li, 2022). Also, this study found that PEoU significantly influences PU. In addition, this study showed that PEoU significantly influence Attitude, which is consistent with previous studies on TAM (Jiang *et al.*, 2021; Sulistiyo *et al.*, 2022).

The present study revealed that PE was found to have significant influence on PEoU but had no significant effect on PU. This finding is quite contradictory to Jiang et al. (2021) who did not find the influence of enjoyment on either PU or PEoU. This contradiction might occur due to several potential reasons. The present study was conducted in an EFL context in Indonesia, and as evident, interaction is particularly critical in a foreign language class. Besides, connection delays and the hardware instability might exacerbate students' unpleasant of e-learning experiences. Therefore, the students perceived e-learning is easy to use but they might not feel the joy of e-learning.

Motivation had a significant effect on PU. This finding is consistent with some previous studies (Pan, 2020; Rafiee and Naghneh, 2021) who found the influence of Motivation on Perceived Usefulness. Besides, motivation mediated the relations of technology acceptance, technological self-efficacy, and attitude toward the use of technology in English learning. On the other hand, Motivation did not have a significant influence on PEoU. A plausible explanation for the absence of a significant influence of Motivation on PEoU in our study is that the respondents in this study were millennial students who already had substantial experience in using technology. They do not perceive technology tools as a new object that is difficult to use and will have little impact on their decisions, but rather as a community of practice focused on sharing knowledge and skills in utilizing technology for English language learning.

E-learning Self-efficacy (SE) had a significant effect on PEoU. It is in line with a study conducted by Pan (2020) who found the influence of SE on PEoU, and self-efficacy showed higher attitude toward technology use in English learning. While, SE had no significant influence on PU. It is consistent with the findings by Jiang et al. (2021) indicated a lack of significant association between self-efficacy and PU. For instance, students may still do well in face to face classrooms, but in e-learning lack of interaction between students and teachers. Therefore, foreign language classes must provide students with as many opportunities for interaction as possible.

Attitude was also shown to be significantly predicted by PU and PEoU, which is in line with the findings by Alfadda and Mahdi (2021) and Zhou et al. (2022) who found that perceived ease of use positively impacts perceived usefulness and perceived usefulness significantly affect users' intention to use technology. When students perceive that e-learning is easy to use and useful, thereby eliciting positive feeling (attitudes towards e-learning) and their behavioral intention to use e-learning.

5.2 EFL University Students' Actual Use of E-learning

The influence of PE, Mot, SE, PEoU, PU and Att on EFL university students' actual usage (AU) of e-learning in English learning was examined by determining the significance and the amount of variance in AU that these variables explained. Together, six variables PE, Mot, SE, PEoU, PU, and Att significantly explained 28.5% of the variance in AU.

The results show that there are complex relationships between the perceived usefulness, perceived ease of use, perceived enjoyment, e-learning motivation, self-efficacy, attitude and actual use of e-learning. Furthermore, attitude was found to be a significant predictor of students' actual usage of e-learning in English learning. This result is consistent with those of previous research on technology acceptance in language learning (Alfadda and Mahdi, 2021; Rafiee and Naghneh, 2021; Arif *et al.*, 2022; Sulistiyo *et al.*, 2022), demonstrating that factors of the technology acceptance model are the main factors influencing students' adoption of technology for language learning.

In the context of EFL university students, these findings are consistent with some of the previous findings (Arif and Handayani, 2021; Al-Fraihat et al., 2020; Ketmuni, 2021; Yavuzalp and Bahcivan, 2021) indicating that, when perceived voluntariness and habit are not taken into account, students' actual usage of e-learning is greatly influenced by attitude, which is the case in this study. Although the support of all TAM hypotheses in this study was expected, the data generated new insights into the perceived enjoyment, motivation, and e-learning self-efficacy and their relationships with other constructs. We found that the main TAM variables (PEoU, PU, and Att) are significant variables on determining the factors that affect EFL university students' acceptance towards e-learning.

The findings of this study explain how the PU and PEoU influence students' actual use of e-learning through the mediating role of attitude. The results of this study showed that only a small portion of actual e-learning usage by EFL university students in Indonesia can be explained by the characteristics of attitude, perceived usefulness and perceived ease of use, with the remainder explained by factors other than the variables studied. This indicates that some additional factors have not been included in this study. Other factors can be inadequate ICT competences of both, teachers and learners, slow internet connection, and lack of technological devices.

6. Limitation of the Study and Future Research

In this study, several limitations exist. First, data were collected through a survey of 298 students from a state university in Indonesia. Although the data are adequate for research in technology acceptance, they may not capture the actual use of e-learning among EFL university students in Indonesia. As a result, including respondents from numerous universities in Indonesia could be considered in future research.

Second, the results indicate that, while perceived enjoyment, motivation, and e-learning self-efficacy may explain the main TAM variables, they can only explain a small portion of actual e-learning usage by EFL university students, with the rest explained by factors other than the variables studied. One of the primary areas of further research might be to examine and discover the reasons for this dissonance. Other variables, such as facilitating conditions, experience, ICT competences of teachers and learners, perceived voluntariness, and social influence, may explain EFL university students' intention to use and actual use of e-learning.

Third, some additional qualitative questions could be used to explore the more nuanced aspects of how/why EFL university students use e-learning in English learning and how specific contextual and personal factors might affect behaviour. This type of data could be gathered via open-ended survey questions and/or follow-up interviews with interested participants in order to inform the educational community on how EFL university students in Indonesia are addressing and dealing with their specific contextual constraints. Furthermore, future research may need to consider more demographic information from respondents, such as socioeconomic status and relevant cultural factors in understanding the relationships between external and internal factors.

7. Implications for Practice

The results of this current study indicate that every aspect of external variable, namely self-efficacy, motivation, and perceived enjoyment, might influence language learners' attitude and actual usage of e-learning. The findings of the study provide significant contributions to both theory and practice. In terms of the theoretical contribution of the study, it validated a model that can be applied in predicting the usage of e-learning in English learning. This study has the potential to contribute to the current debates on the relevance of TAM as a proposed model to explain and predict e-learning usage among EFL university students, as well as to existing literature on the acceptance of e-learning by EFL university students. Moreover, using an extended TAM in a middle-income country allows the validity and robustness of the findings to be assessed in both comparable and different contexts.

In terms of practice, the relationship between the three external variables, namely self-efficacy, motivation, and perceived enjoyment, has a complicated relationship, as these three variables do not completely influence both perceived ease of use and perceived usefulness. Therefore, instructors and students can adjust the integration of e-learning in English learning by implementing a learning curriculum and needs that are in accordance with the user's initial usage objectives, so that users are able to sense the significance of the ease of use and usefulness of e-learning. For educational institutions and e-learning developers who decide to design e-learning for English learning, they should consider developing e-learning apps that support student-centred learning with utility and simplicity of use to improve students' attitudes towards the use of e-learning. By incorporating e-learning into English language learning, students will have more time to practice and improve their English language skills. Furthermore, this study has the potential to inform teacher educators in EFL context such as

countries in Asia. For example, all stakeholders involved in teacher professional development (i.e. policymakers and teacher educators) should promote and provide opportunities to ensure successful e-learning use among EFL university students. Aside from technology skills, teacher educators should address concerns relating to their attitudes and perceptions. Moreover, teachers should incorporate instructional activities that assist EFL students develop positive attitudes and motivation toward e-learning in order to increase their adoption of e-learning for English language learning.

8. Conclusion

This study shows that the factors that influence the actual usage of e-leaning are perceived usefulness, perceived ease of use, and attitude. In this study, it was also found that the self-efficacy and perceived enjoyment influenced perceived ease of use. Another finding of this study is that motivation influence perceived usefulness. The variables that could predict actual use of e-learning in English learning among EFL university students in Indonesia were investigated in this study. In order to explain the respondents' actual usage of e-learning, the extended Technology Acceptance Model (TAM) was applied by perceived enjoyment, motivation, and e-learning self-efficacy as external variables. The findings revealed complex relationships between the perceived usefulness, perceived ease of use, perceived enjoyment, e-learning motivation, self-efficacy, attitude and actual use of e-learning. Furthermore, perceived enjoyment and self-efficacy did not have significant influence on actual use of e-learning through the mediating role of perceived usefulness. Understanding the factors affecting the adoption of new technologies has the ability to improve the quality of the English learning process and enable students to benefit from the potential and advantage of e-learning. Teachers should also be equipped with technological education abilities in order to deliver learning experiences that meet the demands of students in today's digital age. In addition, the findings suggest and encourage the use of e-learning as an innovative approach of English language teaching and learning.

This is one of the few studies in Asia that covers research gaps from previous studies on EFL university students' acceptance and readiness for e-learning. This study includes some external variables; self-efficacy, motivation, and perceived enjoyment. This research also used the TAM approach and data analysed using PLS-SEM. This is what differentiates it from several previous studies. Given the scarcity of such research, it serves as a good reminder to practitioners and researchers to optimize the affordances of e-learning as a tactical and strategic response in teaching English with technology to facilitate both teachers and students in achieving their foreign language educational goals. Because the current respondents are students at a state university in Jambi, Indonesia, and the variables are limited to the TAM model, future research could take a larger research sample and examine other variables that may influence e-learning usage that are not included in the variables of this study.

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Digital, Self-Regulated Vocabulary Learning and Device Control In Out-Of-Class, Higher Education Settings

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Abstract: Self-regulation of learning behaviour is particularly important when it comes to vocabulary learning for academic purposes in a second language because it often needs to be done on a regular and consistent basis and mostly in out-of-class, self-directed settings to be successful. Self-regulation is also vital when this learning takes place using digital activities on smartphones because these are now ubiquitous devices and deeply embedded in both daily life and higher education settings. Features such as notifications from social media applications can end up distracting students from their academic tasks unless they have the capacity to manage and control their behaviour. This naturalistic, mixed methods study conducted with students on an academic English foundation course in a higher education context aimed to measure their capacity for self-regulated vocabulary learning through technology before and after 10 weeks of intentional digital vocabulary learning in out-of-class settings and to see if there was any difference between learning on a laptop and a smartphone. The purpose of this study was to find out if device control was a relevant dimension of self-regulation, which is an under-researched area. The study collected quantitative data through a recently developed self-report survey tool, and differences in scores were measured using Wilcoxon signed-rank tests. Qualitative data was also collected from students through paired-depth interviews, and this was analysed using typological analysis. The results revealed that the students' self-reported capacity for self-regulated vocabulary learning through laptops was significantly higher than their capacity for self-regulated vocabulary learning through smartphones. In addition, commitment regulation when using a smartphone decreased significantly over the 10-week period primarily due to distractions from social media notifications. At the same time, students were aware of when to use each device for different types of learning activities and under different temporal and spatial conditions. Overall, this study showed that device control should be considered an additional dimension of a model of digital, self-regulated vocabulary learning and should also be incorporated into future research in the field of e-learning. In addition, students in higher education need to be given more guidance about the benefits and drawbacks of different devices and how to develop their capacity and strategies for greater device self-regulation.

Keywords: Digital vocabulary learning, Self-regulated e-Learning, Digital devices, Laptops, Smartphones

1. Introduction

Obtaining sufficient receptive knowledge of English vocabulary is often seen as a vital prerequisite for achieving academic success in higher education courses conducted through the medium of English (EMI) mainly because academic reading is a key component of most undergraduate degree courses (Nation, 2013; Schmitt, 2010). Knowledge of the 8-9,000 most frequent word families in English should enable readers to recognise 98% of the words in most written academic texts and result in nearly 70% comprehension of these texts (Schmitt, Jiang, and Grabe, 2011, p.34). However, reaching this size of vocabulary is a particular challenge for students whose first language is not English (Schmitt, 2014).

One of the main challenges for students is that vocabulary learning in a second language (L2) is a lengthy and demanding task (Nation, 2013; Schmitt, 2010) that involves learning the form and meaning of new words to increase vocabulary size (breadth), as well as different aspects of the same word (depth) through repeated encounters and retrievals in different contexts (Schmitt, 2014). Due to the 'word gap' between the number of words students know and need to know, and the limited number of contact hours in many English foundation courses that are taken before a degree course, students often need to take on the main responsibility for this learning in out-of-class settings (Nation, 2013). Those with lower levels of L2 proficiency should devote a large percentage of their vocabulary learning time to deliberate, form-focused learning (Nation, 2013, p.2) and therefore need to be able to manage and control their vocabulary learning through self-regulation (Tseng, Dörnyei and Schmitt, 2006). Indeed, self-regulation is now seen as a key component in L2 learning (Oxford, 2017), and the cyclical process of L2 vocabulary learning (Tseng and Schmitt, 2008).

At the same time, digital vocabulary learning applications and websites, which can be accessed on various devices such as smartphones, tablets, and laptops, have provided students with a greater variety of learning activities and more efficient ways to manage and track their vocabulary learning. Indeed, numerous studies have found that mobile-assisted vocabulary learning is more effective than using traditional, paper-based methods (Lin and Lin, 2019; Yu and Trainin, 2022). However, the use of digital devices, particularly smartphones, can also lead to digital distraction (Dontre, 2021). Some of the features of smartphones, such as notifications from social

Reference this paper: Bowles, M, 2024. Digital, Self-Regulated Vocabulary Learning and Device Control In Out-Of-Class, Higher Education Settings, *The Electronic Journal of e-Learning, 22(1)*, pp 17-30, available online at www.ejel.org

media applications, have often been designed to attract users' attention (Pedro, Barbosa and Santos, 2018), and can end up distracting students from their academic tasks (Pérez-Juárez, González-Ortega and Aguiar-Pérez, 2023), and encourage them to multitask (Hanin, 2021). The capacity and ability of students to develop self-regulation is therefore even more important when learning L2 vocabulary on digital devices, but we do not currently know much about this. Several studies have measured the effects of digital device usage on academic performance in higher education, but these have mostly been conducted in on-campus settings, such as lecture halls (Limniou, 2021) and few have focused on the domain of digital vocabulary learning.

While students' self-regulation in vocabulary learning has been measured in several different higher education contexts (Mizumoto and Takeuchi, 2012; Sentürk, 2016; Soleimani, 2018; Tasnimi and Ravari, 2016), until recently there has been a scarcity of studies conducted on self-regulated L2 vocabulary learning through technology. In a meta-analysis of mobile-assisted vocabulary learning, none of the 33 studies focused specifically on self-regulation (Lin and Lin, 2019). Recent studies have often focused on one particular type of vocabulary learning activity, such as using digital flashcards (Boroughani, Behshad and Xodabande, 2023) and few have analysed different dimensions of self-regulated learning (SRL) nor used qualitative methods.

The purpose of this study is to address some of these gaps by measuring students' capacity for self-regulated vocabulary learning through technology and to see if there is any difference when learning through a laptop and a smartphone. It also explores students' perceptions about the reasons for any differences, which can be used to inform the types of interventions that may enhance and develop students' SRL. The study used the five dimensions of SRL identified by Şahin Kızıl and Savran (2018) as the conceptual framework to address the following research questions:

RQ1: What is students' capacity for self-regulated vocabulary learning through technology at the beginning and end of a period of digital vocabulary learning?

RQ2: What differences are there in students' capacity for self-regulated vocabulary learning through different digital devices?

RQ3: What factors influence students' capacity for self-regulated vocabulary learning through different digital devices?

2. Literature Review

2.1 Self-Regulated Second Language Vocabulary Learning

According to Zimmerman (2008, p.166), "self-regulated learning refers to the self-directive processes and self-beliefs that enable learners to transform their mental abilities, such as verbal aptitude, into academic performance skill". This is particularly important when it comes to informal learning outside the classroom where learners do not have the direct support and guidance of a teacher, such as when trying to develop their vocabulary knowledge. In the field of L2 vocabulary learning, Tseng, Dörnyei and Schmitt (2006) developed the Self-regulating Capacity in Vocabulary Learning Scale (SRCvoc), which focuses on students' underlying cognitive and behavioural actions and consists of five dimensions of SRL (see Table 1).

Table 1: Dimensions of self-regulated vocabulary learning (Tseng, Dörnyei and Schmitt, 2006)

1.	Commitment Control
2.	Metacognitive Control
3.	Satiation Control
4.	Emotion Control
5.	Environment Control

This capacity for self-regulated vocabulary learning has been identified as a vital component in the systematic and cyclical process of L2 vocabulary learning. Tseng and Schmitt (2008), found that SRCvoc had a close relationship with both Strategic Vocabulary Learning Involvement (SVLI) and Mastery of Vocabulary Learning Tactics (MVLT), which then influenced vocabulary knowledge. The SRCvoc was operationalised as a survey instrument and has subsequently been used in other studies (Mizumoto and Takeuchi, 2012; Sentürk, 2016; Soleimani, 2018). These have generally shown low levels of SRL. For example, Sentürk (2016) found a moderate level of SRL among Turkish university students with a mean score of 3.76 out of a maximum score of 6. In all these studies, though, the effects of a period of vocabulary learning, especially through the use of a digital, vocabulary learning tool and different digital devices, were not measured.

More recently, there has been a greater focus on SRL within technology-based contexts. The Self-regulated Vocabulary Learning through Information and Communication Technologies (SRLvocICT) model developed by Şahin Kızıl & Savran (2018) also consists of five dimensions of SRL (see Table 2) and was operationalised as a reliable and valid survey tool (Şahin Kızıl and Savran, 2018).

Table 2: Five dimensions of self-regulated vocabulary learning through ICTs (Şahin Kızıl & Savran, 2018, p.605)

Dimension	Description
1. Commitment regulation	Concerns the preservation or increase of learners' original goal commitment.
2. Metacognitive regulation	Involves the SRL skills for managing concentration, procrastination, monitoring and controlling learning.
3. Affective regulation	Involves SRL skills for coping with impediment feelings (e.g., boredom, stress, etc.) and replacing them with facilitating emotions (e.g., maintaining interest).
4. Resource regulation	Relates to seeking, managing and expanding learning resources to increase learning opportunities.
5. Social regulation	Involves building constructive environments by seeking social support.

Several studies have focused on SRL within a technology-based context and these show that the use of technology for vocabulary learning generally has a beneficial effect on students' capacity for self-regulation (Tasnimi and Ravari, 2016, Boroughani, Behshad and Xodabande, 2023). For example, Boroughani, Behshad and Xodabande (2023) found that students using digital flashcards for vocabulary learning had significantly higher levels of self-regulation than a control group of students who used paper-based flashcards at the end of four months of vocabulary learning. However, none of these studies analysed the results in terms of the five different dimensions of self-regulation.

2.2 Device use in Vocabulary Learning Through Technology

Numerous studies have found that learning through the use of smartphones and other mobile or portable devices has had positive effects on vocabulary learning (Hao, Wang, and Ardasheva, 2021; Lin and Lin, 2019; Yu and Trainin, 2022). One of the main reasons for this is that "the portability and interconnectivity of mobile devices enhance the integration of formal and informal learning, which can promote learners' interest and thus foster comprehension and retention" (Hao, Wang and Ardasheva, 2021, p.662). This has often been enabled by the high rates of smartphone ownership among university students (Andrew *et al.*, 2018).

Studies that have investigated the use of different devices for vocabulary learning have highlighted a student preference for using laptop computers. For example, Lai and Zheng (2018) found that more students preferred using a laptop (50%) than a smartphone (40%). When asked in interviews about their reasoning, most students said that they associated laptops with serious study and were better for academic multi-tasking. Similarly, Stockwell and Liu (2015) found that 83% of Japanese and Taiwanese university students using online activities only accessed these activities from a personal computer (laptop or desktop), while just 17% used their mobile or smartphone. In semi-structured interviews, students said that the small screen size and the corresponding small font size on their smartphones impeded completing the activities properly. There was also general resistance and "psychological barriers" to seeing their smartphone as a device for learning purposes (p.316). At the same time, many university and high school students mainly use their smartphones for non-academic purposes, rather than for learning. Cojocnean (2016,) found that the vast majority of students (72%) "showed neutral attitudes towards the use of mobile-assisted learning tools in their vocabulary learning" (p.31) and perceived their smartphones as "sources of entertainment" (p.36) and opportunities for socialising, rather than as learning devices.

On the other hand, there is some evidence that students use their smartphones for casual learning and for tasks that are quick and light (Jurkovič, 2019; Lai and Zheng, 2018). Lai and Zheng (2018, p.310) found that 73% of students primarily used smartphones to consult dictionaries or translation tools for vocabulary learning, as opposed to only 22% who preferred laptops. More students also preferred using a smartphone when it came to using digital flashcards for learning vocabulary.

In addition to these studies focused on L2 vocabulary learning, educational psychology has identified some negative aspects of smartphones which can impact learning. Many mobile applications on smartphones have

been deliberately designed to compete for the user's attention through "prolonged immersion, frequent distraction and consumption of divisive content" (Hanin, 2021). This is further enabled through the use of push notifications and pop-ups (Pedro, Barbosa and Santos, 2018, p.7), which encourage "dopamine escapes" (Means, 2020, p.269) from academic tasks and challenging learning activities. This often leads to "habitual distraction" (Aagaard, 2018, p.6), increased multitasking amongst undergraduate students (Judd, 2015), and in some cases, nomophobia or fear of being without a mobile telephone and even smartphone addiction (Chiu, 2014). In terms of the effects on students in higher education, digital distractions negatively impact academic achievement (Aaron and Lipton, 2018) and academic performance (Lepp, Barkley and Karpinski, 2015). Aaron and Lipton (2018), for example, showed that non-academic use of digital devices contributed to poorer retention of classroom material. Since students often lack the necessary capacity for self-regulation to overcome these distractions (Mahapatra, 2019), this seems to be a vital issue to investigate further.

3. Method

3.1 Participants

The participants in this study were Gulf Arab students enrolled on an English foundation course at a university in the Middle East. This 16-week, one-semester course was designed for students who had just graduated from high school, but whose level of English language proficiency was not sufficient to start their EMI undergraduate degree course. After reading a written information sheet about the research, those who agreed to take part in the study signed a consent form. Two hundred and sixty-seven participants were initially recruited for this study across 26 separate sections of the same course. Due to course withdrawals, the total number of participants fell to 246 by the end of the study. This constituted 49% of the total student population who completed the 16-week course. The vast majority of the participants (230 or 94%) were female with a small group of male students (16 or 6%) and were all aged between 17 and 20 years old.

3.2 Vocabulary Learning

One of the learning outcomes of this English foundation course was for students to have a receptive knowledge of 500 additional academic English words to help them comprehend the academic texts in their degree courses. To learn to recognise the meaning and form of each word, students were provided with free access to digital activities hosted on Quizlet, which is said to be "the largest user-generated consumer learning platform in the United States", with 50 million active users in 130 countries (Stevens, 2019, p.1). Quizlet features a web-based interface that can be accessed on laptop computers, as well as a mobile application for smartphones and tablets.

The 500 words were divided into 50 daily blocks of ten words, and short definitions and simple gap-fill sentences for each word were uploaded to Quizlet. The site then generated seven different activities for each block. The participants were asked to complete at least five different digital vocabulary activities each day for one block of ten words (250 activities in total) over 50 days (five days a week for ten weeks). Students were not told which activities or which digital device to use. The intervention could be described as an assigned task with other regulation at the macro level (Winne, 2018), with students needing to self-regulate at the micro level in terms of when, where and how they used Quizlet. To check the completion of the digital activities, the number of Quizlet activities that each student completed was recorded by their class teacher on a Microsoft Excel spreadsheet. At the end of the ten weeks of vocabulary learning, the mean number of completed Quizlet activities was just under 210 or 84% of the target number.

3.3 Research Design

A mixed methods research design (Yin, 2006) was used because it helps to capture a more complete picture of the phenomenon being studied (Denscombe, 2014). Two main data collection methods were used (see Table 3).

Table 3: Research methods

Method	Purpose
1. Self-regulated vocabulary learning through technology surveys (Quantitative)	To measure students' capacity for SRL in L2 vocabulary learning through smartphones and laptops.
2. Paired-depth interviews (Qualitative)	To explore students' experiences and perceptions in relation to SRL and use of different devices.

There were two stages to the data collection. The first stage took place at the beginning of the semester when self-regulation surveys (pre-surveys) were administered. The second stage took place one week after the ten-

week vocabulary learning period had ended when the same surveys (post-surveys) were administered again and paired-depth interviews were conducted.

3.4 Data Collection

The SRLvocICT survey tool (Şahin Kızıl and Savran, 2018) was used as a self-report instrument to measure SRL. The scale contains 23 statements that relate to the five different dimensions of self-regulated vocabulary learning described earlier. With a mean scale coefficient of 0.85 (Şahin Kızıl and Savran, 2018, p. 610), the survey instrument is an extremely reliable tool.

In this present study, the original statements were adapted slightly by replacing the word 'ICTs' with 'smartphone' and 'smartphone applications' in Survey 1 and 'laptop' and 'the Internet' in Survey 2. This was undertaken to try and draw out any possible differences between how the participants perceived the two devices. For each statement, participants were required to indicate the degree to which they agreed on a 6-point Likert scale (see Table 4). A numeric value was assigned to each response to enable quantitative data analysis, with a possible maximum score of 138. The surveys were distributed electronically via Qualtrics, an online survey tool.

Table 4: Survey response options

Response	Numeric Value
Strongly Disagree	1
Disagree	2
Slightly Disagree	3
Partly Agree	4
Agree	5
Strongly Agree	6

Paired-depth interviews involved the interlocutor interviewing two participants at the same time, which enabled the participants to interact with each other (Wilson, Onwuegbuzie and Manning, 2016). Initial interview questions and an interview protocol were developed to ensure consistency in how the interviews were conducted. As an example, the initial questions used to explore the students' perceptions of their metacognitive regulation were as follows:

1. How did the choice of device (smartphone or laptop computer) affect your concentration?
2. Which device helped you to concentrate the most / least? How? Why?

Interviewees were purposefully selected from the existing participants and as many different classes as possible. Overall, a total of 28 students were recruited from 20 of the 26 sections and were divided into 14 pairs. The interviews were conducted in English and lasted between 30 and 40 minutes. Each participant was given a pseudonym to use during the interview to protect their identity and this same pseudonym was used to attribute quotes in the results section of this paper.

3.5 Data Analysis

Quantitative results from the SRL surveys were imported into SPSS Version 25.0 to generate descriptive statistics. The study variables were assessed for normality using the Shapiro-Wilk test, histograms and normal probability plots, and these revealed that the scores were not normally distributed. As a result, Wilcoxon signed-rank tests were used to measure the differences between the survey scores. A *p*-value of 0.05 was used to determine the statistical significance of all tests. Cronbach alphas were also calculated to assess the reliability and internal consistency of the SRL surveys. The average mean scale coefficient was 0.83 for the pre-surveys and 0.91 for the post-surveys, demonstrating high reliability and internal consistency.

For the paired-depth interviews, typological analysis and constant comparison (LeCompte and Preissle, 1993) were used to analyse the data. Firstly, a sequence of steps was drawn up to code the responses from the 28 interview transcripts. Then through an iterative process of reading and re-reading, responses within each interview transcript were categorised according to one of the five dimensions of SRL and whether the responses were positive or negative.

