Lecture Notes in Educational Technology

Chutiporn Anutariya · Dejian Liu · Kinshuk · Ahmed Tlili · Junfeng Yang · Maiga Chang *Editors*

Smart Learning for A Sustainable Society

Proceedings of the 7th International Conference on Smart Learning Environments

Springer

Lecture Notes in Educational Technology

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Abstracted/Indexed in:

Scopus, ACM Digital Library, ERIC, INSPEC, Norwegian Register for Scientific Journals and Series, SCImago

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ISSN 2196-4963 ISSN 2196-4971 (electronic)
Lecture Notes in Educational Technology
ISBN 978-981-99-5960-0 ISBN 978-981-99-5961-7 (eBook)
https://doi.org/10.1007/978-981-99-5961-7

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The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

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Preface

Smart education has been gaining the interest of researchers and practitioners for the past years as it can help to provide effective and flexible learning experiences, hence achieving good learning outcomes. The International Conference on Smart Learning Environments (ICSLE) has been organized for the past years aiming to promote research and dialogue on smart education, as well as help in the adoption and development of this research field. It was held in the past editions in Hong Kong of China, Sinaia of Romania, Tunis of Tunisia, Beijing of China, Denton of the United States, Nicosia of Turkey and La Rioja of Spain.

ICSLE 2023 will be held in conjunction with IEC 2023 (the 14th TCU International E-Learning Conference) on August 31–September 01 in Thailand, Bangkok. Its focus is on the interplay of pedagogy, technology and their fusion toward the advancement of smart learning for sustainable society. The theme for ICSLE 2023 is *Smart Learning for Sustainable Society: Emerging Technologies and Applications.* Various components of this interplay include, but are not limited to:

Track 1. AI and Smart Technologies in Education—Natural Language Understanding (text, speech), Educational Data Mining, Machine Learning in Education, Learning Analytics, Adaptive and Personalized Learning, Intelligent Tutoring Systems

Track 2. Innovative Applications of Smart Learning—Applications, Case Studies and Best Practices of Domain-specific/Subject-specific Smart Learning (e.g., STEM, Language, Health Care, Business, Industry, Sports, Arts, Culture, etc.)

Track 3. Pedagogy, Learning Approaches and Instructional Design—Collaborative and Group Learning; Game-based Learning and Gamification; Inquiry-based Learning; Work-Integrated Learning, Simulation

Track 4. Online and Digital Learning Spaces—E-learning; Blended/Hybrid Learning; Mobile Learning; MOOCs; Virtual Reality, Augmented Reality and Mixed Reality Learning

Track 5. Lesson Learned from COVID-19 Pandemic—Educational Responses, Novel Educational Practice, New Educational Models, Delivery Methods, Assessment and Policies

ICSLE 2023 received a total of 69 paper submissions from 15 different countries around the globe. The International Program Committee (IPC) was formed by 44 members from 13 countries. Each paper was anonymously reviewed by at least three PC members. Based on the given reviews and recommendations, ICSLE 2023 Program Chairs made the final decisions accordingly. Finally, 38 papers (13 full papers, 17 short papers and 8 discussion papers) were accepted and presented at the conference.

On behalf of the Conference Organizing Committee and Conference General Chairs, we would like to express our gratitude to all the authors, reviewers, conference partners, local hosts and local organizing teams for their contribution to the success of ICSLE 2023. We believe that the conference proceeding will be useful for all researchers and practitioners working in the field of educational technology and smart education.

Kind regards,

Chutiporn Anutariya
Dejian Liu
Kinshuk
Ahmed Tlili
Junfeng Yang
Maiga Chang

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Editor Biography

Prof. Ahmed Tlili is an Associate Professor at Beijing Normal University, China, Adjunct Associate Professor at An-Najah University, Palestine and a Visiting Professor at UNIR, Spain. He is the Co-Director of the OER Lab at the Smart Learning Institute of Beijing Normal University (SLIBNU), China. He serves as the Editor of Springer Series Future Education and Learning Spaces, and the Associate Editor of Smart Learning Environments, IEEE Bulletin of the Technical Committee on Learning Technology, and the Journal of e-Learning and Knowledge Society. Prof. Tlili is also an expert at the Arab League Educational, Cultural and Scientific Organization (ALECSO). He has edited several special issues in several journals. He has also published several books, as well as academic papers in international referred journals and conferences. He has been awarded the Martin Wolpers 2021 Prize by the Research Institute for Innovation and Technology in Education (UNIR iTED) in recognition of excellence in research, education and significant impact on society. He also has been awarded the IEEE TCLT Early Career Researcher Award in Learning Technologies for 2020.

Measuring the Impact of Content and Dialogue on Student Satisfaction in Online Learning

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Abstract. E-learning is an education system that is general and flexible in the learning process, especially during the Covid-19 pandemic. So, most likely, e-learning will be adopted for the learning process. In an e-learning system, various kinds of facilities must be facilitated according to learning needs. These facilities include Course Content and Dialogue facilities to increase satisfaction in learning interest in online media. This research is interested in exploring the influence or impact of these facilities on increasing student satisfaction with online learning. The analysis was carried out by involving 570 university respondents with PLS-SEM analysis. The results of the research show that the implementation of e-learning must be facilitated by providing quality content so that it is easy to understand properly and dialogue facilities between teachers and students so that they can interact in exchanging information. With all of this fulfilled, student satisfaction will automatically increase in using online learning.

Keywords: Course Content Quality · Course Design Quality · Instructor-student dialogue · Student-student dialogue · Student Satisfaction · Online Learning

1 Introduction

At this time, e-learning has become a phenomenon whose usage has surged due to the Covid-19 pandemic situation. E-learning is an education system that generally changes the learning process [1]. E-learning provides facilities for online student involvement in the learning process [2–4]. E-learning can be utilized effectively for more self-confidence, reducing stress, and increasing care and empathy from its users [5]. For lecturers and students, E-learning can provide interactive learning materials/modules that can be presented in an attractive visual form [6–8]. Developed countries have digital learning to provide effectiveness [9]. e-learning indicates that not all students will be successful in online learning [10].

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 1–11, 2023.
https://doi.org/10.1007/978-981-99-5961-7_1

In its application in university, it is necessary to concentrate on course content and course design to improve the quality of e-learning so as to increase student satisfaction [11, 12]. In addition, in terms of learning effectiveness, both perceived learning outcomes and student initiatives can determine student satisfaction. Another thing identifying that student-student dialogue, course design, and instructor-student dialogue are the main predictive factors in the learning process of Online Learning [12–16]. e-learning needs to design courses with multimedia resources to increase learning interest [17] and can be fun during learning [18].

In e-learning, dialogue as a medium of communication and information sharing is good for interactions between students and instructors to increase understanding of the subject matter and stimulate student interest in learning [13]. In addition, it can build productive learning by increasing the development of problem-solving and critical-thinking skills in online environments [19]. In one study, students who exhibited high levels of interaction with other students reported high levels of learning outcomes and satisfaction [20].

With this online learning, students get comfortable learning because they can innovate by using computer technology [21, 22]. Thus, this study aims to explore and analyze the effect of student learning satisfaction during the pandemic via online on the availability of Course Content Quality, Course Design Quality, availability of Instructor-student dialogue, and Student-student dialogue. So that the provision of online learning services can pay attention to these factors in the development of e-learning platforms.

2 Theory and Development Hypothesis

2.1 Course Content Quality

The quality of content in e-learning must be well structured and attractive in the form of visual information so as to facilitate the online class learning process [23]. In addition, the learning content design must display according to competence and learning targets to increase student understanding [24]. E-learning provides courses with various resources (multimedia) to increase interest in learning and easily understand concepts from students [17]. Thus, the right Content Quality can increase online learning satisfaction for students because they find a pleasant environment during their learning [18]. So, it is proposed hypothesis 1 that Course Content Quality can have a positive impact on online learning satisfaction.

2.2 Course Design Quality

Design Quality designed in Course Design can improve the quality of e-learning. Therefore, e-learning can facilitate students in the learning process for the better. This can provide satisfaction with online learning [25]. Good and good course design can generate, shape and combine many ideas developed for learning [26]. So, it is proposed hypothesis 2 that Course Design Quality can have a positive impact on online learning satisfaction.

2.3 Instructor-Student Dialogue

The dialogue process is a conversation between individuals to be able to interact. Dialogue is crucial in the teaching and learning process between instructors and students. The dialogue that occurs can be in the form of providing information, motivating, providing feedback, and concerns from students [27]. Dialogue between students and instructors can be in the form of asking questions, or communicating about learning activities. Interaction requires communication to share and provide information from instructors to students and vice versa [13]. Instructor-student dialogue is important and significantly influences student satisfaction in participating in learning [28]. So, it is proposed hypothesis 3 that the Instructor-student dialogue can have a positive impact on online learning satisfaction.

2.4 Student-Student Dialogue

Interaction between students provides an important experience in the learning process. Online learning can be successful and important because it gets support for communication mechanisms. Interaction between students occurs in a group learning activity that can be built virtually. This process provides a space between students to exchange information and ideas in the online learning process [13]. Interaction between students is very important for building community in an online learning environment to be more productive and improve critical skills [19]. In existing studies, students show high interaction between students can provide high satisfaction because learning outcomes are improving [20]. So this hypotesis 4 is student-student dialogue impact to Student Satisfaction in e-learning.

2.5 Student Satisfaction

Student satisfaction can be perceived as a positive learning experience in the learning process. Students get satisfaction from a student's success in getting good grades [29]. Higher satisfaction can increase persistence and greater commitment to learning [29, 30]. Institutions can improve facilities properly to support the development of online learning strategies [31]. This strategy can be in the form of developing content quality and content design [19, 20, 26]. Thus, satisfaction is important in improving learning outcomes [32, 33].

3 Methodology

This study evaluates the research model built and hypotheses with a quantitative approach. The research model developed is five variables with 21 indicators. Furthermore, these indicators are used as questions and distributed online using the Google form. Questions are measured on a scale of 6 from level 1 (strongly disagree) to 6 (strongly agree). Statistical analysis with PLS_SEM with SMART PLS 4.0 software to test and measure the research model (Fig. 1). Data was obtained from 587 respondents, and 570 respondents used valid data. Furthermore, this study discusses, concludes, and recommends statistical results in detail.

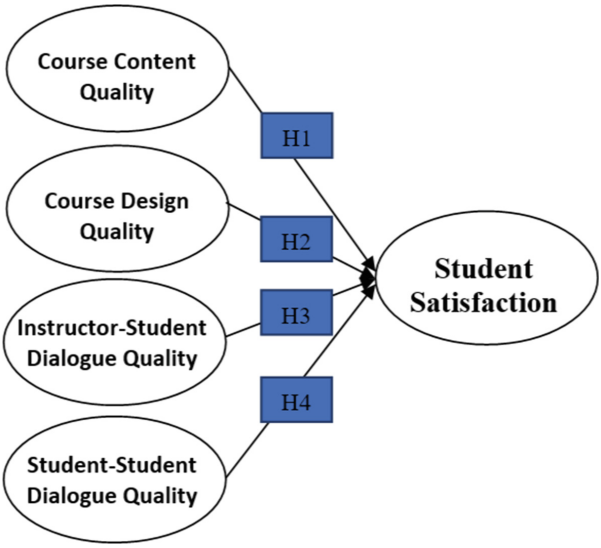

Fig. 1. Research Model

4 Analysis and Result

4.1 Sample of Respondent

Valid respondents for this study amounted to 570 undergraduate respondents at universities in Indonesia and used e-learning platform to study. This consisting of several categories is the gender category is male, with 322 (56.2%) respondents and 288 female (43.5%) respondents. Age category with the majority aged 17–27 years. Long study time category, with the majority in 1–3 h/day amounting to 233 (40.1%) respondents and 3–5 h/day amounting to 227 (39.8%) respondents. The categories of subjects studied while studying, with the majority of 1–2 courses were 266 (46.7%), and 2–3 courses were 257 (45.1%). From these results, it can be described that the sample data is very relevant to this study (Table 1).

Table 1. Discriminant validity Testing

Category	Subcategory	Freg	%
Sex	Men	322	56,5
	Women	248	43,5
Age	< 17 years	2	0,35
	17–27 years	568	99,6

(*continued*)

Table 1. (*continued*)

Category	Subcategory	Freg	%
Length of Study Time	< 1 h/day	79	13,9
	1–3 h/day	233	40,9
	3–5 h/day	227	39,8
	5–7 h/day	15	2,63
	> 7 h/day	16	2,81
Number of Courses Studied	1–2 Course	266	46,7
	2–3 Course	257	45,1
	3–4 Course	44	7,72
	> 4 Course	3	0,53

4.2 Measurement Model Assessment

A statistical measurement of the model assessment is carried out by measuring the validity and reliability. Finally, the measurement results for each item are shown in Table 2, all constructs pass the Cronbach alpha evaluation criteria with a value of more than 0.5 [34, 35], which is 0.541 - 0.864. Evaluation of the consistency of the items is seen in the composite reliability (CR) value with a higher 0.7 [34, 35] which is 0.863–0.927. The validity evaluation calculated from the Average Variance Extracted (AVE) value can be accepted if it is higher than 0.50 [34, 35] (shown in Table 2). The results of all tests show that the constructs and indicators are declared reliable and valid, so they are suitable for further analysis. Another evaluation, namely, Discriminant Validity, is carried out to find out a variable is different from other variables. Testing is assessed based on the Fornerll Larcker criterion. The Fornerll Larcker criterion value shows the correlation value between the variable and the variable itself and the variables with other variables. It can be seen from Table 3 that the Fornerll Larcker criterion has met the requirements. The results of the Reliability and Validity testing can be seen in Table 2 and the Discriminant validity test can be seen in Table 3.

Table 2. Validity and Reliability Testing

Variable	Indicator	Course Design Quality	Cronbach's alpha	Composite reliability	AVE
Course Design Quality	CCQ02	0,802	0,802	0,863	0,562
	CCQ03	0,779			

(*continued*)

Table 2. (*continued*)

Variable	Indicator	Course Design Quality	Cronbach's alpha	Composite reliability	AVE
	CCQ04	0,724			
	CCQ05	0,780			
Course Content Quality	CDQ01	0,777	0,774	0,855	0,595
	CDQ02	0,809			
	CDQ03	0,541			
	CDQ04	0,786			
	CDQ05	0,802			
Instructor Student Dialogue	ISD01	0,822	0,816	0,879	0,646
	ISD02	0,850			
	ISD03	0,839			
	ISD04	0,692			
Student Student Dialogue	SSD01	0,813	0,853	0,901	0,694
	SSD02	0,864			
	SSD03	0,811			
	SSD04	0,844			
Student Satisfaction	SS01	0,783	0,908	0,927	0,645
	SS02	0,791			
	SS03	0,811			
	SS05	0,806			
	SS06	0,837			
	SS07	0,796			
	SS08	0,800			

Table 3. Discriminant validity Testing

Path	Cource Design Quality	Course Content Quality	Instructor Student Dialogue	Student Satisfaction	Student Student Dialogue
Course Design Quality					
Course Content Quality	0,963				
Instructor Student Dialogue	0,895	0,900			
Student Student Dialogue	0,797	0,773	0,962		
Student Satisfaction	0,784	0,789	0,868	0,836	

4.3 Model Fit Measurement

The fit model was measured to analyze the model proposed in this study. This fit model can be seen from R2 (R-square) value. The value of R2 can predict the effect of a model developed to see student satisfaction in online learning. The results of the analysis show that R-square = 0.6467, which indicates that the influence of each of these factors is 64.67%. This shows the model at a moderate level. Furthermore, it can be seen in Fig. 2.

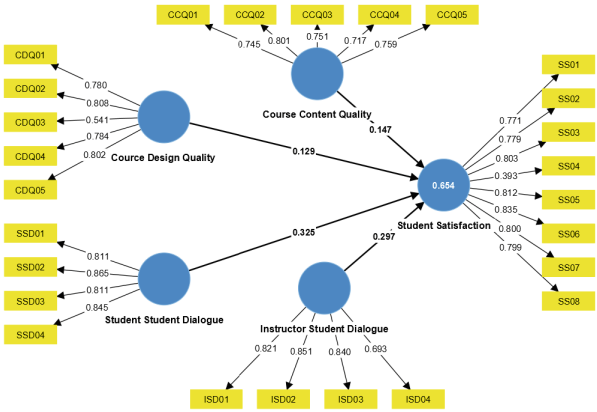

Fig. 2. Measurement Model Assessment

4.4 Hypothesis Testing Results

The results of the analysis of hypothesis testing were carried out with SEM PLS with four hypotheses. The measurement results of the model can be seen from the standard regression coefficients, namely the T-statistic and P-Value, with the results of 3 hypotheses being accepted and 1 hypothesis being rejected. As seen in Table 4 and Fig. 3.

Table 4. Results of hypothesis testing

Hypothesis	Path	Original sample	T stats	P values	Result
H1	Course Design Quality - > Student Satisfaction	0,139	2,615	0,009	Not support
H2	Course Content Quality - > Student Satisfaction	0,158	3,280	0,001	Support

(*continued*)

Table 4. (*continued*)

Hypothesis	Path	Original sample	T stats	P values	Result
H3	Instructor-Student dialogue - > Student Satisfaction	0,283	4,792	0,000	Support
H4	Student-Student dialogue - > Student Satisfaction	0,317	6,044	0,000	Support

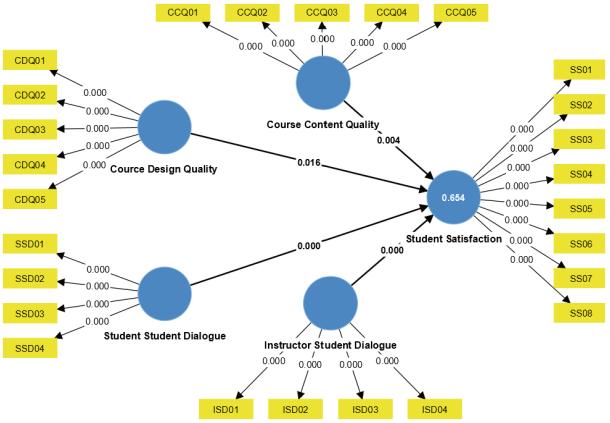

Fig. 3. Model FIT measurement

5 Conclusion

The results of successful research show the satisfaction of students in the online learning process using e-learning. The factors used came from literature studies from previous research, so a research model was built consisting of Course Design Quality, Course Content Quality, Instructor-Student Dialogue, and Student-Student Dialogue and Student Satisfaction factors. The developed model has 4 hypotheses. Furthermore, testing is carried out and produces 3 accepted hypotheses and 1 rejected hypothesis. Factors that influence student satisfaction in online learning are Instructor-Student Dialogue, Student-Student Dialogue, and Course Content Quality. Because student learning outcomes are felt in learning, the quality of content in courses affects the success of online learning with the right material, and course websites can provide easy access to course material. So, the more students feel the results of learning, the more students will take the initiative to study independently and reflect on what they have learned. Students agree that positive and constructive interactions between students in online classes due to COVID-19 help improve the quality of learning outcomes in general, and students feel satisfied with learning during the course. In addition, there is a course design quality factor that does

not significantly affect student satisfaction, meaning that students do not feel the support provided by good content design because they focus on adjusting learning so that they can only get the core of learning material. The results of this study really need the role of online learning providers (universities or others) to provide quality online media suggestions. Therefore, future research is needed to look for the characteristics of online learning. In addition, from the results described, many factors can still explore user behavior, the image of universities, and the competence of available devices.

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Knowledge Graph Analysis of Smart Learning Trends in Thailand

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Abstract. Smart learning has emerged as a prominent area of research among international scholars. This study provides a comprehensive review of smart learning trends within Thailand over a span of 19 years. A total of 413 journal articles pertaining to smart learning, available on the Web of Science (WOS) database from 2004 to April 2023, were scrutinized in this study. Through the use of bibliometric analysis and scientific knowledge mapping, a visual representation was created, showcasing the co-occurrence map, clusters, burst coefficients, and timeline via CiteSpace software.

The study found that while smart learning research in Thailand is undergoing swift advancement, there is a noticeable need for increased collaboration among research institutions. Popular topics within smart learning, as evidenced in the research, include deep learning, neural networks, machine learning, and artificial intelligence. The study concludes with the projection that the progression of smart learning will increasingly embrace multidisciplinary and multidomain comprehensive applications.

Keywords: Smart Learning · CiteSpace · knowledge graph

1 Introduction

The smart learning encapsulates the development of a flexible learning environment, one that offers tailored content, seamless adaptation to modern education models, a conducive communication atmosphere, and a plethora of resources. This 21st-century educational phenomenon strives to cultivate all learners into global leaders by overhauling existing educational frameworks, including content, methods, evaluations, and environments [1]. This potential manifests in several ways, such as efficient classroom management [2], enhanced teaching and learning diagnosis [3], personalization of learning content [4], and the development of skills and competencies [5].

This transformative learning mode, smart learning, has attracted extensive attention from researchers worldwide and instigated various research initiatives. While there has been some research and investigation into smart learning in Thailand, an overall description of smart learning in the country is still relatively lacking.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 12–21, 2023.
https://doi.org/10.1007/978-981-99-5961-7_2

This study seeks to provide a comprehensive understanding of the extant research on smart learning. It employs visual analysis to review relevant studies, delving into the evolution of smart learning research within Thailand, and identifying prevailing trends and research hotspots. This could serve as a foundation for those engaged in smart learning research to further deepen their studies.

2 Research and Design

2.1 Research Methods and Tools

The research methodology comprises bibliometric analysis, a compendium of scientific knowledge, and quantitative literature analysis via CiteSpace, an information visualization tool. CiteSpace enables keyword co-occurrence analysis, literature co-citation analysis, and burst detection, serving as a multivariate visual analysis tool. By leveraging the keyword co-occurrence map, clustering view, and timeline view, the study elucidates the current state and potential future directions of smart learning research in Thailand.

2.2 Data Sources and Processing

In this study, the data was sourced from the Core Collection Database of Web of Science (WOS). Managed by the Institute for Scientific Information (ISI) in the United States, the WOS database serves as a central repository for high-quality academic journal articles from around the world. Within the WOS Core Collection Database, a specific search strategy was employed, involving "Thailand smart learning" as the key phrase, yielding a total of 432 entries.

These initial results, however, still included papers from other countries and regions. Consequently, the search was further refined by restricting the "Country/Region" option exclusively to "Thailand". To enhance the accuracy and scientific rigor of the data, a manual selection was made, focusing on "Conference Proceedings", "Articles", "Review Articles" categories, deliberately excluding less relevant types of work such as "Book Reviews". Articles with weak relevance, determined by their titles and abstracts, were subsequently weeded out. This process culminated in a final selection of 413 pertinent articles.

3 Research Status of Smart Learning in Thailand

3.1 Statistical Analysis of the Number of Articles Issued

In Thailand, there are 413 journal articles on smart learning, and the number of articles published annually is depicted in Fig. 1. The graph trend indicates a linear increase in the number of articles published on research related to smart learning sites in Thailand, and it is anticipated that the volume of literature will reach a new high by the end of 2023. In conjunction with the analysis of the total number of articles published each year, the relevant research on smart learning in the Thailand reveals three distinct stages:

the stage of flat start (2004–2011), the stage of steady rise (2012–2015), and the stage of rapid development (2016–present), A possible reason for this might be the global rise of smart learning. In addition, in 2016, the Government of Thailand unveiled the Thailand 4.0 policy, a component of which was the Education 4.0 initiative. This strategy underscored the importance of fostering digital education. Consequently, this emphasis on policy level is also one of the factors that has propelled the surge in the volume of publications. The majority of articles are found in IEEE's conference papers.

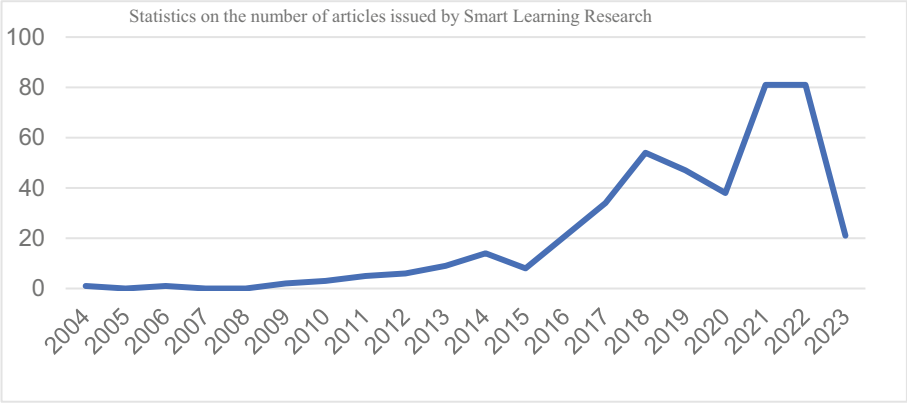

Fig. 1. Number of smart learning publications from 2004 to April 2023

3.2 Research Institution Publication Statistics

The number of publications from research institutions signifies the state of research in smart learning. Eight research institutions have published 20 or more articles between 2004 and 2023 (as shown in Table 1), with CHULALONGKORN UNIVERSITY, KING MONGKUTS UNIVERSITY OF TECHNOLOGY THONBURI, MAHIDOL UNIVERSITY, KHON KAEN UNIVERSITY, and KING MONGKUTS UNIVERSITY NORTH BANGKOK ranking among the top five.

Many schools in Thailand are actively promoting Smart Learning. For instance, Khon Kaen University (KKU) has established the Smart Learning Academy with the aim of reducing educational disparities within the country. [6] Assessing their geographic dispersion, it was found that the locations of many research institutions were quite widespread. A rigorous analysis of the degree of collaboration among these institutions revealed a somewhat tenuous inter-institutional connectivity. It is imperative to bolster the cohesion of research efforts. Moreover, a majority of these collaborative undertakings were identified to occur intramurally, within the confines of individual schools (Fig. 2).

Table 1. University ranking map 2004 to April 2023

Ranking	Research Institutions	Number of posts
1	CHULALONGKORN UNIVERSITY	64
2	KING MONGKUTS UNIVERSITY OF TECHNOLOGY THONBURI	41
3	MAHIDOL UNIVERSITY	37
4	KHON KAEN UNIVERSITY	34
5	KING MONGKUTS UNIVERSITY OF TECHNOLOGY NORTH BANGKOK	30
6	KING MONGKUTS INSTITUTE OF TECHNOLOGY LADKRABANG	27
7	CHIANG MAI UNIVERSITY	23
8	THAMMASAT UNIVERSITY	20

Fig. 2. Cooperation network of Research institutions

4 Research Hotspots for Smart Learning in Thailand

By analyzing annual publication numbers, highly-cited literature, and institutional contributions, and employing keyword co-occurrence mapping, high-frequency keywords, and keyword clustering views, we distill the current research hotspots in smart learning.

It has been observed that the implementation of smart learning encompasses a wide array of disciplines. Early research primarily targeted areas such as engineering, electrical and electronic computer science, artificial intelligence, and computer science information. However, research related to smart learning has since proliferated into a myriad of fields.

As research related to smart learning expands, its application now permeates various academic disciplines. Early studies were primarily concerned with primary and secondary education. However, recent research delves into vocational education, examining, for instance, the promotion of instructional practices in vocational schools through smart learning. Significant within Thai society, tourism has also inspired relevant research.

4.1 Analysis of the Cooperation Network of Keywords

By scrutinizing the network of co-occurring and high-frequency keywords, we can gain insight into the common focal points of researchers, otherwise referred to as research hotspots. We have defined a time span from 2004 through to April 2023 in CiteSpace and proceeded to execute the program. This yielded the keyword collaboration network which is visually represented in Fig. 3.

With 326 nodes and 624 connections, the network has an aggregate density of 0.0118. Each node represents a keyword, with the keyword's frequency increasing as its size increases. The keyword frequency is ordered from most frequent to least frequent. Deep learning (48 occurrences) and machine learning (40 occurrences) are the terms that occur more frequently than forty times. Combined with the map, smart learning-related research in Thailand has primarily focused on Deep Learning, Machine Learning, Models, the Internet of Things system, Neural Networks, and other topics. Digital technology has caused a lot of changes in the learning behavior. It's can be tools for expanding educational opportunities, promote lifelong learning for people of all ages and all the professions [7].

4.2 Analysis of the Clustering of Keywords

CiteSpace's keyword aggregation feature can elucidate the context and characteristics of the research field's development. In the Time Slicing area, the time is set to "2004 to 2023," the time slice is set to 1, and the node type is set to "Keyword." Fig. 4 depicts the results of the clustering visualization analysis, which yields nine clustering tags. They are: #0digital mammogram, #1brief survey, #2asymmetric friction, #3smartmanufacturing, #smart application, #5effient big data sharing, #6online learning adoption, # 7differential equation, # 8university service quality, and #9 q-sine circular extreme learning machine.

The higher the sequence number, the more keywords the cluster identifier contains. The Modularity of the map is 0.8236, which is greater than 0.3, and the Weighted Mean Silhouette is 0.9284, which is greater than 0.5. It demonstrates that the division's clustering structure is significant and reasonable.

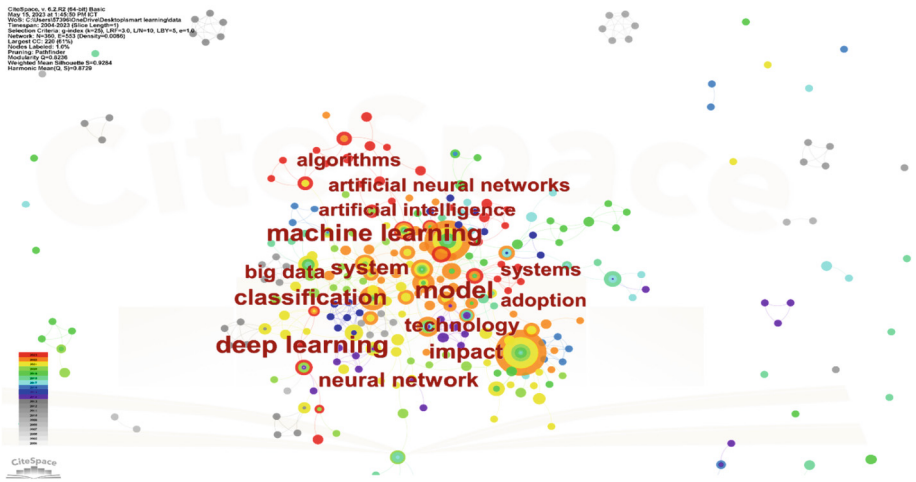

Fig. 3. Cooperation network of keywords

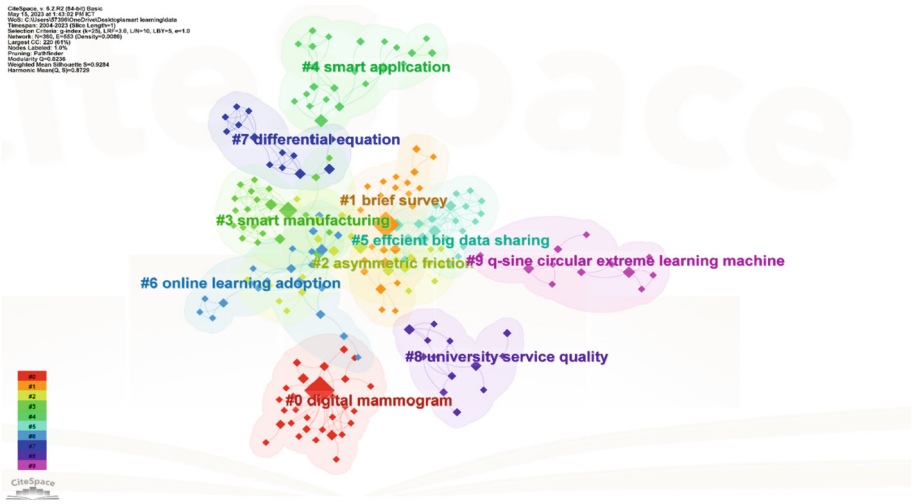

Fig. 4. The clustering of keywords

5 Research on the Trend of Smart Learning in Thailand

5.1 Research Keywords with the Strongest Citation Bursts

The mutation coefficient of keywords signifies sudden changes in keyword frequency over time, representing emerging frontiers and shifts in research trends. A higher mutation coefficient indicates a more significant current rate of change for a keyword.

Applying the mutation coefficient in CiteSpace, we evaluated the mutation rate and the historical trajectory of the literature (as illustrated in the Table 2). We identified

Table 2. Keywords with the strongest citation bursts

Top 23 Keywords with the Strongest Citation Bursts

Keywords	Year	Strength	Begin	End	2004 - 2023
cooperative learning	2014	1.12	2014	2016	
impact	2014	0.84	2014	2015	
networks	2015	1.35	2015	2017	
blended learning	2016	0.84	2016	2019	
extreme learning machine	2014	2.67	2017	2018	
active learning	2017	1.54	2017	2018	
circular extreme learning machine	2017	1.11	2017	2018	
higher education	2018	2.18	2018	2019	
classification	2018	0.4	2018	2019	
behavior	2019	1.03	2019	2020	
system	2017	0.82	2019	2020	
deep learning	2016	3.19	2020	2023	
technology	2020	1.67	2020	2023	
algorithm	2014	1.01	2020	2021	
artificial neural networks	2020	0.95	2020	2023	
acceptance	2016	0.58	2020	2021	
energy	2021	1.62	2021	2023	
convolutional neural network	2021	1.62	2021	2023	
model	2011	1.35	2021	2023	
design	2021	1.3	2021	2023	
challenges	2021	1.3	2021	2023	
network	2021	1.3	2021	2023	
adoption	2021	0.75	2021	2023	

23 mutant words in intelligent learning research from 2004 to April 2023. Based on the duration and intensity of mutation, keywords like “deep learning” mutated between 2020 and 2023 with a peak intensity of 3.19.

The term “extreme learning machine” underwent mutation from 2017 to 2018, with an intensity of 2.67. The mutation of “higher education” occurred from 2018 to 2019, registering an intensity of 2.18. The keyword “technology” mutated between 2020 and 2023, demonstrating an intensity of 1.67. The term “energy” mutated from 2021 to 2023, with an intensity of 1.62. Meanwhile, the phrase “convolutional neural network” experienced mutation between 2021 and 2023, recording an intensity of 1.62.

Recent smart learning research in Thailand has primarily centered on deep learning, artificial neural networks, convolutional neural networks, etc., as inferred from an analysis of keywords exhibiting the most substantial citation surges.

5.2 Timeline of Sight Chart Analysis

The timeline view illustrates the relationship between clusters and time, thereby visualizing a research topic’s evolution, significance, and legacy. Figure 5 displays a timeline based on the Log-Likelihood Rate (LLR) method of clustering, with the highest feature term serving as the cluster name. By organizing and analyzing the interconnection

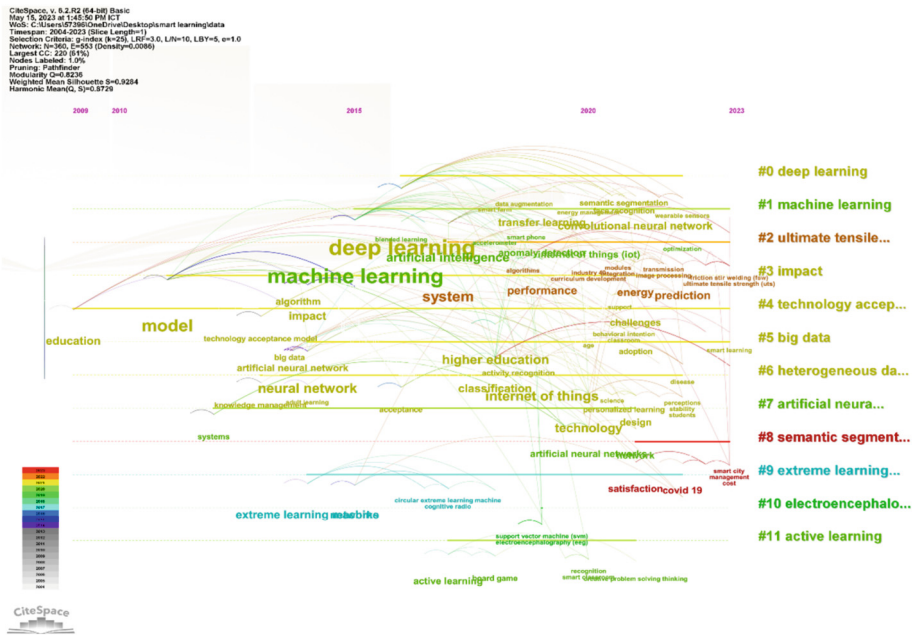

Fig. 5. Time Development Line Chart

relationship between each feature word in the timeline view, we can gain a clearer understanding of the direction of smart learning research and development in Thailand. The term "COVID-19" starts to emerge in the timeline during the years 2020–2023, which suggests a resurgence of articles focused on optimizing online learning during this exceptional period. This trend underscores the emergence of smart learning research in response to the pandemic.

6 Conclusion

Despite Thailand's smart learning research development appearing somewhat slow, the government's stance on promoting smart learning is encouraging. Education is considered central to national development in Thailand. The Office of the Education Council, Ministry of Education, established the national education plan for 2017–2036. Among its objectives is to develop a high-speed fiber-optic network system and wireless access across all institutions and communities. Crucial to delivering high-quality learning are educators using the most effective methods.

The evolution of smart learning is expected to exhibit the following trends:

1. Broadening Applications: Future advancements in smart learning should continue to expand its application contexts. The diverse concept of smart learning represents a potential challenge. Future studies should aim at consolidating relevant conceptual components as a reference for deploying smart learning in novel contexts [8]. Thus, exploring how to enhance the implementation of smart learning infrastructure in

Thailand's rural areas and employing online and participatory learning to narrow the educational resource gap between urban and rural students merit further research.