4. Results

4.1 RQ1: Students' Capacity for SRL Through Technology

When comparing the pre- and post-survey scores for each device, there was little change in the overall self-reported capacity for self-regulation. In terms of SRL through smartphones, there was a very small decline in the overall average scores between the pre-and post-surveys from 102.93 to 101.73 (see Table 5), while the average score per survey item fell from 4.48 to 4.42. This difference was not statistically significant (Z = -0.204, p = 0.838).

Table 5: Overall self-regulated learning through smartphones survey scores

	N	Max.	Min.	Range	Mean	Median	SD
Pre-Survey	246	138	23	115	102.93	104	18.46
Post-Survey	246	138	23	115	101.73	105	24.55

For SRL through laptops, there was a small increase in the overall average score of 2.11 points between the pre- and post-surveys, while the average score per item increased from 4.67 to 4.76 (see Table 6). Again, this difference was not statistically significant (Z = -1.656, p = 0.098).

Table 6*:* Overall self-regulated vocabulary learning through laptops survey scores

	N	Max.	Min.	Range	Mean	Median	SD
Pre-Survey	246	138	28	110	107.30	111	18.49
Post-Survey	246	138	23	115	109.41	114	21.51

Thus, the period of vocabulary learning does not appear to have had any effect on students' overall capacity for self-regulated vocabulary learning through laptops or smartphones.

By examining each dimension of SRL, some more significant differences were identified. In terms of SRL through smartphones, the mean survey score for three of the five dimensions (commitment, affective and resource) decreased after the period of vocabulary learning (see Table 7). Commitment regulation decreased by nearly 5% and the post-survey score was statistically significantly lower than the pre-survey score (Z = -2.286, p = 0.022).

Table 7: Mean scores for five dimensions of self-regulation in smartphone surveys

	Commitment	Meta-cognitive	Affective	Resource	Social
Pre-survey	4.59	4.47	4.48	4.59	4.17
Post-survey	4.30	4.50	4.41	4.54	4.30

For SRL through laptops, the mean scores for all five dimensions increased slightly between the pre-survey scores and post-survey scores (see Table 8), but none of these increases were statistically significant.

Table 8: Mean scores for five dimensions of self-regulation in laptop surveys.

	Commitment	Meta-cognitive	Affective	Resource	Social
Pre-survey	4.86	4.69	4.66	4.73	4.43
Post-survey	4.89	4.77	4.72	4.81	4.54

4.2 RQ2: Differences in Capacity for SRL by Digital Device

A comparison of the survey scores between the two devices shows some significant differences (see Table 9). In both the pre-survey and the post-survey, students' capacity for self-regulated vocabulary learning through laptops was statistically significantly higher than that through smartphones and the differential increased. However, the increase in the differential before and after vocabulary learning was not statistically significant (Z = 1.073, p = 0.283).

Table 9: Comparison of self-regulation through smartphones and laptops

	Pre-survey	Post-survey
Laptop	107.30	109.41
Smartphone	102.93	101.73
Difference	4.37	7.68
Z	-4.572	-5.916
Sig (2-tailed)	.000	.000

A comparison of the scores for the five dimensions in the two pre-surveys indicates that the mean scores for all five dimensions in the laptop pre-survey were statistically significantly higher than those in the smartphone pre-survey (see Table 10). The largest difference and the most statistically significant was in commitment regulation ($Z = -4.133$, $p < 0.001$).

Table 10: Pre-survey mean dimension scores

	Commitment	Metacognitive	Affective	Resource	Social
Smartphone	4.59	4.47	4.48	4.59	4.17
Laptop	4.86	4.69	4.66	4.73	4.43
Difference	0.27	0.22	0.18	0.14	0.26
Z	-4.133	-3.174	-2.907	-2.107	-3.229
Sig (2-tailed)	.000	.002	.004	.035	.001

In the two post-surveys, the mean scores in the laptop post-survey for all five dimensions were also statistically significantly higher than those in the post-smartphone survey (see Table 11). The difference for commitment regulation was again statistically significantly higher ($Z = -6.677$, $p < 0.001$) than the other dimensions.

Table 11: Post-survey mean dimension scores

	Commitment	Metacognitive	Affective	Resource	Social
Smartphone	4.30	4.50	4.41	4.54	4.30
Laptop	4.89	4.77	4.72	4.81	4.54
Difference	0.59	0.27	0.31	0.27	0.24
% Difference	13.72	6.00	7.03	5.95	5.58
Z	-6.677	-3.624	-4.409	-4.419	-3.613
Sig (2-tailed)	.000	.000	.000	.000	.000

As the results in Tables 10 and 11 show, the differential between the scores in the two pre-surveys and between the scores in the two post-surveys for four of the five dimensions increased over the period of vocabulary learning. The largest increase was in commitment regulation and this increase in the differential was statistically significant ($Z = -2.868$, $p = 0.004$). These results suggest that when learning vocabulary through a smartphone the learners' commitment regulation was negatively affected during the vocabulary learning period.

4.3 RQ3: Factors That Influenced Capacity for SRL

Six main factors were identified from an analysis of the pair-depth interviews.

4.3.1 Social media distractions on smartphones

Many students were aware that notifications from social media applications were a significant distraction from learning vocabulary on their smartphones and made it more difficult for them to stay focused on their learning goals:

> *"While I'm doing my Quizlet on my phone, maybe the notifications will disturb me, and the notifications tell me like, don't do Quizlet and do chatting" (Beth).*

In many cases, messaging from friends proved too distracting:

> *"the notification pop from the app and I am doing my Quizlet, I feel like I want to reply to what my friend tells me or when they call me" (May).*

There was also evidence of FOMO (Fear of Missing Out):

> *"I should check it because they're always talking, and they're all talking without me, so what they are saying, what they are doing" (Sam).*

4.3.2 Self-regulation of smartphone use

The ability of students to self-regulate their use of their smartphones while completing the vocabulary learning activities was mixed. Some students were quite proactive:

> *"I put it on silent, so I don't hear" (Jane),*
>
> *"I just turn off the notifications, because I want to focus on something" (Mary).*

Some students took more drastic steps:

> *"I don't use my phone because I know that I will go to use other apps and not Quizlet" (Ann).*

At the same time, there was also evidence of an unwillingness of some students to self-regulate their use of social media on their devices:

> *"We need updates, that's why we don't turn off notifications" (Faye).*

There was also some evidence of how the smartphone can negatively affect concentration and increase procrastination:

> *"the phone makes me so lazy, every time when I look at it, I'm like, 'Oh'. I only use it while I'm lying down like on the bed" (Jo).*

4.3.3 Physical features of the laptops

The positive aspects of laptops were often related to how the physical characteristics of the device helped students stay focused on their vocabulary learning. The larger screen size means that:

> *"you can see everything" (Rachel),*
>
> *"can concentrate better" (Nina).*

The physical keyboard on the laptop gave students the ability:

> *"to write faster, with no spelling mistakes" (Beth),*
>
> *"to choose the correct spelling on the laptop" (Mary).*

Some students also felt the physical keyboard better enabled learning to take place:

> *"When we're typing, we learn more and we can concentrate more, but when we only tap, we will not remember the words later" (Jill).*

Another relevant factor was the perception that a laptop is a serious device for studying:

> *"We only like to do our work on the laptop, not play or do anything else" (Ann).*

4.3.4 Portability of smartphones

Many of the positive mentions of using a smartphone centred around its portability. Several students mentioned how their smartphones enabled them to learn in a range of different locations:

> *"while I'm in the car for 25 minutes from the university" (Kim),*
>
> *"sitting in a coffee shop or I have free time outside or in class" (Clare).*

This gives the smartphone an edge over the laptop in certain out-of-class learning settings.

4.3.5 Smartphone touchscreen

Some students spoke about how they used different devices for different digital vocabulary learning activities, based on both the activity requirements and the physical characteristics of the device. For example, Quizlet activities like 'Spell', which require physical input via a keyboard, were usually done on a laptop because of limitations of the onscreen keypad of the smartphone:

> *"If I use the phone, I will make mistakes because it's a small device" (Kim).*

On the other hand, the touchscreen of the smartphone was seen as advantageous for some of the other Quizlet activities:

> *"The activity 'Match' was better on the smartphone because I can just read fast and touch the word" (Mary).*

4.3.6 Switching between devices

Some students used their laptops and smartphones sequentially:

> *"I use my phone, but when I finish, I use my laptop to see what I finished and what I didn't finish" (Monica).*

Several students described how they multi-tasked across both devices at the same time, using the laptop for the main digital learning activities and the smartphone to access additional learning resources:

> *"I have in my smartphone an app, Google Translate app, and in the laptop Quizlet" (Jill).*

A few students also accessed social media applications on their smartphones to help them overcome a sense of boredom while doing Quizlet on their laptops:

> *"Yeah, I only use the laptop, but I can take a rest and watch my phone" (Jane).*

Thus, there was evidence of the dual role of social media applications on students' smartphones. They were both a negative distraction that took them away from vocabulary learning, but also a positive response to alleviate stress and boredom.

5. Discussion

5.1 RQ1: What is Students' Capacity for self-Regulated Vocabulary Learning Through Technology at the Beginning and end of a Period of Digital Vocabulary Learning?

Using technology for vocabulary learning seems to have had a beneficial effect on students' capacity for self-regulation, based on the SRL survey results. The average item scores of 4.42 (post-smartphone survey) and 4.76 (post-laptop survey) were significantly higher than those found in previous studies conducted in non-technology contexts. For example, Sentürk (2016), reported an average score of 3.8 with pre-intermediate and advanced learners in Turkey. This supports the findings of Tasnimi and Ravari (2016) and Boroughani, Behshad and Xodabande (2023) who found that students who used online crossword puzzles and digital flashcards had higher levels of self-regulation than students using traditional paper-based materials. One reason for this could be that the accessibility of digital learning activities, the automatic and instant feedback on answers and tracking of completed activities may enable students to shift more cognitive effort to the actual learning.

At the same time, the findings revealed that there was no statistically significant difference between the student's overall capacity for self-regulated vocabulary learning at the beginning and end of the 10-week learning period both for laptops and smartphones. This suggests that students were already familiar with using both devices for learning purposes. However, there was one dimension of SRL that saw a statistically significant decline – that of commitment regulation when using Smartphones, which has not been identified in any previous study. The possible reasons for this decrease will be discussed below, but clearly, there was something about the Quizlet mobile application and smartphone that negatively affected students' ability to persist and maintain their interest in achieving their learning goals.

5.2 RQ2: What Differences are There in Students' Capacity for Self-Regulated Vocabulary Learning Through Different Digital Devices?

Students' capacity for self-regulated vocabulary learning through laptops was significantly higher than through smartphones, both at the beginning and end of the 10-week period in terms of each of the five dimensions of

SRL and overall. However, because there was little change in the differences over the period, it seems that students were already aware that laptops were more suitable for sustained, out-of-class digital vocabulary learning than smartphones before the study started, which supports the findings of Lai and Zheng (2018) and Stockwell and Liu (2015).

5.3 RQ3: What Factors Influence Students' Capacity for Self-Regulated Vocabulary Learning Through Different Digital Devices?

5.3.1 Commitment regulation

Based on the findings from the pair-depth interviews it would seem that both psychological and physical factors decreased the students' original goal commitment while completing the vocabulary learning activities on a smartphone. The first factor was the distraction from social media applications which are more accessible on a smartphone than a laptop, especially through visual pop-up and sound notifications. When you are trying to focus on something mentally demanding, such as vocabulary learning, it is much easier to be distracted from that task after a few minutes of concentrated effort, especially with the "ubiquitous presence of digital devices and social media in students' lives" (Pedro, Barbosa, and Santos, 2018, p.1) and the promise of 'dopamine escapes" (Means, 2020, p.269). This is a serious issue that is rarely discussed in the literature on mobile vocabulary learning and seems to be one of the main reasons for the decline in students' capacity for commitment regulation.

The second factor is that many students had a general resistance to using their smartphone as a device for learning purposes due to both the physical constraints of the small screen and virtual keyboard, and its primary role in their lives as a communication device. These findings align with those of Cojocnean (2016), Jurkovič (2019) and Lai and Zheng (2018) who identified "psychological barriers" (Lai and Zheng, p.316) that stopped students from using smartphones as learning devices. At the same time, the students in the current study also seemed to associate laptops with more focused, out-of-class learning. As Lai and Zheng (2018) found, laptops seem to better enable academic multi-tasking because students can have multiple screens open at the same time and more easily switch between them where necessary.

5.3.2 Metacognitive regulation

Perhaps the main reason for students perceiving laptops as having a more positive influence on their capacity for metacognitive self-regulation in vocabulary learning is that the physical characteristics of the device, such as the larger screen size and a physical keyboard, better enabled them to concentrate on their digital vocabulary learning than smartphones. The ability to see the whole menu of options, and clearer tracking of correct answers and overall scores perhaps also allowed students to better monitor their vocabulary learning. This mirrors the conclusions of Stockwell and Liu (2015). In addition, the ease of typing in answers for most of the Quizlet activities seems to allow the students to concentrate more and not get frustrated as some did when trying to use the virtual keyboard on their smartphones. Conversely, the use of smartphones for accessing the two game-like activities on Quizlet - Flashcards and Match - shows the value of a touch screen for certain vocabulary learning tasks and activities which do not require textual input. Tapping a smart screen with your fingers can be more efficient than having to use a mouse or a trackpad (Lai and Zheng, 2018), but there is the danger of mindless tapping with little cognitive effort.

One aspect of metacognitive regulation through using smartphones which did show a positive change at the end of the vocabulary learning period was students' ability to plan tasks and relevant materials to learn vocabulary outside of the classroom. In particular, their use of smartphones on the go underlines the portability affordance of the device (Kukulska-Hulme, 2012). Applications on smartphones can also be accessed more quickly than websites on laptops which allows students to make better use of "fragmented time" (Hu, 2013, p.147) in between classes on campus and while outside the home. At the same time, the ability to access the same digital vocabulary learning tool through both a web-based platform on their laptops and a mobile application on their smartphones perhaps gave students the confidence to switch between devices depending on the location and time, as part of a seamless mobile learning experience (Wong and Looi, 2011).

5.3.3 Affective regulation

Although the survey results showed that affective regulation when learning on smartphones was lower than on a laptop, some students relied on their smartphones to overcome boredom by checking their social media feeds, rather than using them to access digital vocabulary learning activities. This seems like a positive step to some extent, but it does not tell us how easily students were able to return to their vocabulary learning at the end of

their "social media break". Since many students in the interviews mentioned that they had difficulty self-regulating their use of social media on their smartphones, it would probably be a challenge and may be evidence of smartphone addiction, as found by Chiu (2014).

5.3.4 Resource regulation

The fact that students also used their smartphones to access mobile applications, such as the Quizlet wordlist and the Google Translate application to quickly check word information, such as definitions or Arabic translations shows that they possess the capability of accessing different learning resources to increase learning opportunities. This is similar to the findings of Lai and Zheng (2018).

5.4 Theorising Self-Regulated Vocabulary Learning Through Digital Devices

As a result of the findings of this study, I propose that Şahin Kızıl and Savran's model of self-regulated, vocabulary learning through technology (2018) would benefit from the addition of a sixth dimension - device regulation/control - and the inclusion of four new statements of belief (see Table 12). These statements specifically relate to learners' capacity to use different devices for vocabulary learning in terms of the digital activities, temporal and spatial factors and features of the devices. This dimension also recognises the reality of digital distractions in out-of-class, digital, self-regulated vocabulary learning.

Table 12: Device regulation dimension

1. I know which device is better to use for different digital vocabulary learning tasks and activities.
2. I believe that I can switch between using different devices depending on the time and place.
3. I know how to use different devices simultaneously to maximise my digital vocabulary learning.
4. I can identify digital distractions and find ways to overcome them to refocus on learning.

6. Conclusion

This study aimed to measure students' capacity for self-regulated vocabulary learning through technology with a particular focus on different digital devices - laptops and smartphones - using five dimensions of SRL (Şahin Kızıl and Savran, 2018) as the conceptual framework. It also aimed to explore students' perceptions about the device-related factors that may have affected their capacity for SRL. The findings make several contributions to the field of second-language digital vocabulary learning and e-learning in general. Perhaps the main contribution is that students' commitment regulation was negatively affected when learning vocabulary through a smartphone primarily because of the digital distractions caused by the ease of access to social media applications and notifications. Secondly, the findings provide evidence that a period of digital vocabulary learning in out-of-class settings has little effect on the other four dimensions of self-regulation when learning through either a smartphone or laptop. Thirdly, the findings highlight the complex interplay between digital devices, digital vocabulary learning activities and the different dimensions of students' self-regulated vocabulary learning. Finally, they support previous research findings that students' levels of SRL in a technology-based context were significantly higher than in non-technology-based contexts and that students in higher education settings have an overall preference for using laptops to access digital vocabulary learning activities.

One of the main implications of this study is that models of self-regulated vocabulary learning through technology need to include a dimension related to device control which recognises how the features, architectures and affordances of different digital devices impact SRL and the importance of digital distraction. In addition, because smartphones are ubiquitous and deeply embedded in both daily life and higher education settings, students require awareness raising about digital distractions and guidance on how to develop their use of self-regulated learning strategies (Wang *et al.*, 2022) when using different devices for academic-related tasks, such as intentional, digital vocabulary learning, in out-of-class settings.

This study has a few limitations. Firstly, self-regulation was only measured through students' perceptions, which inevitably added a subjective nature to the results. Another limitation is that only the total number of Quizlet activities completed by each participant was calculated. This did not allow for a more nuanced picture to emerge about the use of individual Quizlet activities and the relationship with the five different dimensions of self-regulation. Finally, the characteristics of the participants in this study limit the generalisability of the results to some extent. The vast majority were female, and it might be possible that they are more attached to their smartphones than male students. In addition, Gulf Arab cultures may have a stronger affinity to using their smartphones than other cultures.

The results and limitations of this study suggest some fruitful areas to focus on in follow-up research. Replication of Tseng and Schmitt's study (2008), both before and after a period of digital vocabulary learning on different devices, might help to identify any effects on strategic vocabulary learning involvement (SVLI) and mastery of vocabulary learning tactics (MVLT) or specific learning strategies. This would also enable further testing of the relationships between the different components of their model of motivated vocabulary learning in technology-based contexts. Furthermore, using the extended SRLvocICT survey with the new sixth dimension of device control would allow testing of the validity and reliability of the revised tool, and also provide further insights into the ability of students to manage and control their use of different digital devices during periods of digital vocabulary learning.

Disclosure statement

The author reports there are no competing interests to declare.

Acknowledgement

I acknowledge that this submission to the EJEL has been derived from the work discussed in my PhD thesis and that parts of this work have been published as:

Bowles, M. K. (2021). An exploration of the mediating effects of a digital, mobile vocabulary learning tool and device use on Gulf Arab learners' receptive vocabulary knowledge and capacity for self-regulated learning. Lancaster University (United Kingdom).

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Digital Teaching Competence and Educational Inclusion in Higher Education. A Systematic Review

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Abstract: This article presents a systematic review of the literature with the aim of providing an updated framework for the scientific production developed in the field of digital competence and inclusive education in Higher Education, as indexed in the Web of Science (WoS) and SCOPUS databases. Twenty-one scientific articles published between 2016-2023 were included and analyzed, with no temporal cohort established. The search matches yielded a first document of the topic of study in 2016 in the Social Sciences Citation Index. The results obtained on the conceptual structure of the analyzed documents were carried out through a multiple correspondence analysis (MCA) observing the existence of two dimensions composed of three clusters. Cluster one was composed of studies on digital competence, virtual learning environments, digital divide, and functional diversity, among others. Cluster two comprised studies carried out on digital tools and competencies, inclusive education, educational processes, and digital strategies; while cluster three was made up of educational inclusion related to interculturality and digital competence. Among its limitations, there were aspects related to the heterogeneity of the studies, which make it difficult to compare the data, and the sample and size of the study, which makes the results obtained and the generated data have a lower percentage of generalization compare to studies that use larger simples. This study has implications for researchers and Higher Education institutions interested in research on digital competence for inclusive education, with the possibilities of digital competence for inclusive education being established from the studied variables, allowing teachers to adapt and personalize learning to meet individual student needs. All of this is in line with the goals of the 2030 Agenda, concerning the empowerment of citizens and the digitization of public services to ensure the population's access to such services via the internet.

Keywords: Digital competencies, Inclusive education, Digital divide, Interculturality, Universal design for learning, 2030 Agenda

1. Introduction

The development of digital teaching competencies in the use of Information and Communication Technologies (ICT) to enhance educational inclusion in the university context is multidimensional, heterogeneous, and complex (Kerexeta-brazal et al., 2022). Therefore, it must be addressed from different perspectives. On one hand, it requires the education system to create new policies, regulations, and provisions that highlight and create conditions for its development. On the other hand, it involves universities in providing resources and regulations to ensure the safe and efficient access and use of virtual devices and resources by both teachers and students (World Health Organization and World Bank, 2011). Additionally, it calls for teachers and students to engage in training in both educational technologies and inclusive education (Ainscow, 2020).

Various frameworks for the development of digital teaching competence share significant similarities in defining it as the acquisition and development of knowledge, skills, and abilities in technology use to equip the educational population with tools enabling them to harness digital technologies and participate in the new society of the 21st century (INTEF, 2017; ISTE ORG, 2022; UNESCO, 2019). The absence of digital competence in teachers and students can be a barrier to access quality education and sustainable educational inclusion, widening the digital gap for populations already disadvantaged by various conditions (United Nations). The post-COVID-19 era has underscored the challenge and crucial need for the training of teachers and students to use technologies (UNESCO, 2020) to prevent limited or complete exclusion from participation in various societal systems.

Addressing the use of ICT as a key element for educational inclusion in the university classroom requires educational institutions to eliminate not only architectural barriers, access barriers to virtual spaces and resources, and attitudinal barriers (Lapierre et al., 2022) but also those related to implicit pedagogical understandings in educational models based on limiting beliefs (Ainscow and Echeita, 2011). Although the definition of the concept of educational inclusion is multifaceted (Tomlinson, 2023) and linked to actions transforming educational practices into opportunities for meaningful and flexible learning (CAST, 2018).

Reference this paper: Zarceño García de Soriano, A.J, Agreda Montoro, M. and Ortiz Colón, A.M, 2024. Digital Teaching Competence and Educational Inclusion in Higher Education. A Systematic Review, *The Electronic Journal of e-Learning, 22(1)*, pp 31-45, available online at www.ejel.org

In this regard, others research has demonstrated the need to update and innovate the education system by incorporating digital resources to adapt teaching processes for the benefit of learning and the participation of all students (Hoogerwerf et al., 2017; Bong and Chen, 2021). Teachers must have adequate digital competence to meet the educational demands imposed on them, ensuring quality education based on inclusive education. This is evident in research results on digital competence in higher education (Cabero et al., 2020; Calderón, Gustems and Carrera, 2020; Guillén and Mayorga, 2020). The incorporation of ICT into educational processes as pedagogical strategies suitable for the age groups of students, with adjustments to the discipline under study and the skills to be developed (Borgobello et al., 2019; Cateriano et al., 2021; Quota et al., 2022), has been possible when teachers know how to use technologies based on the discipline and pedagogical criteria (Mishra and Koehler, 2006).

Furthermore, the 2030 Agenda for Sustainable Development defines global challenges, and specifically, Goal 4 refers to inclusive and equitable quality education that aims to "ensure quality and inclusive education, promoting lifelong learning opportunities for all people" (UNESCO, 2020, p. 17). One of the main tasks for developing inclusive education (Ainscow, 2007) is to identify barriers hindering the learning and participation of all students to eradicate inequality and establish educational equity. In light of this, various studies emphasize the urgent need for teachers and students to have domains and skills for the use of digital resources, which are increasingly vast (Cabero et al. 2022; Cateriano et al., 2021).

To achieve an inclusive environment, teachers must teach all students regardless of their intrinsic, structural, or cultural abilities and capacities (Juárez and Comboni, 2016). This substantial shift in knowledge transmission requires a teacher with competencies built by educational technology, truly enabling inclusive education for all students with or without disabilities (Batanero, Cabero and López, 2019). Therefore, it is essential for teachers to have program designs for training based on universal design for learning and the necessary resources to attend to all students, as well as specific technological and pedagogical training (Cabero et al., 2020).

Systematizing evidence from research and experiences with an emphasis on the use of educational technology for educational inclusion in the university serves as a reliable resource for decision-making at different levels. This strategic commitment is crucial because studies in this field at the university level are more limited and relatively recent.

2. Method

2.1 Objectives

This research advocates for digital competence as a basis for the development of inclusive education that values diversity as an enriching element of the teaching-learning process and as an enabler of human development. The goal of education in the current context of the 2030 Agenda is to overcome the digital divide that poses a challenge for those who cannot access technology, resulting in feeling excluded from global society. The aim is to facilitate accessibility of the population and eliminate barriers and obstacles on an equal footing, particularly for the most vulnerable groups. Taking this challenge as the focus of study, the objective of this article is to provide an updated overview of studies conducted on digital citizenship competence in inclusive contexts, investigating the type of research design, instruments and analysis used, as well as the results obtained after their application, their implications and limitations.

This research is directed through the following research questions:

RQ1: What is the international scientific production regarding the relationship between digital competence and inclusive education?

RQ2: What are the research methods used in studies conducted on digital competence and educational inclusion?

RQ3: What are the results obtained in studies developed on digital competence and educational inclusion?

RQ4: What are the limitations arising from research on digital competence in inclusive contexts?

Therefore, the objective of this research is to provide an updated framework of scientific production on the relationship between digital competence and inclusive education. This involves exploring the type of research design, instruments, and analyses employed, as well as the results obtained following their application, along with their implications and limitations. The aim is to parameterize this data and offer relevant information to researchers regarding scientific publications that link digital competence and educational inclusion.

2.2 Design

The methodology used in this research responds to a systematic literature review, characterized by: a) being systematic, with scientific rigor and non-arbitrary; b) being comprehensive, including all scientifically rigorous productions related to a specific topic; c) being explicit, detailing the procedure for locating sources and the criteria considered; d) being reproducible, allowing other researchers to verify the process (Onwuegbuzie and Frels, 2015).

This study conducts a systematic literature review using the Web of Science (WoS) and SCOPUS databases. It is noteworthy that a specific time range was not selected; instead, all search matches in the database were considered. The first publication record in the WoS database dates back to 2016, while in SCOPUS, it is from 2019. These databases were chosen for their global recognition and prestige in the field of science, ensuring strict criteria for scientific quality. The review has been limited to analysing the most recent documents on the research problem. Additionally, it has been found that prior to 2015, international research on digital competence and inclusive education was non-existent. While scientific and academic documents related to disability and impairment linked to the use of ICT appear before 2015, the concepts of inclusive education and digital competence surpass the established notions to date. Therefore, the scientific production within this emerging trend is quite recent. The search and selection of publications included in this study were conducted by three independent researchers, experts in conducting systematic review research, and whose lines of research are related to the area of Inclusive Education and Educational Technology. In this research, we followed the quality standards established in the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure the internal consistency of the systematic review (Thanasi-Boçe and Kulakli, 2023; Urrútia and Bonfill, 2010), which include: description of eligibility criteria, sources of information and publication search; selection process of works; procedure for data extraction and synthesis of results obtained.

3. Procedure

The process of systematic analysis of literature requires an initial search of publications in the selected database. Thus, the preliminary analysis for the search of documents is carried out according to the search equation based on the key descriptors that are part of this work: "Digital Competence", "Inclusive Education", "Higher Education". These terms have been used in both Spanish and English, in the title, abstract and keywords sections in the database, complemented through Boolean operators AND and OR. From these terms and the use of different Boolean operators, the following search equation was designed: "inclusive education AND digital competence AND higher education OR educación inclusiva AND competencia digital AND educación superior".

The second phase includes filtering the results based on the inclusion and exclusion criteria for publications, which are described in Table 1:

Table 1: Criteria for inclusion and exclusion of publications

Inclusion criteria	Exclusion criteria
Articles published in high-quality scientific journals that undergo peer-review process. Publications written in Spanish or English. Publications related to the fields of Social Sciences and Educational Research. Documents published between 2017-2022, inclusive. Open-access publications available for consultation.	Articles not related to the general objective of this study. Publications related to other educational professionals. Publications with restricted access. Books or book chapters, conference proceedings, doctoral or master's theses, final papers, etc. Duplicate publications in both databases.

In the third phase, the quality of each publication was evaluated by reading the full text to ensure its affinity and relevance to the general objective of this research. This evaluation resulted in 21 primary data sources out of the 134 publications. Figure 1 shows the process followed for searching, selecting, and reviewing publications until establishing the final sample.

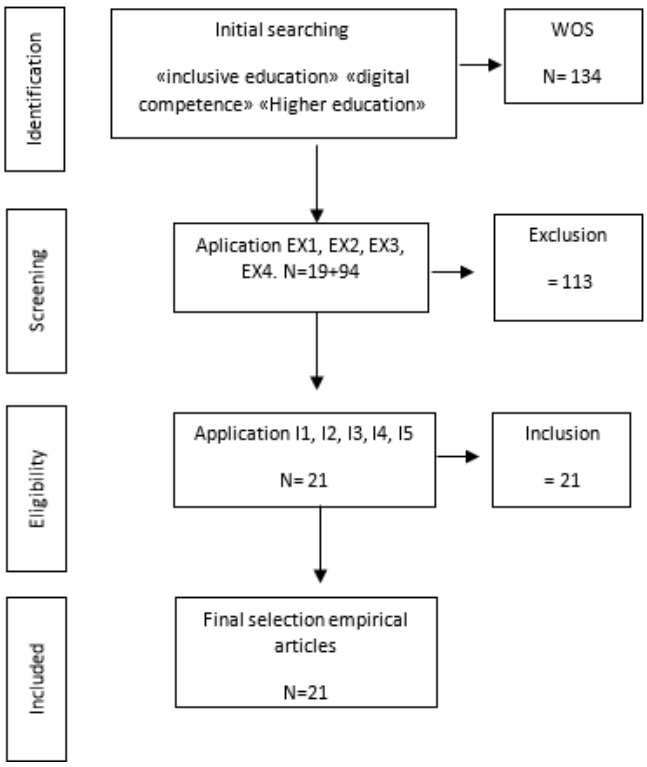

Figure 1: Flowchart of the sample search and selection process

The twenty-one studies that met the inclusion criteria were independently examined in depth. The studies recorded information related to general aspects (authors, year of publication and topics), participants (sample size, educational level), method/methodology (qualitative, quantitative, systematic review), and the main results and conclusions obtained in each study (Appendix 1)

The findings showed that research on digital competence and inclusive education was first studied in 2016 and that the highest number of articles appeared in 2021. Digital competence in inclusive contexts in higher education is examined from a global perspective in this study, suggesting the direction for in-depth research as well as future lines of investigation.

4. Results

At the outset, the quality of the chosen documents for the systematic review was appraised using the AMSTAR 2 tool (Shea *et al*., 2017), and the outcomes are depicted in Figure 2.

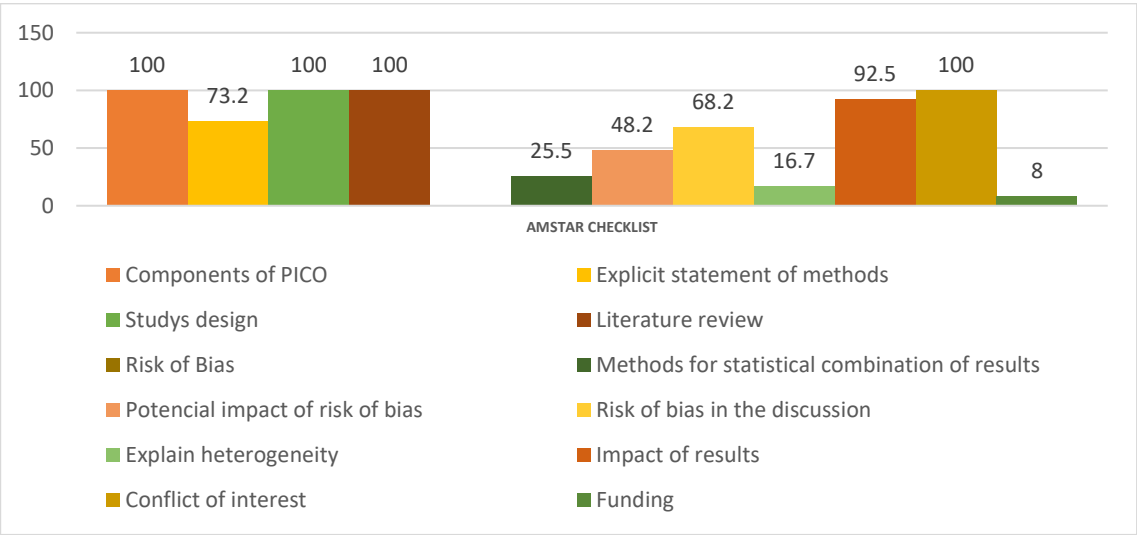

Figure 2: Results of AMSTAR 2 Checklist. Own elaboration

The annual scientific production on publications related to digital competence and educational inclusion in Higher Education has had a really important growth in the year 2022 (Figure.3). It should be noted that the term educational inclusion is relatively recent, traditionally scientific research in educational technology has been related to disability, attention to diversity, and special education, among others. It is now, from 2022, when the educational field is directing its efforts towards conducting studies related to educational inclusion and digital competence in Higher Education. Thus, we find a growing trend that began in 2018, reaching a peak of 5 publications in 2020, 3 in 2021 and a total of 13 in 2022. These results can be related to the onset of the COVID19 pandemic and the needs and challenges that have become apparent regarding the integration and use of technology as an essential element to decrease and mitigate the negative effects of exclusion of the most vulnerable groups. The trend persists in SCOPUS, where the number of documents continues to grow since 2021.

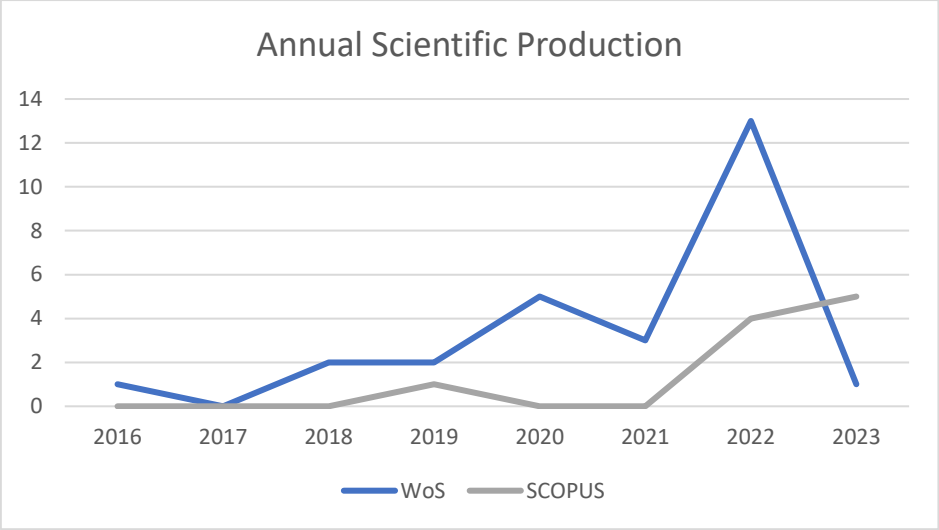

Figure 3: Annual scientific production in WoS and SCOPUS in reference to the search area.

Table 2 presents crucial information obtained from the preliminary analysis of the selected documents, following the application of inclusion and exclusion criteria. The total sample for the study comprised 21 articles, out of the initial 134. In this context, the temporal scope was defined between the years 2016 and 2023, with an annual growth rate of 100% in WoS and 49.53% in SCOPUS. The average document lifespan exceeds a year and a half, signifying that the field of study has been explored more intensively over the last five years. Concerning authorship and co-authorship, it is evident that the majority of research has involved collaboration among multiple authors, with only four instances of a single author. The average co-authorship per document is close to 3. It is noteworthy that co-authorship among researchers from different countries is non-existent in WoS and reaches a rate of 30% in SCOPUS.

Table 2: Main information about the data

Description	Results WoS	Results SCOPUS
Timespan	2016:2023	2016:2023
Sources (Journals, Books, etc)	14	7
Documents	14	7
Annual Growth Rate %	100	49.53
Document Average Age	1,69	0.8
Average citations per doc	7	2.6
References	734	655
DOCUMENT CONTENTS		
Keywords Plus (ID)	29	41
Author's Keywords (DE)	65	57
AUTHORS		
Authors	39	28

Description	Results WoS	Results SCOPUS
Authors of single-authored docs	3	1
AUTHORS COLLABORATION		
Single-authored docs	3	1
Co-Authors per Doc	2,79	2.8
International co-authorships %	0	30
DOCUMENT TYPES		
article	13	7
article; early access	2	0

Note: Biblioshiny output for Bibliometrix. Own Elaboration.

Figure 4 displays the links between the institution where authors are affiliated (AU_UN), the countries (AU_CO), and the keywords of the documents (DE) regarding the WoS database. Spain has the highest scientific production regarding the object of study, with the universities of Seville, Malaga, Almeria, and the Basque Country, and Cordoba standing out. This is followed by South Africa, with the University of Johannesburg, and Norway, with its University of Science and Technology. Thus, research from Spanish universities focuses on ICT, interculturality, inclusion, and accessibility in higher education (Portillo et al., 2020; Rodríguez, Calvo and Martín, 2020; Medina-García et al., 2021; Batanero et al., 2022; Cabero et al., 2022; Leiva et al., 2022), while South African universities also focus on ICT, active methodologies, and hybrid environments to promote inclusion (Azionya and Nhedzi, 2021). On the other hand, Nordic universities focus on higher education and digital competence for the development of holistic and inclusive training programs (Begnum, Pettersen and Sørum, 2019; Joshi, 2021); and Australian universities focus on digital divides and accessibility as key factors for educational inclusion (Nguyen et al., 2022). Lastly, Russian universities focus on the consequences of the COVID-19 pandemic on educational inclusion in higher education (Belenkova, Skudnyakova and Bosov, 2022), while Ukrainian universities study the potential of self-regulation and technology integration in the training of future special education teachers (Mytsyk and Pryshliak, 2022).

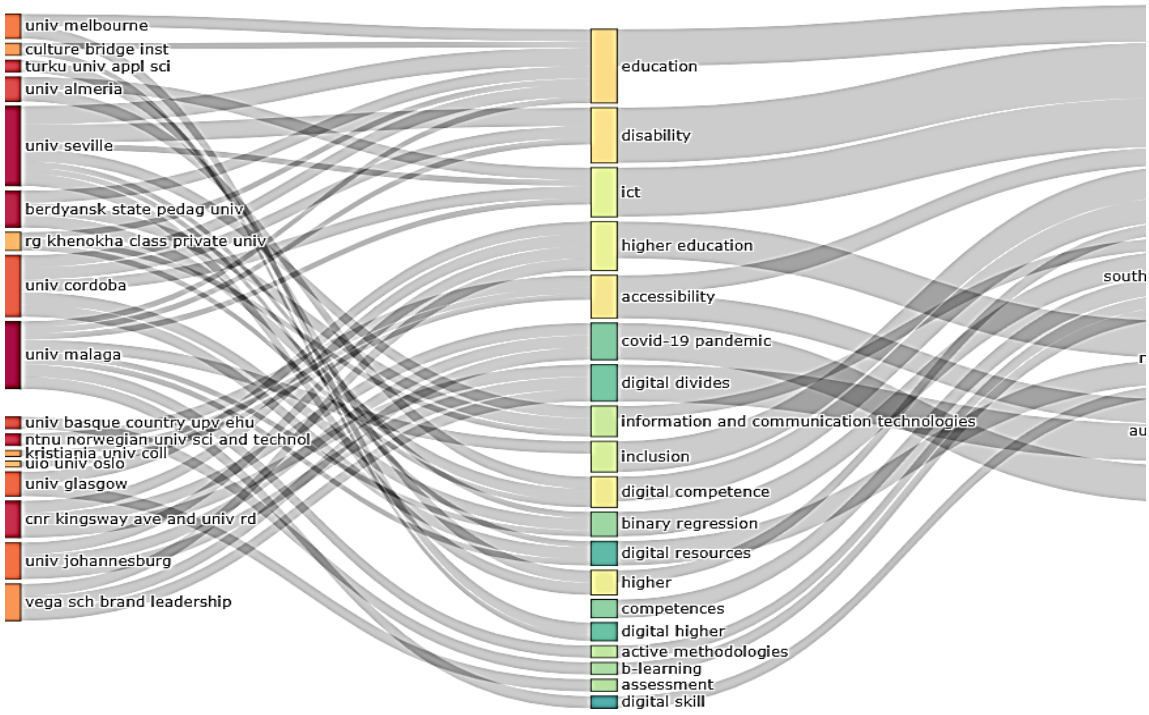

Figure 4: Biblioshiny output for Bibliometrix: Relationship between countries, affiliations, and keywords

Similar to WoS, Figure 5 illustrates the results obtained from the analysis of scientific production in SCOPUS. In this context, the trend observed in the previous database continues, with Spanish universities (University of Granada and Autonomous University of Madrid) (Barroso, Rayón, and García, 2023). Their research focuses on

the design and creation of a MOOC based on UDL for training in inclusive education and digital competence in Latin America (University of the Atlantic). The results were positive, proposing future enhancements, such as including a sign language interpreter and opening access to the global community (Herrera, Crisol, and Montes, 2019). Conversely, Barroso, Rayón, and García (2023) analysed the influence of social platforms in education, using data mining techniques to conclude that influential groups play a crucial role in raising awareness and sensitivity towards inclusive education. This analysis was based on examining over 40,000 posts on Twitter and Instagram. Researchers from the University of Zaragoza (Blasco, Bitrián, and Coma, 2022) investigated the impact of the Flipped Classroom model on promoting inclusive education in the classroom. The results indicate that using videos in the classroom enhances student performance and addresses diversity by presenting information in different formats or codes. Furthermore, several literature reviews from universities in Southeast Asia (Choudhary and Bansal, 2022; Kahanurak, Dibyamandala, and Mangkhang, 2022) and Poland (Kochanowicz, 2023) are associated with the development of digital competence and interculturality for the advancement of inclusive education. Additionally, quantitative studies (Bong and Chua, 2023) have been conducted to validate an instrument for advising teaching practices focused on the development of inclusive education.

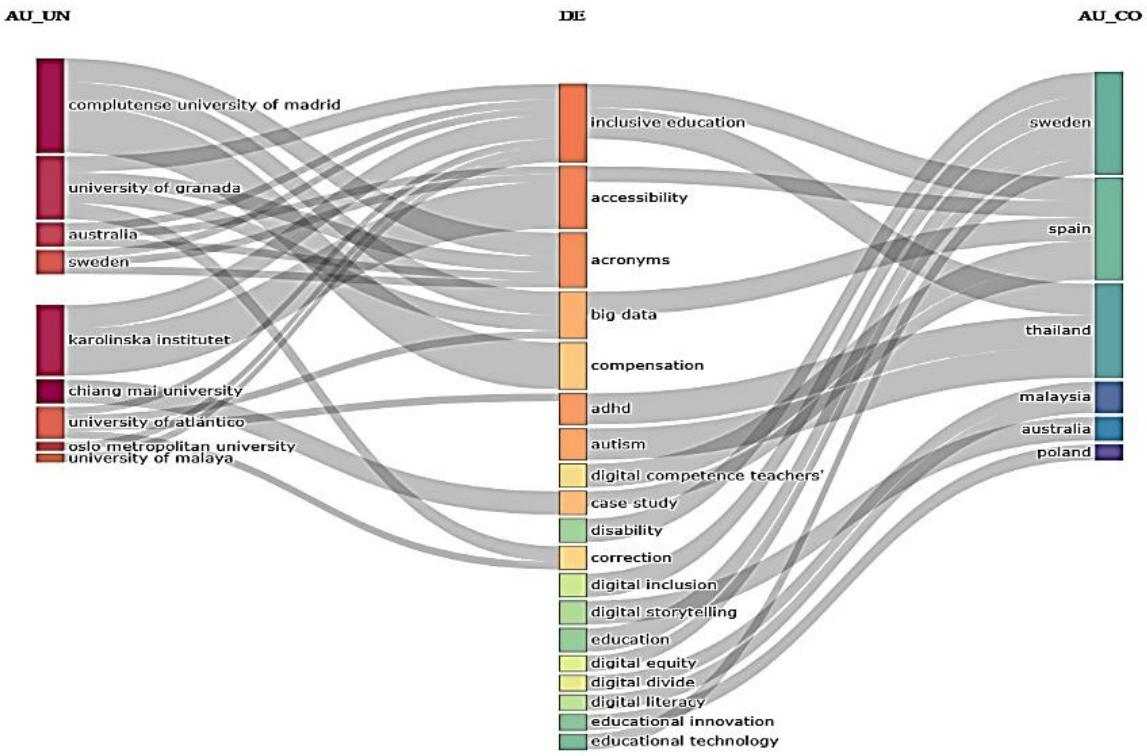

Figure 5: Biblioshiny output for Bibliometrix: Relationship between countries, affiliations, and keywords. SCOPUS

In Figure 6 and 7, the evolution over time of the topics that have generated and continue to generate the most interest in the scientific community is shown, both in WoS and in SCOPUS. It can be observed that there is an upward trend in research related to digital competence, with a significant increase between 2021 and 2022. Similarly, research on digital gaps increased in 2020 and 2021, maintaining its relevance in the last year. Additionally, there has been an increase in interest in studies related to the training of specialist teachers in special education and the principles of universal design for learning since 2021.

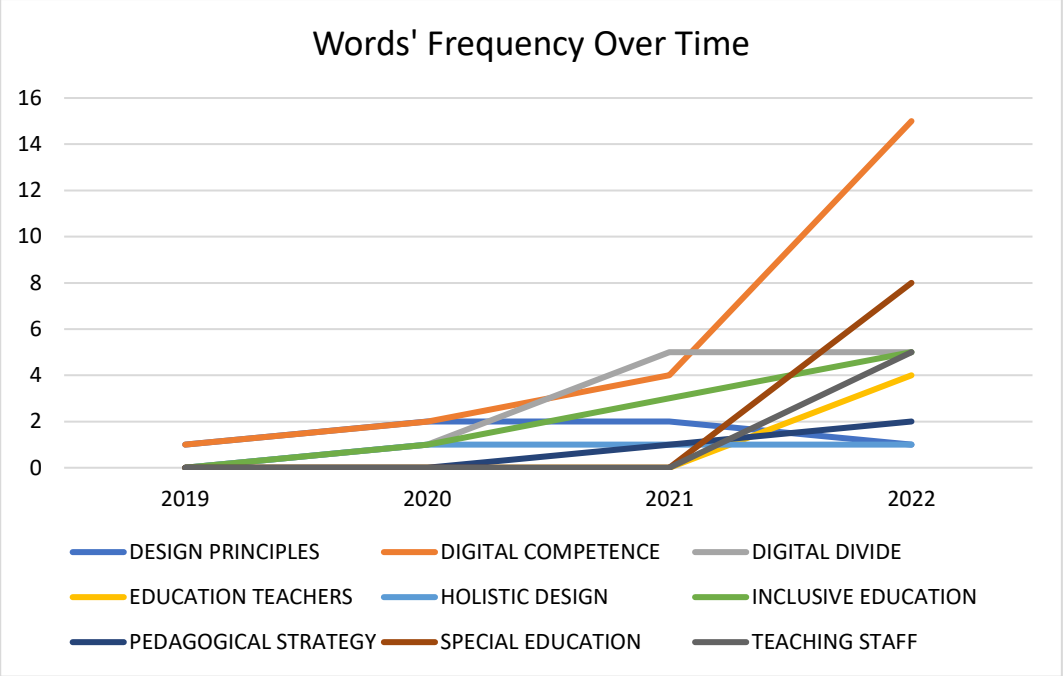

Figure 6: Biblioshiny output for Bibliometrix: Evolution of the topics of interest in the studies analyzed (2019–2023)

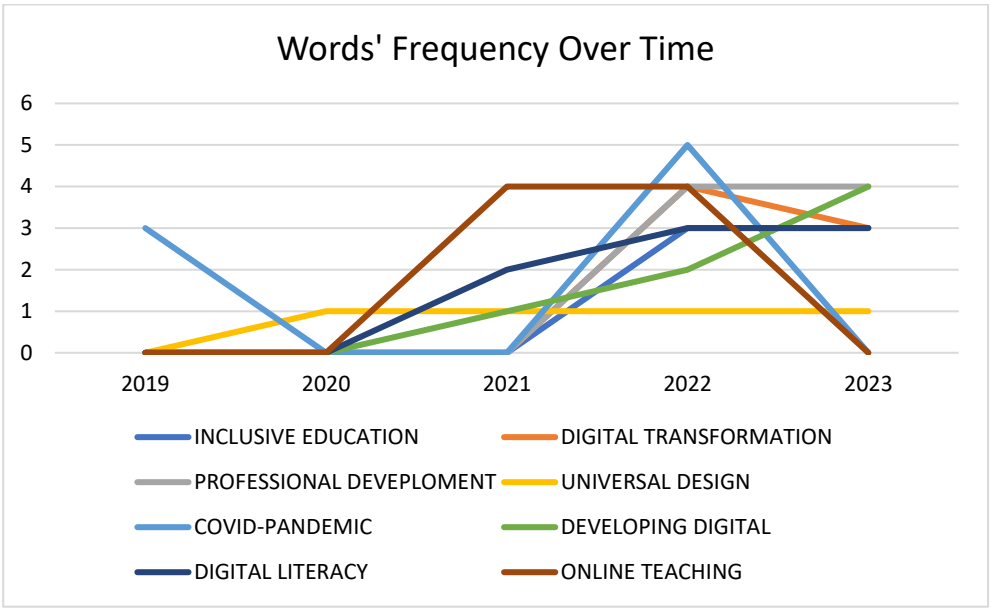

Figure 7: Biblioshiny output for Bibliometrix: Evolution of the topics of interest in the studies analyzed in SCOPUS (2016–2023)

Table 3 presents the results obtained on the conceptual structure of the studied documents. Multiple Correspondence Analysis (MCA) was carried out on the abstracts, as they are a section that all articles have and where more information can be extracted. After the MCA analysis, the existence of two dimensions composed of three clusters is observed, in relation to WoS database. Cluster 1 is formed by the articles of Rodríguez, Calvo and Martín (2020) with 28.21%, followed by Cabero et al. (2022) with 27.03%; Portillo et al. (2020) obtain 21.93%, while Hand (2023), Guo-Brennan (2022), Joshi (2021), and Medina-García et al. (2021) oscillate between 1% and 5%. Regarding cluster 2, it is formed by the articles of Mytsyk and Pryshliak (2022) and Batanero et al. (2022), with 29.32% and 19.74%, respectively. Finally, cluster 3 is composed of Leiva et al. (2022) with 44.35%, Azionya and Nhedzi (2021) with 12.07%, and Nguyen et al. (2022) with 6.48%. With respect to the documents in SCOPUS, we observe that two dimensions have been extracted, each composed of a single cluster where the

document making the most significant contribution is that of Blasco, Bitrián, and Coma (2022), followed by Kochanowicz (2023) and Choudhary and Bansal (2022). The remaining documents contribute between 14-18%.

Table 3: Abstract: Concept structure map. MCA method

Data Base WoS					
Documents	**dim1**	**dim2**	**contrib**	**TC**	**Clúster**
portillo j, 2020, sustainability	0,25	-0,67	21,93	64	1
cabero-almenara j, 2023, br j educ technol	0,81	-0,13	27,03	21	1
azionya cm, 2021, turk online j distance educ	-0,33	-0,42	12,07	7	3
medina-garcia m, 2021, int j environ res public health	0	-0,02	0,01	3	1
joshi ms, 2022, int j educ manag	0,01	-0,17	1,32	1	1
leiva jj, 2022, reice-rev iberoam calid efic cambio educ	-1	0,31	44,35	0	3
mytsyk hm, 2022, inf technol learn tools	-0,02	0,82	29,32	0	2
garcia rodriguez y, 2020, j learn styles	0,71	0,42	28,21	0	1
maria fernandez-batanero j, 2022, rev interuniv form profr-rifop	0,07	0,67	19,74	0	2
ha nguyen hn, 2022, j acad lang learn	-0,35	-0,18	6,48	0	3
hand cj, na, j appl res high educ	-0,14	-0,31	5,08	0	1
guo-brennan l, 2022, j teach learn	0	-0,32	4,46	0	1
Data Base SCOPUS					
blasco ac, 2022, edutec	0,83	0,51	52,8	5	1
choudhary h, 2022, digit educ rev	-0,24	0,62	25,35	3	1
barroso-moreno c, 2023, comunicar	0,57	0,02	18,11	1	1
kochanowicz am, 2023, prz socjologii jakosciowej	0,29	-0,64	28,42	0	1
kahanurak s, 2023, j curric teach	-0,54	0,08	16,43	0	1
bong wk, 2023, educ sci	-0,4	-0,34	15,34	0	1
herrera cr, 2019, aus j educ tech	-0,41	0,31	14,99	0	1

Note: Biblioshiny output for Bibliometrix. Own elaboration.

In Figure 8, concerning the MCA of WoS documents, we can see how cluster 1 was composed of studies on digital competence, virtual learning environments, digital divide, and functional diversity, among others. Cluster 2 comprised studies conducted on digital tools and competencies, inclusive education, educational processes, and digital strategies. Lastly, cluster 3 is composed of educational inclusion related to interculturality and digital competence.