2. Integration of Features: Smart learning encompasses collaborative learning, adaptivity, self-regulation, experience-based learning, and ubiquitous learning. While not exclusive to smart learning, these features interconnect with those prevalent in other technology-enhanced learning approaches like personalized learning [9] and mobile learning [10]. Looking forward, a more comprehensive integration between smart learning and emergent technologies, such as artificial intelligence (AI) and virtual reality (VR), is anticipated.
3. Expanding Domains: The trend indicates that smart learning is being implemented across an increasing number of application domains [11]. Beyond expanding its usage in previously unexplored areas such as business and management or arts and design, it's worth undertaking an in-depth analysis to discern how smart learning practices have been adapted to various domains like language, sciences, and computer studies. For instance, the concept is being expanded from domains with less practical application to fields with more hands-on relevance, such as clinical medicine.

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AGeES: Automatic Multiple Choice Question (MCQ) Generation from Extractive Summary of Video Lectures Using BertSum

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Abstract. Multiple-choice questions (MCQs) from online lectures can benefit students in a number of ways. MCQs are a quick and accurate technique to evaluate knowledge and understanding since they can rapidly and accurately reinforce important topics discussed in the lectures. They are adaptable and time-effective, and they encourage students to study the content covered in class. Existing research focuses on generating MCQs from textbook data which are typically well formatted and structural in the way the information is conveyed, unlike Youtube or any other educational videos where typically, the information is conveyed in an informal or casual manner without upholding the appropriate formal structures or grammar of the sentences. The present technologies for generating MCQs have a number of limitations which include the ability to create MCQs from only highly informative textual content, employing a singular approach for sentence selection, and inefficient keyword extraction for scientific data. The proposed work AGeES overcomes the challenges of generating efficient MCQs from less in-formative content retrieved from video lectures. To enhance the effectiveness of MCQ generation, the proposed method uses a dual approach for sentence selection and works well with generation for scientific data as well. In conclusion, the proposed work overcomes the structural differences that hinder the system's ability to isolate factual information from the video. As a result, this methodology generates coherent MCQs by extracting transcripts from video lectures followed by a dual sentence selection approach.

Keywords: Topic Modeling · BERT · Keyword Extraction · T5 transformer · Sense2Vec · coreference resolution · MCQ Generation

1 Introduction

The Covid-19 pandemic has indeed brought a sharp change in the education system throughout the world. The imposition of the lockdown led to the halt of the physical mode of classes and then made online classes the new norm. Although online classes have been successful in keeping education alive in these difficult times, they cannot completely replace physical classrooms.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 22–31, 2023.
https://doi.org/10.1007/978-981-99-5961-7_3

However, online lectures are still preferred even though the pandemic has taken a step back. This is mainly due to the fact that online lectures provide better flexibility and comfort to both the students as well the teachers. In addition to the flexibility and comfort factors, the online mode of classes tends to be much more cost-effective and time-saving, as compared to the physical mode. These factors combinedly highlight the fact that online lectures will still continue for a number of years in the future.

In fact, online lectures are not just limited to the conventional education system. An immense number of workshops across the world are held online. A number of online learning platforms, like Coursera, Udemy, Udacity, etc., have existed for quite a long time now. This makes us understand the importance and the widespread utility of online lectures.

A vast proportion of the student community pays no heed to online lectures. This not just wastes the time of the faculties who invest their whole energy in teaching but will also bring down the quality of education over time. Consequently, a steep drop can be observed in the grades of students.

In addition to a drop in their grades, the sense of procrastination in the students is associated to bring in emotional and psychological pressure. Their productivity takes a big hit and this automatically brings down their motivation levels in accomplishing things. Moreover, students are inclined towards a bigger problem of poor time management, which will make their lives difficult in the future. Eventually, the students will not be finished products, by the time they graduate from the institution.

A solution to this problem will be to ensure that the students pay attention to the online lectures. It is utterly impractical to constantly go behind the students to demand their attention, especially at times when they cannot be observed. An interactive session can prove to be useful in having the students engaged and not procrastinating. However, this is a massive task in the present era because the attention level of youngsters has decreased due to the advent of technology. Moreover, it depends on the faculties in holding interactive online lectures.

A better idea for this problem will be conducting a small assessment based on the lectures. In fact, the assessments can be conducted immediately after the online lecture ends. Although it is up to the faculties to record these scores, this will ensure that students stay attentive throughout the lectures. In addition to this, these assessments will help teachers to get a better idea about how well they teach and the areas where they can improve.

The type of assessment will play a vital role in the way in which the students will respond. An assessment consisting of descriptive-type questions will prove to be ineffective. Expecting students to come up with answers to such questions is quite impractical. Due to this, an assessment with objective-type questions will fulfill the purpose.

A major problem, however, lies with the implementation of this solution. Within a limited timeframe, it is impossible for the faculties to come up with assessments of their own. Including questions about the concepts not discussed in the lecture can also prove to be a big problem. This will create a huge ruckus among the students and can even bring these assessments to an end.

In this methodology, we tend to address all these shortcomings and build a system that automatically generates multiple-choice questions based on the lectures. The aim

is to generate this e-assessment within a short span of time so that the students can immediately attend the test.

The proposed system intends to extract the audio from the online video lectures and generate transcripts for this audio. This is followed by the provision of the transcript to two modules – one which takes care of text pre-processing and the other is an implementation of the BERTSum model, which takes care of performing text summarization. The pre-processed text is then fed as input to a module that deals with the selection of important sentences to frame questions. Both these modules give a set of keywords as their output. We filter this set of keywords, which is basically the set of answers for the multiple-choice questions that we will generate further. The next task will be to generate incorrect options for the MCQs aka distractors. Similar to the selection of important sentences in the transcript, we make use of two methods in the process of generating distractors. This is followed by the module which deals with the formation of questions. The module makes use of the important sentences (that were found earlier) and the generated distractors, as input. Evaluation of this assessment will take place once the students submit their answers.

2 Related Work

AGeES aims to develop an automatic Multiple Choice Question generator based on the video lectures. Many research papers have dealt with the topic of automated MCQ generation, sentence selection, distractor generation, and question formation.

Chen Liang et al. [4] presented an adversarial training framework consisting of a generator G and a discriminator D for Distractor Generation, along with a cascaded learning framework to improve performance. However, the model lacks an appropriate user interface. Meanwhile, CH et al. [3] discussed a partially subject-independent pipeline for automatically generating middle school-level multiple-choice questions from textbooks, which includes preprocessing, sentence and key selection, and distractor generation, utilizing various techniques such as entity recognition, WordNet, and neural embeddings. Experimental results show that the system is capable of generating high-quality questions, although it struggles with complex, multi-line questions.

Ma et al. [10] proposed a model for extractive and abstractive text summarization that combines BERT's architecture with topic-embedding information to improve contextual information capture. This approach produces high-quality summaries through NTM inferring, using a combination of token embedding, segment embedding, position embedding, and topic embedding. The two-stage model shares information to generate salient summaries while reducing redundancy. The analysis shows that the model can generate consistent summaries with high quality, but may struggle with longer articles containing multiple topics. On the other hand, Nwafor et al. [15] presented an NLP-based system for automatic MCQG in CBTE. This system uses NLP techniques to extract keywords from lesson materials, which are then used to generate exam questions. The system was found to be effective at extracting keywords and generating exam questions, but MCQs based solely on extracted keywords were not found to be efficient for exams.

Mukta Majumder et al. [11] form MCQs by performing PTM or Parse Tree Matching with test sentences, employing topic modeling to filter the sentences according to

topics. NER is used to identify the keywords and gazetteer lists to generate distractors. The system has a tendency to exclude time and date-related information and selects incomplete sentences.

Xian Wu et al. [17] utilize a contextual encoder and attention mechanism to generate semantic representations for text materials, while also introducing two modules to guarantee incorrectness and generate diverse distractors using beam search. However, the model is limited in its ability to generate distractors that require multi-sentence/hop reasoning. Meanwhile, Dhanya et al. [6] propose a system that automates the processes of sentence and key selection, question formation, and distractor generation by using Google T5's sequence-to-sequence approach, tesseract for text extraction, context recognition, and Sense2Vec for distractor generation. While the system produces high-quality work and reduces human intervention, the percentage of relevant auto-generated incorrect options is low.

Mehta et al. [13] introduced a system based on Google's BERT Model to create auautomated questions, generate summaries using BERTSUM, and generate distractors using the WordNet approach. However, the WordNet approach may not be effective in all cases. Maniar et al. [12] proposed an approach that uses transformers to paraphrase the input text before generating MCQs, which are graded using image processing. However, the model may generate multiple MCQs from the same line if the input text has fewer sentences than the desired number of questions. Ming Liu et al. [14] presented a mixed similarity strategy for generating Chinese multiple-choice distractors using a statistical regression model that considers appearance, pronunciation, and semantic meanings. Although the proposed strategy outperforms the common distractor generation strategies, it faces difficulties in extracting semantic distance features of the characters, which are not available in the knowledge base.

Dmytro Kalpakchi et al. [2] have fine-tuned a pre-trained BERT2 for Swedish for distractor generation. Two linear layers with layer normalization and a softmax activation layer had been added on top of BERT2. They have also proposed an effective method to evaluate the generated MCQs. However, only half of the distractors generated using the model were plausible.

Animesh Srivastava et al. [1] proposed a pipeline that integrates natural language processing and image captioning techniques to generate questions, answers, and distractors for both textual and visual inputs. While the system has demonstrated remarkable performance, it is suggested that further improvements can be made to the captioning dataset to enhance the question generation model. Meanwhile, Selvia Ferdiana Kusuma et al. [16] introduced an ontology-based approach that can automatically generate 11 categories of questions. By breaking down all ontology information into categories and converting them into SPARQL queries, questions can be generated with an accuracy of 86%. However, the success of this method heavily relies on the completeness of the ontology information.

Jiaying Lu et al. [7] propose a reinforcement learning-based framework called GOBBET. The framework makes use of pre-trained Visual Question Answering models as an alternative knowledge base to guide the distractor generation process. The performance degradation of existing VQA models is utilized for detecting the quality of generated distractors. The utility of the distractors that are generated is exhibited through data

augmentation experiments. The sparsity of training samples, however, proves to be a major challenge to the framework.

Ainuddin Faizan et al. [9]'s approach uses semantic annotation to find named entities in the slide content and utilizes property information of the entities to generate questions and find appropriate distractors using SPARQL queries. SPARQL is also used to retrieve further information about the entities in the form of RDF triples, which are then verbalized to form the question text. The model has instances where the resource is not identified and inaccurate distractors are produced.

Devi, M.K. et al. [5] utilize a neural network model to extract important information from the comic book cover and generate a brief summary of the story. The system is trained on a large dataset of comic book covers and uses unsupervised learning techniques to identify the key elements of the story. Devi, M.K. et al. [8] generate concise and novel descriptions using unsupervised learning and semantic analysis to generate concise and novel descriptions., with promising results for various applications.

3 Methodology

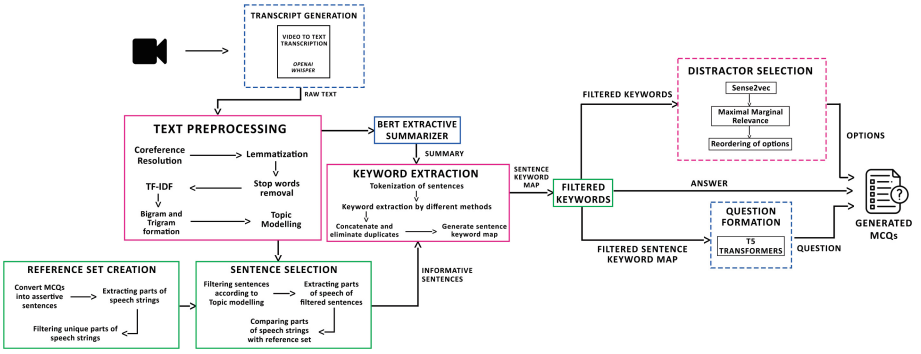

Fig. 1. AGeES Architecture

3.1 Transcript Generation

MCQ generation generally uses textual content from books or journals because of its well-formatted nature. The proposed work intends to extract content from videos as a basis to generate MCQs which can be done in two ways, by extracting the transcript of the audio from the videos or extracting the textual content which is displayed in the video. AGeES focuses on generating MCQs for scientific videos which tend to have a lot of factual information which will help us overcome the challenges posed by the unstructured informal grammar forms used in these videos. These videos typically tend to read out whatever text is displayed on the screen so the transcript would be redundant even if we extracted the text displayed in the video so this work limits to only extracting the transcript of the audio belonging to the video (Fig. 1).

3.2 Preprocessing

The Preprocessing module involves two major processes: Coreference resolution and topic modeling. The transcript extracted from the video is bound to have several sentences that contain prepositions that refer to nouns in different sentences which are resolved with the use of coreference resolution. Several processing steps such as stop- words removal, lemmatization, tf-IDF, and bigram-trigram formation are used to process the transcript for topic modeling. The purpose of topic modeling is to extract topic words which would be used to filter out important sentences from the transcript. The LDA model is used to find the optimal number of topics within the transcript provided based on the coherence score of the model. Then the words from the words probability distribution with probability higher than the set threshold are selected as topic words that are used for filtration.

Algorithm 1: REFERENCE SET CREATION

Input: MCQ Dataset
Output: Reference set for sentence selection

```
Import MCQ question dataset
Extract questions and choices from json file
for each question do
    Extract the parse tree for each MCQ question
    Using the parse tree and answer, generate assertive sentences
    Extract parts of speech string from each assertive sentence
end
for each extracted parts of speech string do
    Compare it with other extracted parts of speech strings to find similarities
    if the strings are similar then
        Keep deleting the other parts of speech strings
    end
end
return A set of unique parts of speech strings is obtained as a result
```

3.3 BERT Extractive Summarizer

The distil-BERTSUM model is used to generate an extractive summary from the transcript. This summary extracted does not change the structure of the sentence and it is assumed to contain the informative sentences which are to be used for the generation of MCQs.

3.4 Reference Set Creation and Sentence Selection

Sentence selection as depicted in Algorithm 2 is used to extract factual sentences from the sentences which were filtered based on topic modeling. These factual sentences are extracted by comparing them with a reference set made of existing MCQs from the SciQ dataset as depicted in Algorithm 1. The existing MCQs are converted into assertive sentences by processing and replacing any option within the question.

Algorithm 2: SENTENCE SELECTION

Input: Processed text and Reference set
Output: Informative Sentences

```
Filter the sentences containing the topic words extracted from LDA model
for each filtered sentence do
    Generate Parts of speech string for each filtered sentence
    for each parts of speech string in reference set do
        if POS of reference set is present as substring in POS of filtered sentence then
            we consider the filtered sentence to be valid
        end
        Extract and save the filtered sentence
    end
end
```

These assertive sentences are then converted into POS strings which is a concatenation of parts of speech of each word within the sentence. String comparison is used to compare the POS strings of the reference set and the POS string of the filtered sentence to find a match in patterns.

3.5 Question Formation

The selected sentence and keyword are sent to the T5 transformer as input where the questions will be formed by rephrasing the sentence according to the keyword. The same sentence can be transformed into multiple questions based on the keywords identified by the keyword extraction phase.

3.6 Distractor Generation

The purpose of distractor generation is to provide false options to confuse the student. The options need to be as similar to the keyword and should be different from each other for optimal effect. AGeES uses the Sense2vec to generate a list of distractors out of which three are selected using Maximum Marginal Relevance (MMR) to make the options as diverse as possible.

4 Discussion and Results

The approach taken by the AGeES system in generating multiple-choice questions from video lectures is a promising and effective method. Unlike the traditional parse tree method used in existing MCQ generation systems, AGeES adopts a more flexible approach by creating Parts of Speech strings of the reference set and the input transcript. This enables the system to select sentences that contain factual information even in cases where the syntax and grammar are not perfect, and the speech is informal. With an increase in the number of keywords, the process of generating desired multiple-choice questions becomes simpler and more efficient. Additionally, the system's use of text preprocessing techniques like coreference resolution and topic modeling further enhances the effectiveness of the overall MCQ generation process.

A few examples of generated MCQs are given below:

1. *What is the capital of France?*
   (a) *Berlin*
   (b) *Madrid*
   (c) *Paris*
   (d) *Rome*
2. *What type of field will form when atoms gain a positive or negative charge?*
   (a) *Electric*
   (b) *Hydro*
   (c) *Pneumatic*
   (d) *A/C*
3. *What is responsible for the exchange of gases?*
   (a) *Pores*
   (b) *Sebum*
   (c) *Oiliness*
   (d) *Scalp*

The proposed MCQ generation system as in [2] addresses some of the limitations faced by previous systems in generating MCQs from video lectures. Previous systems relied on syntactic and semantic parsing of the input text, which proved to be inadequate in handling informal speech and imperfect syntax. In contrast, AGeES utilizes a flexible approach of creating Parts of Speech (POS) strings of the reference set and input transcript and checks if any POS string of the reference set is contained within the sentence from the transcript, which is then selected for further processing. This method ensures that factual information is accurately identified from video lectures, thereby improving the quality of the generated MCQs.

The preprocessing techniques in AGeES, including Co reference resolution and topic modeling, contribute to the effectiveness of the MCQ generation system. Coreference resolution, as described in [5], helps in obtaining unambiguous sentences that are easily understood by computers and in converting complex sentences into simpler ones. Topic modeling facilitates the discarding of unimportant sentences by detecting whether a sentence comes under any specific topic. These techniques improve the accuracy of identifying factual information and generating MCQs from video lectures.

The keyword extraction approach used in AGeES outperforms previous methods, as described in [2]. The proposed method uses a total of 11 keyword extraction techniques, ensuring that a higher number of keywords are extracted without compromising on their quality. This approach addresses the limitations of previous methods, such as NER's inability to identify domain-specific words and RAKE's tendency to give long phrases as keywords on odd occasions.

In summary, AGeES is an effective approach for generating MCQs from video lectures. The combination of flexible POS string comparison, multiple keyword extraction techniques, and advanced text preprocessing techniques, such as coreference resolution and topic modeling, contribute to the accuracy and effectiveness of the system. The proposed system works efficiently and represents a significant step forward in the field of MCQ generation from video lectures.

5 Conclusion and Future Works

In conclusion, AGeES can be a potent tool for not just improving the quality of education but also enhancing the processes of learning and assessment. Moreover, the system saves a large amount of time and energy for the teaching community in framing questions. Such a system has the capability to efficiently extract important material from video lectures or tutorials, produce relevant questions, and assess the responses of students in real-time. However, there are still certain issues that need to be resolved, such as assuring the accuracy and reliability of the questions, reducing bias and mistakes, and accommodating various learning preferences and styles. The question generation model can be upgraded to form multiple kinds of questions other than just 'wh' questions. The current distractor generation model faces setbacks when it comes to generating subject-specific words, which can be improved with the addition of input context. The current model is restricted to creating MCQs for science-based videos. This can be improved by expanding the reference set.

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How to Evaluate Games in Education: A Literature Review

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Abstract. Adding game elements to higher education is an increasingly common practice. As a result, many recent empirical studies focus on studying the effectiveness of gamified or game-based educational experiences. The findings of these studies are very diverse, showing both positive and negative effects, and thus calling for comparative meta-studies. In this paper we review and analyze different studies, aiming to summarise and evaluate controlled experiments conducted within different scientific disciplines. We focus on the clarity of non-experimental conditions' descriptions and show that in most cases (a) educational methods used in control groups' activities are poorly described, (b) educational materials used in control groups' activities are often unclear, and (c) the starting conditions are unclear. We also noticed that studies in the fields of computer science and engineering, in general, report results more clearly than in other fields. Based on the above finding, we conclude with a few recommendations for the execution of future empirical studies of games in education for the sake of allowing a more structured comparison.

Keyword: Gamification · Game-based learning · Literature-review

1 Introduction

The digitalization of education is a common trend in many different contexts. Just to cite a few examples, the amount of courses available online is countless, most books also make a digital version available, and a massive amount of lectures are streamed and available online every day. Digitalization opens the way to new methods to convey information and its applications in education creating spaces for new teaching tools and techniques. A very promising one is extracting elements from video games and their application to enhance education (*gamification*). Moreover, video games can also be used in their entirety to convey scholastic knowledge (*game-based learning*).

In this paper, we collect and analyze studies involving controlled experiments on gamified and game-based learning techniques applied to scientific secondary or higher education. When gamification is applied in this context, experimentation often translates as the application of playful elements in education. On the other hand, game-based

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 32–41, 2023.
https://doi.org/10.1007/978-981-99-5961-7_4

learning usually involves the design of video games fully focusing on conveying educative content. The goals of these experimental tools can vary from enacting behavioral changes [1, 2] to improving knowledge acquisition. In fact, the analysis in [3] reports knowledge acquisition as the predominant learning outcome of 64 studies out of 105.

Regardless of the field of application, the cognitive effects of games or game elements vary as well. The most commonly reported effect is an increase in students' motivation and engagement, in line with the historical trend to utilize games in education as a medium to make experiences more pleasurable [4, 5]. On the other hand, the link between game elements and actual education effectiveness is not as clear. Even though many studies report a positive relationship between the two [6] and are backed by empirical game research [7], many experiments present opposite results [8] with theoretical research to support them [9].

Such diversity of studies (and results) in the field justifies the relatively high number of meta-studies. These tend to focus on specific aspects of the gamified/game-based learning experiments but also include more general information about the contexts of application (where possible). For example, the review in [3] focuses on empirical studies between 2000 and 2013 that apply game-based learning in primary education with the goal of documenting the diversity in the field in terms of learning outcomes, the topic of application, and the quality of the study. Other works focus on game motivators, how games are used in education, and their effect [10]. While the selection criteria of the latter are less strict compared to [3], it includes also more recent papers (from 2000 to 2019). Finally, [11] performs a broader review, focusing on how the studies were carried on. Through this perspective, they draw several conclusions about the quality of the experiments. In particular, they define multiple issues arising from the lack of clarity in the reporting style of many studies. They also report a sharp increase in studies involving gamification which more than quadrupled in one year (2011–2012).

The lack of clarity in the reporting style of many experiments makes comparative approaches challenging. In particular, the impact of different contexts of application related to the game components implemented. The relevance of the context can become especially evident in controlled experiments where the effect of experimental conditions (i.e. the game elements applied to education) can usually be better analyzed with a clear understanding of the control conditions (i.e. the standard education method for that specific context). However, this is often challenging or impossible due to a lack of clarity in the description of the control conditions [11]. In practice, the lack of this type of contextual information makes it difficult to evaluate the experimental approach; how is the subject taught in the control group? What type of material is used? How are the experimental and control groups evaluated?

2 Research Space Definition

Our research focuses on how controlled studies report information about experimental conditions with the goal of improving experimental replicability and enhancing comparability between studies. It is influenced by two main characteristics of the field: diversity in the type of studies and diversity in the context of its application.

Characteristic 1: Type of Studies. Many empirical studies that utilize games involve the use of an experimental and a control group. Although information about control (or no-game) conditions can be helpful to evaluate findings, many studies in the field omit it to different degrees. This is a known issue that can hinder analytical approaches focused on the influence of experimental conditions [12]. Other studies do not use control groups and only rely on qualitative analyses of information gathered over the entire population. Categorizing these studies is even more complex and comparison with different studies is challenging. Based on this initial difference, we select papers based on the presence of a control group. Following the standard academic path, this criterion ensures the relevance of pre-intervention context descriptions (also when provided by the same course results in previous years).

We also determine common elements that are necessary to replicate a controlled experiment involving the use of gamification and game-based in education. We categorize each paper by reporting how much information we can find about starting conditions usually represented by the control group. In this regard we define three elements as relevant: type of teaching material (the tools used to transmit course content), teaching method (how is the course taught), and evaluation method (how is the effectiveness of experimental and control methods evaluated).

Characteristic 2: Context of Application. Games have been studied and used in education throughout different academic curricula, from scientific to humanistic subjects, in academic and technical education. In the study of languages, for example, game elements have been used and appreciated in both academic and "more commercial" settings [13, 14]. Also, the field of mathematics experimented with adding game components to different grades of education [15]. Moreover, games are used and studied for both practical (training) and theoretical knowledge acquisition. Finally, another large part of the studies involves the use of game elements in behavioral change projects aimed at educational environments, for example, to promote safer sexual practices [16]. Such diversity naturally arises from the shared interest in the use of educational games but makes comparisons between studies very challenging. Therefore, we narrow our search by using a few strict criteria in selecting the studies to review. First, we focus on studies about how games influence the absorption of scientific notions. Since we focus on how different fields produce different studies, we include both natural and social sciences in order to preserve some variation. Also, we include only studies that aim to the acquisition of theoretical or practical knowledge. The rationale behind this is to include studies in the field of medicine and nursing which often mix the two. On the other hand, we exclude studies whose goal is to develop behavioral changes. Finally, we focus on studies involving secondary education. This includes high school and university-level courses. It excludes doctoral and specialization studies in which participants are often professionals.

3 Method

We summarise and motivate here further criteria used to filter the studies. We have chosen to focus on studies presented in English and to continue from where [3] left off, considering works from 2013 to 2020. We decided to focus only on recent development

in the field because of the increased number of game-based experiments in education [11]. We consider only video games and hybrid games, in light of the fact that the biggest majority of the studies collected involve digital components. In this way, we want to eliminate the few outliers which could prove difficult to compare. Of course, all experiments must involve the use of game elements or full games. This excludes pure simulations in which game systems, or more generally "pleasurable" components, are not implemented.

We implemented the above criteria by searching the Leiden University Library[1] using the query ("serious game" OR "game-based" OR "gamification" OR "game elements") AND ("experiment" OR "evaluation" OR "impacts" OR "outcomes" OR "effects" OR "education" OR "learning").

After using the above search we proceeded by reading the abstract of each of the first 100 papers sorted by relevance. We then determined whether it respects the rest of the aforementioned selection criteria (double-checking the year of publication). Studies not respecting one or more of the above criteria have been excluded from the review. At the end of this selection process, we collected 89 studies. We further read the full paper and made a final selection of 43 relevant studies.

With the goal of documenting diversity and clarity of starting conditions in mind, we summarise the categories through which the studies are classified:

- Field of application: medical sciences (medicine and nursing), natural sciences (biology, mathematics, physics, computer science, etc.), economics (economics, business, management), and social sciences (sociology, psychology, anthropology).
- Type of education: theoretical, practical (training), or a mixture of both.
- Clarity in the context of application: type of teaching material, teaching method, or evaluation method. For each, we assign the type "Unclear" if the experiment cannot be replicable with the information presented, and "Clear" otherwise.
- Grade of education: high school level or university level.
- Results: The effect of the experimental condition on motivation and performance. We consider "Positive", "Negative", and "Mixed/No-change" effects depending on the quality of the result in game condition.

4 Results

In this section, we report the quantitative results derived from the analysis of the included studies through the aforementioned categories. Of the 43 studies we collected[2] almost half (N = 20) are quite recent (i.e., published in 2017 and 2019) and 9 were published in 2020. The average publication year is 2018.

Medicine is the topic with the highest number of studies (N = 8), followed by math (N = 6) and computer science (N = 6). All the other topics score equal to or smaller than 4. The number of studies which investigate the effect of game-based education also (at least in part) on training is 10, of which 8 are contextualized in courses involving a life science (medicine, nursing, or physiotherapy) (see Fig. 1).

[1] https://www.library.universiteitleiden.nl/

[2] Including [17, 18, 19]. See the Appendix for completing the list of links to the studies considered.

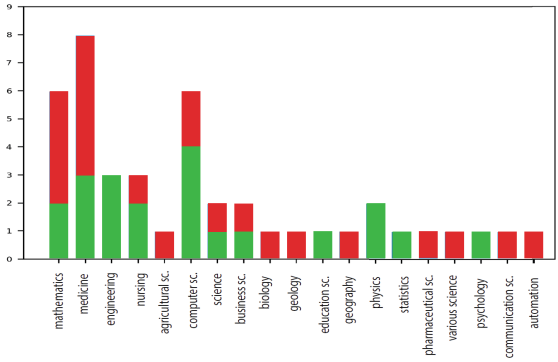

Fig. 1. Number of studies per subject. The positive success rate in green, mixed and negative in red.

We cluster the fields reported in the studies into four categories: hard sciences, life sciences, social sciences, and engineering. For each category, we then calculate the success rate. The two categories with the highest success rate are hard sciences (N = 10/18) and engineering (N = 3/4), with computer science being the subject with the highest success rate (N = 4/6). It is important to remark that there is some possible overlap between these two categories (for example, subjects studied in computer science could be also studied in computer engineering). Life sciences present the lowest success rate (N = 5/14). Almost the majority of the studies reported "positive" results (N = 21/43) while 12 studies reported "mixed" results.

We analyzed the frequency of the scores for the details of the educational context. For 22 studies the details reporting the type of teaching material used in the control groups are deemed unclear (see Fig. 2). In the case of the teaching method, the results show that in 30 studies this information is also unclear. On the other hand, testing methods are often more clearly reported with only 12 studies marked as unclear. Only 6 studies lack detailing in all three categories while 7 studies are clear in all three. Some are unclear in one or two categories (for both cases N = 15).

Almost half of the studies (N = 21) report positive results across both performance and student attitudes (when this was relevant). 12 studies report mixed results, noticing only partial improvement in either performance or student attitudes. The rest (N = 10) report worse results in the conditions involving games.

The Pearson correlation coefficient between the success rate (mapping the scale 'negative' – 'mixed' – 'positive' over a scale from 0 to 2) and the average of the context clarity values (considering the'clear' label as 1 and the'unclear' as 0) for each reviewed article shows no meaningful correlation between the two (r = 0.073). The correlation coefficient for the individual clarity of educational context values and the success scores also does not report a meaningful correlation (teaching material r = −0.078, teaching method r = 0.229, testing method r = 0.004). We additionally calculate the correlation coefficient between the values for the clarity of the educational context. Also in this case, no meaningful correlation is reported (material-teaching method r = 0.369, material-testing r = 0.089, testing-teaching method r = −0.042).

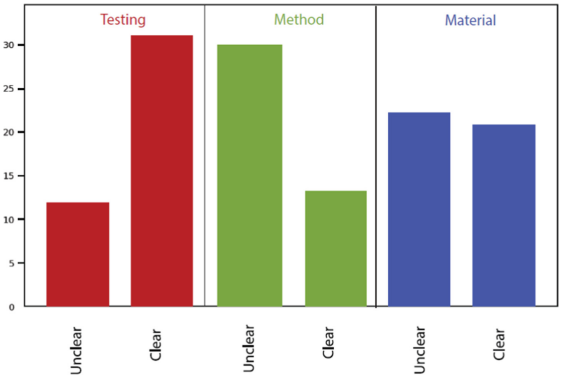

Fig. 2. Number of studies per clarity score.

Within the studies we found lacking in terms of detailing scores, we delineate different groups based on how the lacking aspect is treated. This creates two categories valid for both the scores related to the clarity in reporting teaching material and method. One category includes studies that simply did not mention these two components [17, 18]. The other category does mention these elements of the control conditions but resolves them in generic terms (e.g.: defining them as "standard", "classical" or "traditional") [19, 20].

The same categories cannot be applied to the scores of the evaluation method detailing. The main reason is that these studies are more consistent. Even when being "unclear", the evaluation is mentioned in the paper as an essential part of the experimental design. However, these cases refer to their results (e.g.: the presence of an "improvement") without explaining in detail the type of tests and analyses that led to those conclusions.

5 Discussion

The present review focuses on how information in controlled studies involving games in education is presented. Our analysis shows that the most frequently unclear element of the educational context is the teaching method. In this regard, many studies fail to mention the way the teaching material is presented. It is important to notice that, when it comes to this teaching material, the actual information provided is more complete than the information regarding the teaching method; many studies report at least the type of material used (specific books, PowerPoint slides, and online courses are the most common).

Following also the qualitative parts of our analysis, we cluster those studies which are unclear according to these first two scoring systems and postulate reasons for the lack of detailing. Some of these studies rely on the idea that the respective educational practices (teaching method and material in this case) are supposedly standardized in certain contexts. However, this type of standardization often does not account for teaching methods and/or the variation of these courses throughout the years in terms of content and material used. Other studies, in particular regarding the educational method, might simply overlook the importance of these elements and do not touch the subject.

The description of the testing method is usually clearer and in line with expectations. Few studies score 0, usually focusing on additional qualitative evaluations after the actual performance tests. Overall, it is rarer to encounter studies reporting no information at all in this regard, probably due to the intrinsic and fundamental nature of evaluation methods in experimental designs.

Looking at the success rate, results show that many studies (N = 21) reported benefits from using games for parts of their educational components. However, looking at the success score for each topic, games or game elements do not seem to be equally effective in every subject; for example, only three studies in the field of medicine report "positive" results (N = 3/8). This could indicate that game elements are more effective in some fields compared to others. Topics that often heavily involve the study of technology (engineering and computer science) score instead above average (respectively, N = 3/3 for engineering and N = 4/6 for computer science). This could indicate that students that are usually more involved, or at least interested, in technology are more susceptible to the effects of games or more motivated by such tools. However, other subjects that make heavy use of computational tools, such as mathematics, show a low success rate (N = 2/6).

Finally, it is important to observe that the lack of correlation between the scores (in particular detailing scores and success scores) can in part attest to the research's quality since the final results of the experiment do not seem to influence reporting decisions.

Limitations. Our inclusion criteria are effective in defining the area of interest of our research. However, they also present some intrinsic limitations. For example, our analysis focuses on subjects related to natural, social, and technical sciences. This is functional to collect studies that follow a common scientific experimental method, but it excludes a relevant amount of studies, in particular in the fields of language acquisition and history education. Also, by selecting science we automatically excluded studies in purely professional training settings. This often (but not always) affects experimental applications to training courses in vocational schools. Another limitation comes from the subjectiveness of the clarity scoring system we used, based on our own interpretation of the various texts. Finally, the success scoring system (negative-mixed-positive results) is highly dependable on the scope of the individual study. Some focus and report exclusively on performance improvement, others might include students' engagement and motivation. It also presents a certain level of subjectivity related to the mostly qualitative nature of the measured feature. However, it is a valid parameter to determine how those results are analyzed in each study and what perspective each paper takes on game-based education effectiveness.

6 Conclusions

This paper highlights the lack of clarity in describing the educational context as a common issue in the field of game-based education studies. This has an impact on the difficulty to interpret exactly what educational elements the gamified/game-based experience replace. Subsequently, it strongly hinders comparative analyses. Moreover, studies with incomplete information make it very challenging to perform any in-depth categorization

according to the educational context. We also hint at a relationship between the success of gamified/game-based education and students' intrinsic motivation.

Basing ourselves also on the aforementioned limitations, there are several directions to extend this work. One could use the same method and apply it to studies in the field of humanities. This is a better option than incorporating these studies directly in the current selection since the two groups present very different teaching goals and methods. It is also relevant to apply the same method to studies in vocational education using clarity scores more closely linked to practical education. Finally, comparative studies should take into account the diversity in the completeness of information, developing a methodology that can either adapt to it or compare different perspectives.

Appendix

In this appendix, we list the DOI (where available) of the papers collected and analyzed in our review that have not been already included in the references.

[21] https://doi.org/10.1007/s40037-016-0320-2.

[22] https://doi.org/10.1097/EJA.0000000000000675.

[23] https://doi.org/10.1002/cae.21887.

[24] https://doi.org/10.2196/jmir.9956.

[25] https://doi.org/10.1016/j.nedt.2017.04.027.

[26] https://doi.org/10.1186/s40813-018-0105-6.

[27] https://doi.org/10.2196/16987.

[28] https://doi.org/10.1016/j.chb.2013.06.009.

[29] https://doi.org/10.1111/jcal.12406.

[30] https://doi.org/10.1016/j.ijmedinf.2019.08.004.

[31] https://doi.org/10.2196/15374.

[32] https://doi.org/10.1002/cae.21992.

[33] https://doi.org/10.1007/s10639-019-10008-2.

[34] https://doi.org/10.1145/3282844.

[35] https://doi.org/10.1016/j.compedu.2018.09.011.

[36] https://doi.org/10.1371/journal.pone.0082328.

[38] https://doi.org/10.1002/ase.1927.

[39] https://doi.org/10.1177/0306419018762571.

[40] https://doi.org/10.1016/j.compind.2018.08.005.

[41] ISSN: 14364522, Retrieved from https://www.jstor.org/stable/jeductechsoci.17.3.65.