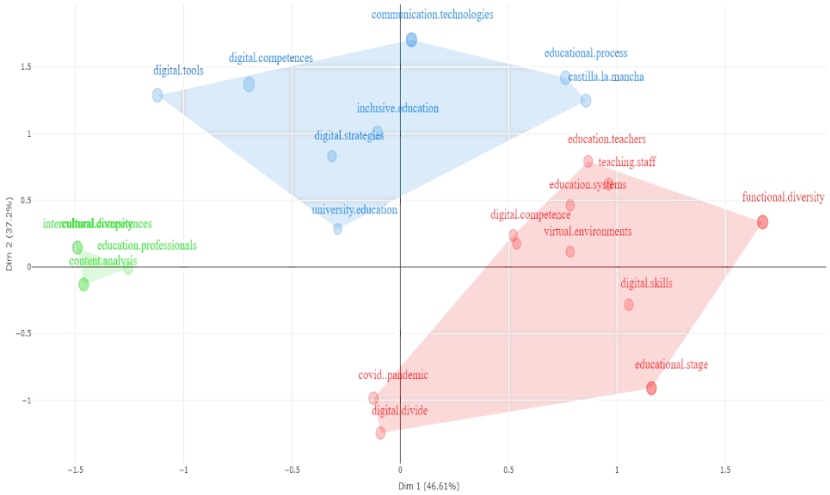

Figure 8: Concept structure graph using multiple correspondence analysis of abstracts

In conclusion, regarding the intellectual structure and social structure, Figure 9 show the co-citation network and the collaboration network among the authors and the institutions they belong to. We can see the co-citation between European and Anglo-Saxon publications, highlighting British Journal of Educational Technology, Computer and Education, Comunicar, Sustainability, Pixel-Bit, Journal of Teaching and Learning, and Information Technologies and Learning Tools.

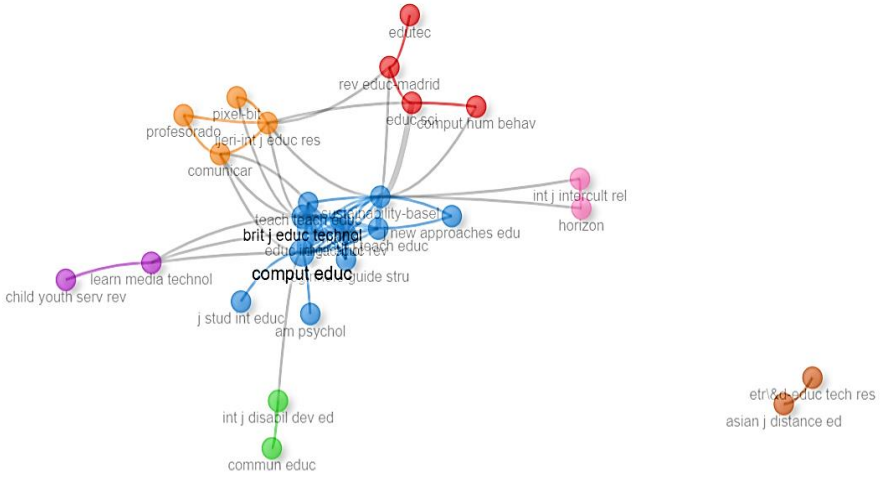

Figure 9: Intellectual structure graph for the source's co-citation network

Finally, regarding the intellectual structure of sources in SCOPUS, based on the co-occurrence network analysis, where terms are considered dependent when their joint usage is prevalent, Figure 10 illustrates how various global common lexical units are interrelated: inclusive, education, learning, digital, teaching, and students. These are interconnected by smaller units such as technologies, content, competence, skills, and improvement, among others.

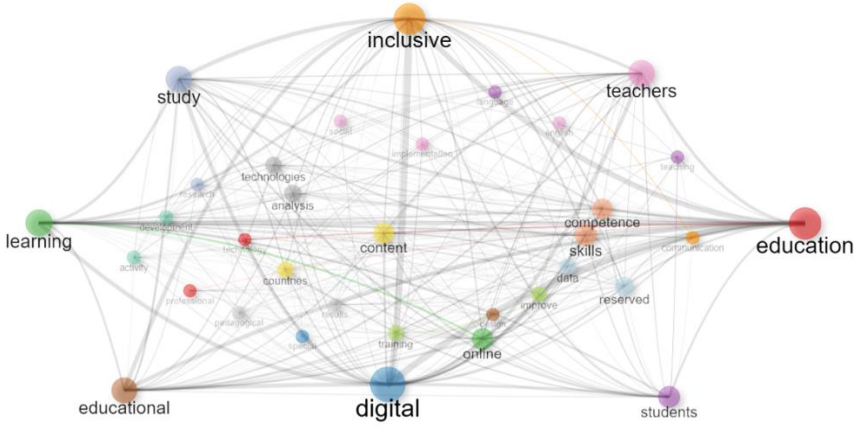

Figure 10: Intellectual structure graph for the sources cocitation network (WoS)

5. Discussion

The international scientific production on digital competence and inclusive education in Higher Education has become prolific in recent years, where there is an increase in the trend of research developed in this regard, both with teachers and students and in reference to the evaluation of training programs implemented in Higher Education institutions. In fact, this coincides with the relevance that the Sustainable Development Goals (SDGs) of Agenda 2030 have taken, specifically with SDG 4, which deals with universalization and education for all (De la Rosa Ruiz, Giménez and De la Calle, 2019).

The study identifies a key barrier to genuine inclusive education: the digital divide in educational contexts, stemming from insufficient resources, infrastructure, and virtual skills. This challenge directly impacts students from disadvantaged backgrounds (Azionya and Nhedzi, 2021). Van der Merwe (2019) emphasizes the emotional well-being and development of affected students. Additionally, Blasco, Bitrián, and Coma (2022) highlight the importance of diverse resources and formats to address classroom diversity.

Portillo et al. (2020) found that post-COVID-19, university teachers faced challenges in virtual teaching due to a lack of training, although their digital competence improved. However, the digital divide and limited training hinder actions for inclusive educational contexts, especially with functionally diverse students (Barroso, Rayón and García, 2023; Batanero et al., 2022; Santana-Valencia and Chávez-Melo, 2022; Walter and Pyżalski, 2022).

Cabero-Almenara et al. (2022) and Medina-García et al. (2021) conclude that teachers, particularly in Higher Education, show medium to low digital competence with functional diversity, with variations by gender, education stage, and age. Deficiencies in teacher training, especially in content creation for diverse students, pose a priority (Belenkova, Skudnyakova and Bosov, 2022; Bong and Chua, 2023; Coker and Mercieca, 2023; Chorosova et al., 2021; Jiménez-Hernández et al., 2020; Masalimova et al., 2022).

Joshi (2021) advocates for holistic learning environment designs in Higher Education for quality inclusive education, aligned with Guo-Brennan (2022) reflecting on global spaces. Methodological changes and teacher training are linked to improved digital competence and progress toward inclusive education (Rodríguez, Calvo, and Martín, 2020; Hand, 2023). However, deficiencies persist in training programs and designing inclusive educational environments (Choudhary and Bansal, 2022; Herrera, Crisol, and Montes, 2019).

Another element to consider when dealing with diversity and heterogeneity in the classroom, and therefore, to pay attention to when discussing inclusive education, is interculturality and how the use of technologies can lead to learning that develops digital and intercultural competencies, fostering creativity, empathy, and support between teachers and students. It also facilitates a shift in focus from diversity to difference and developing intercultural sensitivity (Leiva et al., 2022; Nguyen et al., 2022). We live in a globalized world, with large migratory flows, where cultural diversity exists both in face-to-face environments and in online contexts, favoring communication and acceptance of diversity (Bauman and Portera, 2021; García-Vita et al., 2021; Kahanurak, Dibyamandala and Mangkhang, 2022; Kochanowicz, 2023).

This review has several limitations that should be considered. First, it is a systematic review and documentary analysis that involved 21 studies with great heterogeneity. Due to the small sample size, the results obtained and the data generated have a lower percentage of generalization compared to studies that use larger samples.

Second, the sample sizes in the analyzed studies varied considerably, both in the number of participants and in the type of sample, ranging from teachers and students (Medina-García et al., 2021; Batanero et al., 2022; Belenkova, Skudnyakova and Bosov, 2022; Batanero et al., 2022; Leiva et al., 2022; Hand, 2023) and the design of virtual and inclusive educational environments through universal design for learning (Begnum, Pettersen and Sørum, 2019; Joshi, 2021; Guo-Brennan, 2022), to the analysis of training programs and scientific literature (Bong and Chen, 2021; Joshi, 2021), making it difficult to determine the representativeness of the study population. Additionally, most studies did not provide information on how sample sizes were estimated within the selected population. Third, the research methodologies used in the different studies were also very heterogeneous, making data comparison difficult. Some studies used case studies and qualitative methods, while others used quantitative approaches and methods, with statistical regression and structural equation analyses, among others.

6. Conclusions

In conclusion, this study aimed to update the scientific framework in the field of digital competence and inclusive education within Higher Education, utilizing the Web of Science (WoS) and SCOPUS databases. The systematic review assessed research methodology and quality, employing established variables through a literature review on relationships between search criteria to aid decision-making. Initially analyzing 134 articles based on inclusion criteria, after a documentary review and application of exclusion criteria, the sample was narrowed down to 21 scientific articles published between 2016-2023.

The study explored the link between digital competence and inclusive education, examining variables like functional diversity, interculturality, digital divide, teacher training, universal design for learning, and the need to reformulate curricula for effective education for all. Significantly, the topic's relevance has grown in the last five years due to the COVID-19 pandemic and alignment with the goals of the European 2030 Agenda. This

approach allows researchers to identify patterns, relationships, and research gaps, providing valuable insights for future investigations and enhancing the overall understanding of the subject.

Digital competence is crucial for 21st-century life and quality inclusive education. Acquiring digital skills and using technology effectively are pivotal for success in education and the professional realm. However, true inclusive education must extend accessibility to everyone, including those facing challenges with technology access and usage. Digital technologies can serve as potent tools to foster inclusion and diversity in the classroom, aligning with EU Digital 2030 policies and empowering individuals through a human-centric approach. The Digital Decade 2021 emphasizes universal access to the internet, digital skills, digital public services, and fair working conditions for everyone.

The study implies significant considerations for stakeholders in Higher Education: institutions should revise curricula for inclusive education and adhere to universal design principles; students need digital inclusion, citizenship development, and attention to the digital divide, interculturality, and functional diversity. Faculty members require essential teacher training to proficiently integrate technology, emphasizing technical skills and understanding how to enhance learning experiences while accommodating individual student needs. Digital competence is vital for inclusive education, empowering teachers to tailor learning approaches to individual student requirements. However, despite the importance of digital competence for inclusive education, many teachers still lack the necessary skills to effectively use technologies in the classroom. Beyond this, it is essential that educational policies favour and enable inclusive education and teacher training in digital competence to address the needs and challenges of society, ensuring education for all. In conclusion, it is worth mentioning that, at the time of conducting this study, there was no evidence of scientific production in the Web of Science (WoS) and SCOPUS databases conducting a relational bibliometric analysis on digital competence and inclusive education. For this reason, this study serves as a foundation for future research.

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Challenging the Status Quo: Open Journal Systems for Online Academic Writing Course

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Abstract: Doctoral students require scientific writing skills and appropriate learning media assistance to meet publication requirements in distinguished journals. This investigation evaluates the efficacy of Moodle and OJS in teaching dissertation proposals, based on the experiences of engineering doctoral students, to provide suggestions for the optimal platform. The study examining the efficacy of the OJS-based learning model for developing dissertation proposals as compared to Moodle for engineering doctoral students revealed varying results based on the statistical methodology used by UEQ. While the Comparison of Scale Means indicated OJS to be superior across all scales, the Two-Sample T-Test established significant differences solely on a few scales. While the OJS learning model may have a higher mean value, its superiority across all aspects of UEQ cannot be assumed. To enhance student learning experience, outcomes, and the learning model itself, optimization of all UEQ scales is imperative in the OJS-based approach to dissertation proposal development.

Keywords: User experience, Writing, Open journal systems, Moodle, Engineering doctoral students

1. Introduction

The ability to write scientific papers at a doctoral level is a complex skill that is essential for students. Doctoral students carry the added responsibility to publish their research results in reputable scientific journals (O'Keeffe, 2020; Yeung, 2019). Such a complex skill along with the obligation to publish necessitates suitable learning resources, particularly for engineering doctoral students (Kasparkova and Rosolová, 2020).

In recent years, experts in various fields have extensively reviewed several studies on the use of learning media to support the teaching of scientific writing. Some authors discuss the creation of accessible online learning environments (O'Flaherty and Costabile, 2020), the impact of research writing tutors during revision (Cotos, Huffman and Link, 2020), problem-based learning on enhancing problem-solving and scientific writing skills (Sari et al., 2021), and how the use of learning media and pedagogical approaches can enhance the teaching of scientific writing for doctoral students (Leberecht, 2021). Additionally, other scholars explore the various challenges and supports associated with academic writing (Gupta et al., 2022); Gupta et al. (2022) propose a virtual writing workshop, while Bottomley and Bourgeois (2022) suggest a similar method. Hands and Tucker (2022) advocate for writing pedagogy. Recent studies indicate that the use of WeChat (Qingguo, 2023) and ChatGPT (Huang and Tan, 2023) can enhance scientific writing and improve publication quality through publication-based training frameworks (Kuswandi et al., 2023). Based on the findings of this study, the utilization of electronic learning platforms serves as a substitute for instructors who teach scientific writing.

Based on the findings of this study, the utilization of electronic learning platforms serves as a substitute for instructors who teach scientific writing. Incorporating digital learning tools into the realm of scientific writing has opened up a world of thrilling prospects for students' educational journey. The thorough investigation of student user experience in utilizing such platforms is a new and promising focal point despite the widespread attention that the concept has received (Guo, 2021; Mirallas, 2021; Oktarina, Indrawati and Slamet, 2022; Weaver, Taylor and Osborn, 2019). The integration of technology and enhanced user experience will revolutionize our understanding of how student interactions with electronic platforms impact efficiency, creativity, and the outcome of scientific writing (Eppler et al., 2021; Meletiadou, 2021). Combining research on electronic platforms and user experience studies can provide deeper insights into novel methods for enhancing the learning process and advancing engineering doctoral students' scientific writing capabilities (Haidari, Katawazai and Yusof, 2020; Vurdien and Vurdien, 2020). Creating dissertation proposals is one type of scientific writing activity.

One online learning platform utilized for scientific writing purposes is Moodle (Raouna, 2023). State University of Malang (UM) uses Moodle as its online learning platform, which is named Learning System in Network (SIPEJAR); hereinafter referred to as Moodle. The dissertation proposal development course for doctoral

Reference this paper: Herdianto, R. et al., 2024. Challenging the Status Quo: Open Journal Systems for Online Academic Writing Course, *The Electronic Journal of e-Learning, 22(1)*, pp 46-62, available online at www.ejel.org

engineering students is a follow-up to the scientific writing course, managed within Moodle at SIPEJAR (UM, 2020). The SIPEJAR system, based on Moodle, does not effectively aid the learning process in dissertation proposal development courses. This is consistent with findings reported by El-Maghraby (2021), Fernando (2020), Campo, Amandi and Biset (2021), and Hasan (2021), all of whom exposed the limitations and obstacles associated with utilizing Moodle for the purpose of scientific writing education.

Thus far, despite its widespread use as an online learning platform, Moodle has limitations for learning scientific writing or developing dissertation proposals. These limitations include the lack of peer review and dialogic feedback features (Fernando, 2020), as well as the inability to record results of reviews and feedback (Elizarov, Zuev and Lipachev, 2014). Based on this issue, the author suggests a novel approach by examining the potential of Open Journal Systems (OJS) as an alternative online learning platform in addition to Moodle, which was formerly exclusively a content management and editorial process for scholarly journals (Herdianto et al., 2022). Nevertheless, prior to implementing this solution, it is imperative to thoroughly comprehend the user experience contrast between Moodle and OJS. It is crucial to understand the interaction between these two platforms and their impact on user satisfaction, usability, ease of use, and learning (Schrepp, Hinderks and Thomaschewski, 2017). This knowledge is fundamental to ensure appropriate implementation of OJS and enhance students' learning experience.

This study aims to objectively compare the efficacy of Moodle and OJS as learning platforms for the development of dissertation proposals, based on the experiences of engineering doctoral students. The paper adheres to conventional academic structure and employs clear, value-neutral language, with precise subject-specific vocabulary and correct grammar, spelling, and punctuation. Both qualitative and quantitative data analysis methods were used to ensure a balanced approach, and technical term abbreviations were explained upon first use. The research endeavors to elucidate the key factors that influence students' learning experiences and provide guidance in selecting an appropriate platform.

2. Method

To measure a product or service's user experience (UX), the User Experience Questionnaire (UEQ) is one method utilized. This method incorporates a questionnaire that comprises 26 items rated based on six scales which include attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty (Schrepp, Hinderks and Thomaschewski, 2017). To assess the UX of the learning model using OJS and Sipejar (Moodle), the UEQ method was adopted due to its fast, uncomplicated, and efficient nature in gauging overall UX.

2.1 Subject

A total of sixty postgraduate students from the Faculty of Engineering at State University of Malang were selected as research subjects for the study. These students participated in a semester-long dissertation proposal development course. The students were divided into two groups of thirty each, with one group utilizing OJS and the other group using Moodle as part of their learning experience.

2.2 Research Instrument

The UEQ questionnaire grid consists of 6 dimensions, as follows (1) Attractiveness: This dimension measures how attractive the product or service is to the user. (2) Clarity: This dimension measures how clear the product or service is to the user. (3) Effectiveness: This dimension measures how easy and efficient the product or service is to use. (4) Reliability: This dimension measures how reliable the product or service is. (5) Stimulation: This dimension measures how interesting and fun the product or service is. (6) Novelty: This dimension measures how new and innovative the product or service is.

The UEQ questionnaire uses a 7-point Likert scale, as follows Strongly Disagree, Disagree, Somewhat Disagree, Neutral, Somewhat Agree, Agree, Strongly Agree (Figure 1). The questionnaire used in this study is the Indonesian version. The UEQ scale can be divided into pragmatic quality/classical usability aspects (clarity, efficiency, reliability) and hedonic quality/user experience aspects (stimulation, novelty). Pragmatic qualities describe task-related quality aspects, while hedonic qualities are non-task-related quality aspects.

Less attractive	○	○	○	○	○	○	○	**Attractive**

Figure 1: UEQ seven-point Likert scale example

2.3 Data Collection and Analysis

At the end of the semester, all students taking the Dissertation Proposal Development course from the OJS and Moodle user groups completed the 26-item User Experience Questionnaire (UEQ). The following procedures were followed. (1) Creation of the UEQ in a Google form adapted to the research context. (2). Online distribution of the UEQ via google form to each group of OJS and Moodle users. (3) After students completed the UEQ, they sent it back to the researcher for data processing.

The data set received was 60 responses to UEQ questions, consisting of 30 responses to OJS class UEQ and 30 responses to Moodle class UEQ. All data is processed using data analysis tools provided by UEQ. Once all the data is processed, the UEQ results between the OJS class and the Moodle class are compared. The document presents a simplified t-test to determine whether the means of two measured products are significantly different. The following sequentially mentioned data obtained from calculations using UEQ tools are: (1) OJS and Moodle class user experience data set, (2) UEQ scales (mean and variance), (3) pragmatic and hedonic quality, (4) benchmark, (5) comparison of scale means, (6) two-sample t-test.

3. Results

3.1 UEQ Results OJS and Moodle Based Learning Model

The results of the UEQ for OJS and Moodle show that both online platforms used as learning media have generally met users' expectations. However, OJS has some advantages over Moodle in terms of attractiveness, clarity, efficiency, accuracy, stimulation, and novelty (Table 1).

Furthermore, the average UEQ score of the OJS-based learning model is 1.89 and that of Moodle is 1.39 for all six scales. This result means that, on average, users rate the user experience of OJS higher than that of Moodle. The UEQ is measured on a scale from -3 to +3, with 0 being neutral. A positive value indicates a positive rating, while a negative value indicates a negative rating (Schrepp, Hinderks and Thomaschewski, 2017). Therefore, the values of 1.89 for OJS and 1.39 for Moodle indicate that both platforms are rated positively by users, but OJS is rated more positively than Moodle (Figure 2).

Table 1: Comparison of Scale Means

Scale		OJS		Moodle	
		Mean			
Attractiveness	Attractiveness		2,02		1,57
Perspicuity	Pragmatic Quality	1,91	1,92	1,48	1,42
Efficiency		1,94		1,47	
Dependability		1,92		1,33	
Stimulation	Hedonic Quality	1,96	1,78	1,29	1,24
Novelty		1,60		1,19	
Means			1,89		1,39

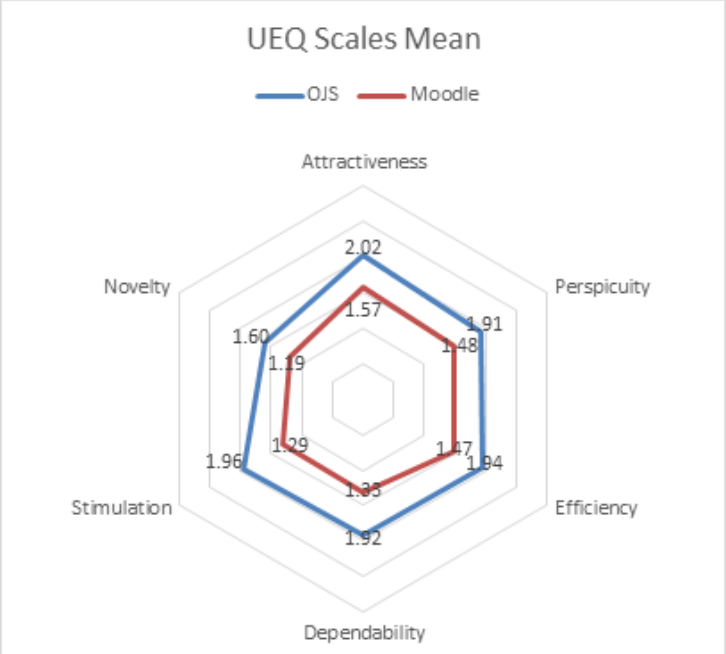


Figure 2: Visual Diagram of Scale Means Comparison

3.2 OJS and Moodle Benchmark

A benchmark in UEQ is a standard or reference used to compare the results of User Experience Questionnaire (UEQ) measurements on a particular product or service with the results of UEQ measurements on other products or services. Benchmark UEQ can help evaluate the UX quality of a particular product or service and compare it to similar products or services in the market.

Based on the scale means of the UEQ benchmark results of the OJS class, the scale means of Attractiveness, Efficiency, Dependability, and Stimulation are in the excellent category, while Perspicuity and Novelty are in the good category (Figure 3). While the scale means of the UEQ benchmark results of the moodle class show all scale means in the above average category except for Novelty in the good category (Figure 4).

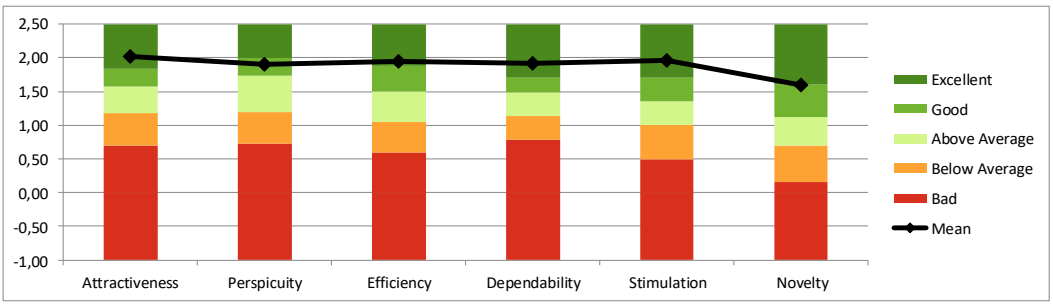


Figure 3: OJS Benchmark Results

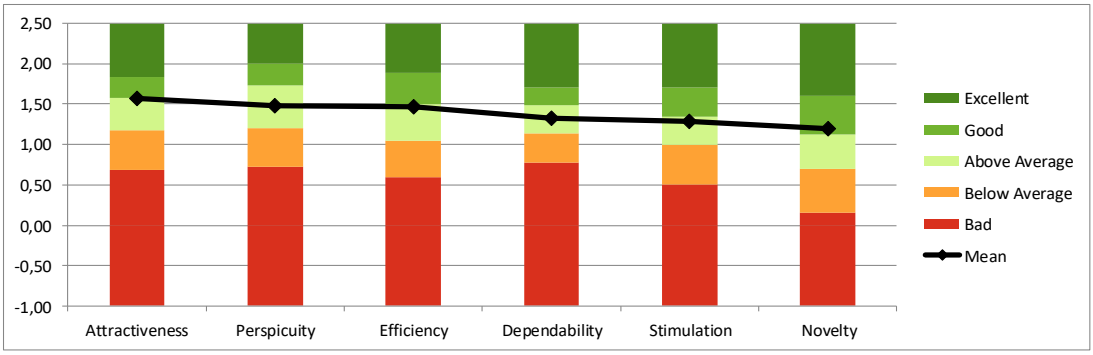


Figure 4: Moodle Benchmark Results

Calculations by the UEQ product comparison tool show the results of a two-sample t-test assuming unequal variances to test whether there is a significant difference between the measured means of the learning models using OJS and Moodle (Table 2). Two-sample t-tests assuming unequal variances are a more accurate method than two-sample t-tests assuming equal variances. The default alpha level is 0.05. In general, the comparison of scale means of the OJS class is higher than that of Moodle (Figure 5), but the results of the two-sample t-test with unequal variances show insignificant differences in the scales for Perspicuity, Efficiency, and Novelty. Attractiveness, Reliability, and Stimulation show significant differences.

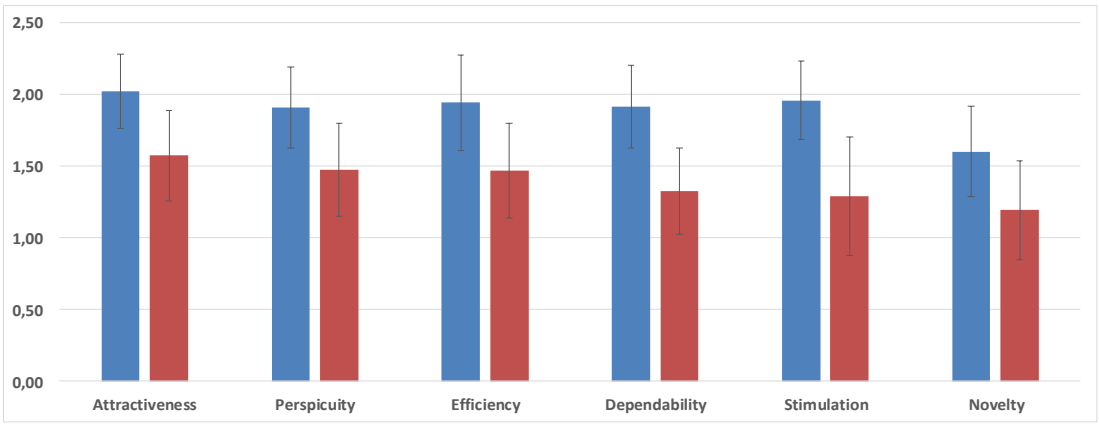


Figure 5: Comparison of Scale Means

Table 2: Two Sample T-Test Results (UEQ Compare Products Tools)

Two sample T-Test assuming unequal variances This sheet shows a simple T-Test to check if the scale means of two measured products differ significantly. As default the Alpha-Level 0.05 is used, but you can simply change this value in this sheet if you want to use a different level.		
Alpha level: 0,05		
Attractiveness	0,0361	Significant Difference
Perspicuity	0,0527	No Significant Difference
Efficiency	0,0518	No Significant Difference
Dependability	0,0072	Significant Difference
Stimulation	0,0112	Significant Difference
Novelty	0,0924	No Significant Difference

4. Discussion

4.1 Attractiveness

The results of the comparison between the OJS and Moodle-based learning models for dissertation proposal development, based on the Attractiveness UEQ results, showed significant differences. The OJS model has a higher Attractiveness UEQ value (2.03) compared to Moodle (1.57), indicating that students are more engaged, have a better learning experience, and feel more comfortable when using OJS. The quality of the OJS-based learning model was also rated as better in supporting the development of dissertation proposals. These findings confirm the superiority of OJS as a more engaging and effective learning platform in this context, but the selection of a learning model should still take into account students' needs and preferences, as well as specific teaching objectives (Priego and Peralta, 2013; Stufft and Brogadir, 2011).

OJS is primarily designed for scholarly publishing, not learning. However, OJS can be a useful tool for educators and students interested in publishing their research or teaching materials in a scholarly format and can be used to enhance teaching and learning by creating an authentic peer review process for students (Hurkett, 2018; Koskinen, Roinila and Syvälahti, 2021). The use of OJS as a learning platform, especially for the development of dissertation proposals, is a breakthrough in creating a positive learning experience, and the high quality of the learning model and user convenience are key factors in higher education (Ho, Cheong and Weldon, 2021).

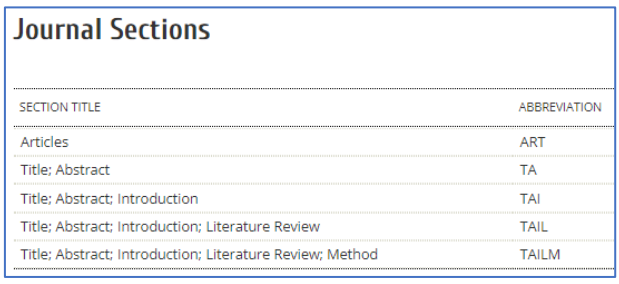
Reigeluth found that a positive and effective learning experience in higher education involves four main components: motivation, comprehension, evaluation, and application (Reigeluth, Beatty and Myers, 2016). In the context of the OJS learning model, these components are well integrated to create a positive learning experience. First, OJS provides motivation through attractive and effective design, which motivates students to engage in the learning process. Overall, attractive and effective design can be used to motivate students to engage in the learning process in higher education (Hooshyar et al., 2019; Van Hanh, 2020).

Second, the learning platform assists students in comprehending the course material through its provision of a range of learning resources and tools, including learning modules, discussion forums, and tutorials (Arora, 2021; Mabasa, 2023). Thirdly, the platform facilitates student evaluation and feedback by offering assessment tools that enable supervisors to provide comments and suggestions directly, thereby supporting students in achieving their educational objectives. Finally, the Open Journal Systems (OJS) platform enables students to apply their learning materials in real-life contexts through exercises, imulations, and projects (PKP, 2023).

OJS is among the e-learning platforms that support life-based learning in real-world situations. OJS offers a robust and diverse learning experience that allows students to gain practical and theoretical knowledge. Lecturers can develop relevant learning activities that assist students in developing skills and knowledge that are applicable in the workplace or daily life. The incorporation of a Life-Based Learning approach within the OJS-based learning model enhances students' engagement and comprehension by demonstrating the material's relevance to their daily lives and learning objectives. According to Widianto, Purwasih and Perguna (2020), the integration of Life-based learning through E-LMS amplifies students' comprehension of community practices and knowledge construction. It also allows students to cultivate self-direction, ongoing inquiry, adaptability, and sustainability in preparation for the challenges of the 21st century post-graduation (Muntari et al., 2021). Additionally, the quality of the OJS-based learning model plays a pivotal role in enhancing students' learning experiences.

The selection of Open Journal Systems (OJS) as a platform for developing dissertation proposals considers student characteristics (Man, Nural Azhan and Wan Hamzah, 2019), learning objectives (Manescu, 2013), and resource availability for ensuring high quality (Madusanka et al., 2023). OJS is adaptable to accommodate diverse student characteristics by offering flexibility in terms of time and location, enabling students to access learning materials according to their own schedules and preferences (Owen, 2008). Interactive features, such as chat rooms and discussion forums, are embedded in OJS to promote student and supervisor collaboration, which enhances engagement in learning. While OJS version 2 does not provide full support for online discussion forums, OJS version 3 offers online interaction capabilities.

Additionally, it is essential to consider the learning objectives. The Open Journal System (OJS) can be customized to attain precise educational goals, such as furnishing structured learning modules and explicit steps to aid students in their dissertation proposal development. Figure 6 exemplifies the four components designed for the dissertation proposal development course. Every student must complete these four stages to ensure a well-organized and structured approach to composing a dissertation proposal in scientific article format (PKP, 2022). A gradual learning process is a efficacious methodology for learners to attain knowledge and skills in a meaningful and enduring way (Caetano, Luedke and Antonello, 2018; Penissi, 2021). Avoiding subjective evaluations, ensuring clear and concise language, maintaining conventional structure, utilizing objective and value-neutral language, adhering to style guides, and utilizing hedging techniques while avoiding biased phrasing and unclear sentence construction are essential components in the creation of high-quality academic writing. Additionally, precise word choice, correct grammar, and appropriate punctuation contribute to the overall excellence of the written work.



Journal Sections

SECTION TITLE	ABBREVIATION
Articles	ART
Title; Abstract	TA
Title; Abstract; Introduction	TAI
Title; Abstract; Introduction; Literature Review	TAIL
Title; Abstract; Introduction; Literature Review; Method	TAILM

Figure 6: Journal Section

Finally, it is crucial to consider resource availability (Savin, 2020). OJS can enhance access to pertinent resources, including reading materials, scientific journals, and related references, for students. Furthermore, OJS is capable of integration with various learning platforms, including YouTube, social media, open educational resources, and research tools, thereby enhancing students' comprehension and proficiency while composing dissertation proposals (refer to Figure 7). Furthermore, OJS's features are tailored to facilitate students' dissertation proposal writing learning process.

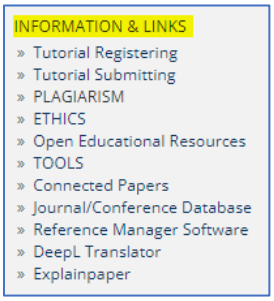


Figure 7: Educational resources link on the OJS sidebar

Considering student characteristics, learning objectives, and resource availability, utilizing OJS as a learning model platform for developing a dissertation proposal can offer both convenience and high-quality learning experiences for students. Furthermore, according to the constructivism learning theory framework, students construct their own knowledge through active interaction with learning materials. Thus, the quality of the learning model is crucial for facilitating deep understanding (Pundir and Surana, 2016).

The efficacy of the learning model in promoting deep comprehension is pivotal, as is the degree of comfort students experience when engaging in OJS-based dissertation proposal development learning. The results of both the UEQ and statistical analyses indicate a substantial contrast between student comfort levels when interacting with the OJS-based dissertation proposal development learning model and the moodle. Alojaiman (2021) confirms that the choice of platform used strongly influences student comfort in the learning process.

To support effective student learning, an OJS-based learning model must prioritize several crucial aspects, with ease of use being essential. Achieving ease of use involves user-friendly design and intuitive navigation, as emphasized by Abuhlfaia and Quincey (2018). In order to ensure the quality of learning, it is crucial that the learning materials are relevant to the needs and interests of students (Sutini, Emzir and Rasyid, 2021). Additionally, proper facilities should be available to support interactive and independent learning processes (Kuo et al., 2014). Finally, the role of instructors in delivering quick and precise feedback on student work is vital for enhancing the quality of learning (Dawson et al., 2019).

Furthermore, the learning model for developing dissertation proposals that utilizes the OJS digital platform holds potential for personalizing and adapting content to individual preferences. The materials relevant to article anatomy, publication ethics, academic writing, composing papers, research tools, drafting, and layouting are available as an example for lecturers to present the most pertinent information to students in accordance with their course (refer to Figure 8). The alignment of learning materials with students' needs and interests within the dissertation proposal development course is essential for the achievement of successful learning outcomes.

GENERAL	TEACHING MATERIALS	STUDENT	RESEARCH TOOLS
- Introduction	- Paper anatomy	- Author Guideline	-VOS Viewer
- Similarity check	-Publication Ethics	- Online Submission	-Biblioshiny
-OER	-Academic Writing	- Scispace	-Elicit
- License	- Composing Paper	- LEX	- Research Rabbit
-User Experience	- Research Tools	-Litmaps	-ZoteroBib

Figure 8: Materials Required for OJS Dissertation Proposal Development Courses

4.2 Perspicuity

Based on the results of a two-sample T-test assuming unequal variances, there is no significant difference between the OJS-based and Moodle-based learning models for dissertation proposal development. However, it is noteworthy that the OJS class (1.91) outperformed the Moodle class (1.48) according to the Scale Means comparison. The results of the two-sample T-Test indicate no significant difference between OJS and Moodle-based learning models in terms of their performance in the Perspicuity aspect of UEQ.

Various factors could be attributed to the lack of significant difference experienced when students utilize OJS and Moodle-based models, including the quality of learning content. It is important to note that both OJS and Moodle function solely as platforms to present learning material. The quality of the academic content is the main determinant of successful learning. If the content is of high quality, students will be able to learn effectively irrespective of the platform. As explained by Hökkä et al. (2022), Hou, Li and Wang (2021), and Razak, Rahman and Moktar (2021), the selection of learning models and development of learning content should take into account several factors, including accuracy, reliability, relevance, usability, interactivity, multimedia, accessibility, user-friendliness, and pedagogical approach.

Additionally, students' ability and motivation are crucial factors beyond the quality of learning content. If students possess adequate skills and motivation, they can learn successfully irrespective of the learning environment utilized. For instance, digital literacy (Araniri et al., 2021), student motivation (Attention, Relevance, Confidence, and Satisfaction), student outcomes (knowledge, skills, and attitudes) (Yahiaoui et al., 2022), and students' temperament (Mo, Jin and Jin, 2022) have a significant impact on learning achievement irrespective of the platform employed.

Furthermore, the learning procedure is a crucial element to consider. An effective learning process is essential for successful education. Thus, a combination of these various factors is required for an effective learning process. It can help to maximize the potential of the platform being used. Achieving an effective process involves classroom management (Iacob and Muşuroi, 2021), learning strategies (Sumeracki and Weinstein, 2018), collaborative learning, effective communication, teacher-student interaction (V. Kumar and Sharma, 2021), and adaptive learning (Khedr, Idrees and Alsheref, 2019). These factors can greatly influence learning success and aid in comprehension of dissertation proposal development.

Earlier factors affect ease of understanding dissertation proposal development regardless of platform selection, but there is a higher Comparison of Scale Means value in the OJS class than in the Moodle class. This suggests that users find it easier to comprehend and utilize OJS when learning dissertation proposal development compared to Moodle. A T-Test is a statistical analysis utilized to ascertain if there is a significant difference between two groups' means (Liang, Fu and Wang, 2019; Setyosari, 2015). In contrast, a Comparison of Scale Means directly compares the means of two groups (N. Kumar and Goyal, 2018). Therefore, if the T-Test indicates no significant difference, the Comparison of Scale Means may still detect a difference in their means (Çoban and Yildirim, 2018).

Several reasons suggest that OJS may be easier to use than Moodle based on the Comparison of Scale Means. Firstly, OJS's interface design may be more intuitive and align better with users' preferences, providing it with an advantage in clarity. Additionally, the characteristics of the course on dissertation proposal development closely relate to scientific writing mentoring. While the Open Journal Systems (OJS) is deliberately created for the purpose of managing and publishing scientific journals, it features a peer-review process that provides intensive writing assistance (Hurkett, 2018). Due to its exceptional interface design and manuscript management process, the OJS is highly appropriate for dissertation proposal development courses.

Secondly, users' familiarity with the platform can influence their comfort and confidence in using it. Familiarity with e-learning platforms yields advantages such as ease of use, time savings, enhanced learning outcomes, customization, collaboration, personalization, and flexibility (Alojaiman, 2021; Yuen, 2012). When students are familiar with the OJS platform, their comfort and trust in using it will increase, enhancing the perspicuity aspect of the OJS-based dissertation proposal development learning model compared to Moodle.

Third, OJS offers more robust features and functionality for presenting information clearly and facilitating navigation in learning dissertation proposal writing than the Moodle platform. OJS provides peer review, editing, multi-format publishing, structured archives, flexible access rights systems, and usage statistics (Adler and Liyanarachchi, 2015). All elements are displayed in a customizable interface for the dissertation proposal development course. Furthermore, the editorial review process can be tailored into multiple sections according to the scientific article format's dissertation proposal writing stages.

Customizing the editorial review process in Open Journal Systems (OJS) enables editors to modify the review workflow by selecting a single/double blind review model, open review, or editorial review (Kim et al., 2018). Reviewers can use specially designed assessment forms to evaluate the quality of titles, abstracts, introductions, literature studies, and methods, and automatic notifications can be established for effective communication between instructors and learners. Regular formatting of the section headings and author and institution details must be maintained to ensure conciseness and clarity in the document. It is also essential to use objective and

neutral language, avoid biased and ornamental expressions, and stick to standard sentence structure to improve the manuscript's grammatical correctness and academic writing quality. This aligns with Willy et al.'s (2017) research, which created an automated rating recommendation system within the review form to assist editors in evaluating the quality of peer reviewers. In the context of dissertation proposal development, implementing the recommendation system can boost the overall quality and efficiency of the learning model.

Additionally, a streamlined registration and submission process, an effective feedback system for constructive criticism from supervisors, regular notifications regarding proposal status, and a repository for easy access to published proposals, aid in enhancing student comprehension when engaging in learning. OJS provides comprehensive system support for students during the dissertation proposal writing process. Caminero et al. (2013) stressed the importance of the availability and suitability of features in the LMS in facilitating student learning.

The comprehensibility and learnability of a learning model often hinge on the complexity of its structure and presentation during instruction. A properly organized learning model with a clear structure and straightforward presentation of the materials it contains can facilitate students' comprehension of the concepts covered. Clear instructions and materials are essential in the learning model to enable students to focus and comprehend the learning objectives. The resultant effect is a simplified and effective learning experience for all students.

4.3 Efficiency

Regarding efficiency, there exists no significant distinction in outcomes between a learning model based on OJS and one utilizing Moodle. The Two Sample T-Test result is 0.0518, with a comparison of scales indicating Mean OJS = 1.94 and Mean Moodle = 1.47. The unimportance of the statistical test outcomes can be clarified by examining the speed of material comprehension, efficiency, practicality, organizational structure, and learning materials.

Students learn to develop dissertation proposals on Moodle and OJS. They have the same experience with regard to material comprehension speed. This finding was confirmed by a Two Sample T-test. The similarity in experience can be attributed to the similar design and features of both systems. The similarity in experience can be attributed to the similar design and features of both systems. For instance, the online platform provides unrestricted access to learning resources, enabling students to learn conveniently. The teaching materials can be customized to suit students' individual learning needs, and organized methodically to facilitate comprehension. Additionally, multimedia elements can be integrated into the learning materials to enhance their engagement and clarity. Furthermore, interactive sections, such as discussion forums, quizzes, and assignments, are available to stimulate students' participation and evaluation. Notably, some of the features may differ between the OJS and Moodle-based dissertation proposal development learning systems (Moodle, 2023; PKP, 2022).

In terms of the practicality and organization of learning materials for developing dissertation proposals, the reliability of OJS and Moodle is more or less equal. Moodle (2023) and PKP (2022) provide similar examples. For instance, both platforms offer user management features such as creating user accounts, assigning user roles, and managing user profiles, as well as metadata management features. Metadata management features enable managers to manage metadata and simplify tagging and content retrieval. Additionally, a statistic management feature allows managers to access usage statistics, including visitor numbers and content downloads.

While the research suggests that both learning models have comparable efficiency, significant differences exist between the two when applied to dissertation proposal development. The OJS-based learning model has distinct advantages for this purpose, as outlined in Herdianto's (2022) explanation. (1) The collection of student writing in this case pertains to the work that has successfully undergone the mentorship and review process with the instructors. (2) The editorial assessment method is implemented during the educational process, specifically involving the creation of research articles from mentored proposals. Abbreviations for technical terms are explained upon first usage. (3) An email notification is sent as a reminder when all stages of the mentorship process - before, during, and after - have been completed.

In general, the rate at which students comprehend learning materials is highly influenced by the practicality, efficiency, and organization of the material structure. If the learning materials are well-structured and presented through efficient pedagogy, students can more quickly and effectively comprehend the materials. Achieving faster and more effective comprehension can also be facilitated by providing easy access to teaching materials and utilizing practical learning methods. Efficient and practical material organization, along with structural coherence, significantly enhance students' ability to comprehend and retain learning materials.

4.4 Dependability

The Two Sample T-Test results from the UEQ Compare Products Tools comparing the OJS-based learning model and Moodle indicated a substantial disparity with UEQ scales average of 1.92 for OJS and 1.33 for Moodle. These results demonstrate the benefits of utilizing the OJS platform rather than Moodle for learning to construct dissertation proposals. The benefits of OJS are explained with regards to predicting and achieving learning outcomes, supporting the learning process, and maintaining a secure learning environment.

First, based on the prediction and fulfillment of expectations for learning outcomes, OJS offers a reliable system that allows assessment and evaluation of learning progress and systematic stages of the learning process adapted from OJS and structured in section packaging. Comprehensive monitoring tools, such as review forms, enable educators to track and assess student engagement and performance. This facilitates prompt feedback and interventions to enhance the student experience, foster positive learning outcomes, and meet academic expectations. Supporting findings by Singh (2019) and Szabo et al. (2017) highlight the crucial impact of feedback and interventions on student learning outcomes within higher education.

Second, to support the learning process of developing dissertation proposals, OJS enables the creation of dissertation proposals in the form of scientific articles. OJS allows for easy access to scientific literature, offers a systematic peer review process that provides constructive feedback, and gives writing and formatting guidelines, as well as reference management tools. Furthermore, the utilization of OJS provides students with hands-on experience in the editorial process of journals, such as submitting and revising articles based on feedback from professors. The OJS also serves as a beneficial learning resource for students in developing their scientific writing skills by granting access to previously published articles and educational materials. Establishing an all-encompassing, adaptable, and captivating learning platform is crucial for the success of education (Nacheva-Skopalik et al., 2020).

Third, the security of OJS's learning environment is robust. With its emphasis on scholarly publications, OJS maintains a strict security system to ensure the legitimacy and accuracy of published content. OJS employs rigorous security measures for protecting sensitive data and preventing unauthorized access, utilizing encryption and authentication protocols to safeguard user information. It is crucial to uphold user confidence in all research results and datasets stored on OJS servers. Ensuring a productive and beneficial learning environment necessitates the consideration of physical, digital, and emotional factors (Lam, Chan and Wong, 2019).

Additionally, predicting learning outcomes affords students insight into what they can anticipate from the learning experience, instilling a crucial sense of purpose and confidence. Providing assistance throughout the learning process helps students navigate challenges and attain their objectives, thus bolstering their faith in their capacity to learn. The safety of the learning environment is critical to students' ability to focus and concentrate without distraction, enabling effective learning. Additionally, aligning the learning process with students' expectations minimizes uncertainty, disappointment, and enhances the learning model's dependability to achieve desired learning outcomes. Overall, the dependability of UEQ establishes a sturdy and trustworthy basis for fostering successful and efficient learning.

4.5 Stimulation

Based on a Two Sample T-Test comparison of the OJS-based learning model for dissertation proposal development with Moodle, the result was a value of 0.0112. The Comparison of Scale Means indicates that OJS (1.96) has a higher value than Moodle (1.29). The Two Sample T-Test result of 0.0112 suggests that there is a significant difference in the stimulation aspect of student experience when learning the development of OJS-based dissertation proposals compared to Moodle. The comparison of scale means between OJS-based and Moodle-based learning models reveals that the former is more effective in motivating students and generating interest in dissertation proposal development. The results indicate a significant difference in favor of the OJS-based model.

The effectiveness of the learning model in enhancing students' cognitive and creative abilities heavily relies on the adaptability, relevance, and interactivity of the approach (Baimakhanova, Kali and Orynbasar, 2023; Hidayati et al., 2019). Furthermore, active stimulation during the learning process encourages participants to feel a connection to the material, ensure its relevance, and fosters creativity and innovation (Petkova, 2019). Positive feedback plays a crucial role in sustaining participants' motivation (Wondim et al., 2021). A learning model with robust stimulation elements can enhance the learning experience, maximize learning outcomes, and promote continuous learning (Anderson, 2016; Lah, 2020).

The OJS-based learning model for developing dissertation proposals effectively stimulated doctoral postgraduate students in electrical engineering. For instance, during the initial and later phases of producing a dissertation proposal, OJS offers functionalities to acquire input from advisors (see Figure 9). According to Figure 9, instructors give students feedback focused on the content of the article, grammar, typography, punctuation, reference list, and writing approach. All of this feedback can ultimately optimize educational results and promote ongoing learning by publishing numerous articles based on dissertation proposals in prestigious international journals (Sulistyo et al., 2023) and accredited national journals (Manga' et al., 2023.).

Furthermore, OJS version 3 supports synchronous discussion forums, whereas in OJS version 2, communication takes place asynchronously. In order to enable synchronous talks in OJS 2, it is possible to incorporate online communication applications such as WhatsApp, Telegram, or Tawk (Figure 10). This facility primarily serves two purposes: (1) facilitating consultations between students and instructors (researchers) to address technical issues such as access difficulties, password changes, and article upload processes, and (2) enabling discussions in the review process, whether synchronously or asynchronously, outside of the OJS platform. These tools have the potential to enhance comprehension and drive in the dissertation proposal creation course for PhD candidates in electrical engineering and informatics (Herdianto, 2022).

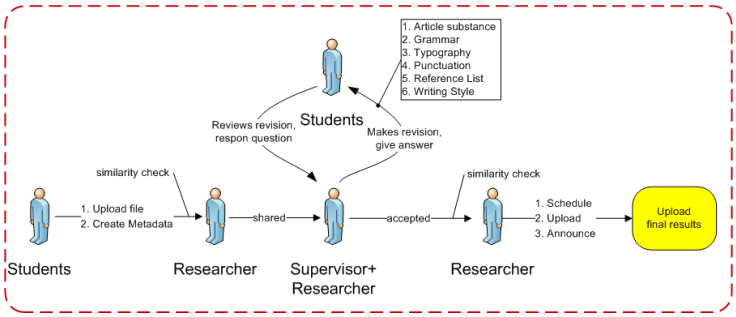


Figure 9: Process in OJS-based learning model

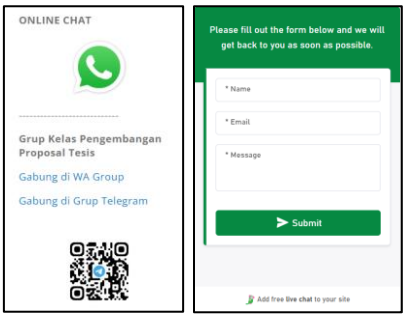


Figure 10: Communication forum link on OJS sidebar

Ample amounts of pleasant stimulation can effectively motivate students to offer more constructive feedback and actively engage. When students experience a sense of happiness and contentment, they are more inclined to offer constructive and beneficial comments (Abrahamsen et al., 2020). Moreover, the comments given by students might offer valuable information about the degree to which positive stimulation has been effectively accomplished in the course on dissertation proposal development.

4.6 Novelty

The comparison of scale means on the novelty scale in the User Experience Questionnaire (UEQ) between the Open Journal Systems (OJS) based dissertation proposal development learning model with a value of 1.60 and Moodle with a value of 1.19 shows that OJS has a higher mean value in the novelty aspect compared to Moodle. However, after a Two Sample T-Test analysis, it was found that the difference between the two platforms was not statistically significant. This suggests that although OJS has a higher mean score on the novelty scale, the difference cannot be considered statistically significant. Thus, the two learning models using different platforms may have similar levels of novelty in their user experience according to the results of the Two Sample T-Test analysis.

The assessment of user experience on the novelty scale can be seen based on the level of creativity of the learning model used. In line with Gocłowska et al. (2019) who explained that there is a relationship between

novelty and high creativity. The following factors cause OJS and Moodle-based dissertation proposal development learning models to generally have the same level of creativity of learning models according to students. (1) Both help students to develop creativity and critical thinking in scientific writing. (2) Provide opportunities for students to collaborate with lecturers or instructors to get new ideas. (3) Provide constructive feedback from lecturers or instructors to help students develop their ideas. Some of these factors are supported by previous studies that discuss creativity, critical thinking, collaboration, and student feedback in learning with elearning platforms (Barysheva et al., 2020; Buhu and Buhu, 2018; López López and Silva, 2010; Mitina, Sleptsova and Shevelyova, 2021; Samihah and Savitri, 2021; Wu and Schunn, 2021).

Regarding the sophistication, familiarity, and creativity of the learning model, the statistical data indicates that there is no significant distinction between the utilisation of OJS, which has an average score of 1.60, and Moodle, which has an average score of 1.19. Both OJS and Moodle include similar capabilities and characteristics in offering advanced learning solutions. While both platforms may employ distinct methodologies or possess specific functionalities, they generally meet the requirements of users in a contemporary digital learning environment. Currently, in the realm of digital education, the level of complexity of e-learning platforms is consistently increasing (Alojaiman, 2021), and both platforms have adapted accordingly.

While there may not be any substantial disparities in terms of prevalence and creativity between OJS and moodle-based dissertation proposal development learning methods, there are distinct and fundamental distinctions between the two. Table 3 presents a concise summary of the distinctions between OJS and Moodle-based dissertation proposal development learning models, focusing on their ubiquity, originality, and novelty. Nevertheless, it is crucial to acknowledge that both systems undergo continuous development, resulting in modifications to their features and functionality.