[42] https://doi.org/10.1016/j.nedt.2019.05.010.
[43] https://doi.org/10.1111/bjet.12346.
[44] https://doi.org/10.1080/09585176.2015.1018915.
[45] https://doi.org/10.12973/eurasia.2016.1519a.
[46] https://doi.org/10.1111/bjet.12896.
[47] https://doi.org/10.1016/j.compedu.2017.05.022.
[48] https://doi.org/10.1016/j.ijhcs.2020.102496.
[49] https://doi.org/10.1088/1742-6596/1223/1/012006.
[50] https://doi.org/10.1002/cae.12116.
[51] https://doi.org/10.1002/cae.22077.
[52] https://doi.org/10.5688/ajpe6606.
[53] https://doi.org/10.1016/j.ecns.2020.05.010.
[54] https://doi.org/10.1016/j.iheduc.2017.02.002.
[55] https://doi.org/10.1016/j.compedu.2018.01.009.
[56] https://doi.org/10.1145/3383456.
[57] https://doi.org/10.1016/j.compedu.2019.103666.
[58] https://doi.org/10.1080/10511970.2015.1122690.
[59] https://doi.org/10.1177/0098628316677645.
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Practical Lessons in the Covid-19 Pandemic: The Example of Analytical Chemistry Laboratory

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Abstract. The aim of research is to determine the opinions of pre-service teachers on laboratory skills in the application of analytical chemistry laboratory carried out with distance education. The research was designed in mixed method. The sample of the research consists of 23 pre-service chemistry teachers. Data were collected through laboratory skills scale and semi-structured interviews. The laboratory skills data was analyzed descriptively and interviews were analyzed by content analysis. As a result, it was determined that pre-service teachers had the highest average in recognizing tools and chemicals dimension and the second is in self-readiness. The considering feedback and communication in the laboratory dimensions have the lowest averages. According to interview analysis, pre-service teachers stated that they were worried about not being able to do the experiment in the laboratory, and that they were afraid because they did not know what to do when something went wrong in the laboratory.

Keywords: Analytical chemistry laboratory · Laboratory skills · Pre-service chemistry teachers · Covid-19 Pandemic

1 Introduction

Young people define chemistry as a science that is difficult to understand and make a career [1]. For example, chemistry is sometimes described as boring and even challenging because it is difficult to visualize topics such as the structure of the atom [2]. Undergraduate chemistry programs are expected to make the concepts in chemistry understandable and to provide the ability to combine these concepts with laboratory practices. For this reason, chemistry programs should be arranged to include experimental design. If necessary, changes should be made in chemistry programs. From time to time, the extent to which students understand the relationship between theory and practice should be evaluated, and the results should be taken into account when arranging the curriculum [3]. There is no one who is familiar with the traditional laboratory understanding, in which a detailed procedure for the experiment is given. In this laboratory understanding, experiments usually aim to demonstrate concepts learned in lectures and provide training in practical techniques. However, students cannot have an idea about the actual design of the experiment. Unless laboratory applications are made as an important component of course evaluation, all efforts to emphasize the experimental nature of chemistry unfortunately cannot see the success they deserve [4].

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 42–50, 2023.
https://doi.org/10.1007/978-981-99-5961-7_5

Analytical chemistry is perhaps the most common field of laboratory applications in chemistry. Analytical chemistry is a science that is used in all fields of science and medicine and is based on measurement. Analytical chemistry involves identifying, separating, and quantifying the components that make up an example we encounter in our daily lives [5]. While performing qualitative analysis experiments, color change and precipitation reactions are widely used in the identification of substances [6]. The student who will perform an analysis must have a basic knowledge of the traditional quantitative analysis laboratory chemical analysis [7]. With qualitative analysis, the student should learn how to use a given sample, how to identify the cations that are present or not in each group, perform laboratory practices involving changes in color and/or appearance, and reach conclusions based on both theory and reactions. Students should combine theory with experimental work [8].

During the Covid-19 pandemic process, laboratory courses in which practical applications are carried out appear as courses that cannot be decided on how to conduct. Simulations have come to the rescue in order to overcome the difficulty of this process. Simulation is a simulation used to model the theoretical or physical real model in a computer environment, to reflect the real model in a virtual environment, to create models by simulating known events in a virtual environment, to see the behaviors occurring in the system according to this model, and to predict the results of the strategies to be followed [9]. Simulations; It is a system of multiple, complex and advanced non-stationary models. With the virtual reality created by simulations, it helps to better understand many situations that may pose a danger. In the educational environment, teachers provide students with the opportunity to create experiments without a risk environment and to observe the result [10].

It can be said that simulations used in education are beneficial for students and teachers. Science education is a course in which students should experience the situation in an experimental environment. It can be difficult for each student to experience in an experimental environment. At the same time, obstacles such as the use of risky materials, the duration of the experiment, and the experiments that need to be repeated may be encountered. Creating a virtual experiment environment in the simulation environment can perform safe experiments without the risk of experimentation, to collect data again. During the Covid-19 pandemic process, simulations, which have many examples in the world and in our country and are frequently used especially in science education, have been used as aids in laboratory courses. This research was carried out in order to determine the competencies of pre-service teachers for laboratory skills in the application of analytical chemistry laboratory carried out with distance education.

2 Method

The research was designed in mixed method. Qualitative and quantitative re-search techniques were used together. Mixed method is defined as the combination of qualitative and quantitative research methods, techniques and approaches [11]. Collecting qualitative and quantitative data together is very important to obtain more accurate research results and to reduce the margin of error [12].

In the quantitative dimension of the study, a single group pretest-posttest design was used. The single-group pretest-posttest model is usually done to reveal the importance

of a new teaching method or to draw attention to an innovation in the curriculum. In this design, the researcher measures a group's related characteristics such as attitude and achievement. It then performs an experimental operation. This process is designed to increase the attitude or success of the group. After an experimental procedure, the researcher measures the relevant characteristic of the group again. It examines the differences between pretest and posttest scores by drawing attention to the effects of the experimental procedure applied [13]. Qualitative data of the research were collected by semi-structured interview. The data obtained from the interviews were analyzed by content analysis. Content analysis allows individuals to create indicators of worldviews, values, attitudes, prejudices and views and compare them among communities [14]. Themes were created based on qualitative data. The themes were presented with sample expressions directly quoted from the pre-service chemistry teachers' sentences (e.g. [PCT7]). This research is a good example of content analysis method. After collecting data in the study, how the process of developing a series of categories, testing their reliability, and finally analyzing the findings took place is summarized below.

2.1 Sample

Purposeful sampling method, which is one of the non-random sampling methods, took the sample of the study. Purposeful sampling is a sample selection using the personal judgments of researchers to select a sample based on a group's previous knowledge and the specific purpose of the research [15]. The sample group of the research consists of 23 pre-service chemistry teachers studying at a state university. The research was conducted in the spring term of 2020–2021.

2.2 Data Collection Tools

Data were collected through laboratory skills scale and semi-structured interviews.

Laboratory skills scale: Laboratory skills scale. The scale was developed by [16]. It has a 4-factor structure consisting of 25 items. Cronbach Alpha internal consistency coefficient for the whole scale was found to be 0.910, for recognizing the materials and chemicals sub-dimension was found to be 0.916, for considering feedback sub-dimension was found to be 0.774, for the communication in the laboratory sub-dimension was found to be 0.809 and for the feeling ready her/his-self sub-dimension was found to be 0.643. These findings show that the scale is valid and sufficiently reliable.

Semi-structured interview form: A form was prepared to examine his thoughts in detail in the analytical chemistry laboratory conducted by distance education. In this form, "What are your thoughts on the analytical chemistry laboratory conducted by distance education? How effective are experiment simulations and home experiment applications when you enter the laboratory at the university and conduct an experiment? What competencies did this process add to you?" Two experts were consulted for the form, one from the chemistry department and the other from the chemistry education department. Interviews lasting approximately 30 min were conducted with each pre-service teacher and recorded.

2.3 Application Process

The study was carried out at the analytical chemistry laboratory II course throughout the 2020–2021 fall semester.

Analytical chemistry the determination, separation, and quantification of the components that constitute an example we encounter in our daily lives. Simulation applications and home experiment activities were used while conducting this complex process remotely. The analytical chemistry laboratory quantitative analysis applications first started with lectures over theoretical zoom. Afterwards, the students performed experiments using quantitative analysis simulations. Later, they experimented with the materials at home and took a video of it and shared it with their friends (Fig. 1).

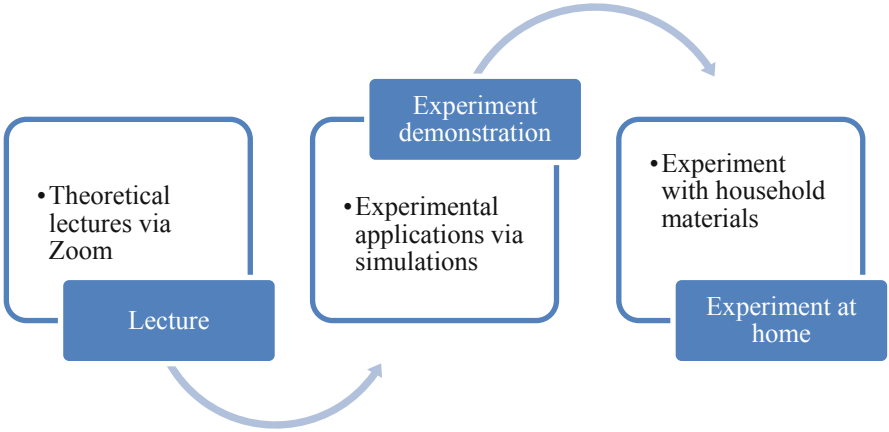

Fig. 1. Application process of the research in analytical chemistry laboratory.

2.4 Data Analyze

Analysis of Quantitative Data. SPSS23 was used in the analysis of the quantitative data obtained from the study. After the distance education and analytical chemistry laboratory applications, the difference between the pretest and posttest scores was examined with the Wilcoxon Signed Rank test. Before starting the analysis, the assumption of normality was examined. According to the literature, non-parametric tests are recommended if the sample size is < 30 and the distribution is not normal. Another literature states that the number of samples reaching 30 ensures that the distribution of the averages approaches normal [15]. In this study, the assumption of normality was tested statistically through the significance level of the Shapiro-Wilks test. According to the results of the analysis, since Shapiro-Wilks Test $p < .05$ normality assumption was not provided, non-parametric tests were used.

Analysis of Qualitative Data. Qualitative data of the research were collected through semi-structured interviews. Interviews were transcribed. The obtained data were analyzed by content analysis. Content analysis allows individuals to create indicators of

worldviews, values, attitudes, prejudices and views and compare them across communities [14]. Analysis of qualitative data obtained from interviews. The coding of the data was carried out by following the steps (1), creating the themes (2), organizing the codes and themes (3), identifying and interpreting the findings (4) [17].

3 Results

3.1 Quantitative Findings

Descriptive statistics related to pretest-posttest scores of laboratory skills was summarized in Table 1. As a result of the examinations, the data obtained from the research do not meet the normality assumption. The effect of the analytical chemistry laboratory conducted by distance education on the laboratory skills of pre-service teachers was reviewed. The Wilcoxon Signed Rank test was used to examine whether there was a significant difference between the pretest and posttest findings of pre-service teachers' laboratory skills. The results of the examination are given in Table 1.

Table 1. Descriptive statistics and Wilcoxon signed-rank test results laboratory skills scale pretest-posttest scores.

Observed variables		Pretest score	Posttest scores		Mean rank	Sum of ranks	Z	p
Recognizing the materials and chemicals	Mean	3.54	4.47	Negative ranks	4.33	13.00	−3.802	.000*
	SD	.59	.39	Positive ranks	13.15	263.00		
Considering feedback	Mean	4.42	4.72	Negative ranks	5.00	25.00	−3.034	.002*
	SD	.33	.29	Positive ranks	12.33	185.00		
Communication in the laboratory	Mean	2.22	2.74	Negative ranks	10.58	127.00	−.401	.688
	SD	.81	1.16	Positive ranks	11.56	104.00		
Feeling ready her/his-self	Mean	2.74	2.75	Negative ranks	9.95	109.50	−.209	.834
	SD	.81	1.06	Positive ranks	12.15	121.50		

* $p < 0.05$

a. Based on negative ranks.

When the table is examined, it is seen that there is a statistically significant difference between the pretest scores and posttest scores of the recognizing the materials and

chemicals and considering feedback sub-dimensions of the laboratory skills scale ($Z = -3.802, -3.034$; $p < 0.05$). It is noteworthy that the pre-application average of the candidates (X: 3.54) in the dimension of recognizing the materials and chemicals was (X: 4.47) after the application. It is seen that while it is average (X:4.42) in considering feed-back size, it is (X:4.72) after application. There is no significant difference in other dimensions. Based on these results, it can be concluded that distance education, experiment simulations and home experiment practices in the analytical chemistry laboratory have a significant impact on the development of pre-service teachers' laboratory skills.

3.2 Qualitative Findings

Content analysis started with the transcription of interviews with pre-service chemistry teachers. Content analysis was carried out in 4 steps. These steps are; coding the data, finding the themes, organizing the data according to the themes and codes, and interpreting the findings. The coding of the data was done according to the open coding technique. The data obtained from the form were collected under two themes. These themes are recognizing the materials and chemicals, feeling ready her/his-self (Table 2).

Table 2. Themes and codes of qualitative analyze semi-structured interviews.

Themes	Code
Recognizing the materials and chemicals	Know the materials
	Inability to read chemicals
Feeling ready her/his-self	Awareness
	Anxiety

According to the analysis of the interviews, two themes emerged. These are recognizing the materials and chemicals and feeling ready her/his-self. The first theme, Recognizing the materials and chemicals, is described by two codes. These codes are recognizing materials and inability to read chemicals. The expressions for the materials identification code are as follows: *"I know glass materials very well [PCT3], I can mix balloon and balloon jug [PCT15]"*. In the code of inability to read chemicals, "*I know hydrogen and oxygen, but I cannot say the compounds by heart [PCT11], I know the formulas of the compounds but I do not know how to pronounce them [PCT3]"*.

The second theme from the interview analysis is Feeling ready her/his-self. Pre-service teachers stated that they were worried about not being able to do the experiment in the laboratory, and they were afraid because they did not know what to do when something went wrong in the laboratory. The expressions for this theme are as follows. *"I am afraid of doing something wrong because of my excitement [PCT7], I wonder if I will be able to do the steps I followed in the simulation in the laboratory [PCT13]"*. The statements in the awareness code are as follows: *"I know that I will remember everything well when I enter the laboratory [PCT21], I am aware of what to do when something goes wrong [PCT9]"*.

4 Discussion and Conclusion

This research was carried out to determine the effect of distance education supported by simulation in the analytical chemistry laboratory and experimentation at home on the laboratory skills of pre-service chemistry teachers. As a result of the research, it was determined that distance education and home experiments had a significant effect on improving the laboratory skills of pre-service chemistry teachers. The effect of distance education on laboratory skills is also supported by other research results. When the sub-dimensions of the laboratory skills scale were examined in the study, it was determined that there was a difference between the pretest/posttest scores in the dimensions of recognizing materials and chemicals and feeling ready.

The success of the simulation applications obtained as a result of the research is supported by the literature. The use of educational technologies, virtual applications and mobile technologies in the classroom and access to these technologies outside the classroom have the potential to enrich the teaching and learning experience in different subject areas [18–21]. It is reported that the technology supported learning system increases the learning satisfaction and motivation of the students [22]. Technology-assisted instruction shows that it is effective in facilitating behavioral, cognitive and emotional participation of students according to the results of classroom interaction, unit tests and learning satisfaction analysis [23]. Technology supported applications increase class participation and motivation. This is emphasized by the teachers as the strength of technology [24]. There is a lot of evidence proving that there are interactive, social, affective and cognitive benefits obtained from the use of technology supported learning applications such as augmented reality [25–27]. As a result of the research, the students' feeling ready her/his-self finding is supported by the positive effect of technology-supported applications on motivation and attitude.

Science learning includes many complex and abstract concepts that are difficult to understand [28]. Abstract concepts have a very negative effect on students' learning of chemistry. It is clear that there is disconnect between theoretical knowledge and skill practice [29]. Simulation laboratory activity offers students opportunities such as communicating learning objectives, giving detailed information about activities, data visualization and working with chemical solutions [30]. Analytical chemistry laboratory applications supported by simulations not only increase the success of the students, but also improve their motivation [31–33].

In this study, the effects of simulation and home experiment applications on the laboratory skills of pre-service teachers were examined. Simulation applications provided pre-service teachers with the opportunity to check whether they have theoretical knowledge about the experiment, to know the chemical materials and tools required for the experiment, and to use the data obtained from the experiment to calculate the experiment result. Simulations give you the chance to try all these requirements multiple times and test them until you find the truth. Simulations also allow each individual to progress at their own learning pace. Virtual applications cannot provide the competencies that real experience will gain. For this reason, simulations should be used to prepare students for the experiment in the post-pandemic period or should be presented as helpers to remember things they forgot after the experiment.

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How Learning Motivations and Strategies Affect Engagement and Outcomes in Introductory Computer Programming Courses

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Abstract. In recent years, computer programming has become an essential skill in STEM education. In instructor-led courses, students are provided with a variety of learning activities, such as lectures, coding exercises, and additional resources for self-study, to help them attain proficiency. Nevertheless, the persistent problem of high student failure rates has prompted the research community to investigate and address the issue. In this research, we collected learning data from 500 enrolled students throughout 3 semesters. A sequence of multiple regression analyses was performed to investigate potential factors that could impact students' learning outcomes. Initially, all significant learning activities were assessed to determine the degree to which each activity contributes to students' learning. In the second stage, data gathered from the Motivated Strategies for Learning Questionnaire (MSLQ) was used to investigate which learning motivations and strategies influence each learning activity. According to the study, the most important factors affecting students' performance in an introductory programming course are active participation in class and practicing assignments. The analysis further reveals that, among various learning motivations and strategies, effective time and study environment management is the main factor influencing students' class participation and assignment practice. Additionally, the research confirms that formative assessments, such as scores from coding practice, are highly predictive of exam scores. These findings suggest that programming course instructors should focus on designing instructional delivery that prioritizes coding assignments combined with coding practice sessions in controlled environments (e.g., workshops and labs) with sufficient support from teaching assistants.

Keywords: Learning Motivations · Introductory Computer Programming Course · CS2 · MSLQ · High Student Failure Rate Course · Learning Analytics

1 Introduction

The issue of underperforming students has long been recognized as a significant problem in most academic programs. Among many disciplines, the failure of introductory programming courses in undergraduate computer science has been a major concern

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 51–60, 2023.
https://doi.org/10.1007/978-981-99-5961-7_6

globally [1]. This issue is also prevalent in Thailand, where the failure rate has been a topic of discussion among university lecturers. Despite their attempts to address the issue, solutions and outcomes have been inconsistent. The underlying causes may vary based on multiple factors, such as the course settings, instructional design and delivery, and the characteristics of the student. A more thorough analysis of the root causes may be necessary to make meaningful improvements.

In the aspect of student learning, most prior studies primarily focused on examining how learning motivations and strategies impact students' performance. This research proposes that students' learning motivations and strategies are likely to manifest in their learning behaviors, which in turn directly affect their learning performance. Hence, our analysis explores the role of learning activities as mediators between motivations/strategies and performance. A sequence of multiple regression analyses was conducted to investigate what learning motivations and strategies affect each learning activity and the degree to which each learning activity contributes to students' learning performance. Analyzed data was collected from 500 enrolled students of a Java course in a Computer Science curriculum over a period of 3 semesters. Learning activity data was obtained from a Learning Management System (LMS), while data regarding students' learning motivations and strategies was collected at the beginning of each semester using the Motivated Strategies for Learning Questionnaire (MSLQ).

The research outcomes provide an in-depth understanding of the aspects that influence students' academic performance. The findings can direct instructors in promoting high-impact learning motivations and strategies that enhance student engagement. Additionally, the identified effective learning activities can guide instructors to reinforce the instructional design, which ultimately improves students' success.

2 Related Work

The impact of learning motivation and self-regulation on students' academic performance has been long recognized. Over the past few decades, there has been a wealth of research conducted on this topic in the academic community. Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich [2] is one of the most widely used instruments designed to measure students' motivation and self-regulated learning [3]. The questionnaire composes of 14 scales and divided into two parts: the Learning Motivation part, which evaluated students' motivation towards the course, and the Learning Strategy part, which inquiries about students' approach to learning. Table 1 depicts the scales' short description.

Since 2000, a number of studies in computer programming education domain have investigated the impact of learning motivations and strategies on student performance. Intrinsic goal orientation, self-efficacy, and task value have been identified as significant motivations in many studies [4–7]. Some other attributes have been identified by several studies. For instance, according to Chen's study [8], effort regulation has a positive effect on learning outcomes, whereas peer learning has a negative impact. In contrast, Bergin's research [9] found that cognitive strategies, such as rehearsal, elaboration, and organizing, have no significant impact on any analytical aspects, and are thus not useful in programming education. Although previous studies have primarily investigated the association between MSLQ attributes and learning performance, the current research adopts

Table 1. MSLQ scales and brief description.

Acronym	Brief Descriptions
IntscGoal	*Intrinsic Goal*: The degree to which the student perceives herself to be participating in a task for reasons such as challenge, curiosity, and mastery
ExtscGoal	*Extrinsic Goal*: The degree to which the student perceives herself to be participating in a task for reasons such as grades, evaluation by others, and competition
TaskValue	*Task Value*: The students' evaluation of how interesting, how important, and how useful the task or course material is
LearnBlf	*Control of Learning Beliefs*: The Students' beliefs that their efforts to learn will result in positive outcomes
SlfEffc	*Self-Efficacy for Learning and Performance*: The judgments about one's ability to accomplish a task as well as confidence in her own skills to perform that task
TstAnxty	*Test Anxiety*: The students' negative thoughts that disrupt performance, and the affective and physiological arousal aspects of anxiety
SelfReg	*Metacognitive Self-Regulation*: 1) Planning, goal setting. 2) Monitoring, tracking, self-testing. 3) Regulating, adjustment of one's cognitive activities
TimeEnvn	*Time and Study Environment*: Scheduling, planning, and managing study time and environment
EffortReg	*Effort Regulation*: Ability to control effort and attention in the face of distractions, uninteresting tasks or difficulties
PeerLearn	*Peer Learning*: Collaborating or dialogue with peers to reach insights one may not have attained on one's own
HelpSeek	*Help Seeking*: Identifying and manage person to provide assistance and support
Rehearsal	*Rehearsal*: Reciting or repeating to memorize content
Elaborate	*Elaboration*: Paraphrasing, summarizing. Store information in long-term memory
Organize	*Organization*: Clustering, outlining, selecting main idea from learning contents
CritThnk	*Critical Thinking*: Applying previous knowledge to a new situation

a different perspective by examining learning activities as the mediator between motivation /strategies and learning performance. The outcome of the study should provide valuable insights into the comprehensive success factors that contribute to introductory programming education.

3 Research Questions

Prior studies have primarily examined the influence of students' learning motivations and strategies on their academic performance. However, this current study proposes that a more precise gauge of students' motivations and strategies can be derived from their degree of engagement in learning activities, and that higher levels of engagement in

such activities can lead to better academic performance. The goal of establishing such a mediator effect is reflected in our two research questions illustrated in Fig. 1.

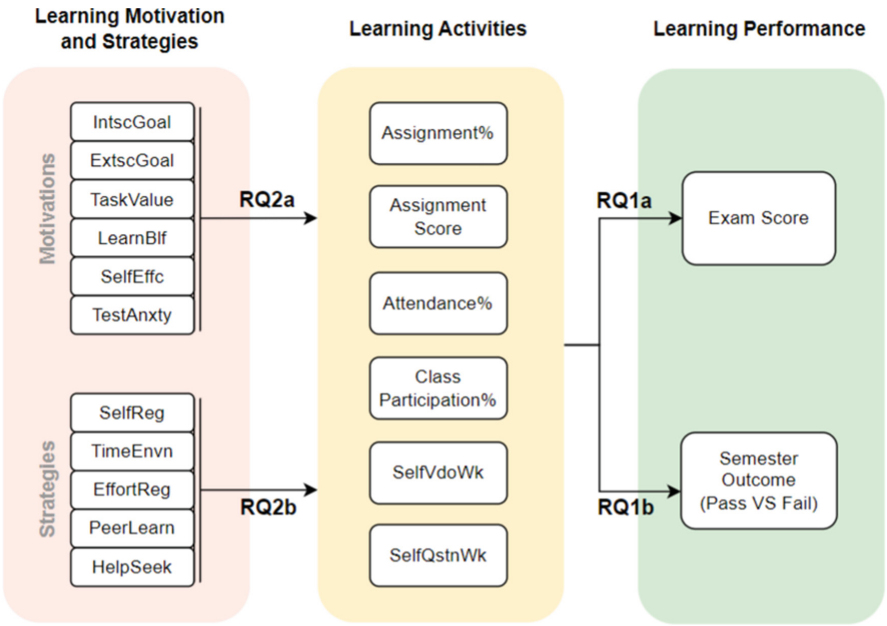

Fig. 1. Diagram of the research questions

RQ1. What are important learning activities that influence learning performance? The study evaluates the effect of educational tasks on academic achievement in two ways: firstly, by analyzing students' exam scores (RQ1a), and secondly, by examining whether they pass or fail the semester (RQ1b).

RQ2. What are important learning motivations & strategies that influence learning activities? The study utilizes data gathered through MSLQ to evaluate how learning motivation (RQ2a) and learning strategies (RQ2b) of students influence their learning activities.

4 Data Collection and Data Analysis Methods

4.1 Course Information

The subject of this study is a Java programming course with the main objective to build basic Object-Oriented (OO) programming competency for first-year undergraduate students in computer science curriculum (CS2). The data collection was conducted for 3 consecutive semesters with 500 enrollments from 352 students. The course has 8 learning topics with 2 lecture-hours and 4 lab-hours per week. The instructor assigned weekly programming questions as homework. All 3 semesters were conducted online due to

the pandemic, using an LMS for auto-grading students' code and a teleconference tool for virtual classroom sessions. This Java course has been suffering from high drop out and failure rates in recent years. On the research duration of 3 semesters, only 50% of students passed (175/352). Considering the number of enrollments, the pass rate was as low as 35% (175/500).

4.2 Student Learning Data

Learning Motivation and Strategies: At the beginning of each semester, enrolled students were asked to complete the MSLQ and provide their consent for using the data for research purposes. The study selected 10 MSLQ scales out of 14. Four scales in Cognitive Strategies were omitted as they were not relevant to programming education [9], namely Rehearsal, Elaboration, Organization, and Critical Thinking. The questionnaire was translated into Thai and reviewed by a skilled linguist to ensure that the question was clear and precise.

Learning Activity Rates: Data from an LMS log was compiled in 5 types of students' learning activities, i.e., Class Attendance, Class Participation, Assignment Practice, Self-Study VDO Watching, Self-Study Question Practice. Table 2 depicts how students' interactions are observed and categorized into learning activities for analysis.

Learning Performance: Three types of students' performance were observed:

1) exam score: a cumulative score from summative assessments throughout the semester, 2) assignment score: an average score from assignment questions in which a student hand on, and 3) learning outcome: the semester verdict of student on the course, i.e., pass and fail.

4.3 Statistical Analysis Methods

The research conducted a series of relationship analyses. Initially, learning activities were evaluated to determine the degree to which each contributes to students' performance. Subsequently, the MSLQ data was analyzed to determine which learning motivations and strategies influence each learning activity.

RQ1: To analyze the impact of learning activities that influence learning performance, a multiple regression analysis was conducted on students who had completed the semesters ($N = 280$) to examine coefficient between learning activities and exam score (RQ1a). The study also used a Mann-Whitney U Test to compare the rate of learning activities between students who passed ($N = 175$) and those who failed ($N = 105$) the semester (RQ1b).

RQ2: To analyze what learning motivations & strategies that influence learning activities, a multiple regression analysis was conducted on students who had completed the semesters and responded to MSLQ ($N = 150$) to examine the effect of students' learning motivations (RQ2a) and strategies (RQ2b) on each learning activity.

Table 2. Student interactions on LMS categorized into 4 learning activities.

Learning Activities	Student Interaction on LMS	Student Learning Activity Rate
Class Attendance	A student logs in to LMS or joins the VDO conference session on class start time ± grace periods	**Attendance%**: Percentage of a students' attendance to total class attendance in the semester
Class Participation	A student interacts with learning material (e.g., pop-up question, coding question, and video) in which the instructor introduced in classroom	**Participation%**: Percentage of material a student works on to total class-time materials in the semester
Assignment Practice	A student submits code on questions or watches VDOs in which the instructor assigned as homework	**Assignment%**: Percentage of homework material a student works on to total homework material in the semester
Self-Study VDO Watching Weeks	A student watches video which the instructor did not assign outside classroom period	**SelfVdoWk**: Number of Weeks that a student watches at least 1 non-assignment video in the semester
Self-Study Question Practice Weeks	A student submits code on questions which the instructor did not assign outside classroom period	**SelfQstnWk**: Number of Weeks that a student works on at least 1 non-assignment question in the semester

5 Analysis Results

Figures 2 and 3 outlines analytic results of RQ1 and RQ2, respectively. All statistical details are clarified in Table 3.

The results from the analysis (RQ1a, RQ1b) indicate that the learning activities that significantly impact learning performance are class participation, assignment practice rate and self-study question practice rate. Moreover, average assignment score is also found to have a strong influence on learning performance. Multiple regressions of RQ2 demonstrate that assignment practice and class participation are positively affected by effective time and environmental management, but negatively affected by effort regulation. Lastly, self-study videos watch rate is influenced by self-regulation and seeking help.

6 Discussion and Conclusion

Analytic results reveal interesting findings which lead to potential course instruction improvements for introductory programming courses:

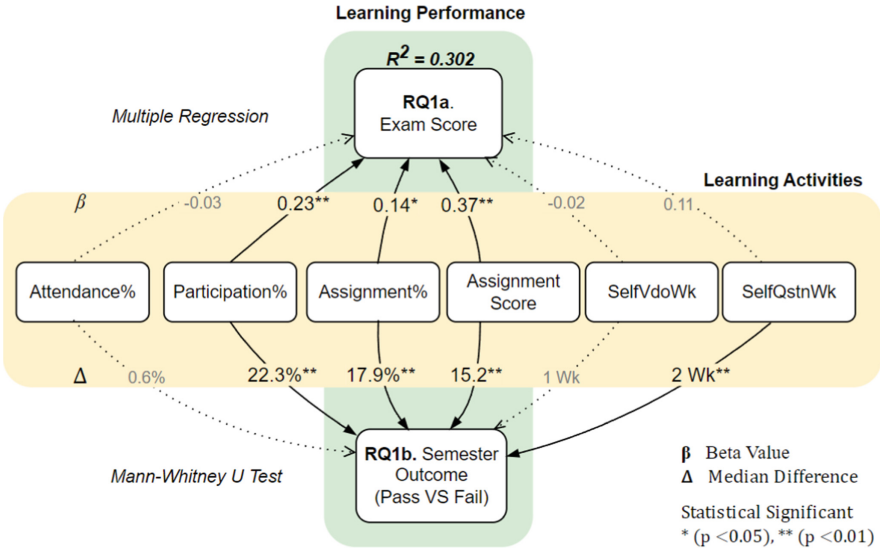

Fig. 2. Learning activities that impact learning performance (RQ1)

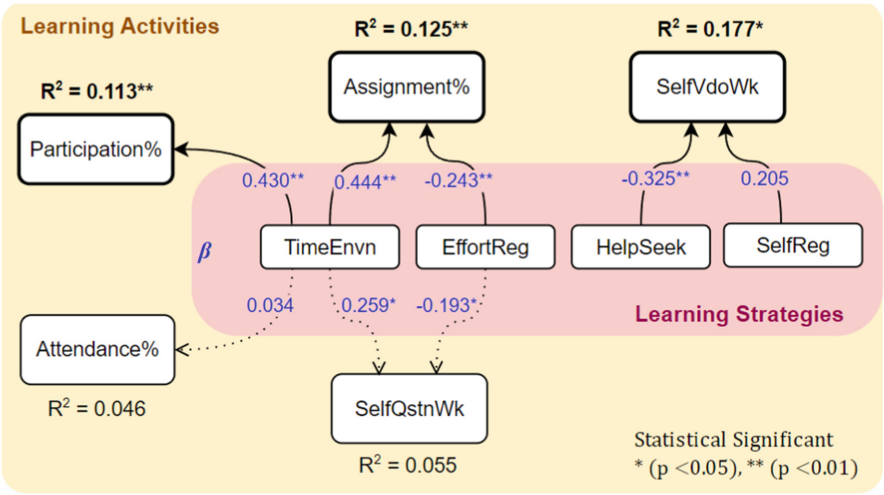

Fig. 3. Learning motivation & strategies that impact learning activities (RQ2)

1) Class participant rate had a significant impact on learning outcomes. In contrast, class attendance rate did not have a significant impact because the course, like most curricula courses, mandates a minimum attendance rate for students to pass. The histogram of class attendance rate shows that the distribution is highly left-skewed (Mean = 0.72, Median = 0.82) indicating that most students have a similarly high attendance. Instructors should take advantage and enhance the instructional approach in a way that fosters greater student engagement during class. Many studies reported

Table 3. Statistical results of RQ1 and RQ2.

Learning Activities	RQ1a. Multiple regression on L.activities to exam score B, β, t, p	RQ1b. L.activities difference Pass and Fail students (MWU) Median Pass/Fail, Z, p	RQ2. Multiple regression on Motivations & strategies to L.activities	
			Model Result R^2, F, p	Sig.Coefficients B, β, t, p
Attendance%	−3.754, -0.033, −0.480, −0.631	82.9/82.3, −0.710, 0.477	0.06, 0.881 (143/11), 0.560	No significant coefficient
Participation%	25.099, 0.225, 2.968, 0.003**	54.1/32.8, −3.231, 0.001**	0.12, 1.971 (143/11), 0.041*	TimeEnvn (0.129, 0.415, 3.453, 0.001**)
Assignment%	16.683, 0.144, 1.926, 0.048*	81.8/63.9, −3.887, 0.000**	0.25, 2.105 (143/11), 0.023*	TimeEnvn (0.134, 0.444, 3.750, 0.000**) EffortReg (−0.075, -0.247, −2.588, 0.022*)
Self-Study VDO Watching Week	−0.176, -0.019, -0.316, 0.753	3.0/4.0, −1.758, 0.079	0.10, 1.410 (143/11), 0.174	No significant coefficient
Self-Study Question Practice Week	0.871, 0.108, 1.547, 0.123	8.0/6.0, −2.549, 0.011*	0.06, 0.893 (1.43/11), 0.549	No significant coefficient
Assignment Score	44.709, 0.366, 6.558, 0.000**	83.3/68.1, −4.561, 0.000**	Not Available	Not Available

effective teaching approaches that can increase student participation, such as live coding, gamification, team-based/project-based learning, and pair programming.

2) Assignment practice and self question practice rates have a notable impact on the learning outcome. This highlights the importance of question practice, which can profoundly enhance a students' comprehension in STEM education [10]. The result shows both activities are effective indicators. The weak correlation (Spearman's rho $r(278) = 0.076$, $p = 0.207$) implies that an increase in assignment practice rate does not necessarily lead to a better assignment score. Thus, instructors should intervene with students who exhibit a lack of assignment practice or receive low scores, whoever come to evident.
3) This study does not identify any learning motivation that significantly affects learning activities, but on learning strategies, the results unveil that:

   - The effective management of time & study environment (TimeEnvn) has a high influence on class participation, assignment practice, and question self-practice which subsequently contribute to better learning performance. TimeEnvn also has some impact on class attendance, but the result is inconclusive as the regression model is not statistically significant.

- Effort regulation has a negative effect on assignment and question self-practice which is contradictory to expectation. One potential explanation that the instructors have considered is that the MSLQ questions regarding this scale are phrased in a way that asks students to indicate whether they are willing to persist in studying the subject even when it is boring or uninteresting. Students who have previously failed the course may be more inclined to answer positively, as they may feel greater pressure to complete this mandatory course. The questionnaire may need to be reviewed to be suitable for courses with a large number of repeaters.
- Self-regulation and help seeking significantly impact the rate of watching supplement VDOs. Students who possess strong self-regulation skills tend to recognize when they struggle with a topic and utilize the VDOs for clarification. Conversely, students who prefer seeking help from others exhibit a negative correlation with the VDO watch rate.

The findings suggest that programming course instructors should design an instructional approach that enhances students' Time and Environment management for coding practice. An effective approach is to facilitate regular coding workshops or lab sessions with adequate teaching assistants' support. This approach not only promotes student problem practice, but also allows prompt guidance to enhance comprehension of lagging students.

While this study provides valuable insights into the factors of students that influence learning performance, future research should focus on gaining a deeper understanding of students who repeat the course by analyzing the differences in learning motivations, strategies, and activities between the semester that they fail and the semester that they pass. This could support instructors as they adjust course settings and design including develop targeted interventions that would ultimately improve high-failure programming courses.

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Results of Using Business Intelligence Forecasting Customer Insight of World Integrated Suvarnabhumi Education Platform

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Abstract. The World Integrated Suvarnabhumi Education (WISE) Platform, supported by the Suvarnabhumi Institute of Studies, operates under the Social Sciences, Humanities, and Fine Arts College (TASSHA) of the MHESI's Permanent Secretary's Office. PSU was responsible for analyzing, designing, and developing the platform with a focus on sociology. It serves as a central hub for connecting historical data contexts and offers specific time-axis capabilities. Over 100 users participated in user flows and prototype testing, resulting in improvements. The platform includes more than 60 infographics and 200 categorized and summarized articles to enhance SEO activities. It is integrated with six social media platforms. Global user insights were analyzed based on over ten thousand visitors between Nov 18 and Dec 20, 2022. The WISE platform utilizes Business Intelligence (Power BI) for more accurate SEO analysis. A satisfaction assessment with dashboard users indicated a high overall satisfaction level, with a mean rating of 4.484 and a standard deviation of 0.677.

Keywords: Integrated platform · Suvarnabhumi Education · Temporal data · Business intelligence

1 Introduction

The land of Suvarnabhumi appears in Buddhist scriptures, affecting the study of history for more than 2,500 years, with the area covering Southeast Asia linked to the history of the world in many dimensions. International historians are interested. And can access Suvarnabhumi's research on sociology and archaeology, which can express opinions as well by various groups of people. Evidence collection takes many forms through primary/secondary documents, lectures, photographs, electronic files, and research reports with a huge amount. As an alternative, it has been stored in a fragmented, unstructured organization that manages the administration separately unrelated links, and lack of

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 61–70, 2023.
https://doi.org/10.1007/978-981-99-5961-7_7

coordination points. Some pieces of evidence do not have electronic backups that could disappear over time. Those who can comprehend such knowledge must have specific expertise. As a result, it has been applied to the national strategy in terms of economy, public interest, and academics. However, passing it on to the next generation and new learners is difficult to access due to a lack of international communication and the absence of a comprehensive and systematic information management system.

Hence, a time-axis-specific platform connects historical scholars of all contexts and makes it available to developers and API enthusiasts, facilitating the effective and widespread use of knowledge management at the Suvarnabhumi Institute. This platform has a beneficial effect on the development and application of such knowledge among personnel in the humanities and social sciences, as well as between local institutions, academic experts, and the public who are interested in national and international academic benefits.

The platform serves as a learning ground, a source of ideas, and a research outlet for scholars, villagers, and the public to address historical issues. It strengthens the Suvarnabhumi Education Society for Sustainability, promoting local and regional understanding of Southeast Asia while connecting it to world history for economic benefits. This Suvarnabhumi knowledge-exchange platform acts as a multicultural hub that facilitates information for tourism route planning and cognitive enhancement. The outline of this article, after the introduction, consists of the following sections: Related Work, Methodology, Results, and Discussion.

2 Related Work

2.1 Platform Development

During the search for scholarly works related to sociology from 2011 to 2021 worldwide, to gather information for all Suvarnabhumi Studies projects, numerous relevant documents were found. The representation of these documents can be seen in a keyword cloud chart. It indicates that 75% of the knowledge utilized is derived from the field of computer science, while sociology accounts for only 40%. Similarly, when employing keywords related to archaeology, word density charts with a time axis become relevant. Additionally, word density charts associated with authors, philosophy, science, data, and systems emerge when using keywords related to history and ontology.

In the field of data management for knowledge exchange, various disciplines such as social science, ethnography, ethnology, linguistics, epigraphy, and the study and interpretation of ancient texts, which fall within the domains of social science and humanities, have their own research methods. However, if they share the minimum unit of information, such as the concept of Constructed Past Theory (CPT), events created in the past can be presented using a data model. The ontology-mediated concept, as developed by [1], posits that the past is constructed based on reflections of past events. This allows for the traceability of processes through an integrated historical discourse or debate, utilizing all available sources regardless of their origin. Consequently, it establishes an information system for collecting data and leveraging specific experiences from the past, defining "geographical areas" and "bystanders." When employed within the archaeological domain, it results in an archaeological information system that works in conjunction

with other historical sources. Its strength lies in enabling the traceability of historical events from their beginnings, thus avoiding duplications within the system [1], or the utilization of specific periods in history [2]. The context in which articles are written within the platform depends on expert interpretation and assessment, such as the effects of global warming and the loss of mountain glaciers and ice caps on archaeological resources, or the implications for paleontological climate and paleontology [3], as well as specific historical and civilizational aspects [4], or the origins of Arya Asura Buddhist sacred books [5].

There are several approaches to developing a digital platform. One possibility is to implement an archaeological cloud platform based on spatial and temporal big data [6]. Search Engine Optimization (SEO), commonly regarded as a marketing tool, can also be employed. For instance, data collected from respondents can be loaded onto SAS bases for exploratory factor analysis and multiple regression [7].

3 Methodology

The methods are as follows:

Fig. 1. Overview of the project

3.1 Scope and Development Concept

The Office of Digital Innovation and Intelligent Systems at PSU is responsible for the development of the WISE platform. The data is presented in the form of temporal data linkage and includes the following key features:

3.1.1 Time Axis Linkage

The origin dimension of ancient artifacts is linked to space and time, providing important information. This temporal linkage connects the place where the artifact was discovered

with its current location. For example, it enables us to track the presence of Southeast Asian artifacts in foreign museums or the dispersion of early Ayutthaya treasures across various parts of the world. There are numerous references and names associated with these artifacts. Simplifying the explanations allows individuals with a general interest to comprehend and disseminate the knowledge of Suvarnabhumi Studies. This knowledge can benefit a wide range of knowledgeable groups and be applied in various contexts. Many reference documents, such as [2] and [3], contain extensive collections of such information.

3.1.2 WISE Platform

To facilitate discussions on analytical issues and engage various stakeholders, including historians, individuals with general knowledge, and local communities, a learning courtyard has been established. This space serves as a gathering place where communities can invite friends to learn together, create references, and foster further academic development.

In the operational aspect, two processes were implemented in the research project. The working group is divided into two main parts. The first part focuses on adding information to the WISE website, which can be accessed at https://wise.psu.ac.th/. This involves updating and expanding the content to provide a comprehensive resource for users. The second part is responsible for creating public relations materials to promote and raise awareness about the project.

3.1.3 Preparation of Public Relations Information

Regarding the preparation of public relations information for the project, there are two main components. The first part involves creating a video demonstrating the utilization of the system. The second part entails developing public relations media materials for the project. In the creation of the video, the process begins with studying the WISE project website and summarizing its key aspects to formulate a storyboard. The video is then produced by incorporating appropriate sound elements.

In addition to video production aimed at promoting the WISE project, the organizing committee has also generated various other types of media, such as posters, user manuals, websites, images, and short clips. These materials are created through a comprehensive examination of the project's details and the content available on the WISE website. Public relations efforts also include search engine optimization.

For the WISE website advertisements, the organizing committee has selected the first two steps of the customer journey to fulfill specific purposes. The initial step, *Awareness*, aims to create awareness of wise.psu.ac.th by introducing the website to the target audience and enhancing its visibility. The second, *Consideration*, focuses on how website users interact with the website through the search box on Google.com. The goal is to encourage users to engage with the website by utilizing the Google Search channel.

To advertise WISE, the team utilizes Google Ads (without concern for the position of placement but focusing on the outcome) to promote the website. The advertisement design is divided into two forms: creating awareness for WISE and emphasizing user interaction with the website through the Google Search channel.

3.1.4 Data Analysis and Forecasting in WISE Platform and Visitors

Data collection involves various methods, including keyword searches in reference sources such as books, articles, research papers, and museum information. Here are the steps involved in the data collection process: Step 1: search by keyword (e.g., Suvarnabhumi Land). Step 2: summarize the articles found during the search for further reference. Step 3: the article content focuses on an ancient item known as 'Things'. Take note of the antique's name for further information gathering, including details such as its name, era, history, discovery location, exhibition site, and more. Step 4: utilize the obtained information to conduct additional searches. Step 5: continue the search process to gather information from various sources, such as reliable information from the National Museum. Once acquired, summarize, and save the information to the WISE platform database.

3.1.5 Data Study and Data Collection Process

The procedures for studying and collecting data are outlined as follows: Step 1: Visit the WISE platform. Step 2: Navigate to Academic Data and click on Search. Step 3: Upon selecting the option to search for academic information, a page displaying all the available content will appear. On the left side, you can utilize filters to refine the information based on categories such as archaeological sites, antiquities, research, books, and articles. Step 4: Choose the desired topics to display and access the relevant information. Step 5: Retrieve various details from the sources, including name, type, place, location, era, history, and source of information. Step 6: Export the data from the WISE platform to the Microsoft Excel program for further analysis or use.

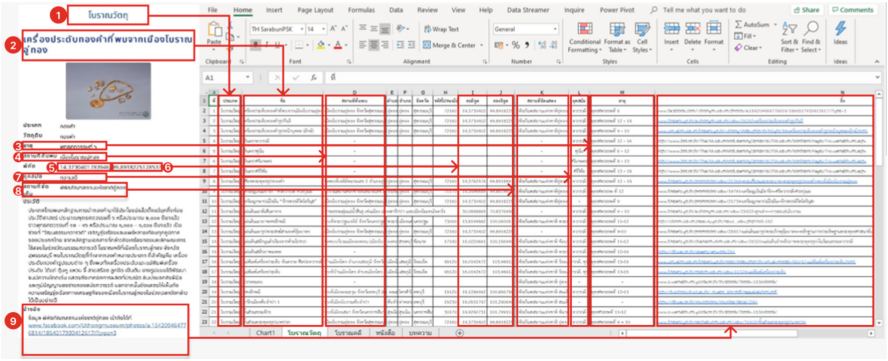


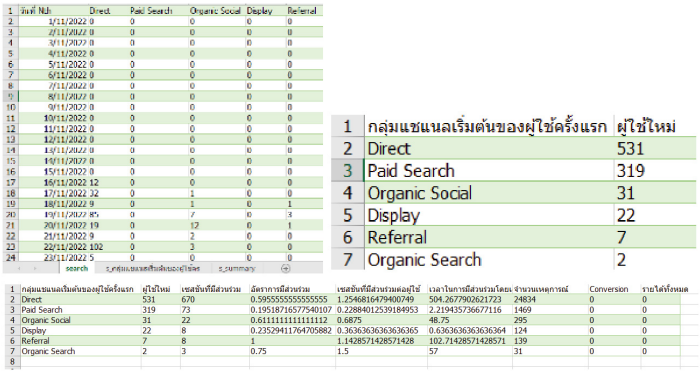
Fig. 2. Example of data obtained from the WISE platform.

For example. The antique information includes the name of the artifact, location of discovery, latitude, longitude, exhibition location, era, age, and data source from the WISE platform. This data can be extracted and used in an Excel file format.

Here is a breakdown of the sample data for antiquities obtained from the WISE platform: 1) Antiques are listed in the "Type" data column (Column B in Excel of Fig. 2). 2) Gold jewelry found at U-Thong Ancient City is listed in the title information

column (Column C). 3) The age range of antiquities is shown in the age data column (Column M). 4) The location of discovery is listed in the discovery location data column (Column D). 5) The latitude coordinates (14.3730401783946) are shown in the latitude data column (Column I). 6) The longitude coordinates (99.891822512853) are shown in the longitude data column (Column J). 7) The era is indicated in the epoch data column (Column L). 8) The storage location is listed in the venue information column (Column K). 9) References are provided in the link information column (Column N). In this example, the sample antiquities data obtained from the WISE platform consists of a total of 70 rows. Columns E, F, G, and H contain additional data such as sub-district, district, province, and postal codes.

Regarding the Data Cleansing step, which is a verification process to ensure data accuracy and eliminate errors from multiple databases, the cleaned data can then be imported into Microsoft Power BI for data analytics. This allows for the matching of datasets and facilitates the creation of dashboards in a more efficient manner. The data file can be separated into multiple sheets, each containing a table. For instance, in the customer base section, the "N^{th} date" column can be converted to a date format such as day/month/year (e.g., from 1/11/2022 to 4/12/2022). This information can be found in the customer base section shown in Fig. 3.



วันที่ NUI	Direct	Paid Search	Organic Social	Display	Referral
1/11/2022 0	0	0	0	0	0
2/11/2022 0	0	0	0	0	0
3/11/2022 0	0	0	0	0	0
4/11/2022 0	0	0	0	0	0
5/11/2022 0	0	0	0	0	0
6/11/2022 0	0	0	0	0	0
7/11/2022 0	0	0	0	0	0
8/11/2022 0	0	0	0	0	0
9/11/2022 0	0	0	0	0	0
10/11/2022 0	0	0	0	0	0
11/11/2022 0	0	0	0	0	0
12/11/2022 0	0	0	0	0	0
13/11/2022 0	0	0	0	0	0
14/11/2022 0	0	0	0	0	0
15/11/2022 0	0	0	0	0	0
16/11/2022 12	0	0	0	0	0
17/11/2022 32	0	1	0	0	0
18/11/2022 9	0	1	0	0	1
19/11/2022 85	0	7	0	0	3
20/11/2022 19	0	12	0	0	1
21/11/2022 9	0	2	0	0	0
22/11/2022 102	0	3	0	0	0
23/11/2022 5	0	0	0	0	0

กลุ่มแชนแนลเริ่มต้นของผู้ใช้ครั้งแรก	ผู้ใช้ใหม่
Direct	531
Paid Search	319
Organic Social	31
Display	22
Referral	7
Organic Search	2

กลุ่มแชนแนลเริ่มต้นของผู้ใช้ครั้งแรก	ผู้ใช้ใหม่	เซสชันที่มีส่วนร่วม	อัตราการมีส่วนร่วม	เซสชันที่มีส่วนร่วมต่อผู้ใช้	เวลาในการมีส่วนร่วมโดยเ	จำนวนเหตุการณ์	Conversion	รายได้ทั้งหมด
Direct	531	670	0.5955555555555555	1.2546816479400749	504.2677902621723	24834	0	0
Paid Search	319	73	0.19518716577540107	0.2288401253918495	2.219435736677116	1469	0	0
Organic Social	31	22	0.6111111111111112	0.6875	48.75	295	0	0
Display	22	8	0.23529411764705882	0.36363636363636365	0.6363636363636364	124	0	0
Referral	7	8	1	1.1428571428571428	102.71428571428571	139	0	0
Organic Search	2	3	0.75	1.5	57	31	0	0

Fig. 3. Summarizes data from Google Analytics before the Data Cleansing step.

3.1.6 Evaluate the Satisfaction of Dashboard Users

A dashboard has been developed to provide an overview of various information from the WISE platform, including archaeological findings and antiques over time. The dashboard utilizes the available content on the platform and predicts traffic and platform usage from different channels. It has been shared with 30 developers and individuals to assess their satisfaction with the dashboard. A scaled assessment form with 5 levels is used for scoring, following the satisfaction scoring criteria outlined as follows: Very good: 5 points, Good: 4 points, Moderate: 3 points, Low: 2 points, and Improvement: 1 point.

The evaluation results were analyzed using the mean (Mean) and the standard deviation (S.D.). The satisfaction levels are interpreted based on the following criteria: 4.51–5.00: Very good, satisfied level, 3.51–4.50: Good, satisfied level, 2.51–3.50: Moderate, satisfied level, 1.51–2.50: Low, satisfied level, and 1.00–1.50: Improvement, satisfied level.

4 Results

4.1 Public Relations Results Through SEO

The results of the initial set of advertisements over a span of 6 days revealed that the number of clicks on the first day exceeded one hundred times, and this number consistently increased each day. The highest number of clicks on the final day reached nearly 700 times, as depicted in the line graph displayed in Fig. 4. Furthermore, it was observed that the number of ad views surpassed ten thousand, reaching nearly 40,000 views per day.

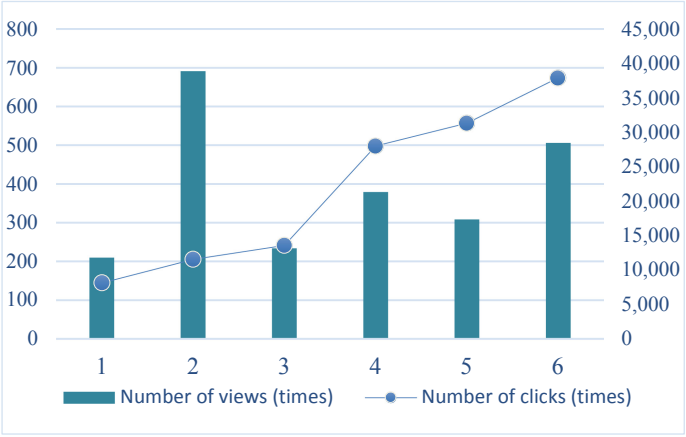


Fig. 4. Number of views (times) and number of clicks (times) from the 1st set of Ads.

When it comes to calculating Click Through Rate (CTR), it refers to the number of clicks your ads receive divided by the number of times the ad is shown (clicks/impressions = CTR). The value is depicted in Fig. 5, where the 6-day CTR value is compared to the average CTR presented by Word-stream.com (Average click-through rate). It was discovered that the website wise.psu.ac.th falls under the education category, as listed by the WordStream website, with an average CTR range of 0.53% for the education industry. It was found that most of the advertising CTR rates fall within or above the 0.53% range, with some exceptional values reaching 3.21%.

When classified by the age range of perception for this advertisement, it was found that the highest number of views came from the 25–34 age group, representing 35%. This was followed by the 18–24 age group, representing 20%, and the third highest was the

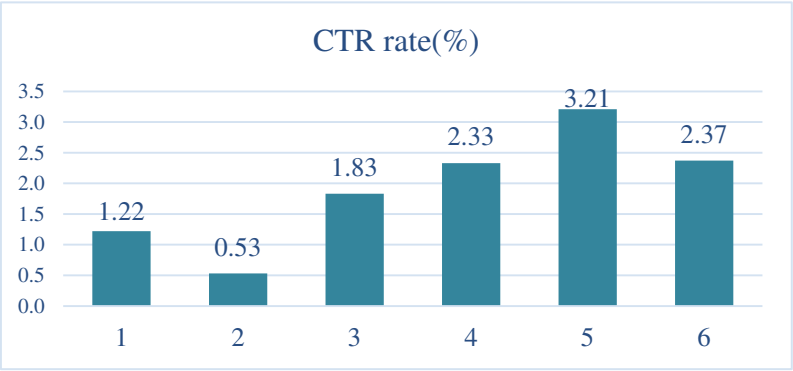


Fig. 5. CTR rate (%) from the 1st set of ads.

35–44 age group, representing 17%. In terms of device usage, mobile devices accounted for 95% of the views, followed by tablets at 3%, and computers at 2%. Furthermore, the ad garnered significant attention from numerous provinces in Thailand, with more than 1,000 ad views in 23 provinces. The most viewed ads comprised 48% of the total.

4.2 Results of Testing and Using the WISE Platform

Phases 1 and 2 involve adding information to the WISE platform (https://wise.psu.ac.th/) in five different categories, namely archaeological sites, antiquities, research, books, and articles. These additions amount to a total of 201 posts. Additionally, a video was created to showcase project information and public relations.

4.3 Dashboard Development

After studying the data, the developer extracted data from Suvarnabhumi using the WISE platform and Google Analytics. The collected data was then subjected to data cleansing. Figure 6 serves as an example of how the data is utilized in the inception phase to create a report using Microsoft Power BI, as shown on the right side of Fig. 1. This report generates a dashboard that presents an image diagram for effective presentation, highlighting the potential of the economy and providing academic and decision-making support to executives. The dashboard not only provides an overview of various information from the WISE platform but also offers predictions of traffic and platform usage from different channels over time, primarily based on the available content on the platform.

4.4 Using Dashboards

The Suvarnabhumi-related information extracted from the WISE platform comprises the decision-supporting dashboard. The results of the satisfaction assessment of dashboard users revealed a highly satisfactory overall design satisfaction level, with a mean of 4.484 and a standard deviation of 0.677. Furthermore, the assessment results indicated that users were "very satisfied" to "extremely satisfied" in all aspects, particularly with regard

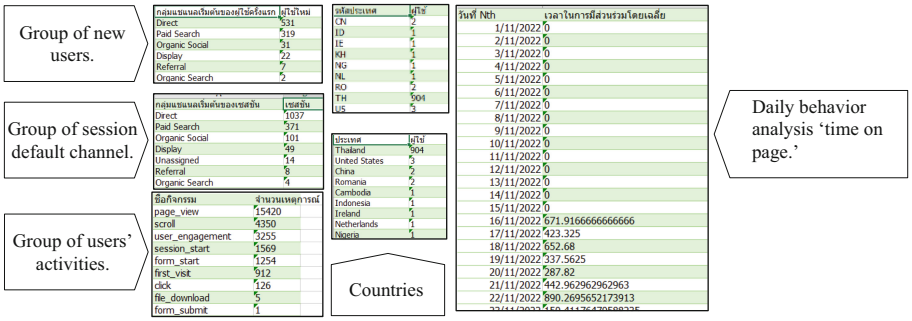


Fig. 6. Example of data that has been cleaned.

to the consistent and meaningful images and content. Figure 7 illustrates a satisfaction mean of 4.581 and a standard deviation of 0.564.

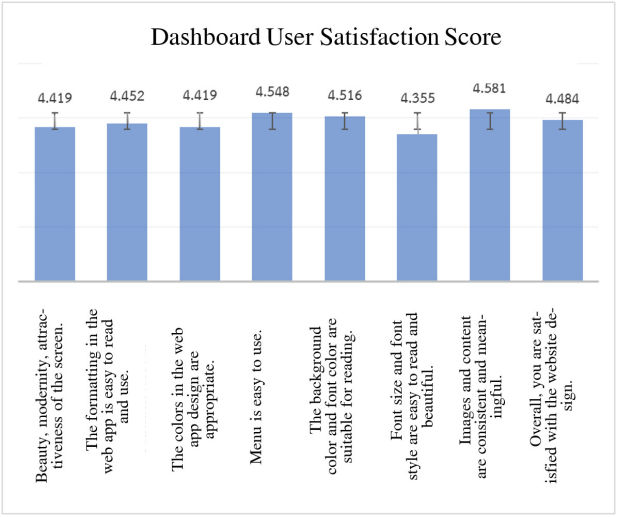


Fig. 7. Dashboard user satisfaction scores in each aspect

5 Conclusion

The implementation of a research project involves PSU's efforts to link the dimensions of ancient artifact origins with temporal information on the platform (https://wise.psu.ac.th). The platform provides community-specific learning and knowledge-sharing center services and can be transformed into an online social science classroom for use by groups of instructors. This has been demonstrated through activities conducted with the support of GISTDA, Silpakorn University, Thammasat University for content, and

PSU Phuket Campus for the article writing workshop on the platform. The project can be applied to various user groups and operates across the upstream, midstream, and downstream stages. All these factors contribute to the platform's organic search capabilities and direct platform usage. All the results are captured in Google Analytics. We retrieve the data, cleanse it, rearrange it, and integrate it to develop the BI dashboard and forecasting page. The output of the decision-supporting pages is accessible through the Power BI web application on the cloud, which is shared with the users. The results of the satisfaction assessment of dashboard users revealed a highly satisfactory overall design satisfaction level.

Acknowledgements. I would like to extend my sincere gratitude to Dr. Jakraphan Chaopreecha from the College of Computing, Dr. Nicha Tovankasame of the Faculty of International Studies at PSU Phuket, Asst. Prof. Dr. Phiphat Krajaechan from Thammasat University, Assist. Prof. Chawalit Khaokhiew of Silpakorn University, and GISTDA for their collaboration on the 178773/642505011895 Suvarnabhumi Education Integration Platform Project. This project aims to facilitate global connections and is supported by the NRIIS National Budget Fund 2021 from the National Research Council of Thailand (NRCT), which provides research support to the Office of Digital Innovation and Intelligent Systems (DIIS) at Prince of Songkla University.

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Electronic Copy Portfolio to an ePortfolio to Facilitate a Spirally Evolving Course on Health Humanities

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Abstract. The University of Peradeniya's Department of Pharmacy introduced a course on health humanities to foster advocates of humanism. Reflective writing was encouraged using an electronic copy portfolio, replaced by an ePortfolio halfway through the course. Students' experiences and perceptions of the ePortfolio were compared to the electronic copy and their perceptions towards assessment by portfolio were evaluated. The transition to the ePortfolio was highly appreciated, leading to increased engagement compared to the previous method. Reasons cited included ease of use, attractive features, perceived value through the ability to build a professional profile, networking opportunities, and enhanced motivation to maintain a portfolio. Students agreed that assessing the course on health humanities through portfolio evaluation was ideal, as the course targeted learners' affective domain and promoted development of diverse competencies.

Keywords: Portfolio · Reflective writing · Health humanities

1 Introduction

The Department of Pharmacy of the Faculty of Allied Health Sciences at University of Peradeniya (UoP), Sri Lanka, in the latest curriculum revision of the Bachelor of Pharmacy (BPharm) degree in 2021, introduced a one credit compulsory, non-GPA course titled "Introduction to Health Humanities" [1]. Students following the BPharm degree come from across the country and are selected for entry to national universities such as UoP through a competitive selection process after excelling in the bio-science discipline during the advanced level (A/L) examination. Education in national universities is free and students come from diverse socioeconomic backgrounds representing the major ethnicities of the country. All students have completed secondary education in either Sinhala or Tamil languages. Upon entry to the University students must make a rapid transition to active learning from the didactic recall-type learning, while adapting to communicating in English. Many students identify this transition of learning medium as a major challenge [2].

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 71–76, 2023.
https://doi.org/10.1007/978-981-99-5961-7_8

The course on health humanities is offered in the third semester of the four-year BPharm degree program, following the completion of the first academic year. The intended learning outcomes (ILOs) of the course are to: 1) deploy more effective communication methods with patients and others by empathizing with both illness and caregiving experiences; 2) develop skills to humanize the healthcare services in modern medical settings through understanding of non-clinical determinants of health and illness; and 3) build reflective professional portfolios on their future roles as pharmacists [1]. Course development focused on alignment of the ILOs with the University of Peradeniya graduate profile [3], 21st century skills [4], and CanMed competencies [5]. Furthermore, a predominant focus of the course was to target the affective domain of the learners and to bring about a shift in attitudinal change, intrinsic motivation, and meta-learning. Therefore, introducing reflective portfolio entries, sharing experiences and giving and receiving feedback was essential for achieving the course ILOs. This was predominantly facilitated through experiential learning activities incorporated within the course design.

The course consisted of 10 h of lecture/discussion-based teaching and 15 h of experiential learning. The course structure consisted of four pedagogical sets, where each set included a pre-lecture online survey, lecture/discussion, experiential learning activity and reflective writing-based portfolio entries. The structure and expectations of the components of a pedagogical set that make up the course are described in Table 1.

Portfolios were introduced at the beginning of the course to promote reflection on learning through reflective portfolio entries. Introduction of the portfolio also facilitates spiral evolvement of the course throughout the BPharm degree program with students encouraged to engage in reflective writing particularly during experiential learning components of the study program. However, formal assessment of the portfolio is limited to the course on health humanities and reflective entries and maintaining a portfolio contributes 80% to the final marks of the course. This was another major change for students who are used to a structured method of assessment involving end-semester examinations along with other various components of continuous assessments. Since portfolio development was a novel concept to students, to help initiation, a structured electronic copy portfolio template in MS Word was provided at the beginning of the course. The structure included: 1) an introduction to self ("about me"); 2) sections for course-related knowledge and skills acquired; 3) entries for each lecture and activity for the course on health humanities; and 4) reflections regarding competencies for learning and intrapersonal skills. Students maintained this electronic copy portfolio for the first half of the course. Mid-course, students were switched to an ePortfolio when ePortfolio was introduced to UoP through a collaboration with an external company. Students were encouraged to transfer their entries from the electronic copy to the ePortfolio.

We assessed students' experiences and perceptions of maintaining an ePortfolio compared to an electronic copy portfolio, as well as their perceptions on assessment through portfolios. Challenges in initiating and maintaining a portfolio were also explored.

2 Methods

As part of the mid-course evaluation process, the 26 students enrolled in the course were requested to share their experiences and perceptions with switching to the ePortfolio through written responses to three open-ended questions. Students were provided the

Table 1. Pedagogical components of a set of the course on introduction to health humanities.

Pedagogical component	Purpose	Implementation
Pre-lecture online survey	– To induce cognitive affective and meta cognitive reflections	– Google form survey 3–5 days prior to lecture – Completion time is usually < 5 min and no longer than 10 min
Lecture/ discussion	– To impart concepts of 21st century skills – To discuss the procedure and expectations of the experiential learning activity	– Two-hour classroom session – Google form survey findings incorporated within lecture – Written student guide for experiential activity
Experiential learning activity	– Experiential learning, reflecting, sharing perspectives/experiences and peer feedback	– Four different activities of four-hour duration following each lecture: 1) visit to hospital ward; 2) simulated patient activity; 3) talking to a real patient; and 4) student led presentations to promote humanism in health – Each activity included leaners' reflections and discussions/feedback in small groups of 5–7 students – Facilitator training prior to each activity and written facilitator guide provided
Reflective portfolio entries	– To promote self-reflection and growth – To improve reflective writing and writing skills in general – To promote meta learning	– Portfolio entry following each pre-lecture online survey/lecture and following each experiential learning activity – Peer evaluation and feedback encouraged – Initiation through structured electronic copy portfolio (in MS Word template) – Switched to ePortfolio mid-course

opportunity to: 1) compare the ePortfolio experience to that of the electronic copy portfolio; 2) describe their perceptions towards assessment by portfolio; and 3) state any challenges they faced in developing a portfolio.

3 Results

Of 26 students, 25 participated in the evaluation. Compared to maintaining an electronic copy portfolio, all students appreciated the transition to the ePortfolio. Figure 1 illustrates the predominant reasons for preferring the ePortfolio to the electronic copy. The main reasons were: 1) ease of use; 2) features that enabled inclusion of videos and images with ease; 3) attractiveness; and 4) perceived value through the ability to build a professional profile and associated opportunities.

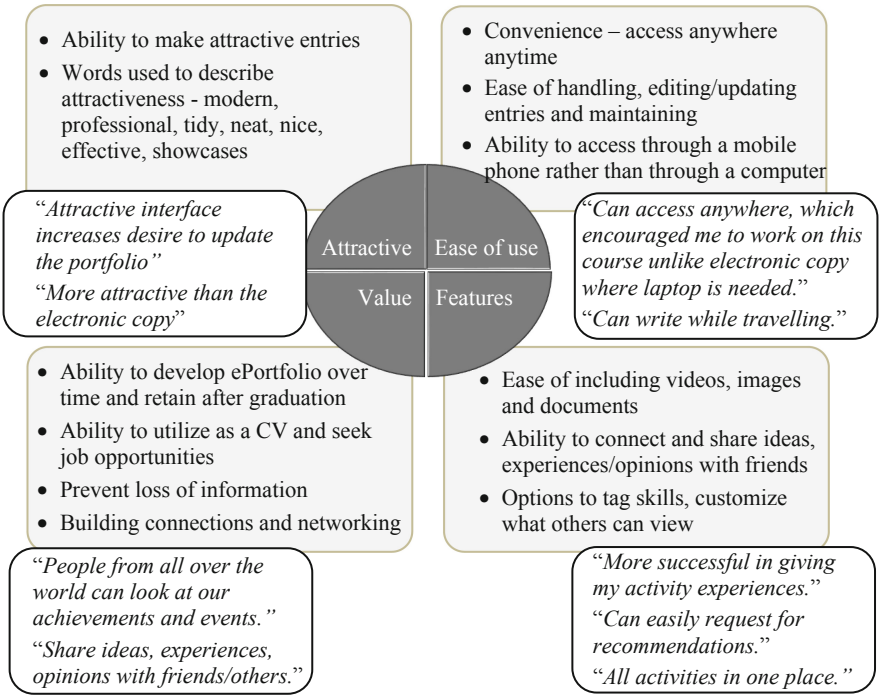

Fig. 1. Reasons for preferring ePortfolio over the electronic copy portfolio

Students faced several challenges in initiating portfolios due to a combination of factors. First, it was an unfamiliar concept for a group of students attuned to didactic learning, and all students had no prior experience in making portfolio entries nor assessment by portfolio. Second, students were expected to carry out reflective writing in a non-native language (English), which was the language of instruction of the BPharm degree. Third, not all students had access to personal computers, and most are not yet fully versatile in using computers and text editing software for creating documents. Surveys during emergency remote teaching during COVID-19 revealed that the predominant way students engaged in learning was through mobile phones [6]. Thus, students appreciated the ability to access the ePortfolio through their mobile phones rather than through a computer, effectively eliminating the added burden in accessing and developing an electronic copy portfolio. While the other two challenges remained

(novelty and language), students were supported by a structured electronic copy portfolio which included some guiding questions to induce reflection. Pre-lecture online surveys were also designed to induce reflection. Small group discussions (SGD) following experiential learning activities facilitated sharing experiences, peer feedback and SGD facilitators highlighted points for reflection. Furthermore, students reported that the structure, functionalities, and elements of the ePortfolio motivated them to create portfolio entries (Fig. 1). Other motivating factors included identifying the ePortfolio as being "more fun" and like a social media platform, being inspired by reading portfolio entries of others and thereby motivating self-improvement, enabling the sincere sharing of thoughts ("*rather than just writing, but sharing thoughts sincerely with others*") and identifying ePortfolio as a successful method of sharing experiences.

Not only was developing a portfolio novel to students, assessment by portfolio was also a novel concept and is currently under implementation in the course on health humanities. Students observed that portfolio assessment was fair for this course and Box 1 illustrates reasons identified for their support for assessment by portfolio.

Box 1. Students' observations on assessment by portfolio.

- *"It is better to assess the module on health humanities using ePortfolio rather than end-semester exam"*
- *"Good that there are no exams as humanism cannot be limited to an exam"*
- *"Exams are not practical for this module as it is heavily attached with emotions"*
- *"Experiences are different from each other, therefore using ePortfolio to assess is good"*
- *"Evaluating ePortfolio is more successful than evaluating assignments as [you] can get more information about students"*
- *"No exams is better because it is less stressful and more chance to be creative and [display] presentation skills"*

Nevertheless, students expressed several concerns. Concerns were particularly raised pertaining to challenges they faced with language proficiency and were concerned that this will be disadvantageous during portfolio assessment. Many students expressed difficulty in converting their feelings and thoughts into English ("*Language issues can affect my grades as I can't express my ideas in a nice way*") and concerns regarding grammatical errors in their writing. Some students also raised concerns regarding variations in entries made by students and how this will be considered in the assessment process ("*What we learn in the module is different from person-to-person. Some can write paragraphs, and some can write one line of heartfelt things. Therefore, it* [i.e., assessment] *is not going to be that fair*"). Students suggested providing feedback on their portfolio entries mid-course or before.

General challenges in portfolio writing, irrespective of the type of portfolio (electronic copy vs ePortfolio), predominantly pertained to language proficiency. This covered components such as fluency, grammar, vocabulary, spelling and organizing as challenges to expressing feelings and reflections in English. Due to its novelty students expressed that they found it difficult to initiate creating entries at the beginning ("*At the beginning didn't know how to write it and create it*", "*mental pressure whether entries are right or*

wrong"). Others identified challenges with creativity. Other common challenges mentioned were those related to the use of technology (*e.g.*, connectivity issues, difficulty in logging into ePortfolio, economic concerns due to data consumption) and balancing time with other academic work.

4 Conclusion

Switching to an ePortfolio appeared to have motivated students to develop and maintain a portfolio. Improving accessibility using mobile phones and transition to a platform that is easy to use removed one major challenge for creating portfolio entries. The electronic copy portfolio was identified as being harder to use due to additional resource requirements such as a laptop. Furthermore, students at this stage had limited familiarity with text editors and maintaining electronic documents. However, having initiated the course with the electronic copy facilitated the smooth transition to the ePortfolio and likely enhanced the students' positive experience with the ePortfolio. While challenges such as language proficiency and novelty among a group of students attuned to didactic learning remained, attractiveness and perceived value of the ePortfolio motivated students to develop and maintain a portfolio. Despite the challenges students agreed with assessment through portfolio for the course on health humanities, a course that target the affective domain of learners and involve development of interpersonal and intrapersonal skills and promoting meta-learning.

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A Development of Web-Based Instruction Using Self-directed Learning to Enhance English Reading Comprehension for Undergraduate Students

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Abstract. The objectives of this study were to 1) develop and evaluate the efficiency of web-based instruction using self-directed learning to enhance English reading comprehension of undergraduate students, 2) compare the achievement scores before and after learning English reading comprehension through web-based instruction, and 3) evaluate students' satisfaction towards web-based instruction using self-directed learning. The sample in this study which was 30 first-year students in total studying at Royal University of Phnom Penh, Cambodia in the academic year 2022 was obtained by means of purposive random sampling. The research instruments were 1) web-based instruction lesson on English reading comprehension, 2) the achievement tests, and 3) the satisfaction questionnaires of the students. The statistics used in the study were mean, standard deviation, and t-test for dependent samples. The result indicated that the quality of content was at good level ($\overline{X} = 3.84$, S.D. $= 0.13$), and the quality of web-based instruction was at good level ($\overline{X} = 4.24$, S.D. $= 0.10$). It is also found that the efficiency of web-based instruction lesson was 82.83/81.53, all of which was depended on the hypothesis that it should not be less than 80/80. The post-test score ($\overline{X} = 25.83$, S.D. $= 3.10$) was higher than that of the pre-test ($\overline{X} = 18.60$, S.D. $= 4.74$), and t-test analysis was 11.97. The satisfaction towards web-based instruction using self-directed learning in learning English reading comprehension was at high level ($\overline{X} = 4.22$, S.D. $= 0.17$).

Keywords: Web-based Instruction · Self-directed learning · English reading comprehension

1 Introduction

The new technologies of information and communication have become a significant instrument that can develop new interests and capabilities among people. At the present time students need to be inquisitive and use their imagination to discover subjects. They

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 77–87, 2023.
https://doi.org/10.1007/978-981-99-5961-7_9

not only need to get information but also to understand how and why things work. It is undeniable that the internet has changed our society. It has broken communication barriers and assisted a new way of information exchange. Besides, it has provided access to broader knowledge [3]. Hence, we can find some web materials that have become an abundant support for improving the learning processes in various disciplines. The use of some web information for classroom activities not only gets students closer to their authenticity but also offers both teachers and students the opportunity to exchange knowledge. Web-based activities constitutes an easy to use way for learning management and they make the internet a useful tool for education [7]. Reading serves as a substantial tool in every field of professional service and one of the essential channels around the world to recognize, interpret, and perceive written or printed materials. Therefore, reading plays an abundant role for comprehension of written texts. Without reading, students will encounter the difficulties in extending their advanced education in higher level fields. Offering appropriate teaching methods and sophisticated teaching media to actively encourage students to interact with the target language and create plenty of opportunities for students to practice is the efficient method for improving students' reading comprehension [14]. Based on the information described above, reading technology appears to play a crucial role in helping learners' develop their reading comprehension. It will be useful if the study of web-based instruction and teaching of reading are conducted together. Therefore, there is a study emphasizing the use of web-based instruction using self-directed learning to enhance English reading comprehension of undergraduate students at Royal University of Phnom Penh, Cambodia.