Table 3: Differences between OJS and Moodle-based Dissertation Proposal Development Learning Models

Aspect	OJS-based learning model	Moodle-based learning model
Usability	Known for scientific journal publications Specific user interface for the review and editing process of scientific articles	Commonly used for e-learning User interface familiar to educational institutions
Innovation	The engineering editorial review process for publishing scientific journals in OJS is adapted for the mentoring and consulting process between lecturers and students. The recording function of OJS will keep the guidance data alongside the review findings that are packed in the session for reviewing an article. OJS has identical system and process characteristics for dissertation proposal development courses.	The e-learning platform has complementary functions in providing various forms of learning materials such as text and multimedia, organizing online discussions, creating assignments and evaluations. It also serves as a storage function for teaching materials. These features contribute to the platform's overall function in offering an immersive and comprehensive learning experience.
Novelty	Utilizing OJS for dissertation proposal development provides a novel and all-encompassing method that leverages the functionalities of scientific journal platforms to facilitate a more organised and collaborative academic learning process. It also supports experiential learning and can serve as a virtual laboratory for students to enhance their scientific writing skills. Examples of features include the implementation of a peer review structure, the automation and tracking of processes, the use of layered permission for security, the facilitation of cooperation, interaction with scientific databases, the utilisation of standardised templates and formats, and the ability to record information.	This e-learning platform serves a broad purpose, not limited to scientific writing or primarily focused on dissertation proposal production.

The constraints of discussing the results of the User Experience Questionnaire (UEQ) in the context of the Open Journal Systems (OJS) based learning paradigm are as follows: Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty. There are various constraints associated with this research. Initially, the research sample consisted solely of 30 engineering PhD students from a single university in Indonesia, thereby constraining the applicability of the research findings. Furthermore, the study's duration was confined to a single semester, perhaps constraining the researcher's comprehension of the user experience over an extended period. Furthermore, the research is constrained to users' evaluation of the OJS-based learning model,

thereby restricting the researcher's comprehension of additional variables that could impact user experience. The research employed a quantitative approach, utilising the UEQ questionnaire as the primary tool.

The following are recommendations for additional research. Initially, it is important to carry out extensive research with a broader and more heterogeneous sample. Expanding the size and diversity of study samples can enhance the applicability of research findings (Andrade, 2020). Furthermore, carrying out research for an extended duration. Extended research duration enables a more comprehensive comprehension of user experience in the extended term (Karahanoğlu and Bakırlıoğlu, 2022). Furthermore, broadening the scope of the investigation. Expanding the scope of research might enhance comprehension of additional variables that might impact user experience (Semerádová and Weinlich, 2020). Additionally, alternative approaches, such as qualitative methodologies or a combination of methods, are employed to assess UX, aiming to yield more comprehensive study findings (Lanius, Weber and Robinson, 2021). By overcoming these constraints, additional investigation can yield more comprehensive and all-encompassing insights on the user experience of OJS-based learning models.

5. Conclusions

The effectiveness of the OJS-based dissertation proposal development learning model using Moodle, as perceived by doctorate students in electrical and informatics engineering, can be assessed through two distinct statistical computations. According to the Comparison of Scale Means, the OJS-based dissertation proposal development learning model is superior than Moodle in terms of all UEQ scales (Attractiveness, Perspicuity, Efficiency, Dependability, Stimulation, and Novelty). Secondly, the Two Sample T-Test, assuming unequal variances, reveals contrasting results. Specifically, there is a noteworthy disparity in user experience on the Attractiveness, Dependability, and Stimulation scale. However, there is no significant difference in user experience on the Perspicuity, Efficiency, and Novelty scale. This is intriguing because while the mean value of the Comparison of Scale Means calculation for the OJS-based dissertation proposal development learning model is higher than that of Moodle, the Two Sample T-Test assuming unequal variances does not show a significant difference on all UEQ scales between the OJS-based dissertation proposal development learning model and Moodle. Maximising all UEQ scales of the OJS-based dissertation proposal development learning model is crucial in order to optimise the learning experience and outcomes for students.

Acknowledgement

The authors express their gratitude to Universitas Negeri Malang for providing a Dissertation Research Grant for this research.

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Task-Technology Fit Analysis: Measuring the Factors that influence Behavioural Intention to Use the Online Summary-with Automated Feedback in a MOOCs Platform

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Abstract: The purpose of this study was to evaluate the factors that influence behavioural intention (BI) to use the Online Summary-with Automated Feedback (OSAF) in a MOOCs platform. Task-Technology Fit (TTF) was the main framework used to analyse the match between task requirements and technology characteristics, predictng the utilisation of the technology. The relationships between TTF and BI was moderated by students' performance. This TTF provides an illustration of the extent to which the suitability of technology support for tasks will affect the performance and utilization of technology. There were 9 hypotheses examined in this study. The participants consisted of 151 students at a public university in East Java, Indonesia. In order to analyse the collected data, PLS-SEM (partial least squares - structural equation modeling) was employed, using SmartPLS 3.0. In this study, several points can be concluded, namely: 1) task characteristics and technology characteristics were not positively and significantly effected by TTF, while students' characteristics had a positive and significant effect on TTF; 2) TTF and utilization which are influenced by social influence, have a positive effect on performance impact. In this case the performance impact is constructed from 3 dimensions, namely: learning performance, personal integrity, self-confidence, except TTF were not postitive and were significantly affected by self-confidence. 3) TTF and performance impact positively influence behavioural intention, except in the dimension of performance impact, personal integrity was not postively and significantly effected by behavioural intention.

Keywords: Automated feedback, Formative assessment, Online summary, Task-Technology Fit (TTF), MOOCs

1. Introduction

MOOCs have provided innovative open learning environments since the term was first introduced in 2008 (Littlejohn and Milligan, 2015). MOOCs have been derived from distance education. The MOOCs platform providers collaborate with many top educational institutions and organizations to create courses and programs, giving students all over the world access to variety of subjects at low cost or even zero cost (Jung and Lee, 2018). Therefore, until now the number of users of the MOOCs platform continues to show very rapid development. This positive trend can be seen in Coursera which is one of the popular MOOCs platforms which currently has 92 billion students with an increase of 29% in the number of students year on year by 2021 (Coursera, 2021). So, it is only natural that there is an assumption that MOOCs will revolutionize learning in higher education.

In the past few years, there have been many studies regarding how MOOCs have the opportunity to be used to obtain a formal education (Goodman, Melkers and Pallais, 2016; Mohsen, 2016), and today , MOOCs have been increasingly positioned as a platform to integrate formal traditional courses with informal learning experiences included in the K-12 context (Cha and So, 2021). Since its popularity, many questions have arisen regarding the quality of education offered by MOOCs. Bayne and Ross (2014) said that there are three issues that arise in MOOCs pedagogy, namely: 1) the role of the teacher, 2) student participation and 3) assessment.

This paper will focus on assessment since it is an important component in a learning process. There are some assessment methods that can be selected to collect the students' learning perfomances and progress. This research focused on online summary writing. Online summary means students summarize the learning materials through online tool, in this research, the tool was embedded in MOOCs Platform. The online summary tool equipped with a summary checker tool that could give automated feedback which contained scores and informative comments in real-time). This MOOCs platform was originally design and developed by the authors (see Figure 1). One of the benefits of Using Summaries as Assessment is measuring the students' reading comprehension and by providing the automated feedback to students, this system enabled the students to self-evaluate and monitor their learning progress or performance (Sung, et al., 2016).

Reference this paper: Ulfa, S. et al., 2024. Task-Technology Fit Analysis: Measuring the Factors that influence Behavioural Intention to Use the Online Summary-with Automated Feedback in a MOOCs Platform, *The Electronic Journal of e-Learning, 22(1)*, pp 63-77, available online at www.ejel.org

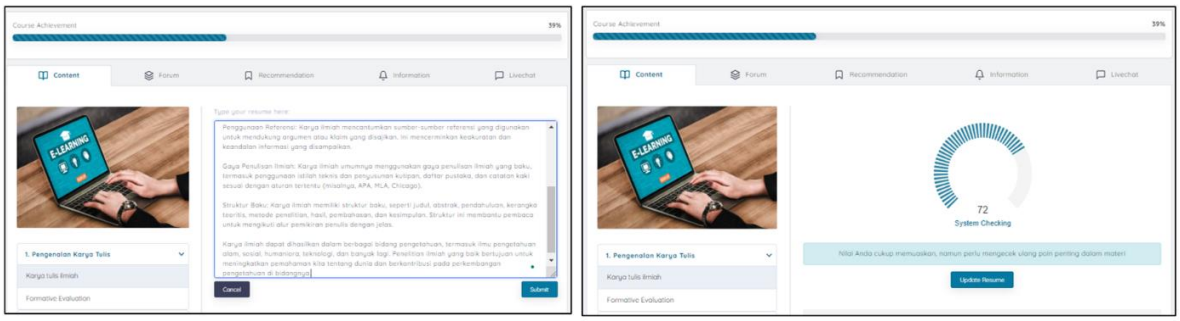

Figure 1: Interface of online summary-with automated feedback in MOOCs platform

The objectives of this research is to measure the relationship between Task-Technology Fit (TTF), student performance impact and behavioural intention (BI). Goodhue and Thompson (1995) proposed the concept of TTF; it is a theoretical framework that studies the relationship between a task's qualities and the attributes of the technology used to do it. In essence, it evaluates how well a technology meets users' demands to complete particular tasks. The purpose of TTF in this research is to understand the relationship between the characteristics of a task, in this case summary writing, and the features of a technology used to perform that task namely the summary writing with automated feedback.

This paper considers the role of TTF in a MOOCs platform, and addresses the question of how TTF influences the students' performances and behavioural intention (BI) to use the technology, since BI is an important factor in predicting the adoption of new technology, in this case educational tools like summary writing with an automated feedback tool. By identifying the factors that influence BI, some strategies can be developed to encourage the desired technology adoption for educators or policy makers. In order to achieve the objective of this research, several hypotheses were constructed. A statistical method was used to analyse complex relationships between multiple variables.

2. Theoretical Frameworks

2.1 Assessment in MOOCs

Assessment is an integral component of Massive Open Online Courses (MOOCs) because it ensures that students have acquired the required knowledge and skills (Xiao, Qiu and Cheng, 2019). Students are able to monitor their progress, while teachers are able to determine which topics require additional attention. Assessments also shape students' educational experiences. In addition, assessment can provide a sense of accomplishment for each module, thereby increasing the motivation of students to complete the course (Xiao, Qiu and Cheng, 2019). Regular assessments ultimately ensure that students have mastered the necessary skills and knowledge prior to moving on to the next module.

Massive Open Online Courses (MOOCs) employ a variety of assessment methods. The two primary types of assessment used in MOOCs are summative and formative assessment. The purpose of summative assessments is to evaluate a student's knowledge and skills at the end of the course. Typically, these assessments are used to determine a student's final grade and may consist of tests, quizzes, and/or projects. Summative assessments provide a snapshot of a student's learning and can assist teachers in identifying areas where additional instruction is required. In contrast, formative assessments are used throughout the course to provide students with feedback and direction (Janelli and Lipnevich, 2021). Typically, shorter and less complex than summative assessments, formative assessments may consist of short answer questions, multiple-choice questions, and/or brief writing assignments as well as open-ended feedback (Nanda, et al., 2021). Formative assessments enable instructors to better comprehend their students' learning needs and verify that they are on the right track, student engagement, for example. (Sun, Guo and Zhao, 2020).

2.2 Task-Technology Fit in MOOCs

Task-Technology Fit (TTF) is a theoretical framework used to comprehend how technology can be employed to accomplish a specific task. It is the process of determining the optimal combination of hardware and software to meet the requirements of a given task. The TTF model focuses on the task, the technology, and the user. The objective of the TTF model is to identify the most suitable technology for a given task, taking the user's knowledge and experience into account (Kim and Song, 2022). To achieve an optimal Task-Technology Fit, the skills and preferences of the user must be considered. The features and capabilities of the technology should

also be considered to ensure they are suitable for the task. In addition, the environment in which the technology is used should be considered to ensure that the user is comfortable with it. Lastly, the cost of the technology must also be considered. Task-Technology Fit can be utilized to enhance the user experience, performance, and overall system efficiency including its own acceptance by users (Khan, et al., 2018). It can be used to determine the most suitable technology for a given task and to ensure that users are comfortable with it. In addition, it is essential to note that Task-Technology Fit is an iterative process, as users must frequently adapt to the technology as they gain experience with it (Ouyang, et al., 2017).

TTF is a key concept in the design of MOOCs (Massive Online Open Courses). TTF is a measurement of how well the design and technology of a course or system correspond to the tasks a user must complete. It is the extent to which the design and technology of a course or system support the user's ability to learn or perform tasks (Kim and Song, 2022). When designing a course or system, it is essential to consider the TTF, as the user will struggle to learn if the technology and design do not match the tasks. An effective TTF necessitates that the course or system design takes into account the user's tasks and adapts the technology to facilitate learning (Wu and Chen, 2017). TTF is also closely related to the MOOCs continuance intention of the students (Shanshan and Wenfei, 2022). It also aims for the sustainability of students learning at MOOCs and the existence of the MOOCs themselves in the long term (Alyoussef, 2021).

TTF includes the user, the tasks they must complete, the technology employed, and the course or system's design. The design of the technology must facilitate user performance on the tasks. This involves creating a design that allows the user to complete tasks quickly and easily, is intuitive, and has a low learning curve. The technology must also be dependable, because if it fails, the user will be unable to complete the task. Additionally, the course or system must have an effective layout (Kim, et al., 2021). This includes clear instructions on how to complete the tasks, effective user feedback, and support for maintenance and troubleshooting. Lastly, the user must possess the necessary skills to complete the tasks, including the ability to use the required technology. TTF is an essential concept for the development of MOOCs. It is a measurement of how well the design and technology of a course or system correspond to the tasks a user must perform (Ouyang, et al., 2017; Khan, et al., 2018). It necessitates that the technology facilitates user performance and that the course or system design is effective (Jung, et al., 2019). Additionally, the user must possess the required skills to complete the tasks.

2.3 Students' Performance in MOOCs

The performance of students in MOOCs can be affected by a variety of variables, including the type of course, the instructor, the medium of instruction, and the students' own disposition (Sari, Bonk and Zhu, 2020). The type of course is a significant factor in student performance. A course that is either too easy or too difficult can result in either boredom or confusion (Jung, et al., 2019). The instructor is also a significant factor in the performance of students in MOOCs. An effective instructor can cultivate a stimulating learning environment and provide students with feedback and direction throughout the course (Janelli and Lipnevich, 2021). A poor instructor, on the other hand, can create a hostile environment that makes learning more challenging and less enjoyable (Sari, Bonk and Zhu, 2020). Regarding student performance, the medium of instruction is also essential.

Multiple factors can influence a student's success in MOOCs. These include the student's dedication to the course, the time and effort they devote to it, their level of engagement with the material, and their capacity to work independently and motivate themselves (Janelli and Lipnevich, 2021; Shah, et al., 2022). In addition, having access to the necessary resources, such as textbooks, course materials, and dependable internet access, can help students to learn. To help students in achieving their optimal learning performance, MOOCs must be designed to encourage students' active participation in knowledge construction. This pertains to independent learning or more often known as self-regulated learning (Tang and Bao, 2022). Even though self-directed learning is rife with learning motivation, in the context of MOOCs, the instructor must be able to design learning processes, and assignments that encourage students to investigate the material in depth (Kim, et al., 2021).

2.4 Behavioural Intention to Use Technology

Theoretically, BI is a development of the theory of planned behaviour (TBP) (Ajzen, 1991), which analyses an individual's intention to do and not do something based on attitudes, understood norms and perceived behavioural control (Luarn and Lin, 2005). Attitudes relate to a person's perception of whether he likes or dislikes the impact of an action. Meanwhile, subjective norms are interpreted as a person's perception of the norms adopted by the surrounding community. The perceived behavioural control is related to whether or not there are supporting sources available to carry out a behaviour (Ajzen and Madden, 1986). Research on the determinants of a person's intention to use MOOCs has revealed complex findings involving complex variables

that encourage students to continue learning online using MOOCs. Research conducted by Li and Zhao (2021) reports the importance of perceived usefulness and perceived ease of use of systems used in MOOCs, both of which are fundamental components o Technology Acceptance Model (TAM) theory. This criterion explains how students perceive the usefulness of MOOCs in achieving their learning goals, and how easy it is to navigate the learning resources available in MOOCs. Considering that the aim of MOOCs is to make it easier for users, with the support of learning resources that are easily accessible, interesting, and important to master to increase their understanding and improve their skills, this can encourage active motivation in continuing online learning practices through MOOCs (Wang, van Hemmen and Criado, 2022).

2.5 Utilization of MOOCs

Utilization in the context of MOOCs is defined as a learning decision to use MOOCs as a way to improve the understanding and skills they need due to internal encouragement in the form of BI which arises because their expectations are fulfilled as a result of the services provided by the MOOCs provider (Samim, 2018). Research on factors influencing the use of MOOCs has produced varied findings, but the perception of ease of use and usefulness of MOOCs is often the driving factor for someone to like and apply MOOCs as an alternative way of learning and improving their competence (Liyanagunawardena, Adams and Williams, 2013). Apart from perceived ease and usefulness factors, social elements are also reported to be important in influencing someone to utilize MOOCs. Poquet, et al. (2018) emphasizes the importance of aspects of social presence, collaborative learning, and peer interaction in building a supportive environment in using MOOCs sustainably. Social presence also fosters a supportive and interactive atmosphere, enhancing meaningful learning experiences. This is what causes students to feel comfortable implementing MOOCs in their daily lives.

The Task-Technology Fit (TTF) paradigm, which assesses the relationship between technology and the system being developed, provides a useful perspective to examine aspects driving the implementation of MOOCS. A study conducted by Wu and Chen (2017) used TTF to analyse the implementation of MOOCs, highlighting the importance of matching MOOC platform features with the learning objectives that learners want to achieve. This research reports that when users perceive significant alignment between the features and services provided by MOOCs and the requirements of the tasks they have to perform, this has a positive impact on their intention to adopt MOOCS as their choice. Thus, appropriate task design influences learners' perceptions of using MOOCs. Furthermore, the TTF framework can also be extended to consider contextual elements, such as users' learning experiences before using MOOCs with their technical proficiency. A study conducted by Kim and Song (2022) highlighted the importance of individual traits in shaping the alignment between tasks and technology and features in MOOCs. Individuals with different levels of proficiency in using technology may have different levels of adaptation in implementing MOOCs.

3. Research Model and Hypotheses

This study uses a model of the TTF. Goodhue and Thompson's Task-Technology-Fit (TTF) model has been used as a predictor of performance in a technology context (Goodhue and Thompson, 1995). The general premise of the TTF Model is that if an information system has a good fit with the tasks it supports, it will have a positive impact on the user's performance of the task. The concept of "fit" defined by Goodhue and Thompson (1995) is the extent to which a technological system provides necessary features and support required by a task. TTF also affects user behavioural intention (BI) to use technology. Goodhue and Thompson (1995) also state that TTF is a significant predictor of BI. Figure 2 illustrates the research model and hypothetical framework of this study.

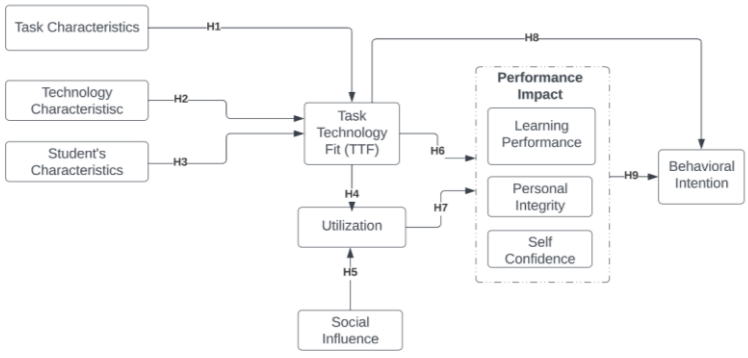

Figure 2: Research model and hypothetical frameworks

Overall, there were fifteen hypotheses tested in this study. In detail, the research hypotheses investigated can be seen in Table 1.

Table 1: Research Hypotheses

H-Code	Hypothetical statement
H1	Task characteristics has a positive and significant effect on Task-Technology Fit
H2	Technology characteristics has a positive and significant effect on Task-Technology Fit
H3	Student's characteristics has a positive effect and significant on Task-Technology Fit
H4	Task-technology has a positive and significant effect on utilization
H5	Social influence has a positive and significant effect on utilization
H6a	Task-Technology Fit has a positive and significant effect on learning performance
H6b	Task-Technology Fit has a positive and significant effect on personal integrity
H6c	Task-Technology Fit has a positive and significant effect on self-confidence
H7a	Utilization has a positive and significant effect on learning performance
H7b	Utilization has a positive and significant effect on personal integrity
H7c	Utilization has a positive and significant effect on self-confidence
H8	Task-Technology Fit has a positive and significant effect on behavioural intention
H9a	Learning performance has a positive and significant effect on behavioural intention
H9b	Personal integrity has a positive and significant effect on behavioural intention
H9c	Self-confidence has a positive and significant effect on behavioural intention

4. Research Methodology

This study uses a quantitative method. It is measurable and a questionnaire was used for the data collection. The proposed model and questionnaire were conceptualized, validated, and examined using the structural equation modelling (SEM) software, SmartPLS 3 (Chin, 1998).

4.1 Research Participants

The participants in this study were Educational Technology Department students from a public university in the city of Malang, in the province of East Java, Indonesia. The participants numbered 151 students with a composition of 49.4% female and 50.6% male.

4.2 Data Collection and Research Procedure

The data was gathered using a structured questionnaire survey in November 2022. The research participants were asked to register a course at a MOOCs platform. The following is the learning procedure:

- A student accesses the course in a MOOCs platform consisting of 3 chapters per course.
- MOOCs provide a formative evaluation in each chapter. After completing each chapter, a student should complete a formative evaluation. The type of formative evaluation is an open-ended question, namely summary writing.
- The system will automatically analyse and grade the student's summary and provide immediate feedback to the student in real-real time. Feedback would be different for each student, as it depends on the student's summary score.
- Each student can make multiple attempts to write the summary until getting a satisfying score.

4.3 Instruments

A questionnaire survey was used to assess the Task -Technology Fit (TTF) of the effectiveness of Online Summary-with Automated Feedback in Massive Open Online Courses (MOOCs) Learning Environment. The initial part of the survey consisted of information used in TTF to measure the conceptual construction of the model, namely: task characteristics (TCK), technology characteristics (TC), student characteristics (SC), Task-Technology Fit (TTF), utilization (U), social influence (SI), plus performance impact which consist of three categorizes, namely: learning performance (LP), personal integrity (PI), and self-confidence (SC). The conceptual construct used a 5-point Likert scale. Table 2 shows the variables and question items on the instruments used in this study.

Table 2: Research instruments

Variables		Items	References
Task	**TK1**	Through the use of the online summary-automated feedback feature, I can understand the content or materials	(Bridgeman and Carlson, 1983; Bigot and Rouet, 2007; Akbari Chermahini, Hickendorff and Hommel, 2012)
	TK2	The online summary-automated feedback feature can train me to make a summary	
	TK3	The online summary-automated feedback feature can encourage me to monitor my learning progress	
	TK4	The online summary-automated feedback feature can generally help me understand what parts of the content I don't understand	
	TK5	The online summary-automated feedback feature in general can help personalize learning because it suits my learning needs	
Technology	**TC1**	Simple online summary-automated feedback user interface with a clear layout	(Pantic and Rothkrantz, 2003; Ho, et al., 2018; Huang and Renandya, 2020)
	TC2	The navigation system on the online summary-automated feedback user interface is clear and easy to use	
	TC3	Visual presentation of material content is simple and attractive	
	TC4	Material content is creative and not monotonous	
	TC5	The existing user interface is interactive and fun to use	
	TC6	I am satisfied with the interface design on the MOOCS platform	
	TC7	The online summary-automated feedback feature provides real-time feedback	
	TC8	The feedback provided by the online summary-automated feedback system is accurate	
	TC9	I can understand the message (feedback message) given by the online summary-automated feedback feature	
Task-Technology Fit	**TTF1**	The use of online summary-automated feedback can improve reading comprehension skills	(Ouyang, et al., 2017; Wu and Chen, 2017; Khan, et al., 2018; Alyoussef, 2021; Kim and Song, 2022)
	TTF2	The use of online summary-automated feedback can train me to determine the main idea in reading (study material)	
	TTF3	Using online summary-automated feedback can help me focus on important words or phrases in the text (study material)	
	TTF4	The use of online summary-automated feedback can train me to rewrite ideas (paraphrases) in reading texts (learning materials).	
	TTF5	The use of online summary-automated feedback can give me an idea of which parts I understand and do not understand	
	TTF6	The use of online summary-automated feedback can show correct and inaccurate answers	
Student's characteristics	**SC1**	I prefer to get an assessment of my (exam) work in person rather than an assessment given sometime after the exam	(Thurmond, et al., 2002; Bernard , et al., 2004)
	SC2	I prefer studying online by accessing digital content rather than studying through textbooks	
	SC 3	I prefer online-based exams/assessments rather than paper-based (written exams)	
	SC4	In studying, I like to make my own schedule (to record targets that must be achieved) and try to achieve them	
	SC5	I like to study independently	
	SC6	I like the flexible learning style without being bound by time and space	
	SC7	I like solving learning problems on my own by searching for answers/solutions through searching on the internet	
	PI1	Online summary-automated feedback-based exams can improve integrity	

Variables		Items	References
Personal Integrity	**PI2**	The use of online summary-automated feedback can support fairness (honest and fair) learning, because the assessment is according to my ability	(Hartman, DesJardins and MacDonald, 2011; Hussein, 2017)
Self-Confidence	**SC1**	Online summary-automated feedback-based exams can increase confidence in learning	(Scott, 2017; Ross, et al., 2018; Jensen, Bearman and Boud, 2021)
	SC2	The online summary-automated feedback-based exam increased my learning independence	
	SC3	The online summary-automated feedback feature can increase my motivation to continue learning	
Social Influence	**SI1**	I was asked by my lecturer to use this feature	(Venkatesh, Thong and Xu, 2012)
	SI2	My friend recommended the use of this feature to me	
Utilization	**U1**	I often use this kind of system	(Goodhue and Thompson, 1995)
	U2	I often use the online summary-automated feedback feature repeatedly	
Learning Performance	**LP1**	The online summary-automated feedback-based test has a positive effect on my learning performances	(Pedrosa-de-Jesus, et al., 2018; Cavalcanti, et al., 2021)
	LP2	An online summary-automated feedback-based exam can improve my critical thinking skills	
	LP3	The use of online summary-automated feedback can increase my productivity in learning	
	LP4	The use of online summary-automated feedback can increase effectiveness and efficiency in learning	
Behavioural intention	**LP1**	I intend to frequently use a feature like this online summary-automated feedback	(Marikyan, et al., 2022)
	LP2	I will use the MOOCSs platform which is equipped with summary-automated feedback in the future	

4.4 Data Analysis

A total of 151 questionnaire forms were completed by research participants via Google Forms. The analysis used 151 completed questionnaire sets which were sufficient based on Hair, et al. (2021) that served as a rule of thumb for the sample size required in PLS-SEM (partial least squares - structural equation modelling).