1.1 Objectives of the Study

This study aims to:

1.1.1 Develop web-based instruction for teaching English reading comprehension to undergraduate students, depended on E1/E2 = 80/80 efficiency criterion as subsequently defined.
1.1.2 Compare the achievement tests before and after learning English reading comprehension through web-based instruction using self-directed learning.
1.1.3 Find students' satisfaction in learning English reading comprehension through web-based instruction using self-directed learning.

1.2 Research Hypotheses

The research hypotheses are as follows:

1.2.1 The value of efficiency achieved with the developed web-based instruction using self-directed learning to enhance English reading comprehension of undergraduate students meets E1/E2 = 80/80.
1.2.2 Students have high level of learning achievement through web-based instruction using self-directed learning to enhance English reading comprehension.
1.2.3 Students are satisfied with learning English reading comprehension through web-based instruction using self-directed learning at high level.

2 Literature Review

A. Web-based instruction Uparimpanich [15] defined web-based instruction (WBI) as a hypermedia-based instructional program which uses the attributes and resources of the internet and World Wide Web to facilitate the development of interactive electronic learning processes and curriculum materials, creating a more meaningful learning environment. Hazari and Schnorr [6], demonstrate that this new development in information communication technology (ICT) benefits students' learning environment by helping to escalate their understanding where other methods have had limited success. This is because the instruments supports the constructivist theory which is the development of learners' capacity for goal setting, self-planning and self monitoring where they can assimilate their knowledge at their own learning pace. According to Salomon [10], the use of hypermedia may not only be useful in terms of improving deeper learning by encouraging learners to think about how new information is connected to existing knowledge, but also it may be an different tool to the extent that it offers a cluster of learning modes such as text, audio, graphics, and synchronous and asynchronous communication that can be made to suit specific learning styles.

B. Self-Directed Learning According to Tough [13], self-directed, or self-planning is the predominant means of adult learning because of a variety of reasons. Students knows what is the best course of action, or feels they would lose time by consulting someone else, may not trust others, or they may be more highly skilled than others. Students decides everything from the specific activities of learning to location, time, as well as make the payment. Tough figured out that most learning projects contain four or five other human resources; most of this insight is from friends, neighbors, or acquaintances. Non-human resources are also paramount in this process such as television, books, and newspaper.

C. Reading Comprehension Reading is considered as a complex process dealing with constructing meaning from text in a wider range of contexts and for a variety of purposes. What research tells us about the reading processes is that it is not only sounding out words but also is meaning driven. It is important to understand that decoding and reading words is only a part of the complex process of reading (Adams) [2]. In other words, there is a distinction between reading aloud and reading for meaning. Rumelhart [9] described the act of reading as involving the reader, the text, and the interaction between reader and text. In addition, the level of reading comprehension in the text depends on the reader's background knowledge, level of language proficiency, interest, the use of strategies, and cultural knowledge about reading (Aebersold & Field) [1]. In the present research, reading is viewed as an active and constructive process in which readers take part to reconstruct meaning from the text. Goodman [8] viewed comprehension as the only objective for reading. Reading is the process of three kinds of information: one kind, the graphic information, where readers visualize information. The other two, syntactic and semantic information, are supplied when procession the visual input. Readers use these three kinds of information to get the meaning because it is the goal of comprehension. The following are the objectives of this study.

1. Develop web-based instruction for teaching English reading comprehension to bachelor students, depended on E1/E2 = 80/80 efficiency criterion as subsequently defined.
2. Compare the achievement tests before and after learning English reading comprehension through web-based instruction using self-directed learning.
3. Find students' satisfaction in learning English reading comprehension through web-based instruction using self-directed learning.

3 Methodology

3.1 Research Design

For this experimental model, the researcher carries out the study on the population and sample groups by applying pre-test and post-test (One Group Pre-test – Post-test Design) as follows:

Sample	Pre-Test	Activities	Post-Test
E	O_1	X	O_2

E Sample Group
O_1 Measurement of pre-test score
X Instructional activities using web-based instruction through self-directed learning to enhance English reading comprehension
O_2 Measurement of post-test score

3.2 Population and Sample

The population of the study is all undergraduate students who were in the academic year 2022 of Royal University of Phnom Penh, Cambodia. The researcher employed purposive random sampling which consisted of 30 first-year students who took English course in the second semester of academic year 2022 of Royal University of Phnom Penh, Cambodia. In this classroom, the students also had an average English proficiency at low, moderate and high levels. The criteria using to select the sample size consisting of readiness of computer hardware, internet, and students learning process in which individuals take the initiative without the help of other.

3.3 Research Instrument

The researcher has defined the following instruments:

(1) Web-based instruction to enhance English reading comprehension of undergraduate students of Royal University of Phnom Penh, Cambodia
(2) Lesson through web-based instruction to enhance English reading comprehension
(3) Opinion questionnaire for the experts concerning the development of web-based instruction
(4) Achievement test for undergraduate students who have learned from web-based instruction to enhance English reading comprehension
(5) Satisfaction questionnaire for undergraduate students who have learnt from web-based instruction to enhance English reading comprehension

3.4 Data Collection

(1) Introduce students to web-based instruction using self-directed learning to enhance English reading comprehension of undergraduate students of Royal University of Phnom Penh, Cambodia.
(2) Provide students pre-test in order to receive the score.
(3) Conduct the learning activities with students by utilizing the lessons through the Website.
(4) Give students post-test after they studied with the website, and collect the score to analyze by applying statistical methods.
(5) Have students complete the questionnaires on students' satisfaction toward web-based instruction using self-directed learning to enhance English reading comprehension.

4 Results

Experimental method was adopted in this study. Pre-test was administered in order to find out the entry behavior of the students towards WBI in English reading comprehension. Sample consisted of 30 first-year students of Intermediate level.

Opportunity was given to the students to explore the websites at their own pace. Post-test was conducted in order to find out the effectiveness of WBI. An achievement test was prepared with 30 questions. Scores of the achievement test ranged from 0–30 (Table 1).

A. *Find the efficiency of web-based instruction using self-directed learning to enhance english reading comprehension for undergraduate students.*

Table 1. Evaluation of effectiveness of the web-based instruction for English reading comprehension

Items	n	Mean	Percentage	S.D.	St.	E1/E2
Ongoing score	100	82.83	82.83	3.51	80	82.83
Post-test score	30	24.46	81.53	2.43	80	81.53

The average mean score of ongoing score was 82.83, and the mean score of post-test was 81.53, which indicated a substantial improvement upon the web-based instruction for English reading comprehension of undergraduate students. The result revealed that the value of efficiency of E1/E2 as 82.83/81.53. To summarize, this web-based instruction lessons is developed according to the standard criteria 80/80 defined.

B. *Compare the average score of the achievement tests before and after learning english reading comprehension through web-based instruction.*

Table 2 presented the efficiency of the development of web-based instruction to enhance English reading comprehension of undergraduate students. The mean score

Table 2. Comparison of average score before and after learning English reading comprehension

Items	n	Mean	S.D.	t-test	Sig.
Pretest	30	18.60	4.74	11.97	.000
Posttest	30	25.83	3.10		

of pre-test was 18.60, and the score of standard deviation (S.D.) was 4.74. The result after applying the web-based instruction in English reading comprehension constituted a substantial improvement in students which translated into a high post-test 25.83 and standard deviation (S.D.) 3.10 and t-test analysis before and after the treatment 11.97 which demonstrated a considerable difference was statistically significant at the 0.05 level.

C. *Analyze the satisfaction score of undergraduate students who learn english reading comprehension through web-based instruction using self-directed learning.*

Table 3. Result of evaluation of students' satisfaction

Items	Mean	S.D.	Result Interpretation
Contents			
1. The learning contents are suitable with the learning time defined	4.43	0.50	Agree
2. The learning topics and contents are interesting	4.56	0.50	Strongly agree
3. The demonstrated contents cover the learning objectives of each chapter	4.40	0.49	Agree
4. The learning contents are appropriate for the students' grade level	4.50	0.50	Agree
5. The learning contents are clearly explained and enough for understanding	4.46	0.50	Agree
6. Question items in the unit exercises are relevant to the content	4.46	0.50	Agree
7. The contents of 3 chapters are appropriate for learning with web based instruction	4.60	0.49	Strongly agree
8. The unit exercises are sufficient for checking understanding	4.33	0.54	Agree
9. The question items in the unit exercises are clearly stated and easy to understand	4.63	0.49	Strongly agree
Screen Design			
10. Layout of each page is established appropriately for learning	4.46	0.50	Agree

(*continued*)

Table 3. (*continued*)

Items	Mean	S.D.	Result Interpretation
11. Choices of typeface and size facilities ease of use	4.63	0.49	Strongly agree
12. A loud and clear sound is provided	4.63	0.49	Strongly agree
13. Interaction and timely feedback are provided appropriately	4.50	0.50	Agree
14. Choices of color is appropriate	4.56	0.50	Strongly agree
15. Screen design is attractive to students	4.63	0.49	Strongly agree
16. Lesson navigation and buttons are appropriately established and relevant to these self-directed learning activities	4.40	0.49	Agree
Web-Based Usage			
17. The web-based instruction is easy to use	4.80	0.40	Strongly agree
18. The interactive function between users and instructional contents is effective	4.20	0.55	Agree
19. Learners can control and use this web-based lesson on their own	4.70	0.46	Strongly agree
20. User's manual clearly describes how to use web based instruction	4.53	0.57	Strongly agree
21. This web-based instruction is fun and interesting	4.50	0.50	Agree
22. Specific time for learning with web-based lesson is appropriate	4.40	0.49	Agree
23. If it is possible, you would like to learn other subjects with web-based instruction	4.60	0.49	Strongly agree
Evaluation			
24. Pre-test and post-test offer students the understanding on the contents appropriately	4.73	0.44	Strongly agree
25. The question items are clear	4.56	0.50	Strongly agree
26. The tests are made with the objectives and media	4.53	0.57	Strongly agree
27. The difficulty of the test is appropriate for students	4.33	0.54	Agree
28. The score between pre-test and post-test is clear	4.66	0.47	Strongly agree
Total	4.22	0.17	Agree

Based on Table 3 the mean score ranged between 4.20 and 4.80, which was between averages to high levels. The highest mean score 4.80 was the item "The web-based instruction is easy to use." The lowest mean score 4.20 was the item "The interactive

function between users and instructional contents is effective". The average mean score overall of this dimension was 4.22, which showed that students had very good satisfaction with learning English reading comprehension through web-based instruction.

Evaluation of web-based instruction from three media experts. The 22 items of evaluation consist of the form issued by the Department of Curriculum and Instruction Development were adapted for use in this study. A 5-point rating scale is utilized in this section to represent the media experts' opinion. Each criterion rating is identified as illustrated in Table below (Table 4).

Table 4. Results of evaluation of web-based instruction for English reading comprehension by three experts in media

Evaluation Items		$\overline{X}$	S.D.	Result Interpretation
1. Contents				
1.1	Content structure is clear and each content shows structural relationship	4.33	0.57	Good
1.2	The demonstrated contents of instruction cover the learning objectives defined	4.00	0.00	Good
1.3	Language use is appropriate and correct	3.66	0.57	Good
1.4	The learning content is appropriate for the students' grade level	4.00	0.00	Good
2. Instructional Design				
2.1	The objectives and the students' grade level are clearly identified	4.33	0.57	Good
2.2	The sequence of content presentation is appropriate according to types of media used	4.66	0.57	Very good
2.3	Presentation techniques are attractive to students	4.66	0.57	Very good
2.4	Web-based instruction is creatively designed	4.33	0.57	Good
2.5	The interactive function design in Web-based learning systems such as interaction between users and instructional contents or teacher is effective	4.00	0.00	Good
2.6	The instruction is designed for individual differences and responds to the needs of diverse students	4.00	0.00	Good

(*continued*)

Table 4. (*continued*)

Evaluation Items		$\overline{X}$	S.D.	Result Interpretation
2.7	Instructional design improves the ability of students to control their pace of learning properly	4.00	0.00	Good
2.8	Exercises and assessments cover all learning objectives defined	4.33	0.57	Good
2.9	Interaction and timely feedback are provided suitably	4.33	0.57	Good
2.10	The instructional design enhances students' analytical thinking	4.00	0.00	Good
3. Screen Design				
3.1	Page layout control students' attention, and facilities ease of use	4.33	0.57	Good
3.2	Choices of typeface, size and colour facilities ease of use and is appropriate for students	4.33	0.57	Good
3.3	Choices of colour is appropriate and is applied consistently to specific types of on-screen information	4.66	0.57	Very good
3.4	Images presented are consistent with instructional contents	4.66	0.57	Very good
3.5	Buttons, text displayed, visual message can be properly established and can convey a very clear and correct message to the viewers	4.66	0.57	Very good
4. Techniques				
4.1	The web program is employed correctly such as user's information system	4.00	0.00	Good
4.2	The linkages to each frame or focal point can be correctly established	4.00	0.00	Good
4.3	Images and audio can function correctly and rapidly	4.00	0.00	Good
Total		4.24	0.10	Good

The average mean score of the web-based instruction evaluated by three experts in media is 4.24, which was at a good level. In accordance with the result, there were issues that must be improved before the implementation. There was an item which was to be modified: Language use is appropriate and correct.

5 Discussion

A. *Analysis of web-based instruction's value of efficiency of E1/E2 = 80/80*

The results revealed that the value of efficiency of E1/E2 was 82.83/81.53. The findings of this experiment concurred with several related studies. Boonnark [3] conducted a study of web-based instruction on the theory of mass communication for bachelor degree students, and the result showed that the value of the efficiency of E1/E2 was 80/81.80. In addition, the study on courseware development on research methods in educational technology through web-based instructional systems conducted by Jirasathidpornpong [7] also demonstrated that the efficiency of E1/E2 was 80/80. Saitakham [11] developed a web-based instructional model for English vocabulary learning ability, and the result displayed that the level of the efficiency of E1/E2 was 83.50/84.25 which met the standard criterion.

B. *The comparison of learning achievement tests on english reading comprehension of students who studied with the web-based instruction*

Based on the comparison between the learning achievements on English reading comprehension of students who learnt with the web-based instruction, the result showed that students had higher scores in learning achievement tests at a significant level of 0.05. Learning with web-based instruction produced effective results when learning content with this tool was appropriate. This was because the tool could help motivate users with the fascinating techniques such as motion graphics and images. The comparative study on the teaching of food and nutrition using web-based techniques and traditional teaching methods conducted by Chalaumkate [4] presented that the learning achievement of students who learned with web-based instruction was higher at a significant level of 0.05.

C. *Students' satisfaction towards learning english reading comprehension through web-based instruction*

Based on the results of this experiment, it has been found that students had high satisfaction towards learning English reading comprehension through web-based instruction. Two thirds (2/3) of students in these studies perceived learning through web-based instruction with high satisfaction. This was because they were able to access the web-based course from anywhere and at any time. They benefited from proceeding through the web-based course at their own pace. Additionally, their learning speed could be adjusted in accordance with their learning ability.

6 Conclusion

The effectiveness of web-based instruction on English reading comprehension demonstrated that the coefficient of E1/E2 as the score during the learning process (E1) was equal to 82.83, and the score of performance (E2) was equal to 81.53, which was higher than the standard criteria 80/80 defined. It clearly showed that web-based instruction using self-directed learning to enhance English reading comprehension of undergraduate students at Royal University of Phnom Penh, Cambodia. Had adequate efficiency for

teaching. The result of students' learning achievement which was received from web-based instruction using self-directed learning to enhance English reading comprehension of undergraduate students at Royal University of Phnom Penh, Cambodia, illustrated that students' scores on post-test were higher than that of pre-test at a significant level of 0.05. The result of the students' satisfaction score presented a high level of satisfaction toward web-based instruction which contained mean score 4.22, especially in terms of gaining access to educational content and involving with other learning resources which made it more appropriate to study.

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Hybrid Clustering Learning Models Based on Self-regulated Learning Model Using Unsupervised Learning by Majority Voting Techniques

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Abstract. Disruptive technology has changed the learning achievement model, and the learning style is not limited to the classroom. However, studying learner achievement patterns is still essential for improving learner quality. Therefore, this research aims to study the learner achievement cluster model using machine learning techniques. There are three powerful objectives: 1) to study the context of learners' learning achievement based on a self-regulated learning style in higher education, 2) to construct the clustering model based on a self-regulated learning style by majority voting techniques, and 3) to propose the optimized clustering method for learner achievement based on a self-regulated learning style. The research tool uses the techniques and processes of machine learning to develop a learners' achievement clustering model, including K-Means, K-Medoids, and X-Means. Finding the optimal cluster uses a combination of elbow and ensemble majority voting techniques to reach the optimal categories. The research data were 42 students with 25 attributes from the University of Phayao during the academic year 2022 who enrolled in course 221105 [1] Business Analytics. The results showed that deciding on the appropriate number of clusters was reasonable, which should be used for further predictive cluster modeling and predicting learning achievement.

Keywords: Clustering Learning Outcomes · Educational Data Mining · Online Learning Behavior · Self-Regulated Learning · Unsupervised Machine Learning

1 Introduction

The impetus of technological advancements in the 21st century has resulted in a sudden change in learning patterns and learning styles [1]. Network technology and the Internet disrupted traditional learning in the classroom or face-to-face learning toward online learning [2, 3]. Additionally, the impact of the COVID-19 pandemic has transformed

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 88–97, 2023.
https://doi.org/10.1007/978-981-99-5961-7_10

learning and catalyzed the transition from formal education learning into informal and nonformal education learning [4, 5]. When modern technology and the epidemic accelerate the transformation of learning patterns. As a result, learners, educators, and educational institutions must adapt to the changing life trends in the post-COVID-19 era [6, 7]. The changing learning style also requires research to find reinvigorated learning styles fitting for learners' learning outcomes [8, 9]. Learning styles that have emerged over the past ten years in response to online learning include blended learning, self-regulated learning, and distance learning, known as the Virtual Learning Environment (VLE) [10]. All of these are mainly present and focus on finding the effectiveness of online learning management for learners. However, online learning has been mindful of the impact and degradation of learners' learning performance, such as ADHD, being distracted by other stimuli, and lack of self-control during learning [11–13]. Low tolerance for learning that educators should address earlier becomes a significant problem and hinders the learner's cognitive development.

The basic principle of organizing the learning process to develop learners is to find a group of learning behaviors [14, 15]. Moreover, when combined with the impact of online learning management, it is necessary to determine how to group learners' cognitive development characteristics [16]. Educational experiments and machine learning technologies to improve learner quality are gaining popularity, which are used for many educational purposes. A considerable number of researchers have concocted awareness and open spaces for learner development with technologies aligned with individual learners' learning potential [17]. The value and rebirth of technology have driven researchers to develop a learner clustering process that genuinely corresponds to the behavior and potential of the learners. Therefore, this research has three main objectives. The first objective was to study the context of learners' learning achievement based on a self-regulated learning style in higher education. The second objective was to construct the clustering model based on a self-regulated learning style by majority voting techniques. The third objective was to propose an optimized clustering method for learner achievement based on a self-regulated learning style. All three research objectives focused on answering the research hypothesis, which stated that artificial intelligence and machine learning for effective clustering could predict student achievement according to the learning behavior of the learner. The primary research tools are unsupervised machine learning techniques: K-Means Clustering, K-Medoids Clustering, and X-Means Clustering techniques. The elbow technique is a tool for piloting decisions on the optimal number of clusters in combination with the ensemble majority voting technique.

The clustering model in this study delivers a comparison of learners' learning achievements using a majority voting method with discretionary considerations for each technique, as demonstrated by the research design. The data collection was a purposive sampling selection from 42 students who enrolled in course 221105[1] Business Analytics at the School of Information and Communication Technology, the University of Phayao, during the academic year 2022. The data contained herein consists of 25 attributes from the of the eight chapters, providing online learning activities throughout the semester. In addition, the learners authorized this data to be used for research.

In achieving this research, the researchers are firmly convinced that developing a prototype for clustering learning outcomes based on the self-regulated learning model

using unsupervised learning and ensemble approaches by majority voting techniques will be of immense benefit to the future education industry. Researchers are hopeful that this will be the starting point for a focus on research for modern education and hope to continue to gain support in the international area.

2 Materials and Methods

2.1 Population and Activities

The research population was students enrolled in the course 221105 [1] Business Analytics at the School of Information and Communication Technology, the University of Phayao, during the second semester of academic year 2022. There are 42 students, and the sample selection is a method of purposive sampling with the consent of the students in the course.

The learning activities were online throughout the semester due to the COVID-19 epidemic. Three main activities were: twenty-four quiz assessments, midterm, and final exams. The twenty-four quiz assessments were divided into two sessions of eight chapters: pre-midterm and post-midterm activities. The eight chapters following the course description: are concepts of business analytics, descriptive analytics, predictive analytics, prescriptive analytics, business analytics life cycle, basic analytics models, advanced analytic models, and technology and tools for analytics. Collecting points for each activity is 10 points, with 15 min for students to take the test, both pretest and posttest activities. The midterm and final exams are based on the University of Phayao's regulations, with researchers collecting 30 percent of the scores from both sections.

2.2 Data Collection

The data collection was a record of scores that occurred according to the three main activities based on the self-regulated learning principle: quiz assessments, midterm, and final exam activities. Self-regulated learning design for this research, the instructor assigned learners to set goals for each activity. Therefore, the features in this research consisted of 25 attributes from seven categories. Category 1: set of goals for each activity, Category 2: set of scores for each activity, Category 3: set of goals for the midterm exam, Category 4: set of scores for the midterm exam, Category 5: set of goals for the final exam, Category 6: set of scores for the final exam, and Category 7: set of students' academic results (grades). The data collected are summarized as shown in Table 1.

This data was collected at the online storage (https://bit.ly/3GDLCsv) with anonymity to prevent the derogatory of the owner of the data. In addition, the teacher has asked the students' permission to use the information for research purposes only.

2.3 Research Instrument and Model Development

The research instruments were selected as appropriate and consistent with the model development process for clustering learning outcomes based on the self-regulated learning model. It was composed of 6 steps. Step 1: Establish and determine the k-value for

Table 1. Data Collection.

Activity	Pretest					Posttest				
	Max	Min	Mean	S.D	Time	Max	Min	Mean	S.D	Time
Activity 01	4.00	0.00	2.07	1.33	03:44	10.00	0.00	6.38	3.04	05:24
Activity 02	7.00	0.00	3.48	1.70	04:49	10.00	4.00	8.81	1.45	05:27
Activity 03	8.00	0.00	3.62	1.67	02:49	10.00	1.00	8.91	1.92	04:17
Activity 04	8.00	0.00	3.71	2.00	03:26	10.00	8.00	8.91	2.96	02:55
Activity 05	7.00	0.00	3.60	1.80	03:19	10.00	1.00	6.64	3.51	06:04
Activity 06	8.00	0.00	3.26	2.30	03:36	10.00	4.00	7.36	3.14	04:28
Activity 07	6.00	0.00	2.64	1.59	03:13	9.00	2.00	6.38	2.44	05:32
Activity 08	6.00	1.00	2.71	1.57	02:59	10.00	2.00	6.93	3.68	04:39
Activity 09	9.00	0.00	3.64	2.47	03:13	10.00	2.00	8.14	3.70	03:45
Activity 10	7.00	0.00	3.00	2.10	03:49	10.00	4.00	7.02	2.80	03:59
Activity 11	9.00	1.00	3.48	2.49	03:02	10.00	2.00	7.83	3.70	03:38
Activity 12	10.00	0.00	3.45	2.61	02:25	10.00	5.00	8.74	2.74	03:06
Overview	7.42	0.17	3.22	1.97	03:22	9.92	2.92	7.67	2.92	04:26

the optimal number of clusters, Step 2: Determine the k-value by the elbow technique, Step 3: Voting for a consensus k-value used to define the same number of clusters, Step 4: Specifies which cluster each record belongs to for each technique, Step 5: Decide on a majority vote from the affiliated cluster members for each record and assign a new cluster to the members. And Step 6: Consider and compare the data behavior of members from each technique.

Establish and Determine the k-Value for the Optimal Number of Clusters

In constructing and selecting the appropriate cluster, the researchers used three unsupervised machine learning techniques to compare the voting scores subsequently. It consists of K-Means Clustering, K-Medoids Clustering, and X-Means Clustering techniques.

K-Means clustering [18, 19] is classified as the "Non-Hierarchical Cluster Analysis" or "Partitioning Cluster Analysis". K-Means is the algorithm of the most straightforward unsupervised learning technique because it solves a commonly known clustering problem. The K-Means approach divides the data into k groups and replaces each group with the group means known as "Centroid", which is used as the group's center to measure the distance between the data in the same group.

K-Medoids clustering [20] is an algorithm that uses clustered means (Centroid) like K-Means. The difference is that k-Medoids use the actual data gathered to form clusters. From the aforementioned advantages, when clustering occurs, representatives of the clusters are obtained as actual data.

X-Means clustering [21] is a K-Means amplification algorithm that attempts to determine the number of groups automatically. It uses the principle of the Bayesian Information Criterion (BIC), starting from the smallest number of groups to the largest. The

X-Means algorithm goes into operation after each execution of the K-Means. It makes cluster decisions related to a current subset of centroids able to be clustered to obtain cluster fit data.

The researchers used the three clustering techniques to study the behavior of the data to create the most appropriate cluster of learners.

Determine the k-Value by the Elbow Technique
It is complicated to determine the appropriate number of groups at a time with unsupervised learning. Therefore, a proper value of k must be taken into consideration. The elbow technique based on graph dynamics is the commonly used method for determining k-value [18, 22]. The k-value consideration of the elbow technique is determined by a radical shift of the y-axis to the x-axis.

Voting for a Consensus k-value Used to Define the Same Number of Clusters
With a majority voting for this section, the researchers required to find a consensus on all the techniques used. The result used for voting was to consider each technique by elbow technique.

Specifies Which Cluster Each Record Belongs to for Each Technique
This step is to identify each record in which cluster by each technique. The purpose of this step is to vote for each technique on which cluster this record will be located.

Decision and Majority Voting
Decide on a majority vote from the affiliated cluster members for each record and assign a new cluster to the members.

Consider and Compare the Data Behavior of Members from Each Technique
The final consideration was to study the data behavior in each group reference record for which each technique had a majority vote.

2.4 Research Analysis and Interpretation

In research findings analysis and interpretation, the researchers collected learning behavior data from classroom learning activities: pre-test and post-test scores. It was used to analyze appropriate learning groups using the techniques presented above. Then, the researchers used the learning achievement of each group member to study the behavioral patterns of learning achievement data in each cluster, the results of which are summarized in Table 2 to Table 4.

3 Research Results

This section summarizes the analysis results of k-value changes for each of the three unsupervised machine learning techniques, as shown in the average within centroid (ACD) as summary results in Table 2.

Table 2 shows the average within centroid (ACD) summation for each technique where the appropriate k-Value for the K-Means method is $k = 4$ to $k = 7$, the optimal

Table 2. Modeling Results.

k-Value	K-Means		K-Medoids		X-Means	
	ACD	DPP	ACD	DPP	ACD	DPP
K = 2	117.71	0.00	187.71	0.00	108.93	0.00
K = 3	104.70	13.01	171.33	16.38	108.55	0.37
K = 4*	94.86*	9.84*	155.79	15.55*	108.93	0.37*
K = 5*	86.91*	7.94*	139.40	16.38*	107.89	1.04
K = 6*	78.54*	8.37*	134.17	5.24	107.89*	0.00
K = 7*	71.88*	6.67*	123.81	10.36	107.89	0.00
K = 8	68.29	3.58	118.24	5.57	110.46	2.57
K = 9	64.40	3.89	110.14	8.10	110.47	0.00
K = 10	58.35	6.05	104.62	5.52	108.93	1.54
K = 11	55.84	2.50	100.00	4.62	108.93	0.00
K = 12	52.02	3.82	92.57	7.43	108.93	0.00
K = 13	45.11	6.92	88.55	4.02	108.93	0.00
K = 14	43.65	1.45	80.48	8.07	108.93	0.00
K = 15	41.62	2.03	78.64	1.83	108.93	0.00
K = 16	39.27	2.35	70.93	7.71	110.18	1.25
K = 17	34.70	4.57	70.05	0.88	110.18	0.00

DPP = Distance from the previous point, * = Optimal cluster.

k-Value for the K-Medoids approach is k = 4 to k = 5, and the proper k-Value for the X-Means is k = 4. From the method set in Step 3, it can be concluded that the reasonable k-Value to be used in this research is a k-Value of 4. The researchers summarized the number of members in each cluster by a technique shown in Table 3.

Table 3. Members for each cluster for each technique.

Cluster	K-Means		K-Medoids		X-Means	
	Member	Percentage	Member	Percentage	Member	Percentage
Cluster_0	23	54.76%	27	64.29%	5	11.90%
Cluster_1	8	19.05%	3	7.14%	2	4.76%
Cluster_2	8	19.05%	5	11.90%	16	38.10%
Cluster_3	3	7.14%	7	16.67%	19	45.24%
Total:	42	100%	42	100%	42	100%

Table 3 presents the number of members in each cluster classified by each technique. It found that the number of members was clearly distributed. Each member was then voted on for each record to study the ideal cluster arrangement, which was consistent with the researchers' design Step 5. Due to the large amount of data, the researchers present the results of the discriminant analysis in the online repository as the link: https://bit.ly/3GDLCsv.

Data and voting summaries in the researcher's design are summarized for the number of members in each cluster, and the results are presented in Table 4. In addition, the researcher summarized the cluster-referenced learning outcomes (grade) to compare the learning behavior of the learners' styles in Table 4.

Table 4. Analysis results of the members based on the majority of voting results.

Cluster	Member	Academic achievement details							
		A	B^+	B	C^+	C	D^+	D	F
Cluster_0	20 (47.62%)	9	1	2	2	6	0	0	0
Cluster_1	4 (9.52%)	0	0	0	0	2	2	0	0
Cluster_2	8 (19.05%)	0	0	0	1	1	1	1	4
Cluster_3	10 (23.81%)	0	2	0	1	0	3	4	0
Total:	42 (100%)	9	3	2	4	9	6	5	4

4 Research Discussion

This research optimized the number cluster from K-Means, K-Medoids, and X-Means clustering by the elbow technique. Researchers found the $k = 4$ that was appropriate for the clustering model produced accuracy. Then, researchers used the majority voting techniques to determine a new cluster of members, as shown in Table 4. Researchers found that members of Cluster_0 scored the activity post-tests of 2, 3, 4, and 9 very well, which showed similar self-regulated learning styles. Some members included in Cluster_2 scored equal to 0 from 50% of all members in the activity post-test of 4, 6, and 11. The question is why they did not understand or do it better. The answer may be that they do not like a self-regulated learning style. However, the score of the activity post-test 6, 7, 8, 9, and 10 of member cluster_3 has little scattered values. They showed a slight difference in their knowledge of this activity. From the experimental results, members of Cluster_1, Cluster_2, and Cluster_3 are consistent grades. It offers similar self-regulated learning styles. The members of Cluster_0 like the same activity. It can be concluded that they have good grades and satisfactory grades.

5 Conclusion

In conclusion, this study investigated the use of unsupervised machine learning techniques for clustering learning outcomes based on self-regulated learning and online learning behavior. The study aimed to develop an optimized clustering method for predicting

learning outcomes using educational data mining techniques. The proposed method utilized a combination of K-Means, K-Medoids, and X-Means clustering algorithms and ensemble majority voting techniques to identify the optimal number of clusters and predict learning outcomes. The study involved a sample of students who exhibited self-regulated learning styles and engaged in online learning activities. The results of the study showed that the proposed method is effective in predicting learning outcomes based on self-regulated learning and online learning behavior with high accuracy. The study has some limitations, such as the focus on a specific group of students and the limited number of attributes used for clustering. Therefore, further research is necessary to validate the proposed method in other educational contexts and with a larger number of attributes.

Overall, this study provides a valuable contribution to the literature on clustering learning outcomes and educational data mining and provides insights for improving the quality of education using unsupervised machine learning techniques. The proposed method can be useful for educators and policymakers in designing personalized learning programs and identifying students who may need additional support.

6 Research Limitations

The limitations of this research consist of two main points. The first point is that the researchers did not consider pre-test scores for grades. It resulted in students not focusing on pre-test activities, as determined by the very low average pre-test scores as detailed in Table 1.

The second limitation is that the coursework in this study was online and did not require mandatory attendance. As a result, learners lack interaction and motivation to ask questions. However, there were small groups of students who requested to attend the classroom, where the researchers arranged hybrid learning concurrently to meet the needs of the students.

Acknowledgements. This research project was supported by the Thailand Science Research and Innovation Fund and the University of Phayao (Grant No. FF66-UoE002). In addition, this research was supported by many advisors, academics, researchers, students, and staff. The authors would like to thank all of them for their support and collaboration in making this research possible.

Conflict of Interest. The authors declare no conflict of interest.

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The Influence of University Support and Online Learning Tools on Learning Outcomes to Increase Student Satisfaction with Online Learning

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Abstract. This research aims to explore how university support, online learning tools, and learning outcomes influence e-learning satisfaction. This study explores e-learning satisfaction through quantitative investigations using 19 constructs with 5 variables that make up the proposed research model. Each indicator is used as an online survey instrument using a likert scale with 1–6 point types from strongly disagree to strongly agree. This study obtained the results of 570 respondents who were declared valid and analyzed using SMARTPLS 3.0 software. The results of the study show that student satisfaction in online learning using e-learning media is influenced by University Support, Online Learning Tools, and Perceived Learning Outcomes. The contribution of these findings shows that the role of universities in providing support in preparing for the development of online learning by optimizing online learning tools can increase satisfaction.

Keywords: University support · Online learning tools · learning outcomes · student satisfaction · online learning

1 Introduction

The current COVID-19 pandemic has had an impact on higher education institutions all over the world [15]. National lockdowns were imposed in many nations, prohibiting a lot of student face-to-face connection and physical presence at institutes of higher learning [5]. Even though the pandemic's initial outbreak was initially noted in December 2019,

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 98–107, 2023.
https://doi.org/10.1007/978-981-99-5961-7_11

higher education has yet to overcome it with enormous challenge [3]. Higher education institutions were forced to adjust to the sudden change to online and distance learning to facilitate the delivery of smooth and sustainable teaching and learning online as a result of this circumstance [8].

In the context of education, students are clients who interact with facilitators within the institution to obtain commodities or services [9, 25, 30]. It should satisfy the learners' needs in terms of a service. Ensuring students are satisfied has become crucial to the provider's existence. All service industries prioritize measuring and managing service quality to keep customers and maximize lifetime value. Previous studies have verified that learning outcomes influence satisfaction of the students [2, 23]. A lot of factors have been utilized in the recent studies to explore the impact of learning outcomes on e-learning satisfaction [2, 26]. Furthermore, university support and learning tools can affect students' satisfaction[6, 24]. To evaluate a university's quality which will turn into satisfied users, prospective students look at a variety of factors, including its faculty teaching, quality of support, and infrastructure [24]. Every learning environment today is a multicultural one, and technology needs to be included in the classroom in order to teach to standards and improve literacy [6].

However, a study by [4] indicated mixed findings about the effect of learning outcomes on students' satisfaction. Moreover, a study by [19] indicated that online learning infrastructure had not been proven as a moderating effect between the relationship of service quality and students' satisfaction. The results of previous studies are thus inconsistent. Hence, we seek to answer the research question: Are university support, online learning tools, and learning outcomes related to student satisfaction? In addition, we extend previous research by examining how university support and online learning tools interact with learning outcomes. In addition, we model perceived learning outcomes as a mediator in the relationships between university support, online learning tools, and students' satisfaction.

2 Hypothesis Development

2.1 Relationship Between University Support to Student Satisfaction

Previous study has shown that university support can help raise student satisfaction [28]. University support is even more critical for the students in the online learning environment. University support can be related to many things, such as clear guidelines and technological support from the university. Having good university support can make the student more engaged, increasing student satisfaction, the willingness to learn, and in the end, student performance [20, 28]. The importance of university support in raising student satisfaction is the foundation of hypothesis 1:

Hypothesis 1: University support positively and significantly affects student satisfaction.

2.2 Relationship Between Online Learning Tools to Student Satisfaction

The right online learning tools can help with the students' online coursework and may increase overall student satisfaction [18]. Online learning tools such as hardware, software programs, and features that are easy to access can enhance the learning experience

for students [29]. Students can also collaborate using online learning tools [21]. These benefits help the student to become more satisfied with their learning. Therefore, we propose hypothesis 2:

Hypothesis 2: Online learning tools positively and significantly affect student satisfaction.

2.3 Relationship Between Perceived Learning Outcomes to Student Satisfaction

Learning outcomes are one of the critical factors that should be considered to increase student satisfaction [28]. Having good learning outcomes means that students will learn a lot from the course, which is essential, especially when they learn online. Nevertheless, each student will have a perception of good learning outcomes. Furthermore, their perception of learning outcomes can be related to how successful the course was taken by students [7]. Therefore, we propose hypothesis 3:

Hypothesis 3: Perceived Learning outcomes positively and significantly affect student satisfaction.