5. Research Findings

PLS-SEM (partial least squares - structural equation modeling) model consists of two steps: the outer model assessment and the inner model assessment. In the evaluation of the outer model, the reliability and validity of reflective constructs and the validity of formative constructs were determined, meanwhile, the internal model evaluation comprised a variance explanation of endogenous constructs, measurement of effect sizes, and predictive significance (Table 3).

Table 3: Overall model assessment data

Variables	Items	Mean	Standard Deviation	Factor Loading	Cronbach Alpha	Composite Reliability	AVE
Task-Technology Fit	TTF1	4.139	0.750	0.795	0.866	0.901	0.604
	TTF2	4.032	0.767	0.852			
	TTF3	3.981	0.775	0.835			
	TTF4	4.139	0.725	0.757			
	TTF5	3.892	0.808	0.764			
	TTF6	3.810	0.956	0.639			
Task	TK1	4.108	0.690	0.819	0.863	0.901	0.647
	TK2	4.184	0.753	0.756			
	TK3	4.120	0.732	0.775			

Variables	Items	Mean	Standard Deviation	Factor Loading	Cronbach Alpha	Composite Reliability	AVE
	TK4	4.070	0.772	0.846			
	TK5	4.051	0.736	0.819			
Technology	TC1	4.228	0.770	0.710	0.903	0.919	0.559
	TC2	4.234	0.756	0.723			
	TC3	4.120	0.867	0.790			
	TC4	3.854	0.877	0.767			
	TC5	4.032	0.799	0.803			
	TC6	4.013	0.795	0.752			
	TC7	4.146	0.753	0.705			
	TC8	3.886	0.811	0.724			
	TC9	3.968	0.822	0.750			
Students' Characteristics	SC1	4.222	0.897	0.663	0.770	0.834	0.418
	SC2	3.981	0.889	0.652			
	SC3	4.152	0.828	0.634			
	SC4	4.120	0.830	0.623			
	SC5	3.797	0.877	0.574			
	SC6	4.411	0.843	0.659			
	SC7	4.165	0.786	0.714			
Personal Integrity	PI1	4.133	0.739	0.840	0.625	0.842	0.727
	PI2	4.070	0.764	0.865			
Self-Confidence	SC1	3.943	0.757	0.846	0.823	0.894	0.738
	SC2	4.139	0.725	0.862			
	SC3	3.994	0.742	0.869			
Utilization	U1	3.525	0.998	0.862	0.772	0.895	0.810
	U2	3.570	0.896	0.936			
Social Influence	SI1	4.430	0.774	0.474	0.126	0.669	0.527
	SI2	3.373	1.166	0.911			
Learning Performance	LP1	4.076	0.671	0.794	0.836	0.891	0.671
	LP2	4.000	0.779	0.784			
	LP3	3.943	0.74	0.856			
	LP4	4.063	0.744	0.840			
Behavioural intention	BI1	4.000	0.755	0.915	0.803	0.910	0.835
	BI2	4.177	0.725	0.913			

5.1 Overall Model Assessment

The purpose of measurement model evaluation is to evaluate the consistency and validity of constructs. Validity of the constructs was examined based on convergent and discriminant validity (Hair, et al., 2012).

According to Table 3, The lowest factor loading was 0.574 (student's characteristics). A loading value of 0.7 or higher was considered highly satisfactory (Götz, Liehr-Gobbers and Krafft, 2009). However, although a loading value of 0.5 is regarded as acceptable, the variables with a loading value of less than 0.5 should be dropped (Chin, 1998). On the contrary, Hulland (1999) argued that 0.4 should be acceptable. While Henseler, Ringle and Sinkovics (2009) suggested that variables with a factor loading between 0.4 and 0.7 should be reviewed before elimination.

To measure the reliability of the instrument, the internal consistency reliability method was used using the reliability coefficient Cronbach alpha (CA), which was intended to test the consistency of the constructs' items. In this study, the CA coefficient of all constructs was greater than 0.6, where it was acceptable for exploratory research (Hair, et al., 2006), except for the social influence construct which had a CA coefficient of 0.126. It had a lowest CA coefficient but had 0.527 for Average Variance Extracted (AVE). AVE is commonly used to assess convergent validity which is designed for measuring the validity of each indicator in the construct variables. Nunnally (1967) assumes that CA coefficients as low as 0.50 are appropriate for exploratory research. In addition, the social influence construct had a composite reality (CR) value of 0.669, therefore, the construct was reliable. According to Peterson and Kim (2013),an alternative to CA is composite reliability, which is usually calculated in conjunction with structural equation modelling. This research findings show all constructs had a CR value greater than 0.6, therefore, we can conclude that all the construct items were reliable.

5.2 Structural Model Testing

A bootstrapping technique is used to evaluate the structural model PLS-SEM. According to Chin (1998), the bootstrapping technique is one of the nonparametric approaches used for estimating the precision of PLS estimates. From this process, the path coefficient and significance value (t-statistics) were obtained (see Table 4).

The test criteria with the significance level of 5% was determined as follows: If |T statistics| > Tα, p-value < α (α is signifcance level) , |T statistics| greater than 1.96 and p-value < 0.05 then the hypothesis is accepted. If |T statistics| less than or equal to 1.96 and p-value >0.05 the hypothesis is rejected.

Table 4: Structural model testing

Hypothesis	Path	T Statistics	P-Values	Decision
H1	Task characteristics → Task-Technology Fit	1.554	0.121	Rejected
H2	Technology characteristics → Task-Technology Fit	0.760	0.448	Rejected
H3	Student's characteristics → Task- Technology Fit	4.163	0	Accepted
H4	Task-Technology → Utilization	3.057	0.002	Accepted
H5	Social influence → Utilization	1.361	0.174	Rejected
H6a	Task-Technology Fit → Learning performance	3.132	0.002	Accepted
H6b	Task-Technology Fit → personal integrity	2.838	0.005	Accepted
H6c	Task-Technology Fit → Self-confidence	0.907	0.365	Rejected
H7a	Utilization → Learning performance	11.116	0	Accepted
H7b	Utilization → Personal integrity	9.871	0	Accepted
H7c	Utilization → Self-confidence	8.462	0	Accepted
H8	Task-Technology Fit → Behavioural intention	5.018	0	Accepted
H9a	Learning performance → Behavioural intention	3.292	0.001	Accepted
H9b	Personal Integrity → Behavioural intention	0.632	0.528	Rejected
H9c	Self-confidence → Behavioural intention	2.288	0.023	Accepted

6. Discussion

Task-Technology Fit (TTF) put forward by Goodhue and Thompson (1995) is a theory that describes the relationship between three components, namely technology functionality, task requirements, and individual abilities when using an information system application. Goodhue and Thompson (1995) state that the objective of the TTF measurement is to examine the assumption that the utilization of particular technology results in increased performance only on the condition that technology functionality corresponds to users' task requirements. Spies, Grobbelaar and Botha (2020) define Task-Technology Fit as a theory devoted to quantifying the effectiveness of technology in a system by examining the relationship between the technology and the tasks the technology aims to support. The original model of TTF proposed by Goodhue and Thompson (1995) consists of five construct variables, namely: task characteristics, technology characteristics, TTF, utilization, and performance. In this research, in addition to the five constructs, these had been extended into ten construct

variables, namely: task characteristics, technology characteristics, students' characteristics, TTF, social influence, utilization, learning performances, personal integrity, self-confidence, and behavioural intention.

6.1 Task-Technology Fit

In this study, the dimensions measured on TTF as shown in Table 2 focus on system functionality in learning. As can be seen from Table 4, the hypotheses H1 and H2 were rejected, while H3 was accepted. These findings shows that both task and technology characteristics did not positively effect TTF. Technology is a tool that helps someone complete their work (Spies, Grobbelaar and Botha, 2020). Each technology used has different characteristics in helping to complete the task. From this study, we can conclude that the characteristics of online summary-with automated feedback was not able to help the students to complete the task. There are some improvements in the tool that should be made in order to help the students to complete the task.

Meanwhile, students' characteristics had a positive effect on TTF. The students' characteristics represent the students' individual preferences regarding the online learning. According to Goodhue and Thompson (1995) this constructs variable relates to an individual's internal resources. Student characteristics in this study are more focused on students' learning preferences. Based on the results of this study, it is proven that these student characteristics have a positive and significant effect on TTF, similar to research conducted by Gu and Wang (2015) which uses self-efficacy as a representation of students' characteristics and positively influences TTF on e-Learning.

6.2 External Variables

In the evaluation of the TTF model in this study, the utilization variable is included in the model analysis. The dimensions measured are the level of utilization information system technology (see Table 2), and the variables that affect utilization are also measured, namely the social influence variable. In addition, the relationship between the utilization dimension and performance impact was also explored, and as a result the hypotheses of H4 was accepted and H5 was rejected (see Table 4). This research concluded that TTF has a positive and significant effect on utilization information system technology.

The research conducted by Thompson, Higgins and Howell (1991) confirmed that fit between job, and pc capabilities, and their long-term consequence has a strong relationship to utilization, where what it defines as information systems is related to the act of using the information system in this case the measurement of the frequency of use of the information system and the diversity of the use. Similar findings were also obtained in a study conducted by Anaam, Haw and Palanichamy (2022) which concluded that utilization is a major predictor of individual performance. In addition, McGill and Hobbs (2006) also emphasized that task-technology fit has a positive effect on utilization.

In information system (IS) research, social influence represents interpersonal consideration of the use of technology (Kaneshiro, et al., 2010). Meanwhile, according to Kelman (1958), social influence is a change in the thoughts, feelings, attitudes or behaviour of a person who is influenced by the results of interaction with another individual or a group. Previously, Seddon, Billett and Clemans (2004) had identified that social norms influenced utilization where social norms referred to user's beliefs as to the influence of other individuals to perform that behaviour. Social norms can influence individual behaviour as well as technology adoption but it does not mean it always has the same impact as in the research findings of Beldad and Hegner (2018) that confirmed that social norms do not have significant effects on the repeat usage intention on a fitness app.

6.3 Performance Impact

Performance impact refers to user outcomes which are the effects or impacts resulting from the use of information system technology. Goodhue and Thompson (1995) proposed the technology to performance chain model which describes the effectiveness of an information system technology. So, in this study the measurement of the relationship between task-technology fit was carried out by constructing the H6 hypothesis (H6a, H6b, and H6c) as shown in Table 1. Performance impact in this study focuses on learning performance, student integrity, and self-confidence.

Based on Table 4, it shows that in general, TTF has a positive and significant relationship to learning performance, therefore the hypothesis H6a was acceptable. Several studies have shown a significant relationship between TTF and student performance in online learning environments (Butt, et al., 2021). Previously, Shim and Jo (2020) also conducted an analysis of information quality, system quality and service quality which led to user satisfaction and perceived benefits in a health information system and concluded that TTF has a significant relationship with performance impact.

Personal integrity is a commitment held by students related to ethical decisions, such as being honest in the context of academic settings. Fishman (2014) defines academic integrity as a student's commitment to the fundamental values of honesty, trust, fairness, respect, responsibility, and courage. Academic integrity is an important issue in education, and one example of contravening academic integrity is dishonest behaviour unfairly violating educational rules (Farahat, 2022; Surahman and Wang, 2022). This form of dishonest behaviour is cheating during assessment, especially in online learning. Farahat (2022) said that one of the factors that contributed to academic integrity was academic performance. In this study, the use of the online summary feature with automated feedback can support students to improve their academic integrity so that in this study it is used as one of the variables in performance impact. This research shows that TTF positively and significantly affects personal integrity (H6b), therefore H6b was accepted.

Self-efficacy refers to a person's confidence in his ability to complete a certain task (Bandura, 1978). Self-confidence in this study refers to self-efficacy (SC1), self-regulation (SC2), and self-motivation (SC3) (see Table 1). Landrum (2020) summarizes that self-efficacy to complete an online course is a positive and significant predictor of satisfaction in online learning. In addition, Landrum (2020) also concludes that when self-regulation is coupled with self-motivation, it can make students more independent and confident in acting, and self-regulation behaviours can be implemented in online learning. Based on Table 4, it can be seen that the hypothesis of task-technology fit positively and significantly effecting self-confidence (H6c) was rejected.

Another predictor that influences performance is utilization as shown in Table 4, the hypotheses of H7a, H7b, and H7c were accepted. The results of this study are slightly different from the research conducted by Goodhue and Thompson (1995) which confirmed that utilization does not have power strong enough to predict performance.

6.4 Behavioural Intention

Several studies have combined the technology acceptance model and TTF in exploring the factors that can explain the use of information system technology and its relation to user performance. The technology acceptance model focuses on attitudes toward utilization of a particular information system technology which users develop based on perceived usefulness and ease of use of the information system technology (Davis, Bagozzi and Warshaw, 1989) while TTF focuses on the measurement of the functionality of the information system that supports the task at hand (Goodhue and Thompson, 1995). In this study, behavioural intention is influenced by predictors of task-technology fit and performance impact with the hypothesis as shown in Table 4, namely H8 and H9 (H9a, H9b, H9c). These research findings are in line with research conducted by Dishaw and Strong (1999) who used the TTF predictor in influencing behavioural intention. In extended technology acceptance model research, such as the work of Chao (2019), one of the predictors of behavioural intention is performance expectancy, and the results of the research show that performance expectancy has a positive and significant effect on behavioural intention.

Based on the results of this study (see Table 4) the hypothesis of H8, H9a and H9c were accepted while the hypothesis of H9b was rejected. Personal integrity may not be a direct determinant in technology adoption because it has a complex relationship and affected by several factors, such as ethical consideration, technology trust et cetera.

7. Conclusion

This research has revealed the factors that influence behavioural intention to use " the Online summaries-with automated feedback in a massive open online courses (MOOCs) platform" using task-technology fit (TTF) analysis, and students' performance or performance impact as moderator variables. Performance impact had 3 dimensions namely:, learning performance, personal integrity, and self-confidence. In this study, several points can be concluded as follows: even though the task and technology characteristics did not fit, TTF factors still proved the positive and significant effect on student performance in this case performance impact, TTF did not prove the positive and significant effect on self- confidence. However, the TTF factors and performance impact had shown the positive and significant effect on behavioural intention to use the online summaries-with automated feedback in a massive open online courses (MOOCs) platform.

Addressing the factors that influence behavioural intention to use online summary with automated feedback would be as important as understanding the potential adopters. Furthermore, these findings gave information about factors that can influence the relationship between TTF and behavioural intention to use online summary with automated feedback. As a result, we may understand more about factors that influences the successful implementation of online summary with automated feedback to continue to increase user retention and indeed

recruit future users. One of the limitations of this research is the task and technology characteristics were not achieving a strong fit. However, in order to adjust and achieve this, the continuous improvement of technology should be ongoing especially in summarizing checker tool, the algorithm should be improved in order to give a better feedback to the students.

Declarations

This research was funded by Universitas Negeri Malang's Internal research grant (Number 4.3.13/UN32/KP/2021).

All authors declare that they have no conflict of interest.

All procedures performed in studies involving human participants were in accordance with the ethical standards of Universitas Negeri Malang.

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The Effect of Laptop Note-Taking on Students' Learning Performance, Strategies, and Satisfaction

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Abstract: With the pervasiveness of laptops in the classroom setting, the effectiveness of laptop-assisted note-taking has not been comprehensively investigated. Many inconsistencies in this area still existed with intense debate towards academic performance, learning strategies, and student satisfaction. To fill this missing gap, this study probed the effect of laptop note-taking on the above constructs. The present study applied the comprehensive review by objectively selecting all relative literature from online database, with a main focus on learning areas and conducting the objective procedure. This study covered the positive, negative, as well as neutral effects of laptop note-taking on learning performance. Reasons behind the negative impact and worries were investigated in caution. Tackling the major concerns of distraction and multitasking, this study argued that these concerns might not be the main cause of low performance, individual's characteristics and preference for the teaching styles shall be taken into consideration. Based on the above arguments, this study provided educators with multiple suggestions on alternative pedagogical approaches to improve teaching practice and student learning experience. The satisfaction of courses was probed together with the reasons for low satisfaction which promoted relative teaching instruction and teacher training. In this vein, this study contributed to the laptop note-taking areas by comprehensively analyzing the effect of laptop note-taking on learning strategies and satisfaction, which were unfortunately ignored by previous studies. Moreover, the present study enriches the e-learning knowledge and supports its practice by proving the side effects of simply banning laptops in class and suggests educators to integrate laptops into their pedagogical designs as well as learn more technology-based teaching strategies. Future research should reinvestigate the effect of laptop note-taking in class with more caution and endeavor to enhance the effectiveness of laptop note-taking in the class by capturing all possible variables of student learning, especially technology-relative variables.

Keywords: Laptop note-taking, Longhand note-taking, Learning performance, Strategies, Satisfaction

1. Introduction

Computers are ubiquitous in universities (Dahlstrom and Bichsel, 2014). Most of the undergraduates in the survey use laptops as note-taking mediums for their speed, legibility, and search ability (Fried, 2008; Kim, Turner, and Pérez-Quiñones, 2009). With the pervasiveness use of laptop note-taking, recent decades witnessed a great transformation of pedagogical approaches to dig out the enormous potential of internet resources and learning opportunities. However, the efficiency of laptop note-taking was doubted mainly for its shallow processing, additional distraction, and multitasking burden (Sana, Weston, and Cepeda, 2013; Kay and Lauricella, 2014). Numerous studies have proved the non-significant effect of laptop note-taking on hindering information retention (Eason, 2017), recall comprehension (Wiechmann, et al., 2022), general academic performance (Voyer, Ronis, and Byers, 2022), and peer academic achievements (Aguilar-Roca, Williams, and O'Dowd, 2012). Several studies even revealed laptop note-taking's positive impact on searching for class-related resources, sharing effective information with peers (Kay and Lauricella, 2014), and even better performance in tests (Sun and Li, 2019). Besides, other internal and external variables in the learning process can all entangle with the note-taking method to exert an impact on learning performance. Hence, a fine-grained review of laptop note-taking is still needed to uncover the controversies and pursue what affected learners' learning through laptop note taking.

The relationships between note-taking mediums, learning performance, and strategies have been investigated by enormous researchers, yet resulted in no consistency. As for learning performance, learners with different note-taking mediums would perform in different ways and lead to diversified outcomes. Some learners might be weakened by the verbatim transcription of laptop note-taking for lacking spatial ability (Luo, et al., 2018) and impaired memory (Mueller and Oppenheimer, 2014), while others with poor memory can benefit from this verbal transcription (Bui, Myerson, and Hale, 2013). As for learning strategies, longhand note takers tended to use verbal and spatial strategies to take notes, while laptop note takers were inclined to transcribe verbal notes. These different strategies would affect the efficiency of lecture notes (Luo, et al., 2018), learning ability, memory, and achievement (Mueller and Oppenheimer, 2014). Furthermore, different note-taking mediums were considered vital indicators of learners' satisfaction. The choice of learning mediums would affect student

Reference this paper: Shi, Y. and Yu, Z., 2024. The Effect of Laptop Note-Taking on Students' Learning Performance, Strategies, and Satisfaction, *The Electronic Journal of e-Learning, 22(1)*, pp 78-91, available online at www.ejel.org

satisfaction, which would further influence learning affect and engagement (Albaker, 2021). Although relative studies were growing, there still existed a multitude of inconsistencies which appealed for more exploration; hence, the present study deeply and carefully probed the effect of laptop note-taking on students' learning performance, strategies, and satisfaction.

2. Theoretical Background

2.1 Laptop Note-Taking

Note-taking was prevalent among students while participating in extensive reading and comprehension activities (Erickson, 1996). Notes were considered as an inseparable section of writing practice which encouraged students to select appropriate parts, generate notes, and assemble them into different sections (Flower, 1990). In this vein, notes promised students' active engagement with texts and materials, indicating the comprehension of knowledge (Slotte and Lonka, 1999). Nowadays, with the huge development of technology, laptops were ubiquitous in learning contexts, especially colleges. Hence, laptop note-taking became a hotpot among learners for its effectiveness in recording and organizing notes, which greatly shocked the traditional note-taking method - longhand note-taking. Longhand note-taking was based on handwriting methods to form notes, which was believed to facilitate memorization and retention of knowledge (Mueller and Oppenheimer, 2014). Therefore, many researchers conducted empirical studies to testify the effect of note-taking medium on learning performance, strategies, satisfaction, and so on.

2.2 Learning Performance

Learning performance in this study included learning achievements, behaviors, test or course grades, effectiveness, completeness, and logical order of notes. Regarding the issue of the longhand note-taking versus laptop note-taking methods, numerous inconsistencies existed in research results, whether in replications or independent studies; thus, it led to no exact conclusion. Mueller and Oppenheimer (2014) criticized the negative effect of laptop note-taking on academic learning, and their critique resonated with other researchers (Patterson and Patterson, 2017; Allen, et al., 2020). Later, Voyer, Ronis, and Byers (2022) conducted a meta-analysis, excluding the distraction of laptops, and found that note-taking mediums or methods made no difference in academic performance. Besides the above missing link, many new moderators have been considered in this area, such as visual images (Luo, et al., 2018), encoding, and storage functions (Morehead, et al., 2019), which may interfere with the relationship between the note-taking mediums and learning performance. Hence, different note-taking methods, especially laptops, were central issues in the study of students' learning performance.

2.3 Learning Strategies

Learning strategies were defined as methods or approaches to facilitate the acquisition of new knowledge or skills in the whole learning process. It consisted of setting learning goals, choosing preferred techniques, and monitoring learning process. Learning strategies were an important research topic in technology-based teaching and learning (Yu, Xu, and Sukjairungwattana, 2023). The difference in note-taking contexts might encourage different learning strategies, contributing to diversified outcomes (Mueller and Oppenheimer, 2014; Morehead, Dunlosky, and Rawson, 2019). Hence, numerous studies have endeavored to discover the effect of note-taking mediums on learning strategies. The learning strategy of transcribing with laptop note-taking would boost learning performance and benefit students with poor short-term memory (Bui, Myerson, and Hale, 2013). Establishing a computer-supported learning environment can develop students' ability for strategic learning (Malmberg, Järvelä, and Kirschner, 2014). On the contrary, inconsistencies among different studies still pertained. Digital distraction impeded eleven self-regulation strategies proposed by Parry, le Roux, and Bantjes (2020). It was therefore considered necessary to investigate the influence of laptop-assisted note-taking on student learning strategies.

2.4 Satisfaction

Satisfaction was defined as students' perceptions of their pleasantness with the quality of the lecturer, lecturing styles and speed, lecture content and organization, assessment policies, and overall satisfaction with their courses. Satisfaction was positively associated with performance, i.e., higher satisfaction with the lecture could result in a better understanding of materials and relatively greater performance (Yu, Chen, and Zhu, 2019). Myriad studies have investigated the vitality of student satisfaction in courses through different note-taking mediums, while the effects of note-taking methods on students' satisfaction were not consistent. On the one hand, the convenience of laptop note-taking could increase students' happiness and enjoyment in the courses

(Albaker, 2021). Introducing laptop-needed interactive activities into classrooms could increase student satisfaction and enhance the learning experience (Devasagayam, Stark, and Watroba, 2013). On the other hand, Wurst, Smarkola, and Gaffney (2008) concluded that students reported less satisfaction with laptop-aided courses compared with the longhand group. Hence, it was imperative to probe the effect of laptop note-taking on student satisfaction.

In the whole timespan (2001-2023), learning performance was the locus of laptop researches starting from "the laptop initiative" in 2002. From 2001 to 2013, consumer metaphor was prevalent in relative laptop studies; therefore, many researchers focused on learners' satisfaction in this period (Wurst, Smarkola, and Gaffney, 2008). From 2013 to 2019, technology-based teaching and learning was a hotpot attracting many explorations on learning strategies. From 2019 to 2023, the COVID-19 pandemic caused the largest malfunction of education systems worldwide, which greatly promoted the spread and usage of computer/laptop technology in online learning. Since then, learner's performance, learning strategies, and satisfaction became the most vital and urgent issue. Therefore, seeking to review the above variables comprehensively, the present review was noteworthy in the scope of education, especially in teaching pedagogy. Here we listed three research questions:

RQ1: Could laptop-assisted note-taking improve learning performance?

RQ2: Could laptop-assisted note-taking improve learning strategies?

RQ3: Could laptop-assisted note-taking improve student satisfaction?

3. Research Methods

3.1 Research Design

The researchers adopt a research design of the comprehensive review by objectively selecting all relative literature, with a main focus on learning areas and conducting the objective procedure. Based on inclusion and exclusion criteria, the researchers sifted several journal articles and offered a concise summary of the obtained literature.

3.2 Research Corpus

The data collection process consisted of the following parts: First, the researchers gained much literature by searching online databases. Secondly, the researchers removed unrelated literature and clustered them, after which they summarized the themes based on clustering results. Various databases were contained, such as Current Chemical Reactions (CCR-EXPANDED) and Index Chemicus (IC), which minimized publication bias and improved the representativeness of the study. The researchers collected 2725 relative literature on the 16th October 2023, by keying ("laptop*" OR "computer*" OR "digital*" OR "online*") AND ("note taking" OR "note-taking" OR "tak* notes" OR "note*") AND ("academic" OR "learning" OR "student*" OR "class*" OR "school") AND ("perform*" OR "behave*"OR "outcome*" OR satisfaction OR "strategy*" OR "comprehen*") as topic in online databases such as Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), and Emerging Sources Citation Index (ESCI).

To anchor to a specific research area, the literature was refined into a limited amount and clustered by a bibliographic network. Removing the irrelevant literature from other areas, i.e., "Psychology Multidisciplinary" "Computer Science Interdisciplinary Applications" "Psychology Experimental" and "Education Scientific Disciplines" as well as refining the research scope to "Education and Educational Research" the researchers obtained 569 results which were clustered by bibliographic network study through VOSviewer. The minimum number of occurrences of a keyword was set as 5 in the VOSviewer. Of the 2529 keywords, 172 meet the threshold. The main keywords were students' performance, strategies, and satisfaction. The keywords with the strongest co-occurrence link were selected in Figure 1.

Figure 1: Clustering of Keywords

3.3 Data Analysis and Credibility

The researchers also included and excluded the obtained literature relying on STARLITE (Appendix A) (Booth and Booth, 2006) and Preferred Reporting Items for Systematic Review and Meta-analysis Protocol (PRISMA-P) (Page, et al., 2021) (Figure 2), which were used to describe the essential elements for reporting literature searches.

S: Sampling strategy. A purposive strategy was taken for obtaining relevant literature as soon as possible to further refine the results into the scope of the laptop note-taking method effect.

T: Type of studies. The study reported the study types of qualitative, quantitative, and mixed studies.

A: Approaches. The researchers obtained data through hand search method. By Boolean search method, the researchers selected the keywords “laptop” “notetak* performance” “strateg*” “comprehen*” and satisfaction as titles.