2.4 Relationship Between University Support to Perceived Learning Outcomes

Previous studies have shown that university support is essential in optimizing students' perceived learning outcomes [16, 17]. However, there is also another study that proved university support did not have a significant effect on perceived learning outcomes [28]. Therefore, to clear this inconsistency, we derived the following hypothesis 4:

Hypothesis 4: University support positively and significantly affects perceived learning outcomes.

2.5 Relationship Between Online Learning Tools to Perceived Learning Outcomes

Online learning tools are essential for good learning outcomes [22]. When students use good online learning tools, they feel they are progressing toward their learning goals [27]. In the online learning environment, both variables are noteworthy and highly related [2]. Therefore, we propose hypothesis 5:

Hypothesis 5: Online learning tools positively and significantly affect perceived learning outcomes.

3 Research Methods

This study explores e-learning satisfaction through quantitative investigations. This investigation was conducted on a population of students in Indonesia who use technological devices in the learning process. This study uses 19 indicators with 5 constructs to form the proposed research model (Fig. 1). Each indicator is used as a survey instrument using a Likert scale with 1–6 point types from strongly disagree to strongly agree. This study used an online survey using Google Forms with the results of 570 respondents who were declared valid and in accordance with the provisions. Then do an analysis of 570 data using SMARTPLS 3.0 software.

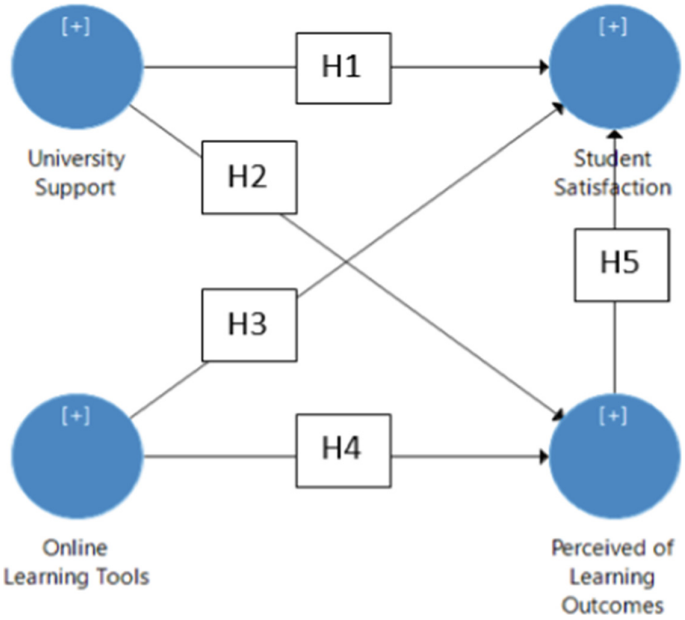

Fig. 1. Research Model

4 Analysis Results

4.1 Demographic Profile of Respondents

This study has 570 undergraduate respondents at universities in Indonesia and use one learning platform. This is declared valid and according to the provisions. Respondents consisted of the following subcategories, male by 56.5% and female by 43.5%. The age of respondents < 17 years by 0.35% and 17–27 years by 99.6%. Length of Study Time from < 1 h/day of 13.9%, 1–3 h/day of 40.9%, 3–5 h/day of 39.8%, 5–7 h/day of 2.63%, and > 7 h/day of 2.81%. Number of Courses Studied with 1–2 courses of 46.7%, 2–3 courses of 45.1%, 3–4 courses of 7.72%, > 4 courses of 0.53% (Table 1).

4.2 Validity and Reliability Test

The validity test is a test of the extent to which each instrument item can represent the sample's behavior as a whole. Construct validity testing can describe the instrument's ability to constructs. So validity testing is very important to do before testing the hypothesis. Validity testing was measured by looking at the Average variance extract (AVE) with a value of ≥ 0.50 and a value of Cronbach's alpha ≥ 0.70 [11, 12]. The AVE test value for each construct is > 0.5, so it is declared valid, as shown in Table 2. In addition, the discriminant validity test looks at the heterotrait-monotrait (HTMT) value of less than 0.9, indicating compliance [13, 14] and can be seen in Table 2. Reliability means the extent to which the results of a measurement can be trusted for the same group of subjects. Indicator reliability testing can use the loading value for each item with a value

Table 1. Demografic Profile of Respondents

Category	Subcategory	Freg	%
Sex	Men	322	56,5
	Women	248	43,5
Age	<17 years	2	0,35
	17–27 years	568	99,6
Length of Study Time	<1 h/day	79	13,9
	1–3 h/day	233	40,9
	3–5 h/day	227	39,8
	5–7 h/day	15	2,63
	>7 h/day	16	2,81
Number of Courses Studied	1–2 Courses	266	46,7
	2–3 Courses	257	45,1
	3–4 Courses	44	7,72
	>4 Courses	3	0,53

greater than 0.4, so it is acceptable [11, 12]. The resulting loading value is greater than 0.6 (can be seen in Table 2), indicating a reliable value. In addition, it can be seen that the construct's composite reliability (CR) value exceeds the threshold of 0.9 [11, 12]. Indicating consistent reliability indicators are shown in Table 2 (Table 3 and Fig. 2).

4.3 Regression Models

Testing the research model can see the value of R Squared (R^2). The result of the value of R2 = 0.715 indicates that this research model is quite good. Because online learning tools and university support variables affect the level of student satisfaction in using e-learning. Furthermore, the second R2 value is 0.360. These results indicate that the online learning tools and university support variables have little influence on the perceived of learning outcomes variable and the perceived value of learning outcomes on student satisfaction also has little influence. All are shown in Table 4.

5 Discussion

The results of testing this hypothesis show that all hypotheses are accepted. This is detailed as follows: The first hypothesis, namely the relationship between University Support and Student Satisfaction, is declared accepted. This is evidenced by the results of the Tsat value of 5.563 and Pvalue 0.000. Also, the second hypothesis, namely the relationship between University Support and Perceived Learning Outcomes is declared accepted, this is evidenced by the results of the Tstat score of 8.345 and Pvalue of 0.000. These results indicate that university support in providing online learning services with

Table 2. Results Validity and Reliability of Tests

Variable	Construct	Outer Loadings	CA	CR	AVE
Online Learning Tools	OLT01	0,675	0,708	0,820	0,533
	OLT02	0,744			
	OLT03	0,750			
	OLT04	0,747			
University Support	US02	0,760	0,766	0,850	0,587
	US03	0,787			
	US04	0,733			
	US01	0,782			
Perceived of Learning Outcomes	PLO01	0,848	0,875	0,914	0,727
	PLO02	0,874			
	PLO03	0,849			
	PLO04	0,838			
Student Satisfaction	SS01	0,774	0,901	0,922	0,627
	SS02	0,787			
	SS03	0,801			
	SS04	0,781			
	SS05	0,823			
	SS06	0,780			
	SS07	0,795			

Table 3. Validity Discriminant Test

	Online Learning Tools	Perceived Learning Outcomes	Student Satisfaction	University Support
Online Learning Tools	0,730			
Perceived Learning Outcomes	0,476	0,852		
Student Satisfaction	0,595	0,787	0,1792	
University Support	0,646	0,586	0,691	0,766

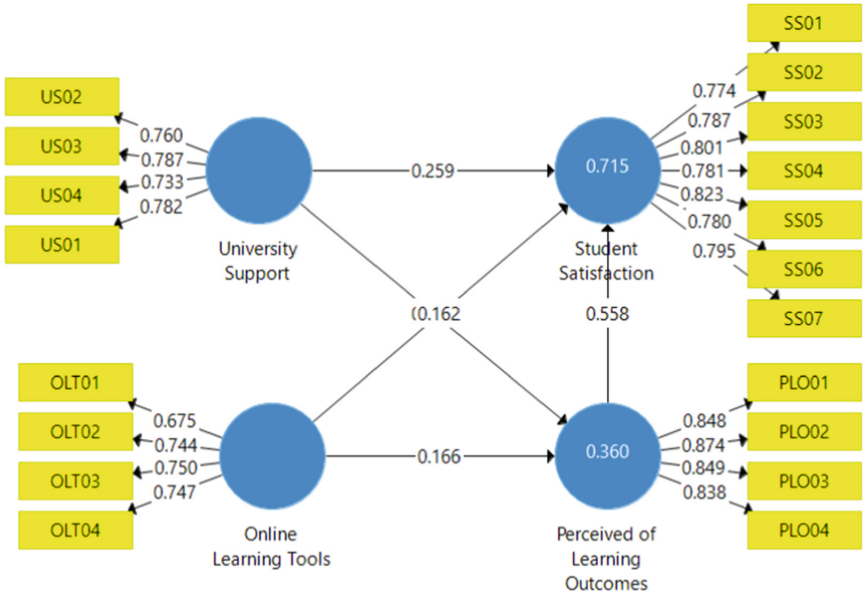

Fig. 2. Measurement Model Assessment

Table 4. Hypothesis test Result

	Hypothesis	T Stat	P Values	Result	Q2	R2
H4	Online Learning Tools −> Perceived Learning Outcomes	2,844	0,005	Support	0,215	0,360
H2	University Support −> Perceived Learning Outcomes	8,345	0,000	Support		
H5	Perceived Learning Outcomes −> Student Satisfaction	12,940	0,000	Support		
H3	Online Learning Tools −> Student Satisfaction	3,959	0,000	Support	0,445	0,715
H1	University Support −> Student Satisfaction	5,563	0,000	Support		

e-learning must be serious and total. The aim is to provide policies that support implementing online learning services. These policies will make it easier to provide learning process services that increase user satisfaction. These results are in line with research [17] which states that learning optimization can occur due to university support. The

third hypothesis is that the relationship between Online Learning Tools and Student Satisfaction is accepted, this is evidenced by the results of the Tstat 3.959 and Pvalue 0.000. Also, the fourth hypothesis, namely the relationship between Online Learning Tools and Perceived Learning Outcomes, is accepted. This is evidenced by the Tstat value of 2.844 and the P-value of 0.005. These results indicate that providing appropriate Online Learning Tools in assisting the learning process is important for the online learning process to run smoothly. Online Learning Tools can be in the form of hardware devices (laptops, PCs and network devices) and software (especially application features that are suitable for use). So these results are in line with research [1, 10] that Online Learning Tools are one of the important things to increase student satisfaction. The fifth hypothesis is the relationship between Perceived Learning Outcomes and Student Satisfaction is declared accepted. This is evidenced by the results of the Tstat value of 12.940 and Pvalue of 0.000. These results indicate that achieving good learning from all learning processes indirectly increases student satisfaction with learning. This can be illustrated by the value of each course obtained as expected or good. This is proven to be consistent with research [28] which states that Perceived Learning Outcomes are an important factor in increasing student satisfaction in online learning.

6 Conclusion

The results of the study show that student satisfaction in online learning using e-learning media is influenced by University Support, Online Learning Tools, and Perceived Learning Outcomes. These findings show that the role of the university in providing support in preparing for the development of online learning by optimizing online learning tools can increase satisfaction. Online Learning Tools are easily available and useful to support good and appropriate courses. So, it can increase its involvement in the two-way learning process and achieve the Learning Outcomes that students need in learning. Thus, a good online learning system will increase learning readiness and encourage collaboration and interaction so that learning satisfaction increases and can boost the achievement of Learning Outcomes. In addition, universities can improve knowledge and skills in a more interactive way. Good and structured online learning system support is needed to encourage readiness and collaboration. These findings also contribute to the development of online learning, especially with regard to efforts to increase student satisfaction in online learning. Future research can study new variables related to AI technology in online learning.

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Small Bites, Big Impact: The Power of Nanolearning

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Abstract. Nanolearning (NL) is a promising approach to education and training as it delivers small, bite-sized chunks of learning content that can be easily consumed and retained by learners. This allows quickly accessing specific pieces of information and knowledge, which can be delivered through a variety of mediums, such as videos, podcasts, or mobile applications, etc. NL has significant potential in educational and training settings, where learners or trainers can quickly upskill or reskill in specific contexts, improving their productivity and mastering some topics. This study provides an overview of NL, addressing the design of NL educational materials and its implementation in several educational applications. It also highlights some considerations and issues. In conclusion, it is recommended that reliable learning resources be used by teachers, the content be closely assessed, the source format be considered, bias be checked for, and learner feedback be obtained to ensure the quality of NL materials. By following the proposed NL framework, teachers can provide their learners with top-notch and productive NL resources.

Keywords: Nanolearning · NANO framework · Short-form videos · Bite-sized content · Cognitive load theory · Spaced repetition

1 Introduction

Traditional learning and training methods consume much time and require learner's dedication in today's fast-paced society, where learners have shorter attention spans and many distractions [1]. Cognitive load theory suggests that learners have limited capacity for processing information, and that information should be presented in small, manageable chunks to avoid overwhelming learner's working memory [2]. This can be accomplished

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 108–116, 2023.
https://doi.org/10.1007/978-981-99-5961-7_12

through strategies such as chunking information, providing worked examples, and utilizing visual aids. Consequently, the concept of Nanolearning (NL) has become a well-liked method for disseminating focused, bite-sized chunks of information that are simple to absorb and remember [3]. For instance, several big social networking platforms like Facebook (Meta) provide a feature "Reel" which is a new way to create short, entertaining videos that can be discovered by new audiences. Similarly, TikTok is also providing similar features that gained users interest and have been widely adopted in education. Some cross-sectional studies suggest an association between NL and Microlearning (ML) in terms of high flexibility, scalability, and cost-effectiveness [4]. NL is a new educational paradigm that focuses on delivering small, focused, and easily understood learning content. It is designed to provide learners with quick and specific information, typically in the form of short videos, interactive learning modules, short quizzes, or infographics resources. The specific objective of NL is to make learning more accessible and efficient, allowing learners to easily consume and retain information in a short amount of time [5].

National Association of State Boards of Accountancy (NASBA) defined NL as "an educational program designed to allow a participant to learn a specific topic in a ten-minute period using electronic media and without real-time interaction" [6]. Khlaif and Salha [7] considered NL as "the condensing of microcontent into small units that are controlled and delivered by learners to achieve a single learning objective." Several lines of evidence described NL as "quick hits of information" and "self-contained or stand-alone, and it offers small nuggets of information" [8].

ML, on the other hand, is "an approach that focuses on a single concept, utilizing multisensory and multimodality in a focused short amount of time" [9]. Both NL and ML, as technology-mediated approaches, have many similarities as both approaches involved delivering small, bite-sized units of knowledge to learners [10]. Despite the widespread use of NL applications, there is a relatively small body of literature that is concerned with it in terms of effectiveness, design, implementation, and the challenges facing its integration in education in general, and in professional development. The purpose of this study is to review recent evidence on the power of NL in education by answering the following research questions:

1) What are the differences between ML and NL?
2) What are the characteristics of NL?
3) How can teachers ensure the quality of NL materials?
4) What are the best practices for designing effective NL?

2 Research Method

Due to the rapid and successive changes in the concept of NL design and implementation, this study used the rapid review approach as emerging methodology to synthesize and summarize evidence on knowledge of single topics in a short period of time [11]. This method provides an overview of the current state of NL to answer the aforementioned research questions, following the rapid review methods recommendations suggested by Garritty et al. [12]. Scientific databases (Scopus, Web of Science, and Google Scholar) were searched because of their wide coverage of the literature and resources related

to the topic. Searching for the literature started in October 2022 and updated in March 2023 by two researchers, using the following term "Nano Learning", A total of 32 papers were obtained from the databases, 12 papers were excluded because of repetition, and the rest of the collected papers were screened and read considering the selection criteria as follow: the paper should be published in the English language and explicitly includes the term NL, in addition to the presence of case studies, presenting results, applications, assessment of educational effectiveness, and providing implications of best practices for designing effective NL.

3 Results and Discussion

This section provides the results reflecting the concept of NL and distinguishing it from ML. Moreover, it presents the characteristics of NL and applications in which NL can be implemented. Several propositions are suggested based on the characteristics of NL, which should be kept in mind by teachers when adopting NL in their teaching practices. Then we are proposing a framework for designing effective NL units and are highlighting the associated challenges in education.

3.1 What is the Difference Between ML and NL?

Notwithstanding, both NL and ML involve delivering small, focused pieces of information, NL is typically used for the delivery of simple concepts or facts, while ML can be used to support a broader range of learning needs and is often designed to meet specific learning objectives. NL, however, is more focused on delivering the smallest possible learning units, while ML activities may be slightly larger in scope and duration [7]. NL is commonly used in situations where learners need to quickly acquire knowledge or skills, such as in emergency response training or safety training [13]. The differences between both approaches are shown in Table 1.

3.2 What Are the Characteristics of NL?

NL can be an effective way to improve learners' learning and engagement, particularly in today's fast-paced and technology-driven age [14]. The first serious discussions and analyses of NL characteristics have been articulated by Gramming et al. [8] as they focused on terms of engagement, retention, and personalization using a variety of media formats such as videos, infographics, or animations to capture learners' attention. It is now well established from a variety of studies that NL enables students to focus on small units of information, which can help to improve their retention and recall of the learning concepts [4]. Moreover, NL can be tailored to individual learners' needs and preferences, allowing for a more personalized learning experience [14]. NL activities are often repetitive in nature, designed to reinforce previously learned concepts or to introduce learners to new topics. This repetition helps to improve retention and recall of information [15]. Figure 1 illustrates some key characteristics of NL which were identified from [1, 3, 7, 13, 15].

Table 1. The difference between ML and NL.

Items	Nanolearning and Microlearning	
	Nanolearning	Microlearning
Focus	Specific and discrete pieces of information	Cover broader topics or multiple related pieces of information
Scope	Focuses on delivering the smallest possible learning activities, dealing with only one idea per piece	Activities are slightly larger in scope and may include more than one idea per piece
Duration (Estimated)	30 s to 2 min	2 to 15 min
Depth	Superficial training with quick reminders for audience	Used to introduce new concepts, improve skills, and provide more comprehensive training
Format	Short videos, visual images, infographics, and text-based activities	Short videos, visual images, infographics, and text-based activities
Audience	Busy professionals, learners with limited time and competency-based training in the workplace, over a short period of time, e.g., one day	Used for a wider range of learners, including those who need to develop some professional skills over a longer period of time, e.g., one month
Learning styles	Self-contained, self-directed	Collaborative and gained feedback from instructors or peers
Cost-effective	More cost-effective than ML methods, as it requires less time and resources to produce and deliver	Needs more cost to produce and deliver learning units

The implementation of NL has many positive effects [5], including keeping the learning material brief and straightforward, cost-effective, and promoting the reusability of learning contents. This involves identifying learning concepts, creating engaging learning activities, delivering them through accessible channels, monitoring and evaluating their effectiveness, and refining them based on feedback and evaluation [16]. NL can also reduce the cognitive load of students [17]. Moreover, NL extends its positive effects to deep learning and the survival of learners' learning by breaking down complex concepts, providing frequent and spaced repetition, personalizing the learning experience, and offering flexibility in delivery [18]. The identified benefits of using NL from the reviewed studies are summarized, as follows:

- *Survival of learning*: NL can help learners retain information over time by providing frequent and spaced repetition of key concepts. This approach helps to reinforce learning and prevent forgetting, which can be particularly helpful for long-term retention of information.

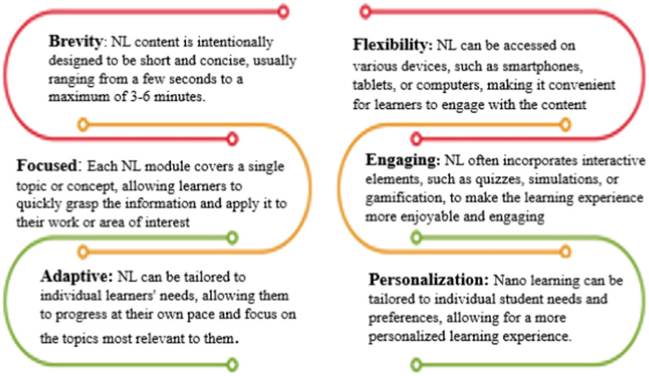

Fig. 1. The key characteristics of Nanolearning

- *Personalization*: NL can be personalized to individual learners' needs and preferences, allowing for a more tailored and effective learning experience. This can help them stay engaged and motivated, leading to better retention and survival of learning.
- *Flexibility*: NL can be delivered in various formats, such as videos, podcasts, or short articles, making it more accessible and flexible for learners who may not have the time or resources for lengthy study sessions. Therefore, this approach can help them fit learning into their busy schedules.

3.3 How Can Teachers Ensure the Quality of NL Materials?

To ensure the quality of NL materials, teachers not only should use reliable sources, evaluate the content carefully, consider the source format, check for bias, and solicit feedback from their students [5], but also consider the theoretical pillars when building their NL materials. Therefore, by analyzing the literature, it is seen that, to the best of our knowledge, no solid theoretical ground of NL is provided, and this hinders NL adoption in education, hence affecting the quality of the learning materials. Accordingly, this part attempts to develop some propositions of NL to ensure the quality of its design.

Proposition 1: Simple content does not imply "ugly" design.

Since the simple content and small amount of information are the main features of NL, this implies that the effective design of learning content is salient to achieve the learning objectives. Therefore, more concern should be paid to the instructional design of NL [14].

Proposition 2: Less is more but much less is much more.

We state this proposition inspired by the popular saying "less is more", when first adopted by a German architect Ludwig Mies van der Rohe. NL has flourished as a promising approach applying the minimalism [19] as lifestyle practice and design philosophy and focused on minimizing distraction and unnecessarily details of things to prioritize what is important. Owing to minimalism as a broad concept of perception, NL strives to refine and shorten the great amount of information to the smallest level [5].

Proposition 3: Repetition of shorter content with repeated intervals facilitates information absorption.

This feature empowered learners to better and deepen their understanding of abstract contents, hence facilitating mastering their learning [21]. This proposition is supported by the spaced repetition learning theory suggesting that learners are more likely to remember information if they are exposed to it multiple times over a period. NL is often delivered in short, frequent sessions that allow learners to review and reinforce information on a regular basis [22].

Proposition 4: NL is a stimulus of learning experience.

The success of NL depends on the learners' motivation, engagement, and ability to transfer their learning to real-world situations. This approach leverages the sense of completion and achievement when the very short and smallest portion is delivered to learners, which motivates them to study and spend more time if they feel engaged with the learning content [10].

Proposition 5: Very short-form of content leads to more control of learning.

While ML aims to achieve a single objective in a short amount of time using short form of content, NL attempts to overpass the microlevel of short content to miniaturize the microlevel to a smaller scale. This miniaturization is in favor of supporting learners' perceptions of control, which could positively reflect on their learning experiences [23]. NL can be used to promote self-directed learning and provide learners with more control over their learning experiences.

3.4 What Are the Best Practices for Designing an Effective NL?

NL has been successfully implemented in various learning settings using apps, online platforms, and gamified learning [19]. These approaches have helped learners learn at their own pace, understand difficult concepts, and improve their grades [20]. Examples of how NL has been successfully implemented in education are given below.

- *Duolingo*: Duolingo is a language learning app that uses NL to deliver bite-sized lessons. The app divides each lesson into small, manageable chunks that can be completed in just a few minutes. This approach has successfully helped learners in learning a new language at their own pace.
- *Quizlet*: Quizlet is a study app that offers NL flashcards and other study tools. The app provides learners with small, bite-sized pieces of information that can be easily memorized. This approach has successfully helped learners in preparing for their exams and improving their grades.
- *Ted-Ed*: Ted-Ed is an educational platform that offers NL videos on various subjects. The platform provides learners with short, engaging videos that explain complex topics in an easy-to-understand manner. This approach has been successful in helping students retain information and understand difficult concepts.
- *Classcraft*: Classcraft is a gamified learning platform that uses NL to deliver game-based lessons. The platform provides learners with small, bite-sized quests that are designed to teach various concepts. This approach has been successful in engaging learners and helping them learn in a fun and interactive way.

4 Nanolearning Framework

Based on the various definitions of NL, as well as its benefits and advantages (see Sect. 1) and propositions (see Sect. 3.3), Fig. 2 proposes a framework to implement NL with various educational applications, considering the theoretical foundations of implementation and building on the aforementioned propositions. As can be seen from the Fig. 2, to effectively design an effective NL, four practical elements should be considered: (1) Needs which highlight to whom (i.e., which type of learners) NL is designed and what needs these types of learners have so that NL can cater to these needs. For instance, if we are targeting a type of learners who are on the move most of the times, static content (e.g., text, image) will not be helpful and it is better to consider a learning format that learners can easily watch, hence learning while moving (e.g., at the airport), such as short audio/video learning content; (2) Affordable design which means, as we pointed out in proposition 1, not anything short should be randomly designed. In contrast, it should be carefully thought of to make the content appealing and accessible; (3) Necessary strategies refer to the different pedagogies used to facilitate consuming the provided learning content, including repetition, visualization, etc.; and (4) Operation which covers the quality standards needed to ensure an effective design and delivery of the content. On the other hand, these practical elements are built on 4 theoretical elements, that is, (1) theories (i.e., learning theories, motivational theories, psychological theories, etc.); (2) Design thinking; (3) Pedagogies; and (4) Quality standards.

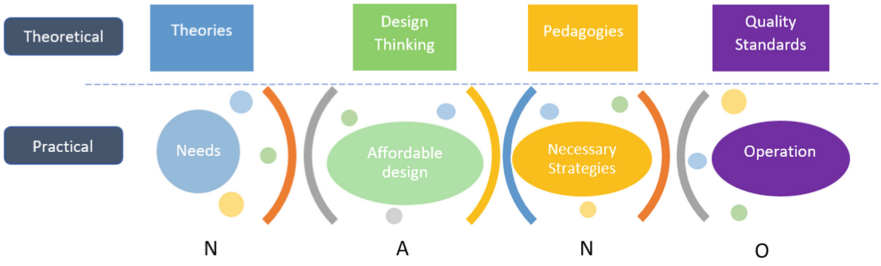

Fig. 2. NANO framework with theoretical and practical foundations

NL implementation with educational applications based on this framework can be summarized as follows:

- **Open Educational Resources (OERs)**: OERs are educational materials that are freely available online and have many forms. NL materials can be created as OERs to support open education [23].
- **Gamification**: Since the micro design approach showed positive impact when various game elements can be incorporated with the gamified assignments [19], incorporating game mechanics such as points, badges, leaderboards, levels, and challenges can make the nano learning experience more interactive and rewarding.
- **Short-form videos**: Short-form videos provide concise and focused information on specific topics, making them readily understandable. The duration of the video determines whether it is on the nano level (a few seconds to a few minutes) or the micro

level (a few minutes). Nano videos can introduce new concepts, demonstrate procedures, or summarize complex ideas. Short-form videos can also be gamified to engage viewers.

- **Location-based learning:** Location-based learning and NL can be connected to create a more immersive and contextualized learning experiences as follows:

  - Location-based triggers: It can be used to deliver NL content that is relevant to a learner's location. For example, a museum could use location-based triggers to deliver short-form videos to visitors as they move through the exhibits.
  - Augment reality (AR)-based NL: AR technology allows overlaying NL elements onto real-world locations. For example, learners could use a mobile app to scan a QR code at a specific location and access NL objects related to that location.

- **Flipped classrooms**: Flipped classrooms and NL can be combined to create an effective learning experience. A flipped classroom reverses the traditional order of learning, with learners engaging in pre-class learning materials and then attending class for interactive activities. NL can be incorporated into the pre-class learning materials to enhance the learning experience [17].

5 Conclusion

Nanolearning (NL) is a new approach for delivering small learning content that can be effectively retained. However, it is important to recognize its limitations, such as its limited scope and interactivity, and the risk of oversimplification. Consequently, it is crucial to ensure that the content is highly relevant, well-designed, and appropriately targeted to the intended audience to optimize the effectiveness of NL. By addressing these factors, NL has the potential to transform the way we learn and acquire knowledge in the digital age. Despite the limited information available on NL, this study takes a step forward in exploring its potential for enhancing education, as well as identifying key considerations for stakeholders such as educators and instructional designers. To this end, the study introduces the NANO framework and proposes a set of guidelines that stakeholders can use when adopting NL in their contexts.

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Prediction of Learner Information-Seeking Behavior and Classroom Engagement in the Advent of ChatGPT

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Abstract. Information source accuracy and trustworthiness are vital in undergraduates' education in terms of how they seek teacher feedback and educational content. Nowadays, the infusion of technologies into education has led to convenient and easy access to learning materials in electronic libraries and web-based platforms or search engines. Undergraduates are expected to make rapid use of ground-breaking technologies to sift for academic information over the internet. With the advent of ChatGPT, it is estimated that undergraduates might rely on it for academic information. The theoretical study gauges the potential impact of ChatGPT on the information-seeking behavior of undergraduates and what it means for classroom engagement. To do this, we utilized the inquiry-based learning theory which emphasizes the active participation of learners in discovering new information. The study is one of the first to contribute to the ongoing discussions on the impact of large language models (LLMs) such as ChatGPT on education.

Keywords: ChatGPT · chatbots · information-seeking behavior · inquiry-based learning · natural language processing

1 Introduction

Information-seeking plays a vital role in the learning progress of undergraduates because of the constant need for educational materials to complete course assignments and research projects. Conventional sources of academic information for undergraduates are their teachers, textbooks, and school libraries. The creation of a digital learning environment has revolutionized the information-seeking behavior of undergraduates. Nowadays, the infusion of technologies into education has led to convenient and easy access to learning materials in electronic libraries (e-libraries) and web-based platforms or search engines. Undergraduates are expected to make rapid use of ground-breaking technologies to sift for academic information over the internet. However, the accuracy and trustworthiness of information sources still remain contentious in the education arena as a result of the ease of uploading information on the internet (Okocha & Owolabi, 2020). Also, the approach used by learners for information-seeking limits their accessibility to

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 117–126, 2023.
https://doi.org/10.1007/978-981-99-5961-7_13

information relevant to their subject (Tella, 2009). Okocha & Owolabi (2020) tag undergraduates as naive users of the web who consume any information on the internet without any rigorous criteria to verify the accuracy or veracity of the source of information.

A new technology that has gained worldwide attention, chat Generative Pretrained Transformer (ChatGPT), which involves natural language processing (NLP) is expected to change the educational landscape (Tlili et al., 2023) and lead to a paradigm shift in how undergraduates search for information (Lund & Wang, 2023). ChatGPT is arguably the most advanced chatbot in these recent times. Because of its powerful functionalities, ChatGPT garnered 1 million users five days after its launch by OpenAI in November 2022. ChatGPT is based on GPT technology which is a machine learning model that makes use of unsupervised pre-training and fine-tuning to generate human-like responses to user prompts and also provides responses to varied topics in a manner indistinguishable from an actual human expert (Lund & Wang, 2023). Within a few months of its release, it has been used to develop games, write academic essays, take exams, prepare research drafts, and serve as an information source for many users on pertinent topics in the field of education (Cotton et al., 2023; Kung et al., 2023; Lund & Wang, 2023). Amid the euphoria about the positive transformation ChatGPT can bring to the education industry, there are also doomsday predictions in terms of the educational dangers it poses.

In this study, we put forward that ChatGPT has the propensity to alter the information-seeking behavior of undergraduates and ultimately influence their engagement in conventional classrooms and call on educators and relevant school leaders to ensure the technology is leveraged in a way that facilitates a good learning experience. We argue that the effective use of ChatGPT for information-seeking will support inquiry-based learning and promote classroom engagement. Conversely, if not properly harnessed, the information-seeking behavior of undergraduates as a result of ChatGPT can reduce classroom engagement (see Fig. 1). Classroom engagement in this study is simply the level of interest and participation of learners during classroom instruction. The paper presents an overview of inquiry-based learning, undergraduates' information-seeking behavior, the role of technology in information-seeking behavior, chatbots and their application in higher education, studies on chatbots and information-seeking behavior, why ChatGPT can alter the information-seeking behavior and classroom engagement of undergraduates, and various ways the powerful features of ChatGPT can be harnessed to support inquiry-based learning.

2 Theoretical Perspective: Inquiry-Based Learning

Inquiry-based learning (IBL) is the process of acquiring knowledge and skills by seeking information (Lee, 2014). It is an exploratory approach to learning in which students make observations, pose questions, examine sources, collect, analyze, interpret, and synthesize data, propose answers, explanations, and predictions, communicate findings through discussion and reflection, apply findings to real-world situations, and follow up on new questions that may arise during the process. IBL emphasizes students' abilities to critically view, question, and explore various real-world perspectives and concepts. It happens when the teacher facilitates and scaffolds learning rather than providing facts and knowledge so that students investigate, question, and explain their world in an environment that emphasizes students.

IBL is an approach used in higher education that can engage students in such an active learning process (Spronken-Smith, 2012). Spronken-Smith (2012) described IBL as a process in which students are actively engaged in knowledge creation that pushes them towards self-directed learning. In IBL, students are compelled to be responsible for their learning by challenging their initial ideas against self-generated data and by actively restructuring their knowledge base (de Jong, 2021). In IBL, students often follow an inquiry cycle, bringing them from conceptualization, through experiment design and investigations, to data analysis and reconceptualization (de Jong, 2021). In this way, IBL is also seen as a way to confront students with their naive conceptions and stimulate them to exchange such conceptions for theoretically sound notions (Brod et al, 2018). IBL is traditionally done with real materials and equipment, but nowadays simulations or digital labs are seen as an effective alternative (de Jong, 2021).

Learning through inquiry is a powerful pedagogical strategy that results in students learning the content of their disciplines as well as the processes used by experts to create new knowledge (Aditomo et al., 2013). The inquiry-based learning (IBL) experience will be its richest when students are capable of fully exploring the complexity, depth, and breadth of the course topic. The quality of students' exploration relies on their abilities to effectively analyze and engage with the scholarly literature in a manner that elicits thoughtful evidence, information, and questions (Aditomo et al., 2013). With appropriate support, students will build confidence and persistence to achieve a deeper level of questioning (Friedman et al., 2010).

IBL varies according to the discipline and the level of structure that educators provide. IBL relies heavily on information literacy (IL), which has been recognized as a key educational objective and fundamental learning skill. Students who lack information literacy skills find it difficult to assess the accuracy of the information and deal with prejudices or opinions (Head, 2013). Researchers in information behavior and librarianship have investigated how students seek out and assess information as they improve their knowledge areas (Budd, 2008). They have developed pedagogies that help students in their inquiry, especially in search techniques, critical thinking, and formulating questions that increase engagement (Budd, 2008). However, the ability to use information effectively in any situation requires a variety of competencies, techniques, attitudes, and perceptions of information. In this study, inquiry-based learning theory is used to emphasise the active participation of learners in discovering new information. We propose that in a digital learning environment, the powerful and attractive features of ChatGPT make it a technological tool that supports inquiry-based learning by influencing the information-seeking behavior of learners and ultimately their classroom engagement (see Fig. 1). In electronic learning environments that facilitate the inquiry process, success can be attained in the information-seeking behavior of learners due to recent technological advancements (in the context of this paper the use of LLM such as ChatGPT).

In this light, we believe call for effective ways to harness the functionalities of ChatGPT to facilitate teaching and learning (this is later discussed in succeeding sections). With the large attention ChatGPT has garnered since its release and the rapid use of ChatGPT for information search by learners, if not properly harnessed, conversely, ChatGPT may reduce classroom engagement and the objectives of inquiry-based learning will not be achieved.

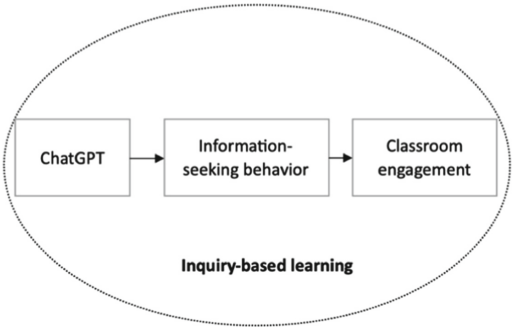

Fig. 1. ChatGPT supports inquiry-based learning by influencing learner information-seeking behavior and classroom engagement

3 ChatGPT, Information Seeking-Behavior, and Classroom Engagement

3.1 Overview of Undergraduates' Information-Seeking Behavior

Information literacy is defined as the adoption of appropriate information behavior to obtain, through whatever channel or medium, information well fitted to information needs, together with a critical awareness of the importance of wise and ethical use of information in society (Boon et al., 2007). According to Boon et al. (2007), information literacy has become increasingly significant for higher education, since the complexity and volume of information available requires that students, academics, administrators, and librarian's alike focus on acquiring the skills needed to access, evaluate, manage, and use information effectively. Information-seeking behavior is an aspect of information literacy (Timmers & Glas, 2010), which is concerned with the purposive seeking of information to solve a certain information problem (Wilson, 1999), and usually includes several steps like identifying access, acquisition, evaluation and manipulation of information.

However, several studies mentioned that undergraduates display poor information-seeking patterns and show a low competence in the use of library systems (Tella, 2009). Brindesi et al. (2013) conducted a case study on the undergraduate students of the Department of Astrophysics, Astronomy and Mechanics in a Greek university, and came to the conclusion that students show a preference for familiar, flexible, and easy-to-use information resources that provide quick access to information, using only one or two terms, with no use of advanced searching techniques such as Boolean operators or truncation. This simple search strategy of relying on basic searches like keywords and neglecting advanced options in search engines (Boolean operators, term modifiers, phrase search), is still applied by most undergraduates without change for nearly 20 years, even though most of them understand that a one-word search is likely to return too many documents.

Apart from applying searching strategies, it is even more unsatisfactory considering the ability to evaluate information. Most undergraduates are heavily influenced by the order of results generated by search engines and prefer those results presented in the

first few pages to support their own arguments. Also, found by a study that investigated the online health information-seeking behavior of undergraduate students during the COVID-19 pandemic, most of the participants did not consider the author's professionalism, which indicates the outcome judgement may be a missing piece of the puzzle in higher education (Hsu, 2021).