R: Range of years. This study included studies ranging from 2001 to 2023.

L: Limits. This study is limited to English-written publications instead of other languages, and the publication site is open to all countries or areas. The sample is refined into high-quality qualitative, quantitative, or mixed studies, including book chapters and excluding reports and unpublished papers.

I: Inclusion and exclusions. The inclusion criteria contained: (1) The study publication time should range from 2001 to 2023; (2) The study is properly designed and reach convincing conclusions; (3) The study can offer enough relevant information to a comprehensive review; (4) The study shall investigate the effect of the laptop note-taking method on at least one of learning performance, strategies, and satisfaction; (5) The study should probe at least one element of learning performance, strategies, and satisfaction in the comparison of laptop and other note-taking methods (longhand, tablet, smartphone); (6) The research methods of the refined studies shall be qualitative, quantitative or mixed. The exclusion criteria containing: (1) duplicates; (2) titles and abstracts were irrelevant to the study; (3) topic-irrelevance; (4) out of educational areas; (5) no abstract and reference; (6) reports and non-published studies; (7) not enough information after contacting the authors.

T: Terms used. This study used search terms of laptop note-taking, learning performance, strategies, and satisfaction.

E: Electronic sources. The retrieval of studies was conducted by searching the core collection of Web of Science, consisting of Science Citation Index Expanded, Social Sciences Citation Index, Arts & Humanities Citation Index, Conference Proceedings Citation Index- Science, Conference Proceedings Citation Index- Social Science & Humanities, Emerging Sources Citation Index, Current Chemical Reactions, and Index Chemicus.

As for the detailed literature selection process, several researchers cooperated to select high-quality studies by looking through each section of a study, such as title, abstract, keywords, introduction, literature review, methods or methodology, results, discussion, and conclusion. Two researchers independently rated all obtained

studies to assess high inter-rater reliability (k=0.795) (McHugh, 2012). If both of them cannot reach an agreement, a third researcher will join in the discussion of the selection and make final decisions about it (more details in Supplementary materials). Based on the bibliographic clustering analysis, STARLITE, and the PRISMA-P, the researchers refined the results to a total of 59 articles of high quality and developed their results.

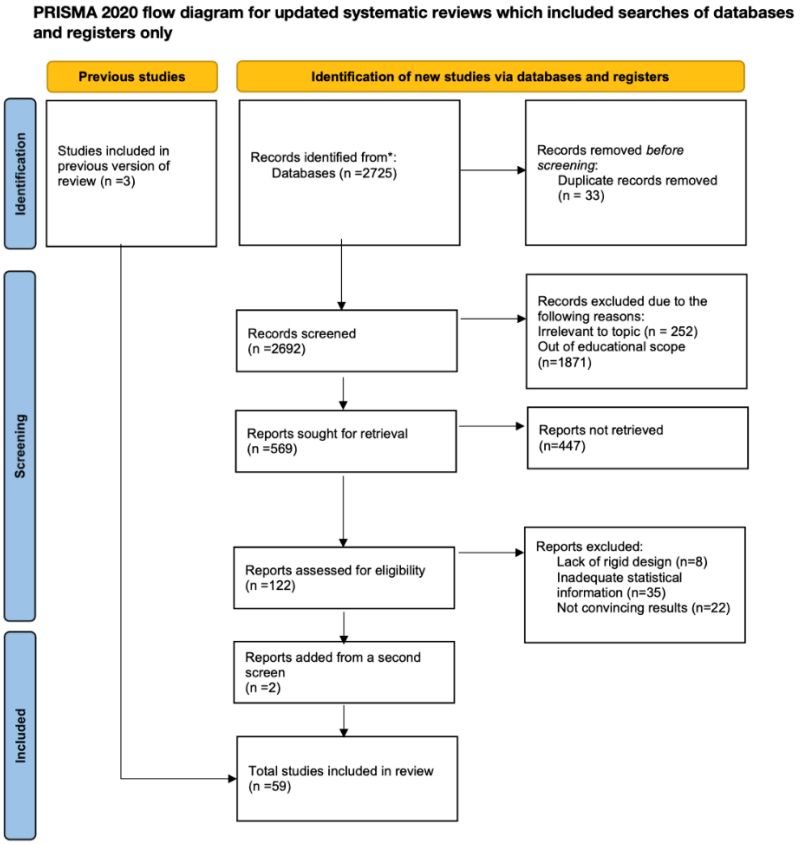

Figure 2: A flow chart of the literature inclusion based on PRISMA-P

4. Results

4.1 RQ 1: Could Laptop-Assisted Note-Taking Improve Learning Performance?

4.1.1 The positive effect of laptop note-taking

Strands of studies concluded that laptop note-taking could boost student learning performance in the classroom setting. Barak, Lipson, and Lerman (2006) found that using wireless laptops could promote learner-centered learning exploration and meaningful interaction among students, teachers, and their peers. "Deliberate engagement" of the laptop in large classes could improve student attentiveness and engagement (Samson, 2023). For undergraduate university students, permission for laptop usage could facilitate laptop-based academic activities, collaboration with peers, concentration, organization, and efficiency (Kay, Lauricella, and Lauricella, 2011). When facing complicated lecture material and continuously provided new information, laptop note-taking could enhance learning performance in recognizing words and writing sentences based on its fast speed (Aragon-Mendizabal, et al., 2016; Thompson, Corrin, and Lodge, 2022). Digging into learning performance, Sun and Li (2019) and Albaker (2021) indicated that laptop note-taking students performed better in declarative, procedural, and conditional knowledge learning. Elliott-Dorans (2018) affirmed that laptop note-taking was beneficial for students because it produced more notes in limited lecture sessions. Concerning the process function and product function of note-taking methods, Luo, et al. (2018) recognized that laptop notes would accelerate learning performance in the immediate tests while the longhand notes in delayed tests after review.

4.1.2 No significant effect of laptop-assisted note-taking

A certain number of studies also claimed that laptop note-taking had no significant effect on academic performance. Note-taking mediums exerted no effect on immediate and distal information retention and associated performance (Wood, et al., 2012). A survey-based observational study suggested that note-taking

methods (longhand, laptop, tablet) produced no difference in factual or conceptual recall comprehension (Wiechmann, et al., 2022). There existed no difference in the effect of mediums on academic achievements (Duhon, 2015). Moreover, by conducting a systemic meta-analysis of laptop note-taking mediums, Voyer, Ronis, and Byers (2022) concluded that note-taking methods did not affect academic performance after diminishing the distraction.

4.1.3 The negative effect of laptop note-taking

Distraction and multitasking

The effects wrought by technology were not all positive. The major concern of using computers in a classroom setting was digital distraction, which contained surfing the web, socially communicating with peers, and entertaining themselves by watching videos or playing games (Kay and Lauricella, 2014), which might disrupt quality (completeness of idea units) and quantity (total words or idea units) of students' notes (Flanigan and Titsworth, 2020). Longer browsing sessions throughout a course posed decrement in students' overall class grades (Grace-Martin and GayPh, 2001), and Ragan, et al. (2014) confirmed the above worry of laptop use in an unrestricted large lecture class, where students spent nearly two-thirds of the time in non-class activities. Moreover, some studies pointed out the drawbacks of laptop multitasking. Kraushaar and Novak (2010) observed that 42% of the class time was spent on multitasking behaviors and non-class applications. Multitasking on a laptop, especially for nonacademic activities, hindered the overall course performance through grades or GPA (Carrier, et al., 2015; Ravizza, Uitvlugt, and Fenn, 2017)

Other worrying disadvantages of laptop note-taking

On the cognitive side, taking longhand notes needed a deeper level of processing (encoding and storage). Mueller and Oppenheimer (2014) criticized laptop note-taking for its great tendency to verbatim overlap with lecture content, which would cause low cognitive processing compared with longhand note-taking. Other studies supported these findings on factual and conceptual questions (Piolat, Olive, and Kellogg, 2017; Crumb, Hildebrandt, and Sutton, 2022). Moreover, Flanigan, et al. (2023) found that during revision longhand note takers added three times as many complete thoughts into their notes than laptop note takers, which predicted better learning achievement. On the general performance side, computer use in the classroom was argued to cause detriment to course performance, especially to male students, final exam performance, and memorization of lecture contents (Hembrooke and Gay, 2003; Aguilar-Roca, Williams, and O'Dowd, 2012; Carter, Greenberg, and Walker, 2017; Patterson and Patterson, 2017; Allen, et al., 2020). On the individual side, students were regarded to understate the frequency of off-task activities during class when self-reporting (Kraushaar and Novak, 2010).

4.1.4 Controversies

The major conflict remained whether the verbatim overlap of laptop note-taking would impede learning performance. Through three experiments, Mueller and Oppenheimer (2014) and other researchers found that longhand note-taking was superior to laptop note-taking in academic performance concerning verbatim overlap's potential detriment to academic learning. On the contrary, Siegel (2023) concluded that verbatim overlap and word count did not account for the difference in performance between the two groups although they were greatly different in verbatim overlap (Morehead, Dunlosky, and Rawson, 2019). Furthermore, Mitchell and Zheng's (2017) replication study even suggested that laptops may promote academic performance for the indirect effect of a greater word count, while the negative influence of verbatim overlap was insignificant.

Other concerning conflicts relied on distraction and multitasking. Students always overestimated their ability to multitask activities of social and educational uses, which indicated that students were unmatured to make informed decisions about using digital devices in the classroom (Zahay, Kumar, and Trimble, 2017). Yet, other studies on multi-tasking showed that students knew the detriment of multi-tasking to their performance in some contexts (Finley, Benjamin, and McCarley, 2014). Some researchers demonstrated that the loss of students' concentration sometimes should not all blame on the distraction but also mind wandering (Was, Hollis, and Dunlosky, 2019). Some opponents contended that multitasking on a laptop caused a great distraction to not only its users but also peers who were directly confronted with laptop screens (Sana, Weston, and Cepeda, 2013). Similarly, a recent study confirmed that laptop usage was detrimental to peers' comprehension and retention of course content, especially when using laptops for non-class activities (Hall, et al., 2020). Nevertheless, Aguilar-Roca, Williams, and O'Dowd (2012) compared laptop-free and laptop-restricted zones to see the impact of laptop usage on surrounding peers who wrote their notes, and their study reclaimed that laptop use in fact did not hinder their overall performance.

4.2 RQ 2: Could Laptop-Assisted Note-Taking Improve Learning Strategies?

4.2.1 Pros and cons of strategies

Different techniques for note-taking resulted in diversified learning processes and strategies, while studies concerning learning strategies were filled with inconsistencies. The learning strategy of transcribing using a laptop, compared with organized handwritten notes on paper, provided effective learning performance, especially for students with poor working memory (Bui, Myerson, and Hale, 2013). For elementary school students, creating a computer-supported learning environment can develop students' strategic learning abilities (Malmberg, Järvelä, and Kirschner, 2014). On the other side, it is contentious that laptops would allure a verbatim typing strategy which encouraged shallow processing and thus hindered academic performance (Mueller and Oppenheimer, 2014). And the distraction of laptops failed eleven self-regulation strategies proposed by Parry, le Roux, and Bantjes (2020) to erode student academic performance.

4.2.2 Appropriate strategies

The generative learning theory claimed that appropriate learning strategies that selected the most relative information from lectures can contribute greatly to meaningful learning (Wittrock, 1989) and even better learning behaviors. Fiorella and Mayer (2017) investigated the spontaneous spatial strategies of longhand, whiteboard, and laptop-assisted note-taking mediums and concluded that paper and whiteboard groups tended to use spatial strategies (e.g., mapping, drawing) while laptop one would use verbal strategies (e.g., words only, lists, or outlines). They yielded the viewpoint that laptop users linked their digital notes to a great number of legible words and fluent reorganization. The above finding implied that different groups would tend to apply diversified note taking habits that were suitable to their cognitive styles; hence, appropriate strategies were pivotal to learning and teaching.

4.3 RQ 3: Could Laptop-Assisted Note-Taking Improve Learning Satisfaction?

Research concerning laptop-assisted note-taking in class displayed no congruence. Students obtained good insights into the learning processes when teachers integrated technology into classes (Milliken and Barnes, 2002). Recently, Albaker (2021) pointed out that students felt more enjoyable and easier to use laptops for note-taking than pen and pencil. Digital note-taking could, in turn, improve student academic performance at all levels, including excellent, intermediate, and underperforming students. On the contrary, students who used laptops reported less satisfaction with their education in comparison to longhand ones in the honor program (Wurst, Smarkola, and Gaffney, 2008). The lower satisfaction of students in the program, as explained by the author, may rely on the original preference of students who habitually took the longhand method while later were forced to use laptops.

5. Discussion

5.1 Difficulty in Determining the Effectiveness of Laptop Note-Taking

Recent decades witnessed ubiquitous usage of laptops in classrooms and dynamically changed pedagogical approaches to integrate technology into multiple disciplines. Nevertheless, it was a tough task to determine the efficiency of laptop use based on the limited literature and inconsistencies among quantitative and qualitative studies. Numerous criticisms of laptop note-taking still existed for poor academic performance (Patterson and Patterson, 2017), digital distraction, and multitasking burden (Kay and Lauricella, 2014). However, due to the greater amount of word count, laptops were promising in promoting academic performance (Siegel, 2023). Distractions from digital devices can be weakened by the proper intervention of lecturers and more laptop-engaged course activities (Griffin, 2014). Additionally, permission for digital note-taking in class can positively predict computer-based learning activities, peer collaboration, and strategic learning (Kay, Lauricella, and Lauricella, 2011; Malmberg, Järvelä, and Kirschner, 2014). To summarize, considering the advantages and disadvantages of laptop note-taking, we still cannot arrive at a definite conclusion about its influence on learning performance, strategies, and satisfaction.

5.2 Concerns on Performance

Major concerns on performance were laptop distraction and multitasking in classrooms (Sana, Weston, and Cepeda, 2013; Ragan, et al., 2014; Ravizza, Uitvlugt, and Fenn, 2017), whose reasons can be classified into internal and external ones. As for internal causes, attentional impulsiveness, Internet addiction, habitual technology use, boredom (Chen, Nath, and Tang, 2020), mind wandering (Was, Hollis, and Dunlosky, 2019), and low self-regulation would increase off-task and nonacademic laptop usage. Concerning external factors,

environmental stimuli such as the availability of technology (Chen, Nath, and Tang, 2020) and laptops' huge capacity (Carrier, et al., 2015) could encourage multitasking activities in class. To solve the problem, educators were encouraged to develop relative and diversified pedagogues to tackle both the inner and outer causes. For one thing, helping students obtain a better understanding of their technology use patterns can improve their self-regulation and self-restriction. Informing students of the side effects of multitasking also enhance their self-correction of the laptop overuse and lower their attentional impulsiveness (Chen, Nath, and Tang, 2020; Dontre, 2021). Educators could include more interactive activities in their lecture designs to decrease students' boredom and mind wandering in class, such as teamwork and peer collaboration.

For another thing, habitual technology use, the strongest determinant of distraction and multitasking, was partially triggered by external stimuli (e.g., the permission to use laptops). Some behaviorist educators would just ban the use of laptops in class while others would intervene in the learning process to eliminate distraction and irrelevant multitasking. As for the banning reaction, Yamamoto (2007) observed a positive influence on student evaluations and academic performance. However, Elliott-Dorans (2018) found that banning instruction was more likely to quiz student performance instead of help. Therefore, other educators decided not to deprive student's right to free choice in note-taking methods, yet they would lay down relative intervention rules for laptop note-taking, such as setting the social norms of digital device use (Hembrooke and Gay, 2003; Fang, 2009), walking around the classroom or teaching from the back to keep students' alert (Griffin, 2014), and encouraging a dedicated education-only device (Dontre, 2021).

Different from the above behaviorist views, certain educators held the belief in social constructivism. They encouraged students to construct meaning from their own obtained knowledge, valued their opinions and choices, and highly promoted collaborative learning in class (Williams and Burden, 1997; Jonassen, 2013). Moreover, previous studies stated that social-constructivist goals, including student-centered interaction and embedded learning, can be achieved in a technology-aided learning environment (Rosen, 2009; Samson, 2010). Based on constructionist theories, pedagogical approaches like data collection, location awareness, collaboration, and class-related academic Internet use were especially suitable to digital devices (Patten, Arnedillo Sánchez, and Tangney, 2006; Chen and Tzeng, 2010). An initial try to introduce laptops into the classroom convinced Granberg and Witte (2005) that internet resources could enliven abstract concepts, enlarge interaction between students and educators, and encourage self-learning and peer learning in class. Intertwining digital content in a one-to-one laptop environment (digital teaching platform, one-to-one laptop support) could not only encourage different teaching planning and flexible designs, but also reduce students' class absences, improve their engagement, and enhance learning achievement, and satisfaction (Rosen and Beck-Hill, 2012).

5.2.1 Other important variables influencing performance

There were internal and external variables that greatly impacted learning performance, such as student personality, the degree of comfort with laptops, peers, lecture content and styles, and disciplines. On the one hand, Artz, et al. (2020) suggested that laptop note-taking had no statistically significant influence on learning performance which, instead, depended on the student's personality. The more neurotic the personality of students was, the less acceptance of introducing mobile computing into the classroom they became; the more agreeable personality they were, students would be more supportive of the introduction of mobile devices in classes (Wergin, Tracy, and DeVee Dykstra, 2011). Students who were prone to accept new things or technologies would benefit from laptop note taking applications, while those who refused to try on new things stayed in the same place (Palaigeorgiou, et al., 2006). Furthermore, students' degree of comfort with usage (Voyer, Ronis, and Byers, 2022) and their aptitude for using digital devices (Dahlstrom and Bichsel, 2014) would affect their fluent operation of laptops and corresponding performance. Regarding different performance levels, laptop note-taking may enhance the academic achievement of high-performing students (Sun and Li, 2019) while hinder the learning of low-performing students (Patterson and Patterson, 2017).

Regarding the external cues, on the other hand, students' behaviors in class, lecture styles, and disciplines would prompt distractions. Students' choices of different note-taking methods also depended on the course material and lecture styles, implying that their learning efficacy and achievement did not solely rely on note-taking mediums (Morehead, Dunlosky, and Rawson, 2019). Organizer completeness (complete, partial, or no organization on PowerPoint-aided lessons) and the contextual congruence of the learning environment and testing environment could exert also a huge influence on test results (Colliot, et al., 2022). Moreover, different disciplines did initiate different learning outcomes, yet the results of studies were still controversial about which kind of discipline preferred a specific type of note-taking method or even a mixed type. Some studies conducted that longhand note-taking was superior in beginning courses, natural science courses (Carter, Greenberg, and

Walker, 2017; Desselle and Shane, 2018; Allen, et al., 2020), and major courses (Patterson and Patterson, 2017). On the contrary, laptop note-taking also benefited students in social and health science (Aragon-Mendizabal, et al., 2016) and computer science courses (Sun and Li, 2019). Nevertheless, Wiechmann, et al. (2022) found no difference in the medical course, which may contradict Desselle and Shane's (2018) conclusion.

5.3 Concerns on Strategy

The main argument on strategy lay in the tendency to transcribe verbatim notes allured by the convenience and fast pace of laptop typing. The tendency to take verbatim lecture notes caused a deleterious impact on recall despite the superior amount of lecture notes (Mueller and Oppenheimer, 2014). However, for transcribing notes, the note quantity was a better predictor of recall performance, which would be friendly to students with poor working memory; for organizing notes, the working memory would be the predictor of recall (Bui, Myerson, and Hale, 2013). Whether transcribing verbatim notes would exert a negative effect on learning outcomes or not shall consider different working memory.

Hence, what kind of good strategies can result from laptop note-taking? Some studies yielded valuable insights into promoting laptop note-taking strategies. Applying a nonlinear association note-taking method could develop more meaningful association styles like linking words with the same contexts (Liu, Huang, and Chien, 2019). Other researchers concentrated on note-taking software or applications. Note-taking applications (e.g., Evernote, SpringPad, OneNote, Memonic, Keeppy, and Ubernote) focused on constructing notes with multiple sources and offloading learners' cognitive pressure (Roy, Brine, and Murasawa, 2016). Palaigeorgiou, et al. (2006) developed electronic verbatim notes (eVerNotes) to promote verbatim note-taking and combine multiple notes into a hierarchy. Combining information visualization tools with note-taking could offer an overview of digital notes with diversified classification and flexible comparison (Willett, Goffin, and Isenberg, 2015), such as OneNote. Using multi-platform cloud-based note-taking application (Evernote) can support learners' mobile learning and improve their ability to manage information, organize and record ideas (Schepman, et al., 2012). Roy, Brine, and Murasawa (2016) even found that note-taking applications can be applied to learn English as a foreign language effectively.

5.4 Concerns on Satisfaction

Laptop, with its huge internet resources, convenient input capacity, and easy modification, won students' appreciation (Steimle, Gurevych, and Mühlhäuser, 2007), while it was also refused and blamed for various reasons, mainly including distraction, inconvenience of equipment, and lack of computer skills. Distraction may cause anxiety and worries (Kay, 2008) and less satisfaction with lectures, resonated with previous studies (Hembrooke and Gay, 2003; Fried, 2008). Hardware and software problems would lessen students' satisfaction towards courses (Rivera, McAlister, and Rice, 2002), and over 60% of students reported that laptops were too heavy to carry to class, diminishing positive learning feelings. From the aspect of lack of computer skills, both students' and faculty's computer capacity maintained the problems. Undergraduate students were found to be less pleased with web-based courses because of their low proficiency in computer skills and knowledge (Rivera, McAlister, and Rice, 2002), yet with increasing familiarity with computer skills, students' worries decreased (Saunders and Klemming, 2003) and their happiness increased (Kay, 2008). Teachers with inadequate skills and knowledge of technology integration resulted in students' feelings of frustration and boredom, and increased mind wandering in class, which hindered the active application of new learning methods (Newhouse and Rennie, 2001).

Therefore, strands of studies investigated solutions to the problem of equipment and computer skills through technological and pedagogical alteration. From the perspective of technological alteration, colleges, and universities are recommended to plan a proper layout for laptop classrooms to improve conductive academic learning while concerning the low visibility of laptop screens due to sun glare (Wurst, Smarkola, and Gaffney, 2008). Installing more electrical sockets in classrooms could ensure the Internet for a comfortable and diversified learning environment (Castillo-Manzano, et al., 2017). In line with pedagogical changes, teachers could participate in relative computer training courses to promote their digital skills and introduce more new technology like Zoom into their classes to provide multiple learning resources. Moreover, experienced information technology leadership shall be called for to guide better strategic use of technology in students' digital devices and faculty teaching devices usage (Dahlstrom and Bichsel, 2014).

6. Conclusion

6.1 Major Findings

This study investigated the effect of the laptop note-taking method on academic performance, learning strategies, and student satisfaction with lectures. Based on a comprehensive analysis, both the negative, positive, and non-significant effects of laptop note-taking on learning performance were explored with caution. Reasons behind the negative impact and worries were investigated. Tackling the major concerns of distraction and multitasking, this study argued that these concerns might not be the main cause of low performance, individual's characteristics and preference for the teaching styles shall be taken into consideration. The satisfaction of courses was probed together with the reasons for low satisfaction which promotes relative teaching instruction and teacher training. Laptop note-taking applications can tremendously enhance learners' ability and offload their cognitive pressure. Hence it was believed that indiscreetly abandoning laptop note-taking is unwise, and further investigation is encouraged to further the research.

6.2 Limitations

Although contributing to the current debate on laptop note taking, the present study was still limited due to the following reasons: firstly, the online databases that were retrieved for literature cannot include all of the relevant resources, which contained literature written in non-English, unpublished works, reports, and so on. Secondly, the current study was based on content analysis of other's studies without the support of statistics, which may result in low reliability of the conclusion. Further meta-analysis studies and experimental studies are invited to carry on the debate on the effect of laptop note taking. Thirdly, the existing literature did not capture all possible student learning variables, which needs further request on this missing link.

6.3 Future Research Directions

Based on the aforementioned limitations, future research could, firstly, probe whether the negative effect of laptop note-taking (e.g., distraction, multitasking, and low satisfaction) can be diminished through technical methods (Castillo-Manzano, et al., 2017) and pedagogical approaches (Kay, Lauricella, and Lauricella, 2011). Secondly, more investigation to the adaptability of mixed or simplified note-taking methods on different disciplines are invited. Thirdly, other learning variables ranging from the external side (e.g., lecture content and material) to the internal side (e.g., student personality and learning styles) are appealed for exploration to contribute to flourished researches. Fourthly, different effects of laptop note-taking on different genders shall be considered in further studies. Fifthly, studies in this review are mainly conducted in the United States (e.g., Mitchell and Zheng, 2017; Wiechmann, et al., 2022), Malaysia (Albaker, 2021), and Finland (Malmberg, Järvelä, and Kirschner, 2014); hence, more cross-sectional studies in other countries are welcomed (e.g., Kusumoto, 2022; Siegle, 2023). Moreover, as for student demographics, this study covers from elementary school students to doctoral students with L1 or L2 English as testing materials (e.g., Rosen and Beck-Hill, 2012; Siegle, 2021). Limited to the technology popularization, university students use laptops more than other groups; hence, more studies on K12 and higher education are highly recommended.

The combination of laptop note-taking and educational technologies is a fascinating trend in the future. Online collaborative note-taking with discussion forum in flipped learning contexts can greatly promote learners' performance (Fanguy, 2023). Future studies can investigate the interaction between collaborative laptop note-taking and online teaching platforms such as Zoom, Tencent Meeting, and MOOCs, which can potentially enhance learners' e-learning ability. In addition, researchers can also explore the effectiveness of laptop note-taking in non-traditional formats like participatory learning (Li, et al., 2024; Yu, 2024). Finally, flipped classrooms (Yu and Gao, 2021), collaborative learning, and virtual reality-assisted learning (Yu and Duan, 2024) may be more productive in successful multitasking learning in class, which calls for more researchers to probe the relationship between multitasking and varieties of instructional formats (May and Elder, 2018). The findings in this study could be applied to the daily practice of educators and institutions in promoting learning performance, strategies, and satisfaction with laptop note-taking in class.

We have no conflicts of interest to declare that are relevant to the content of this article

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Appendix A: The STARLITE Evaluation (Booth, 2006)

Component	Explanation
S: Sampling strategy	Comprehensive: the sample should be comprehensive enough to be representative. Selective: the sample should be scientifically selected. Purposive: the sample should source from related fields.
T: Type of studies	Fully reported: the sample should clearly explain the specific study type. Partially reported: the sample sometimes generally describes the study type.
A: Approaches	Approaches could retrieve literature from online databases and directly search them online.
R: Range of years (start date-end date)	The sample should source from a certain period.
L: Limits	There are some limits on sampling such as the language used and research methods adopted.
I: Inclusion and exclusions	There are criteria to include or exclude literature.
T: Terms used	There must be terms to retrieve high-quality literature.
E: Electronic sources	Samples may be from online databases, free publications or other electronic sources.