3.2 The Role of Technology in Information-Seeking Behavior

Being raised as digital natives, undergraduates of the new generation have experienced the exponential diffusion of connections to the World Wide Web both on stationary and mobile devices. The most common and simple search engines, such as Google and Yahoo, meet the needs of students' demand for the easiest and most convenient method of information seeking, and have become the starting point of undergraduate academic research. Also, mobile devices, such as smartphones and tablets become essentials of student's daily life, providing instant satisfaction and letting students access online learning resources anytime and anywhere (Al-Emran et al., 2016).

It should be noted that, despite the popularity of online search, the traditional way of visiting libraries, both physical library and online subscription databases is still irreplaceable. However, the increasing use of mobile devices does challenge academic library services, since fewer students used such mediums for searching library resources, compared with retrieving information through search engines or encyclopedias like Wikipedia. Therefore, adapting library resources and services to accommodate smartphone and other mobile device technologies becomes extremely important, such as developing mobile apps. Lund and Wang (2023) assert that ChatGPT will revolutionize academia and information retrieval in libraries.

Though information-seeking strategies is a significant and robust predictor of better grades, increasing students' Web expertise will only make them use scholarly database more frequently, it does not necessarily increase the level of sophistication of search queries, or their meta-cognitive strategies (Tsai, 2009). This raises the demand for new technologies which lowers the barrier of search expertise. Chatbots (such as ChatGPT) which are capable of generating human-like response then provides another way or a better alternative regarding information seeking.

3.3 Related Research on Chatbots (ChatGPT) and Information-Seeking Behavior

Driven by various factors like the progress of machine learning (ML), natural language processing (NLP) and large language model (LLM), the prevalence of AI generated content (AIGC), and the raising awareness and expectation of conversational support, the field of conversational information seeking (CIS) which is defined as a system that satisfies the information needs of one or more users by engaging in information seeking conversations, and is often partitioned into three subdomains: conversational search, conversational recommendation, and conversational question answering (Dalton et al., 2022). Conversational agent, also known as a "chatbot" is one of the conversational interfaces of CIS. Since using a chatbot requires almost no technical expertise, it is more user-friendly and flexible for information seeking.

Benjelloun Touimi et al. (2020) developed a chatbot to meet the demands of learners to seek information, express ideas, and participate in discussions in open access platform MOOC (Massive Online Open Courses). This is to say that the use of chatbots for information seeking is highly prized as an effective means of gathering information to assist in teaching and learning and job-related tasks.

3.4 ChatGPT's Influence on Information-Seeking Behavior and Classroom Engagement

For instance, the functionality of ChatGPT that allows it to provide immediate feedback to students in a quality manner similar to human tutors (Tlili et al., 2023) may deter or lessen the rate at which undergraduates turn to their teachers for clarification on confusing topics. In a conventional classroom, teachers might be unable to respond to the individual needs of all students. In such situations, ChatGPT might serve as an alternative tutor for students.

ChatGPT's ability to be fun and sociable might attract undergraduates to turn to the technology as their primary information source. Tella (2009) found that enjoyment in seeking information predicts undergraduates' information-seeking behavior. Thus, because ChatGPT can engage undergraduates in fun games and crack jokes while at the same time producing quality responses (Tlili et al., 2023), the students might perceive it as an information source that stimulates enjoyment in learning.

The personality of ChatGPT and its ability to exhibit emotion (Tlili et al., 2023) can be fascinating to undergraduates and draw them to use the technology for information. ChatGPT is able to admit its mistakes instantaneously, correct responses, and provide new accurate information. Classroom teachers might need time to revisit an educational platform or material to rectify mistakes made in class. Additionally, in correcting mistakes, ChatGPT is able to apologize to a learner which might not occur in classroom settings.

The new version of ChatGPT based on GPT4 technology is multimodal in nature (able to provide information in multiple formats, such as text, images, videos, and audio). Undergraduates can get a graphical representation of an idea or a piece of information. Also, in-class presentations and group projects can be enriched with visualization from ChatGPT.

ChatGPT also promotes inclusivity such as providing information by using language appropriate for different types of learners and expanding educational opportunities. Also, the multimodal nature of GPT4 ensures that students with disabilities can access information in a format appropriate for them. ChatGPT has the potential to create inclusive learning environments for impaired students such as those with disabilities or learning disorders, lack resources, with different learning styles, or from different living environments.

The ability of ChatGPT to summarize lengthy texts (Lund & Wang, 2023; Tlili et al., 2023) could be one principal reason why undergraduates might rely on it for precise and concise information. Instead of searching through the pages of textbooks for relevant information or asking their teachers for clarification on difficult topics, undergraduates might prefer to ask ChatGPT to sift for the essential information they need. ChatGPT

is able to provide summaries of complex topics in an easy-to-understand manner which might be better than a human tutor.

ChatGPT's feature to engage in novel creation (Lund & Wang, 2023; Tlili et al., 2023) can also be an attractive factor for undergraduates to depend on it as a reliable information source. After searching for specific information, undergraduates can go a step further by asking ChatGPT to generate new information on the same topic or a concept of interest. In a conventional classroom, teachers may not have the time to provide deep and further information on varied topics for each individual student. Because ChatGPT can provide undergraduates with customized and personalized information, they might be more willing to communicate with it than their teachers.

ChatGPT can also provide answers based on multilinguistic material, and break the boundary of language. This feature may allow students to access versatile ideas and information from different cultural backgrounds, which might cause students to engage in collaborative learning or be attached to the ChatGPT platform for information.

Students may also be more relaxed while communicating with machine learning tools such as ChatGPT, hence, able to learn at their own pace and develop motivation in learning. As documented by numerous scholars (Arif et al., 2023), ChatGPT promotes convenience in learning and easy access to information.

3.5 Harnessing the Features of ChatGPT to Support Inquiry-Based Learning

The use of Chat GPT may significantly enhance inquiry-based learning. It can provide students with access to a wealth of data and resources on a wide range of topics. There are numerous enjoyable and practical ways to incorporate Chat GPT into any educational setting, such as through games and gamification. These are some examples of how it can be used in an inquiry-based classroom.

Generating High-Quality Questions
Relevant and stimulating questions are essential to inquiry-based learning. It can be difficult for students to come up with questions that are both comprehensive and targeted. Suitable and critical questions are essential to make the learning processes more efficient and effective. For the purpose of fostering learning, developing excellent questions is essential. Chat GPT might inspire students to think critically and encourage them to ask questions. Additionally, it can be used as a model to help students create more insightful questions, which will enhance their reading comprehension and research abilities.

Examining the Quality of the Inquiry Question
Chat GPT has the ability to come up with useful questions and assess student responses. For instance, if a student wants to learn more about the features of SpaceX, they can input "inquiry questions about Space X" and ask Chat GPT to analyse their query when they come across a query they wish to examine in more detail. Here is an example answer to the question "What are the significant challenges and risks linked to SpaceX's mission to make human space travel more commonplace and accessible?".

Examining the Credibility of Chat GPT
Chat GPT is a language model that can be used to find information and answer questions

by using a vast dataset of various written materials. Despite having measures in place to ensure the accuracy of the data it was trained on, Chat GPT has some limitations. The website has a disclaimer stating that incorrect or harmful information might be generated occasionally, and that it has limited knowledge of events after 2021. As a result, questions may not always be answered accurately.

Analyzing the credibility of Chat GPT can be a great inquiry for students, as it allows them to think critically about the technology's purpose and implications. Students can test Chat GPT's credibility by asking a series of questions about a topic they are knowledgeable about, or by requesting sources for its answers. This experiment can help students assess whether Chat GPT is providing reliable information or making mistakes. Overall, using Chat GPT can assist students in developing research skills and critical thinking abilities.

However, Inquiry-based learning benefits greatly from ChatGPT's ability to generate questions, deliver information, and evaluate student responses. Students can increase their understanding, learn how to conduct research, and sharpen their critical thinking skills by using ChatGPT. Still, students should also consider ChatGPT's limitations and evaluate the credibility of its responses.

4 Conclusion and Implications

Through the lens of inquiry-based learning, we proposed in this study that LLM such as ChatGPT has the potential to impact the information-seeking behavior of undergraduates who often make use of digital tools for information gathering and retrieval. Specifically, we argued that the powerful functionalities of ChatGPT such as quick and quality responses, multimodality, multilingual ability, ease of use and convenient interface for interaction, its personality and ability to support collaborative and personalized learning, etc. have the propensity to attract learners as a reliable source of information. In conventional-based teaching where individual learners' needs may not be sufficiently addressed by teachers during classroom interactions as a result of many factors such as large class size or limited time, struggling students, quiet or introverted students, and those who are not satisfied with a teacher's response might turn to ChatGPT as a personal tutor for feedback to their queries. In this way, classroom engagement (i.e. interactions between teachers and students) might be greatly impacted. That is, if not appropriately harnessed to facilitate teaching and learning, it is predicted that ChatGPT might reduce classroom engagement in conventional classrooms where limited technology is used for assessment and provision of feedback. Additionally, since ChatGPT can provide learning resource recommendations, engagement between students and librarians might be reduced if academic libraries are not apt to explore ways to infuse cutting-edge technologies such as ChatGPT to augment information search. However, while ChatGPT can promote inquiry-based learning, when applied in educational settings, ethical issues such as honesty, fairness, the accuracy of responses, inclusion and technical issues, etc. should be considered before their implementation. We call for future studies to conduct empirical research to test the conceptual model proposed in this study.

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Does Gamification Influence Students' Online Learning Behaviors and Academic Performance? A Learning Analytics Perspective

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Abstract. While several studies revealed that gamification could enhance students' learning motivation and engagement, less focus in the literature has been paid to the changes that gamification might bring to students' learning behaviors. Motivated by this research gap, this study harnesses the power of big data and learning analytics (LA) to analyze and compare students' learning behaviors in gamified and non-gamified learning environments. This study first develops a Gamified Learning Management System (GLMS) based on the self-determination theory (SDT). It then analyses the students' learning behaviors on it and compares them to a non-gamified version of it. Involving 204 students who used the two LMSs to learn the Human-Computer Interaction course were divided into two experimental groups. The findings revealed a positive and significant correlation between gamified earning points, students' final grades, and increased student engagement, The implications of this study suggest that gamification could be a practical approach to enhance students' academic performance and engagement in online learning environments.

Keywords: Gamification · self-determination theory (SDT) · student engagement · learning analytics · big data · academic performance

1 Introduction

Higher education institutions are adopting digital transformation techniques to transition from traditional to e-learning education systems but face ICT and operational risks. Most universities worldwide use e-learning systems to facilitate interaction between students and teachers while minimizing time and space constraints to promote active learning. In particular, the COVID-19 pandemic has encouraged teachers to encourage their students to use learning management systems (LMSs) more actively. LMSs are generally used by the majority of educational institutions to handle their courses online (Alturki and Aldraiweesh 2021), storing rich educational data in the LMS server, which acts as a repository. However, in most cases, students do not fully understand the lecture

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 127–138, 2023.
https://doi.org/10.1007/978-981-99-5961-7_14

uploaded on the LMS, leading to several queries the teacher must respond to. Despite the availability of LMS, their capabilities are not always fully utilized.

To address this issue, we observed the traditional LMS (TLMS) at one of Pakistan's public sector universities was observed to develop a Gamified Learning Management System (GLMS) using game design elements and principles. This paper presents the study's findings, which aimed to explore how gamification can improve lecture comprehension and investigate the effects of gamification on students' learning activities in LMS. The first objective of this research was to create a system that improves student engagement, promoting learning activity by attracting students to the system and improving student-teacher interaction. The developed LMS will advance existing TLMS by encouraging its users through points, badges, levels, rewards, and competitive features that will encourage the students to perform to their best potential. Following the design and development of the gamified system, the research seeks to explore how the students' activities within the GLMS relate to their academic achievement. The study's second objective was to assess students learning behavior by applying learning analytics to the data produced by GLMS. Thus, the following research questions guided the study:

1. What are the key design elements of the Gamified Learning Management System (GLMS)?
2. What is the relationship between studying on the GLMS and the academic performance of students?

2 Theoretical Background

2.1 Gamification and Game Elements

Gamification has become a common concept in recent years, covering many fields, such as education. The concept does not assume that games are developed, but the game mechanics and elements are used in non-gaming contexts to engage and motivate users, promote learning, and solve problems (Enders, 2013; Kapp, 2012). Mechanics and elements are the features of the game, a collection of instructions, rules, and feedback mechanisms that create an enjoyable experience (Enders, 2013). Non-gaming contexts mean it is not like the actual game but the use of game rules. Werbach (2014) stated, "Each added game element should have a playful intention to be called gamification." Several gamification design frameworks have been proposed in the literature to gamify learning environments. For example, Werbach and Hunter (2012) suggested a "framework that relies on six gamification steps, called 6D, and contains 30 game elements".

Additionally, Machado et al. (2018) put forth the GAME framework, which comprises 52 game elements categorized according to user types. Specifically, this framework is based on the self-determination motivational theory, the most crucial theory related to gamification research (Rapp et al. 2019). The game elements suggested in the 6D and GAME frameworks share some commonalities, according to Toda et al. (2019). In conclusion, eight-game elements are widely used in the 6D and GAME frameworks. However, the elements used in the proposed LMS are described in the methodology section.

2.2 Gamification's Effects on Academic Performance

Many studies in the literature emphasized that gamification might improve academic performance. Oliveira et al. (2021) "found an 80% increase in student's motivation and further a significant relationship was recorded between student profiles and the results obtained by incorporating gamification". According to (Barata, Gama, Jorge, Gonçalves, & Goncalves 2013), gamifying a Master's-level college course with badges, leaderboards, challenges, and points can increase student participation and attendance. A study by Ramírez (2020) found a positive effect of gamification on students' academic performance. In an empirical study conducted at an Asian institution, Hew et al. (2016) showed that points, badges, and leaderboards significantly impacted student motivation and engagement to participate in more demanding tasks. Akron Glu et al. (2017) demonstrated that quests, leaderboards, points, reputation, and virtual gifts boost students' engagement, attendance, and motivation in course activities.

2.3 Feedback

"Feedback" is the most effective instructional strategy for enhancing learning and increasing accomplishment (Latifi et al. 2021), but depending on its effectiveness and timing, its impact may be either beneficial or detrimental. While there is a long history of research on feedback in educational settings, it is commonly acknowledged that feedback is understood to be cognitive as well as constructive information that is given to a student and also the process by which the student makes sense of the received information to enhance learning and close the gap between their current performance levels and desired levels (Shute 2008).

In this study, feedback is viewed as a teaching and learning activity that teachers and students may carry out to enhance learning in educational contexts, including contexts in higher education. A Gamified Feedback approach was introduced in the GLMS to allow the teacher to obtain timely feedback on the lecture, enhance student comprehension, and reduce the interaction gap between the teacher and students.

2.4 Learning Analytics

Learning analytics is a fast-increasing field of Technology-Enhanced Learning (TEL) research. Its origin dates back more than 15 years. In fact, since 2008, the concept of analysis in education began to gain the attention of researchers with a focus on understanding, enhancing, and optimizing the learning and teaching process. In 2010, the concept of Learning Analytics (LA) was separated from the area of analytics and became an independent field.

With gamification, learning analytics is a crucial area that views the information produced by learning systems (Tlili et al. 2017). In this study, the LA was used in both TLMS and the proposed GLMS to track the students' activities and visualize students learning behavior.

2.5 Learning Analytics and Feedback

The effectiveness of feedback also depends on the quality and how it is conceived and applied by students and its timeliness (Er, Dimitriadis, and Gašević 2021). There is evidence from several studies that Learning Analytics (LA) can facilitate giving students' valuable feedback promptly. In summary, existing literature reveals that LA can offer significant practical support for feedback practices (Er et al. 2021), and it has been suggested that LA should therefore be an essential component of feedback design in data-rich environments (Er et al. 2021). Therefore, this study incorporated the LA analytics to enrich the feedback system and track and access the learning activities in Gamified and traditional LMS.

3 Methods

A GLMS was designed to engage and motivate the students in their Learning process. A self-determination theory (SDT) was used to design the main structure of GLMS. However, we discussed the existing LMS, the proposed design, and the game design elements selected to gamify the LMS. This section provides a detailed overview of the gamified system components. Furthermore covered is the relationship between gamification and academic achievement.

3.1 Gamified LMS and Self-determination Theory

As discussed earlier, using the self-determination theory, GLMS was developed in response to traditional LMS (TLMS) at one of the public sector universities in Pakistan. GLMS was then used to deliver a course to the three sections of BS (Computer Science) students. The students were familiar with the Traditional LMS because they had previously used it at the university in non-gamified settings. The same teacher provided all of the material. Weekly materials in various formats, including videos, pictures, texts, PowerPoint presentations, and external links to web resources, were added for each section. Activities and quizzes that could be completed individually or in groups were included in each course to assess the student's knowledge. To have a successful GLMS should promote students' enjoyment and motivation. Our implemented game elements had to meet the different psychological needs of learners. In light of this, the self-determination theory (SDT) was successfully applied in games while designing GLMS. This theory is founded on three basic psychological needs—competence, autonomy, and social relatedness—that promote enjoyment (Ryan, Deci University, and Rochestu 2004) (Table 1).

Table 1. Game elements used to design GLMS

Psychological needs	Game elements	Matching psychological needs to game elements
Competence	Activity Points Badges Leader board Levels Feedback	"Feedback that shows students' contributions" "Feedback that shows students' achievements" "Feedback that shows students' performance." "Feedback that shows students' expertise." "Feedback that shows students' performance."
Autonomy	Avatar and customization Badges	"Students can freely choose their visual representations within the gamified courses." "Students can display or hide their awarded badges on their profiles."
Social relatedness	Forum discussion	"Students can interact and collaborate to complete a given goal."

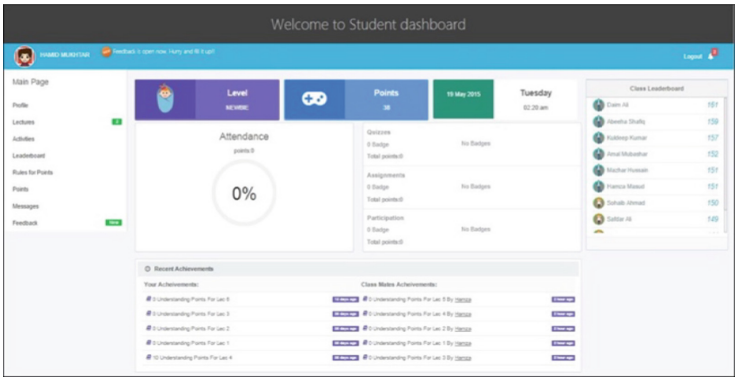

Fig. 1. Gamified LMS

Though (SDT) is previously validated by (Tlili et al. 2017). The results showed a substantial difference between the student's intrinsic motivation levels before and after using the GLMS. This confirms the significance of the designed GLMS and self-determined environment to increase students' intrinsic learning motivation. The Existing features of LMS, like quizzes, assignments, grading, discussions, material, discussion forum, and functions of the LMS, were enriched by incorporating the Game elements and game features. A screenshot of the GLMS is shown in Fig. 1.

The main features and game elements used in GLMS are given below:

(1) **Activity Point:** The Gamification point system in LMS offered more points to specific actions or activities. The points system was customized and added to the leaderboard to increase students' engagement in their learning processes (Zichermann & Cunningham 2011).
(2) **Badges:** The Badges were incorporated to provide students with a target to inform them of what they've achieved Enders and Kapp (2013) within the LMS meaningfully. Teachers were authorized to choose their design and to allocate badges to anything they wanted – for instance, completing an assignment or a series of tasks. Such badges serve as a source of pride and inspiration for learners, and they can be exchanged to improve competitiveness through social media.
(3) **Leader board:** The leader board was used as a visual way to track progress through various activities for a positive emotion that they had a chance of winning (Alaswad & Nadolny 2015). Students were allowed to check their progress against classmates, promote competition and drive them to work harder.
(4) **Levels: Levels** were used to see at what level (Newbie, Mediocre, and Expert) students are. The level was decided according to the no. of activities students performed on LMS. Simoes et al. (2013) recommended this to match the students' new skills. Each week, students were challenged to complete the activities to earn the points to advance to the next level.
(5) **Feedback System:** A feedback system was used against all tractable activities. Teachers at GLMS gave students amusing weekly comments to assure their psychological stability and further motivate them while learning (Edmondson 1999). Considering each student's performance during the course, the teacher wrote the feedback (e.g., based on the number of accumulated points or collected badges). There was also a visual input for activities that needed to be accomplished, what is finished, what percent of the entire task is reached, how many points students have and on what stage students are at, etc.
(6) **Avatars and customization:** Different avatars were used as a game element to increase the feeling of emotional attachment, resulting in a better level of engagement (Dunn & Guadagno, 2012). Avatar is the user's graphical image or alter ego or character of the user. An object or symbol that represents a given person in a game world. Students were allowed to modify their avatar profile, personal information, and the position of the elements. Those elements can be shifted around and made accessible on request.
(7) **Discussion Forum:** The discussion forum discussed the issues related to the lectures and essential concepts. The points were awarded according to the level of discussion by the students. It was used to engage and motivate the users and to enhance their learning through discussion.

3.2 Research Design and Intervention

Regarding the intervention, 204 fourth-semester BS Computer Science students taking the Data Structure" course tested the developed system for five weeks. Two groups of students were formed. Group B, which included 100 students, served as the control group. Group A, which included 104 students, served as the experimental group. During the five weeks of the experiment, Group A (the experimental group) used the GLMS,

while Group B solely used the TLMS. The teacher uploaded lectures in the GLMS in the same manner as in the TLMS. Since the GLMS system was utilized for five weeks, a total of 250 points was calculated for all of the activities, leading to the employment of five levels.

3.3 Sample and Data Collection

The data-collecting phase is essential since it supplies information from the GLMS that could be used for analysis and evaluation. The GLMS is set up such that activity logs can be used to track students' online activities. Each activity a student engaged in while using the GLMS was recorded in this activity log. Following the main objective of this study and the comparative analysis method employed for logs between traditional and GLMS, the following six types of activities were noted: login, Lecture View, Understanding Submitted, Page Visited, And Message Read And Profile Change. Every activity includes characteristics that give a thorough description of that activity. The characteristics of these observed activities are described as (1) Students: Student who has performed the activity, (2) Activity type: Type of activity from the six types, (3) Activity name: Name of specific activity, (4) Date: The date on which activity is performed, (5) Start time of activity, (6) End time: Time at which activity ended. Activity name gives a more precise representation of the activity. For instance, depending on the lecture number a student has viewed, an activity of type "lecture view" may have a different activity name.

The TLMS was based on Moodle framework. Moodle can record activity logs in LMSs that can be kept and used for additional research. The TLMS and GLMS log files from March to July were stored and further examined to analyze and interpret the data.

3.4 Results

A total of 7,200 events for "Group A" from the Gamified LMS and 3,151 for "Group B" from the TLMS were recorded in the activities log and saved throughout the collecting phase. A SPLUNK Tool was used to analyze the events further and gain access to log files. SPLUNK is a collection of log search and analysis components that help with thorough monitoring/Tracking of machine-generated data and gives a thorough visual analysis of log data (Balaji, Karthik Pai, Bhat, & Praveen 2021). The students' various actions were observed and analyzed using the activities log. This made it possible to analyze the events and log data more deeply. When the lecture was uploaded, student lecture views were evaluated and compared for both groups to analyze the activities of students in the Lectures component. Figures 2, 3, 4, and 5 show the traditional and Gamified LMSs' lecture views for the four lectures compared. The x-axis depicts the date, while the y-axis displays the number of events. When compared to TLMS, it can be seen that GLMS had a higher number of views on the day the lecture was uploaded. We may conclude that adding gamification to the Lectures component increased the number of views and downloads of lectures even before they were uploaded. Students used GLMS more frequently than TLMS to view lectures in this approach.

Table 2 displays the total number of views for Group A (Treatment group) and Group B (Control group) on the first day of lecture upload. It demonstrates that more lectures were viewed in the GLMS on the first day than in the TLMS.

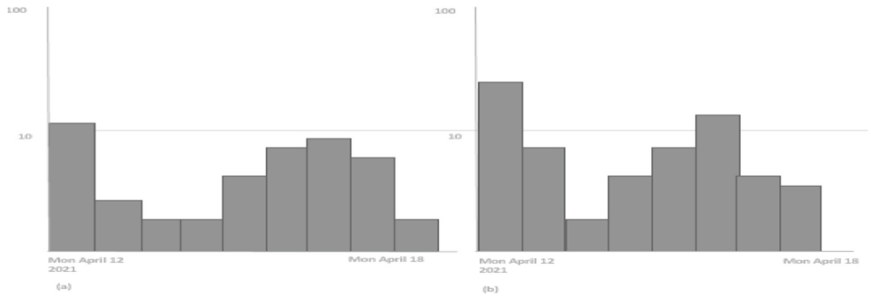

Fig. 2. Views on Lecture 1 in both (a) T LMS and (b) G LMS

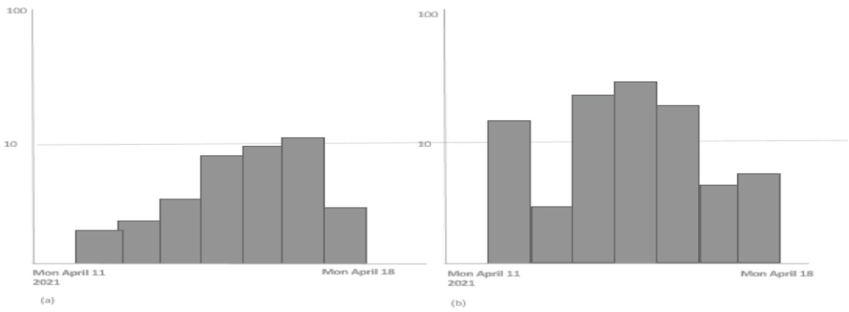

Fig. 3. Views on Lecture 2 in both (a) T LMS and (b) G LMS

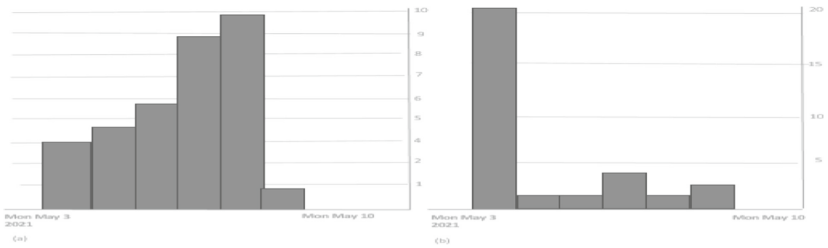

Fig. 4. Views on Lecture 3 in both (a) T LMS and (b) GLMS

Another significant finding was related to the forum discussion and the views on LMS. The more engaged students on the LMS had higher grades on the relevant test and exam when forum discussion was mapped to individual students' monthly test and end-of-semester exam marks. The top students in the class and leaderboard achieved high marks. As a result, we might assume that students' more significant participation in GLMS forums affected their academic achievement.

3.5 Analysis of Understanding Component

We used bivariate Pearson correlation analysis to thoroughly investigate the comprehending lecture component of GLMS, which is the most significant component of GLMS

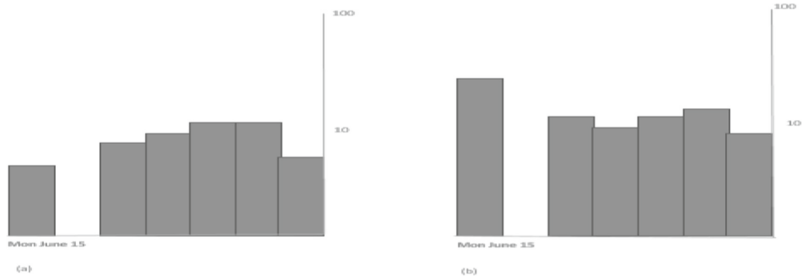

Fig. 5. Views on Lecture 4 in both (a) T LMS and (b) GLMS

Table 2. No. of lectures viewed by groups A and B on the day the lectures were uploaded

Lecture#	Views by Treatment Group-A	Views Control Group B
Lecture 1	41	15
Lecture 2	21	3
Lecture 3	32	2
Lecture 4	37	7

in gamification. We used Pearson correlation to determine the relationship between students' final grades and their understanding points recorded on GLMS. This relationship will enable us to predict how the understanding component of the GLMS will be evaluated.

Bivariate Pearson Correlation

Students from group A were considered, and their understanding points and final grades were considered for Pearson correlation analysis since GLMS was tested on group A. Students who report their understanding of lectures receive understanding points in the GLMS. As a result, we use the students' GLMS understanding points as our first variable. We use the final grades students earned in class as the second variable to find the relationship between the students' understanding points and grades. Since Pearson correlation only works with continuous variables, we translated student grades into the total points earned by the semester's conclusion.

We used the IBM SPSS tool for a Pearson correlation (2-tailed) test on log files, utilizing the students' grade points and GLMS understanding points as the main variables of interest, as shown in Table 3. The first variable is the number of understanding points that students have, which are represented by underscores; the second variable is the number of grade points that they have, which are their final grades after converting the grades they received at the end of the semester; and N represents the number of students whose data were recorded from group A.

The Students' grade points and understanding points have positive Pearson coefficient values, indicating a positive relationship. There is a significant relationship between students' grade score and their understanding points on the GLMS, as indicated by the

Table 3. Results of the Pearson relationship between grade points and understanding points for students

		Grade-Points	Understanding Score
Grade points	Pearson Correlation Sig. (2-Tailed) N	1 104	.381 .018 104
Understanding scores	Pearson Correlation Sig. (2-Tailed) N		1 104

$p < 0.05$

significance coefficient value (Sig.), which is 0.018 and less than 0.05. As a result, we can conclude that there is a significant and positive association between students' grade points and their levels of understanding. This indicates that the students who submitted their lecture understanding assignments on time and earned high understanding points are displayed to have matching high grades in class at the end of the semester.

4 Conclusion and Implications

This study presented the design of a GLMS and the game components used to encourage students to use the LMS, ensure improved student involvement, and foster competition among students. Together with the gamified components, the game features integrated with the point system are covered in detail. During the four weeks the system was used for a course at the university, the Learning Analytics revealed increased student participation and inspired them to comprehend the lecture as soon as possible after it was delivered.

Any built system can continuously be improved; hence the GLMS will likely undergo future modifications and upgrades. LMS can be gamified in various ways to improve student participation and engagement, which may impact their learning. By letting the students choose how much of the lecture slide or what portion they have understood, their comprehension can be more precise. This will enable the teacher to deliver material more precisely. The completion and level of understanding of programming exercises can be used to demonstrate the student's progress, which also calls for active participation from the teachers. At the end of the semester, top scorers on the leaderboard can also receive various awards and present to encourage them to engage with the gamified classes more regularly.

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Does a Team or Individual Performance Contribute to Solve Complex Problem: A Case Study on Active Learning Using Business Simulation Game

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Abstract. This study investigates whether teamwork or individual effort is more effective in solving complex problems using a well-known business simulation game called ERPSim. ERPSim has been used in management education and training and has had widespread use in the last decade. Business decisions are highly dependent among departments, highly dynamic, and uncertain. However, what factors influence the team's performance in solving these complex problems is yet to be determined. We conducted a qualitative study among students with different educational levels. We measured their complex problem-solving performance based on the business performance data generated from the ERPsim system. Our results show that teamwork was more effective than individual effort in solving complex problems. Through teamwork, participants could utilize diverse skills and perspectives to solve complex issues more efficiently.

Additionally, teams could better manage their communication and collaboration, allowing them to be flexible and autonomous. The results also show that the impact of high individual intelligence on team performance was less significant compared to effective teamwork. These findings implied that besides developing individual cognitive skills (e.g., critical thinking, creativity), management education should focus more on social-emotional skills (e.g., communication, collaboration). Moreover, this study can consider an integrated approach to advancing knowledge and discovering new solutions to complex challenges.

Keywords: ERPsim · Team Performance · Individual Performance · 21st-Century Learning Framework · Business Simulation Game · Active Learning

1 Introduction

Complex problems require a high degree of knowledge, skills, and coordination [1, 2]. In today's fast-paced and competitive business environment, organizations face complex challenges. For instance, maintaining the quality of customer relationships and brand

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 139–147, 2023.
https://doi.org/10.1007/978-981-99-5961-7_15

recognition requires them to innovate and adapt constantly. Hence, business organizations must develop the ability to implement Enterprise Resource Planning (ERP). As one such challenge is implementing ERP, knowledge conveys to students in the academic environment, which involves integrating multiple business functions and processes into a single software platform [3, 4]. ERPsim is a business simulation game that simulates a complex real-world problem in a business environment with multiple interconnected systems and processes. The game allows the participants to experience the challenges of running a business in a competitive environment. The game requires participants to make decisions about various aspects of the business, such as production, inventory management, sales, and marketing [5]. These decisions directly impact the business's performance, and participants must analyze data and make informed decisions to succeed. ERPsim requires a deep understanding of the business process, data analysis, and decision-making skills. One study [6] empirically examined students' learning outcomes in an IS (Information System) course. They suggested that ERPsim is a complex problem that requires a wide range of skills to succeed. Recently, collaborative problem-solving has been increasing rapidly in various businesses for providing an authentic learning experience to staff and enhancing decision-making in ERP systems [7, 8].

This qualitative study aims to enhance participants' 21st-century skills, including communication, collaboration, critical thinking, and creativity, through playing ERP simulation games. We explore how various factors, including individual levels of intelligence, student engagement, and team dynamics, may influence the participants' learning outcomes.

The results of this research have significant repercussions for universities seeking to provide ERP system knowledge to students. Universities can better design student teams and processes to achieve successful ERP implementations by understanding the factors or behaviors contributing to practical problem-solving. Additionally, it can help educators and organizations design better training programs to develop teamwork and individual problem-solving skills essential for our youth to thrive in 21st-century industries.

2 Literature Review

In a competitive environment like nowadays, the demand for employees with excellent skills and competencies is increasing dramatically in all workplaces. Hence, many universities must adapt to this trend by changing from traditional to inquiry-based teaching approaches. According to the framework of 21st-century learning, our youth in the 21st century requires life skills beyond essential reading, writing, and arithmetic skills. [9]. These essential life skills include critical thinking, communication, collaboration, and creativity, which can only be cultivated through active learning in an authentic context.

Considerable research that adopted the 21st-century framework used simulation games as a pedagogical tool to enhance students' competencies which are highly desirable for the workplace nowadays. For example, [10, 11] found that serious games can provide an active learning context for students to practice using 21st-century skills in formal and informal education settings. Another study conducted by [12] developed a BI (Business Intelligence) simulation game to improve 21st-century skills and Business Intelligence through the learning process, and its findings indicate that this game

helped students increase their BI knowledge and decision-making skills. Furthermore, [13] implemented the GGSSG (Game for Good Sustainable Seafood Governance) simulation game to enhance participants' 21st-century skills, such as problem-solving skills in bachelor and master programs of the science department in Fisheries and Aquaculture Science subject. The above research findings indicate that simulation games could help students develop the competencies essential for the seafood industry in the 21st century. It also provides an active learning environment that facilitates the development of practical skills such as critical thinking, problem-solving, communication, and decision-making.

ERPsim is a simulation game that is implemented in most universities around the world. The main objective is to provide ERP knowledge to students before they get involved in real-life work. Some researchers on applying the application of ERPsim explored the factors influencing students' learning outcomes. For example, [14] developed a model to explore the correlation between student engagement, team dynamics, and learning outcomes. They found that good teamwork affects team performance and students' learning satisfaction.

The overarching framework of this study's simulation pedagogy is the 21st-century learning model. It is based on the belief that an authentic learning environment, a problem-based learning approach, and a collaborative learning approach are essential for our youth to develop the life skills that help them thrive in a digitally advanced society. Further study is required to comprehend how various factors influence team performance in solving complex problems. This study compares the contributions of individual effort and teamwork to team performance, specifically with the ERPsim problem. A qualitative observation research approach is appropriate for addressing the above research question to gain an in-depth understanding of the whole learning process.

3 Methodology

3.1 ERPsim as a Tool to Solve Complex Problems

ERPsim was developed by HEC Montreal and is used by many universities and businesses worldwide to convey knowledge about the importance of ERP systems. We employed ERPsim, a business simulation tool miming a real-life ERP system, to observe problem-solving in complex business scenarios [15]. ERPsim game was played within 2 consecutive rounds with 20 min each round. Each team organizes its roles and decisions making processes, including setting the product prices, setting marketing strategy, setting inventory policy, and forecasting their demand for operation planning.

3.2 Participants

Participants for this study came from various channels, such as high school students and full-time undergraduate students in Thailand. A total of 255 participants completed the study, with 100 males and 155 females. The age range of participants was from 16 to 22 years old. Furthermore, participants' education levels varied, with 67% being high school students and 33% undergraduate students. In addition, one of the teams from a participating school was considered gifted high school students with a high IQ (Intelligence Quotient) who received scholarships from the Thai government.

3.3 ERPsim Workshops: Enhancing Organizational Knowledge Through Business Gaming

The joining participants would be four to nine people in each online workshop. Before the game started, the instruction of the ERPsim game was provided to them with an oral presentation and soft copy. There would be a few tasks and decisions to manage and be solved in the first round to allow participants to get used to the game's operation. The company's performances were reported at the end of the first round. Additional instructions were provided next. Each team would then receive 10 min of internal discussion to make their plan. The second round is continued (Table 1).

Table 1. The workshop details the number of teams, participants, and type of participant.

Workshop number	Number of teams	Number of participants	Type of participant
1	8	48	High school students
2	6	48	High school students
3	7	42	Undergraduate students
4	5	40	High school students
5	10	57	High School students
6	4	20	Undergraduate students

3.4 Game Performance Assessment

After each round in ERPsim, company valuation data is generated to evaluate the performance of each team. The team with the highest company valuation is deemed the first-ranking team, while the team with the lowest is considered the losing team. Our data collection techniques included recording videos and audio while taking detailed notes. Throughout the game, researchers carefully observed each team's behaviors, and the whole process was video recorded. Qualitative observation is a reliable research method in various fields, including sociology, anthropology, psychology, education, and healthcare. It involves systematically observing and recording people's behaviors and statements in natural settings to better understand complex human behaviors and experiences. This method enables researchers to collect descriptive and subjective information that cannot be obtained through experimental settings. Therefore, qualitative observation is an effective tool for gaining insights into people's actions and experiences in their natural environments [16].

Ethical considerations, including obtaining informed consent from participants and maintaining confidentiality, were considered throughout the observation process. By utilizing these techniques, we gained valuable insights into the impact of individual and team behaviors on team performance in the context of collaboration within the ERPsim problem.

3.5 Data Analysis

Thematic Coding and Categorization

Our research team includes experienced experts who have almost two decades of in-depth knowledge in qualitative research (second and third authors) and graduate students in management technology. During the data analysis stage, these three authors watched a video recording multiple times and noted the participants' behaviors. The triangulation method was utilized to ensure the authenticity and credibility of the data analysis. We conducted thematic analysis by identifying, analyzing, and interpreting the emerging themes. Then we grouped the data items with shared meanings and identified the key insights that emerged from the data. The following is a list of behaviors that were assessed during the interpretation of data.

Coding Scheme of Data

Coding schemes involve categorizing qualitative data into groups based on their shared meaning. To create coding schemes, firstly, researchers need to identify key concepts or themes in the data and assign code to them [17].

Team Observed Behaviors

- Communicative skill: how team members make verbal, direct, or indirect communication to exchange information, ideas, and thoughts.
- Collaborative skill: how team members depend on or relate to each other. Such as active learning, constructive feedback, open communication, clear role and responsibilities, and conflict resolution.
- Team flexibility: team members' ability to adapt and respond to changes and challenges, such as during the game, a team member had some characteristics, including adaptability, creativity, open-mindedness, and willingness to change course.
- Team autonomy: the level of freedom of team members in the group, such as decision-making authority, self-management, and flexibility in approach.
- Critical thinking skills: team members involved with reasoning analysis and discussed ideas from all team members before implementation.
- Creativity: the level of team members within the team; try to use another function in the ERPsim game. For instance, they tried to use graphs before they made a decision in the game.

Individual Observed Behaviors

- Problem-solving skill: different individual problem solving such as trail-error, systematic problem-solving, creative problem-solving, good strategies, and efficient problem-solving.
- Leadership: various leadership styles that each member had used, such as flexibility in leadership style, clear communication, decision-making ability, and empathy.
- Individual intelligence quotient (IQ): the remarkable ability of each team member, such as quick problem-solving ability, logical thinking, creativity, and analytical skills.

4 Result and Discussion

4.1 Emerged Themes

Individual High Intelligence Quotient (IQ) Did Not Affect Team Success in ERPsim
Before the game was implemented, we expected that the team with highly intelligent individuals would perform better during the game. However, according to the researchers' observations, this team needed more communication and collaboration during the game. Regrettably, this led to a lack of ownership among team members and low motivation and engagement, ultimately resulting in the team delivering the poorest performance (Table 2). This group of students lacked the necessary communication and collaborative skills to complete the task. Other factors, such as the technological and social barriers in an online learning environment during the COVID-19 pandemic, made it more challenging for some students to focus and engage in the task.

To sum up, we conclude that the team with a high individual intelligence quotient (IQ) had no advantage in succeeding in the ERPsim context. This finding matches the outcome of another similar research conducted by [18].

Table 2. Emerged behaviors of team and individual during playing ERPsim for all workshops.

Highest Performance Team	Lowest Performance Team
Individual Behaviors	Individual Behaviors
High Problem Solving Effective Leadership	High Individual IQ Lack of Leadership in the Team
Team Behaviors	Team Behaviors
High Critical thinking Skills High Communication Skills High Collaborative Skills High Creatively High Team Flexibility High Team Autonomy	Little Communication Little Interaction within the Team Low Motivation Low Engagement

Clear Communication and High Collaboration Skills Lead to Team Success
Based on the data from researchers' observations, communication and collaboration within a team were crucial in solving complex decision-making. Our research finding indicates that all high-performance teams demonstrated high communicative and collaborative skills. As the members of these teams communicated with each other more, they were better at strategic planning and finding creative solutions to solve operational and tactical problems. They focused more on the collective cognitive game and the success of completing the tasks rather than individual gain. As a result, the team members were more flexible in adjusting to group demands.

Moreover, many members of these teams gave positive feedback after playing the game. They mostly found the game fun and engaging. Hence, clear communication

and effective collaboration led to team success and better individual learning outcomes. This conclusion is supported by some research studies which suggested that team members exhibited good collaboration and communication would help them identify actual problems and stimulate rapid solutions to counter these challenges [19, 20].

How ERPsim Help Develop 21st-Century Skills

Finally, we have identified several essential factors contributing to business simulation game success. These factors included leadership, problem-solving, critical thinking, creativity, and collaboration. In some workshops, we also discovered that team autonomy and flexibility positively impacted team performance. Our finding aligns with the study of [21, 22], which found that team autonomy and flexibility would serve a role in the team's success.

For the following reasons, we propose that the business simulation game, ERPsim, can enhance 21st-century skills. First, this simulation game has some data to provide participants to create visualization tools to support decision-making and match creativity in 21st-century skills. Besides, ERPsim also has one function that allows participants to think critically before deciding: to change the price list of products. This function needs participants to think critically following a dynamic environment. It could be created the critical thinking skill of the 21st-century skill.

Our findings suggest that the ERPsim game helps teams build strong communication and collaboration skills. During the game, each team was granted ten minutes to converse before the commencement to design strategies to win the game. They were motivated to maintain communication and collaboration throughout the game. This methodology is ideal for enhancing 21st-century learning skills. ERPsim is also invaluable for refining proficiencies such as team adaptability and independence. The game presents intricate predicaments requiring players to modify their strategies and objectives. ERPsim further encourages team autonomy as team members are incentivized to explore various game functions, which can enhance their decision-making abilities during gameplay.

We recommend that researchers further investigate the relationship between ERPsim and the 21st-century learning framework. For example, besides the 4Cs (critical thinking, communication, collaboration, and creativity), what other 21st-century skills can ERPsim enhance? Moreover, how can management educators better support members with poor communication and collaborative skills? Besides higher education, can the ERPsim be adapted to other grade levels, such as middle or elementary levels? These are some questions that researchers can look into in the future.

5 Conclusion

In conclusion, this qualitative study shows the business simulation game ERPsim's potential to develop 21st-century skills by providing participants with an authentic and engaging learning context. The finding suggests that individual IQ is a less significant predictor of team success than effective team communication and collaboration. Additionally, through working in teams, ERPsim supports each team member in nurturing the ability to remain flexible and autonomous during teamwork.

Lastly, the results of this study have critical implications for educators and practitioners in business and management to design the class or workshops by implementing

21st-century skills to enhance teamwork and collaboration skills in their curriculum. By doing so, we can better prepare our new generation with more comprehensive skills to thrive in complex and dynamic business environments.

Acknowledgment. This research has been supported by Sirindhorn International Institute of Technology (SIIT), Thammasat University, and the Center of Excellence in Logistics and Supply Chain Systems Engineering and Technology (COE LogEn), Sirindhorn International Institute of Technology, Thammasat University.

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Readiness to Expand Smart Learning via ePortfolio; Perception of Teachers and Students in a Higher Education Institute

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Abstract. ePortfolio is a Smart Learning platform promoting self-directed, reflective, and meta-learning, which can also be used in professional development. Most Smart Learning modalities can be implemented with simple technology readily available in everyday life. However, situational factors (availability and affordability of devices, internet, etc.) and misconceptions of these factors may hinder adaptation. We hypostasize a ground reality of realistic situational factors and imaginative resistance. This work, conducted at the University of Peradeniya, Sri Lanka, probes the influence of these perceptions, with an emphasis on ePortfolio. Both students and teachers are compared on their perceptions of situational factors, familiarity with technology, 21st-century skills, and ePortfolio. Results corroborated our hypothesis of over-emphasizing situational factors, which is more prominent among teachers. The study concludes that we are ready for Smart Learning despite negative techno-economical situational factors. Both groups got a positive impression of ePortfolio as a fruitful approach.

Keywords: Academic Readiness · Smart Learning · Situational Factors · ePortfolio

1 Introduction

Technology can be defined as 'the means of making day-to-day life efficient.' Smart learning connects this concept to pedagogy. The consensus is that Smart Learning in developing nations is hindered by the lack of affordable technology [1]. Contrary to this

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 148–151, 2023.
https://doi.org/10.1007/978-981-99-5961-7_16

popular belief, this study's central hypothesis is that "even though the negative effect of situational factors are significant, the over-emphasis (stigma) placed on such factors due to the fixed mindset of both student and teachers is the key resistance against the readiness towards Smart Learning." While the bulk of the study probes the overall readiness of Smart Learning adaptation, the latter part focuses on the role of ePortfolio. Several surveys were conducted at the University of Peradeniya, Sri Lanka, in March and April 2023 to validate the above hypothesis. 114 students and 27 university teachers representing all the subject areas participated voluntarily. A quantitative 'weighted average' parameter was used to interpret the degree of agreement of the responses. The commonly used scale here was '*Totally disagree*': −2, '*Disagree*': −1, '*Neutral*': 0, '*Agree*': +1, and '*Totally Agree*': +2. Some other scales were also used appropriately.

2 Results and Discussion

First, the perceptions of negative situational factors were probed to establish a baseline. Out of seven parameters surveyed, for both students and teachers, the sternest overall concern is the unavailability of reliable internet. The teachers have ranked the affordability of services as the most crucial issue for students. However, this seems slightly less of a concern for the students themselves than the teachers anticipated. Availability (despite the cost) of electricity seems the least of all concerns, on par with Sri Lankan statistics [2–5]. Students are not as worried about common university IT facilities as teachers expected. The teachers seem more worried than how students realistically perceive the situational factors. This supports the above hypothesis; while there are genuine concerns about negative situational factors, teachers slightly over-emphasize those.

Another critical bottleneck is the lack of readiness to embrace Smart Learning due to the unfamiliarity with technology. The lack of technical skills affects students more than teachers anticipate. Teachers believe that the transformation to Smart Learning does not affect active learning, but the students feel otherwise. None think Smart Learning should wait until technology becomes more available, with teachers taking a significant lead on this positive attitude. Regarding resolving technical issues versus delivering subject matter, teachers struggle more than students anticipate. Conversely, while teachers believe students are comfortable with technology, students also struggle. Both groups underestimate each other's technological underexposure. However, students and teachers equally say teachers are ready for Smart Learning. Both groups believe students are somewhat prepared, while students expressed readiness more than teachers expected.

Outcome-based education (OBE) learning activities and assessments should constructively align with the Intended Learning Outcomes (ILOs). We chose 21st-century learning skills as some general ILOs spanning the entire education system [6–8]. Induction of critical thinking and creativity via online teaching seems possible from both teacher and student perspectives, but students do not recognise it as teachers would. Both felt that technology dependence is detrimental to developing interpersonal skills [9, 10]. Both groups believe online learning can still induce reflective meta-learning, with teachers having greater confidence.

Most students (73%) were unfamiliar with ePortfolio, while teachers had higher exposure. However, systematic mentoring of ePortfolio is almost non-existent. Assessing ePortfolio is a premature but active topic in education [11, 12], while automated

mentorship via Artificial Intelligence is gaining traction [13]. The expectancy-value theory says students should first perceive the value of an outcome to succeed [14]. A value-expectancy analysis is crucial since ePortfolio is a high-gain, high-cost assignment. Here, both groups recognise the value of ePortfolio. Both think ePortfolio is more advantageous for students than teachers. While teachers believe there is no discrimination against disadvantaged students by adopting a technically demanding ePortfolio, some students perceive a risk of bias leading to diversity, equity, and inclusivity concerns. On the fears that ePortfolio might lead to copying and cheating, students stay almost neutral while teachers oppose the claim. This positivity might be due to the degree of the inherent genuineness of an extended assignment like an ePortfolio requiring a higher-order information synthesis [15]. When asked about the induction of self-directed, reflective, and meta-learning, teachers were twice as positive as students.

3 Conclusions and Further Directions

The objective of the survey was to gauge the readiness to adopt Smart Learning and the potential of ePortfolio. The key hypothesis, corroborated by the survey, was that 'the negative perception due to fixed mindset over emphasises the existent situational factors suppress Smart Learning readiness.' Implications for negative situational factors like the availability and affordability of smart devices and services are significant. However, teachers tend to slightly over-emphasize them than students. Teachers have shown a substantial lead in this positive mindset while slightly underestimating the student's readiness. Both groups think there is no need for further technical development and accessibility.

Most of the students were unfamiliar with ePortfolio, compared to teachers. Mentoring of ePortfolio is significantly absent, despite some being graded. Students, as well as teachers, unanimously agree that ePortfolio is beneficial for both, while the benefit to undergraduate students is highlighted. Teachers think technologically involved Smart Learning will not marginalise disadvantaged students, while some students have doubts. On the positive side, neither students nor teachers speculate ePortfolio promotes cheating and plagiarism. Both groups accept ePortfolio as a vehicle to encourage self-directed, reflective, and meta-learning.

It can be concluded that Sri Lankan higher education institutes are ready for Smart Learning despite negative techno-economic factors. Both students and teachers have positive impressions of the merits of ePortfolio as well. The greatest challenge is the over-emphasis on situational factors by the teachers.

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Research Hotspots of International Learner Modeling—Visualization Analysis Based on the Literature of WOS Retrieval Database from 2009 to June 2022

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Abstract. Learner modeling is one of the research hotspots in the topic of smart learning. This study used visual analysis software to map the co-citation networks of 15 kinds of SSCI journals literature published from 2009 to June 2022 in learner modeling, and found that five groups of academic research institutions and six schools of academic communities have been broadly formed internationally. Hot topics of research include context-aware learning environment modeling, affective state modeling based on affective computing, learner community modeling and instructional management system based on intelligent technology, dynamic modeling of learner personalized characteristic parameters based on interaction parameters of the learning process, research on the application of learner modeling in a subject area or a region, learner domain knowledge modeling based on visualization technology and learning evaluation and performance.

Keywords: learner modeling · hot topic and research frontier · SSCI academic journals · knowledge mapping

1 Introduction

As a 'digital native', learners in the 21 st century need to have the skills of learning, innovation, information technology, life and occupation at the same time. Therefore, it is particularly necessary to realize large-scale personalized education through digital technology and cultivate students' core skills. It is necessary to create a new talent training mode combining large-scale education and personalized training through information technology, so as to promote the process of education modernization [1]. In September 2020, UNESCO released the report *"The Digital Transformation of Education: Connecting Schools, Empowering Learners"*, arguing that digital transformation has created a new paradigm for learning [2]. The global novel coronavirus epidemic of nearly three years is not the main cause of digital transformation, but it has played a catalytic role. These involve learner modeling research and will gradually become a normal state in the era of artificial intelligence. Learner model is the core of personalized learning support service. Learner modeling is the process of collecting, analyzing, mining and

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 152–157, 2023.
https://doi.org/10.1007/978-981-99-5961-7_17

constructing corresponding digital models for learners' knowledge and skills, cognitive behavior, emotional experience and other characteristics, and constantly updating learner models[3]. Therefore, this paper uses bibliometrics to explore the frontiers and hotspots of learner modeling.

2 Research Design

In this study, the advanced search formula ((((((((((AK = (learner model)) OR AK = (learner modeling)) OR AK = (student model)) OR AK = (student modeling)) OR KP = (learner model)) OR KP = (learner modeling)) OR KP = (student model)) OR KP = (student modeling)) OR AK = (user modeling)) OR AK = (user model)) OR KP = (user model)) OR KP = (user modeling) was used to search 21 SSCI source journals with influence in the discipline of educational technology from 2000–01-01 to 2022–06-30 in the core database of Web of Science, and finally 289 articles from 15 journals were obtained. Data such as 'full records and cited references'. This study comprehensively uses CiteSpace and VOSviewer software to draw a knowledge map of the above literature, so as to explore the hotspots and frontiers of research on international learner modeling.

3 Bibliometric Results

In terms of the number of publications and citations, both Computers & Education and Educational Technology & Society have a great impact on the research field of learner modeling. From the distribution of academic research institution, there are five academic institutions from China and two academic institutions from the United States and Malaysia, which reflects that China, the United States, Malaysia and other countries have a certain influence in the international community and occupy a certain academic position.

The high betweenness centrality indicates that the importance of points in the network is high, and vice versa [4], to a certain extent, it represents high-impact scholars. According to the author's co-citation clustering map, the six most influential academic community factions in current learner modeling research are Hwang, G.J. of Taiwan University of Science and Technology, Zhang Zhixian, honorary professor of the University of Macau and the University of Auckland, New Zealand, Waleed Mugahed Al-Rahmi of Malaysia University of Technology, and Davis of the University of Michigan. An academic group centered on scholars such as Fred D., Viswanath Venkatesh of the University of Maryland, and D. H. Jonassen of Columbia University.

4 Research Frontier

The literature co-citation map drawn by CiteSpace visualization software can reveal the research hotspots and frontier evolution [5]. CiteSpace software is used to draw the literature co-citation clustering map of international learner modeling related research, as shown in Fig. 1. Spectral analysis module value $Q = 0.822 > 0.3$, which means that

the keyword clustering structure is significant; the average contour value S = 0.9356 > 0.7, indicating that the clustering is efficient and convincing. The top ten key node literatures of citation frequency and burst value are sorted out.

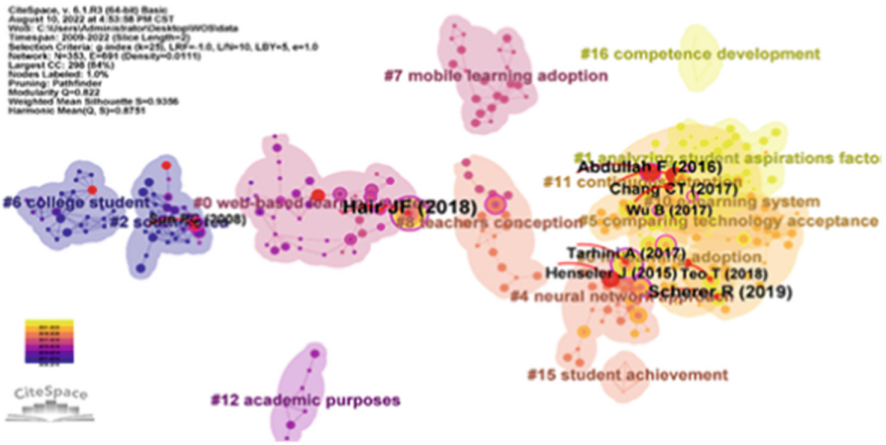

Fig. 1. Literature Co-Citation Map Clustering

5 Research Hotspots

The keyword co-occurrence map can reflect the current and past research hotspots in a certain field [4]. This paper uses CiteSpace visualization software to draw the keyword co-occurrence map, as shown in Fig. 2. Spectral analysis module value Q = 0.7403 > 0.3, which means that the keyword clustering structure is significant; the average contour value S = 0.8917 > 0.7, indicating that the clustering is efficient and convincing.

In order to explore the relationship between high-frequency keywords and reveal the hot spots and trends of current research on international learner modeling, CiteSpace software is used to form a overlay map of keyword co-occurrence clustering and emergent subject words. Combined with the local distribution of keyword co-occurrence clustering of international learner modeling research reflected in Fig. 1, it can be concluded that the current research on international learner modeling mainly focuses on:

Learning Environment Modeling and Learner Emotion Modeling

The research topics of # 2, # 4, # 8, # 9, # 11 are learning environment modeling based on context awareness and emotional state modeling based on affective computing, which are relatively new development directions of learner modeling research in recent years.

Based on the literature retrieved, this type of literature mainly includes three research directions. First, focus on the observation, collection and analysis of data that learners change in the external environment or context, so as to continuously update the learner model. Akgül et al.have shown that the matching degree between perceived technology and learning tasks is the biggest factor affecting learners' use of Facebook or Meta [6].

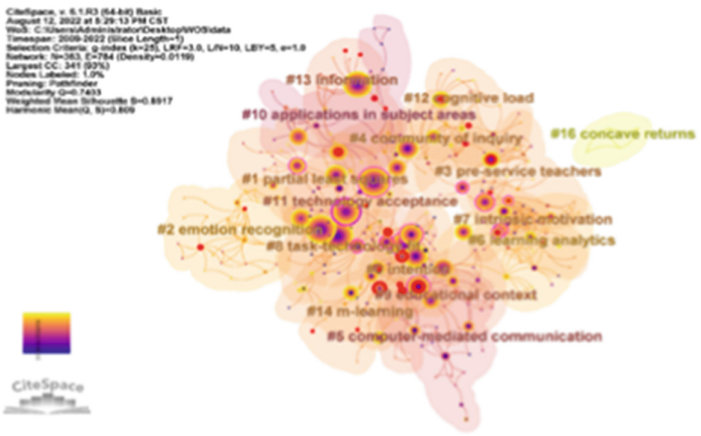

Fig. 2. High-Frequency Keyword Co-Occurrence Network Map

Secondly, according to the learner's subjective decision-making, the model is calculated and predicted. Theodore J. Kopcha et al.'s research shows that immersive learning based on situational models is conducive to learners' decision-making on a certain issue [7]. Thirdly, attention is paid to the identification and monitoring of learners' emotional state through the measurement of learners' psychology, physiology and behavior [8].

Learner Community Modeling

1, # 6, # 16 are learner community modeling and teaching management system based on intelligent technology. Based on the comprehensive research literature, this type of research mainly focuses on two directions. First, with the integration of digital twin, holographic projection and human-computer interaction, learner modeling is developing towards the direction of learner community modeling with space-time integration. For example, Bull, S. and Kay, J. have conducted in-depth research on open learner modeling, which allows learners to see the information of their own models and share knowledge and feedback with peers and teachers, so that learners can reflect on themselves [9]. However, open learner modeling is currently only applicable to certain specific learner groups. Second, the development of intelligent technology promotes the construction of intelligent teaching management system. For example, Hedberg, J.G.confirmed that applying the concept of community of practice to learner modeling can produce new and effective management methods and learning paradigms [10].

Learner Dynamic Modeling

The research topic of the four clusters of # 0, # 7, # 12, # 14 is to dynamically model the learner's personalized feature parameters based on the interactive parameters of the learning process.Based on the existing literature, this research type mainly includes two research directions. First, research on learner modeling based on digital aborigines or digital aborigines. Second, based on the dynamic changes of learners' personalized feature parameters, it provides learners with more timely learning resources, and intelligently evaluates learners based on these dynamic parameters. For example, Mills K. L.

and other scholars have studied the similarities and differences of personalized feature parameters in the learner models of the two major learning groups of digital natives and digital natives, focusing on the influence mechanism of the digital learning environment on the learning process of different learning groups [11]. The research has certain value for the modeling of learners based on different groups.

The Application of Learner Modeling

The research topics of # 3, # 10, # 13 and other three clusters are the application of learner modeling in a certain subject field or a certain area.According to the comprehensive research literature, there are two main research directions in this research type. First, the research on the application of learner modeling in the subject field. For example, Lee M.C. et al.'s research shows that the information system success model is a very good prediction model. However, the existing research has less interdisciplinary research on digital learning and other disciplines, which limits the wide application of the research results [12]. Second, the application of learner modeling in a country or a special environment. For example, Tarhini A. et al.found that e-learning needs to focus on the social and cultural background of learners, thereby overcoming the interpretability of the learner model [13].

Learner Domain Knowledge Modeling and Evaluation

The research topic of # 5 clustering is learner modeling based on visualization technology, which is a new trend in recent years.Based on the comprehensive research literature, there are two main directions for this research type. First, use visualization technology for knowledge representation. Secondly, through the construction of knowledge map, knowledge concept map, subject knowledge map and interdisciplinary knowledge map, this paper explores the cognitive mechanism of learners' decision-making on resource application, so as to provide learners with personalized and accurate learning path and intelligent evaluation.

Acknowledgement. The authors gratefully acknowledge the financial supports by the "Guangxi Postgraduate Education Innovation Plan Project", "Collaborative-Integration-Throughout" Master of Education Talent Training Mode Research ' (Project Number: XJJY2020004).

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An Adaptive Testing Approach for Competence Using Competence-Based Knowledge Space Theory

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Abstract. The increasing demand for personalized learning experience has driven the need for more effective and accurate computerized adaptive testing (CAT) in education. In this study, we present a novel CAT algorithm grounded in the Competence-based Knowledge Space Theory. The algorithm employs maximum likelihood estimation (MLE) for parameter estimation, utilizing a uniform prior distribution in the absence of prior information. It employs a "half split rule" for question selection, ensuring the efficient and accurate estimation of student abilities, and incorporates Laplace smoothing to mitigate overfitting. An information entropy-based termination rule is proposed to strike a balance between efficiency and accuracy in the adaptive testing process. The proposed algorithm contributes to the development of more effective and personalized intelligent tutoring system (ITS) by accurately assessment student competence state and minimizing testing time.

Keywords: competence-based knowledge space theory · adaptive testing · competence state

1 Introduction

Adaptive testing is an intelligent and personalized evaluation method that dynamically adjusts the difficulty of test items according to the actual ability level of the subject. In recent years, with the continuous development of technologies such as big data and artificial intelligence, adaptive testing has gradually become a research hotspot in the field of ITS. Researchers draw from empirical methods, precise measurement, and quantitative analysis techniques found in the natural sciences to explore accurate methods for assessing learners [1]. However, achieving this goal relies not only on the assessment technology itself but also on a deep theoretical modeling and understanding of students' cognitive processes [2]. Hence, Knowledge Space Theory (KST) emerged to provide a theoretical framework for adaptive testing. The Competence-based Knowledge Space Theory (CbKST) is an extension of KST at the competence level, aiming to support the development of adaptive testing methodologies. Recently, adaptive testing systems, such as APeLS, and Knowlab, have successfully employed CbKST across various disciplines

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 158–163, 2023.
https://doi.org/10.1007/978-981-99-5961-7_18

[3–5]. However, existing adaptive testings struggle to strike a balance between efficiency and accuracy. Striking a balance between algorithmic complexity and computational efficiency is crucial to ensure that adaptive testing systems can accurately predict and update a learner's knowledge state in real-time while maintaining a smooth and responsive user experience. This involves making trade-offs between the level of detail and accuracy in the predictions and the computational resources required to achieve those predictions.

In this study, we aim to address the limitations by developing a novel adaptive competence assessment method based on the CbKST framework, which offers a more accurate and efficient approach to adaptive testing.

2 Main Concept of CbKST and Related Work

KST is a knowledge assessment method based on lattice theory, topology, and probabilistic models, proposed by Belgian mathematical psychologists Jean-Paul Doignon and Jean-Claude Falmagne in 1985. CbKST integrates the concepts of competence and skill into the original KST framework, allowing for a more comprehensive assessment of subject's competence state. CbKST provides a more nuanced understanding of learners' observed performance and latent competence, enabling the development of adaptive testing methods that better capture the specific strengths and weaknesses of each individual. This approach, in turn, supports the creation of tailored educational interventions and contributes to improved learning outcomes for students. The adaptive testing process in CbKST comprises both deterministic and non-deterministic processes. The non-deterministic process, which takes into account the factors of students' guesses and errors, is more consistent with real-world scenarios.

Falmagne and Doignon introduced two types of non-deterministic processes: discrete and continuous processes [6]. Discrete processes involve updating preliminary knowledge states generated by deterministic processes, while continuous processes utilize likelihood functions to assess the credibility of knowledge states and update them based on student responses throughout the assessment process. Discrete processes focus on distinguishing between proximal knowledge states, whereas continuous processes continuously update likelihood functions across the entire knowledge structure until the most probable knowledge state is identified. Research has shown that continuous processes outperform discrete processes in terms of both efficiency and accuracy [7]. However, the efficiency and accuracy of continuous processes may be adversely affected when error probabilities for questions and prior information settings are inaccurate.

Within the framework of KST, the classic method for implementing adaptive testing is the Continuous Markov Process method proposed by Falmagne and Doignon [8], shown in Fig. 1. A continuous Markov process is a stochastic process that models the transition of a system between different states over a continuous time domain, with the Markov property dictating that the future state of the system depends solely on the current state and not on its history. The continuous Markov process is an iterative procedure that utilizes a likelihood distribution $\mathcal{L}_m : \mathcal{K} \rightarrow R$ to estimate knowledge states, where $\mathcal{K}$ represents the domain and R represents the range. At each step n, the likelihood distribution is updated based on new information. Unless prior information is available, the initial likelihood distribution $\mathcal{L}_0$ is uniformly distributed. In each step

n, the process: (I) selects a new question for the student; (II) updates the likelihood distribution of knowledge states based on the student's response; (III) determines if sufficient information has been collected, and if so, terminates the process [9].

These three processes correspond to three essential rules in adaptive testing: the question rule, the update rule, and the stop rule.

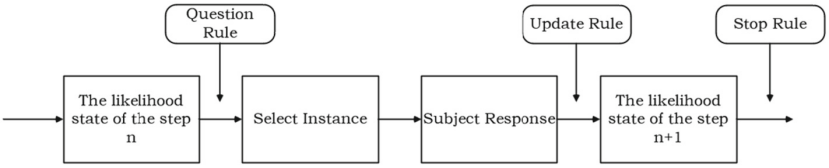

Fig. 1. Adaptive evaluation based on continuous Markov process

Building on the continuous Markov process research, Anselmi et al. introduced an adaptive testing method using Bivariate Markov Processes (BMPs), which consist of two continuous-time stochastic processes, one observable and the other latent [4]. These two processes together form a Markov process, and a series of constraints consistent with the concepts of CbKST are applied to the bivariate Markov process. Researchers applied the bivariate Markov model to real student data navigated in the ITS Stat-Knowlab. The results showed that these constraints helped to better reflect students' learning processes in online educational systems, allowing the bivariate Markov process to more accurately describe students' navigation behavior in ITS and the transitions between states in the competence structure [4]. Following Anselmi et al.'s exploration, Brancaccio et al. proposed three adaptive processes based on Markov Solution Process Models [9] to assess problem-solving skills, outperforming continuous Markov process in accuracy and efficiency. However, these studies have not yet fully addressed the potential shortcomings of their update and stop rules, leaving room for further exploration and optimization in the context of adaptive testing techniques.

3 Approach to Provide Adaptive Testing for Competence

In this study, we propose a novel algorithm for CAT, which employs the MLE method for parameter estimation (see Fig. 2). The likelihood function $\mathcal{L}_0$ represents the prior distribution of the competence state set C $\in C$. In the absence of prior information, a uniform distribution is chosen as the prior distribution.

At each step n > 0, the likelihood function $\mathcal{L}_n$ for the competence state set C $\in C$ is updated. Let $\mathcal{L}_n$ (C) ≥ 0 denote the likelihood of a student's competence state being C at step n (i.e., the probability that the student is in competence state C), satisfying $\sum_{C \in \mathcal{C}} \mathcal{L}_{n(\mathcal{C})} = 1$, in accordance with the probability distribution.

At each step n > 0, the question rule adopts the "half split rule" to choose the most informative question $q \in Q$.$\mathcal{K}_q$ is the set of all states containing item q. The "half split rule" aims to select the question that divides the current knowledge state space roughly in half, thereby maximizing the information gained from the learner's response. The

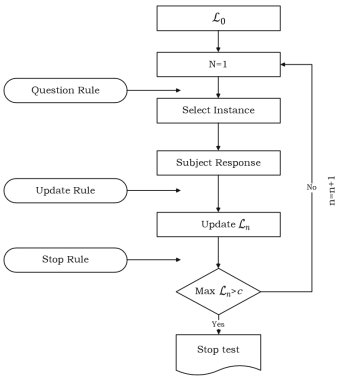

Fig. 2. Adaptive evaluation for competence

selected question minimizes the absolute difference $\left|\mathcal{L}_n(\mathcal{K}_q) - \frac{1}{2}\right|$, which implies that under the current estimated competence state, the likelihood of a student answering the question correctly is approximately equal to the likelihood of answering incorrectly.

The student will proceed to answer the selected question. Based on the student's response to question q (correct or incorrect) denoted by $R_q \in 0, 1$, the update rule determines the likelihood function L_{n+1} at step n + 1 using Bayes' theorem.

While updating the likelihood function, overfitting may occur, i.e., relying too heavily on individual student responses. This issue can generally be addressed through regularization techniques or smoothing methods. Laplace smoothing is a widely used technique in probability estimation, particularly in the context of natural language processing and Bayesian inference [10]. In this study, Laplace smoothing is introduced to modify the original update rule, following the recommendations of [11] and [12]. A small constant α (e.g., $\alpha = 0.1$) is added to each competence state C in both the numerator and denominator of the likelihood function. This ensures that each competence state has a non-zero probability, thereby avoiding excessive reliance on individual student responses. The updated Bayesian formula is as follows (Eq. 1).

$$\mathcal{L}_{n+1}(C) = \frac{P(R_q|C)(\mathcal{L}_n(C)+\alpha)}{\sum_{C' \in \mathcal{C}} P\left(R_q|C'\right)\left(\mathcal{L}_n\left(C'\right)+\alpha\right)} \tag{1}$$

In practical applications, the value of α should be adjusted according to specific circumstances. This approach effectively mitigates overfitting and ensures a more accurate and robust estimation of a student's competence.

Existing stop rules generally involve stopping the diagnostic process when max $\{Ln(C):C \in C\} >$ c is satisfied. In this study, we attempt to employ a stop rule based on information entropy to enhance efficiency and accuracy. Information entropy measures the uncertainty of a probability distribution, and by setting an entropy threshold, the evaluation efficiency can be improved while maintaining accuracy. When the threshold is low, the testing time is shorter but accuracy is still ensured; when the threshold is high, the testing time is longer and accuracy is further increased. The diagnostic process stops when $H(\mathcal{L}_n) < h$ is satisfied, where $H(\mathcal{L}_n)$ is the entropy of the likelihood function distribution $\mathcal{L}_n$, and h is a predetermined entropy threshold. In practice, the selection

of an entropy threshold may involve trial and error or data-driven approaches, such as cross-validation or empirical analysis, to identify a suitable value that achieves a desired balance between efficiency and accuracy in the context of the specific assessment system being used. The entropy calculation formula is as follows (Eq. 2).

$$H(\mathcal{L}_n) = -\sum_{C \in \mathcal{C}} \mathcal{L}_n(C) \log_2 \mathcal{L}_n(C) \tag{2}$$

By adopting this information entropy-based termination rule, the proposed algorithm strikes a balance between efficiency and accuracy in the adaptive testing process, thereby enhancing the overall performance of the ITS.

4 Conclusion

This study focuses on developing an innovative adaptive competence assessment method based on the CbKST framework. The proposed algorithm integrates MLE, a half-split question selection rule, and an information entropy-based termination rule, offering a novel and efficient approach to adaptive testing. The algorithm's potential implications for ITS and competency-based assessments include improved accuracy in measuring student competence and enhanced ITS effectiveness. Additionally, the algorithm's adaptability enables continuous refinement based on real-world performance, increasing the reliability and validity of competency-based assessments.

Future research will be undertaken to verify the practical efficacy of this algorithm, encompassing the design of assessment questions, the recruitment of test subjects, and the analysis of the test's reliability and validity. Adjustments will be made to the algorithm based on its performance in real-world scenarios, with the aim of enhancing its adaptability and effectiveness. This work paves the way for advancements in ITS, ultimately facilitating a more nuanced understanding and support of individual student needs and competences.

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Boosting Digital Transformation: Exploring the Post-pandemic Challenges of Academic Credential Distribution Systems in a Philippine HEI

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Abstract. The COVID-19 pandemic in 2020 forced the widespread adoption of online and digital technologies as physical interactions became limited. As the economy gradually recovered and businesses reopened, companies in the Philippines continued to conduct their recruitment processes online. This posed a challenge for applicants in obtaining their academic credentials like Transcripts of Records and Diplomas. In response to this issue, a study was conducted at Mariano Marcos State University to assess the technological capabilities, personnel skills, and processes of academic credential management and distribution. The study revealed that the university had adequate infrastructure and skilled employees, but delays in processing time were identified as a significant problem. The university's reliance on issuing hard copies of credentials also posed difficulties for online job applications. It is recommended that the university transition to a system that provides both hard and digital copies of credentials and offers verification options without requiring personal authentication at the university.

Keywords: Education · Record Management · Transcript of Records · Diploma · Academic Credentials

1 Introduction

With the global COVID-19 pandemic, imposition of different lockdown measures by governments worldwide, including the Philippines. This resulted in job losses as businesses downsized their workforce. However, the introduction of new vaccines in 2021 allowed the country to gradually open, leading to a rapid economic revival and a surge in employment opportunities. Employment rate reached 91.1 [1] and further increased in to 94.7% and 95% in August and September 2022, respectively. With significant growth in sectors like manufacturing, education, public administration, social securities, transportation and real estate.

Leveraging the COVID-19 pandemic's impact on job search methods, Filipinos have embraced e-recruitment platforms, leading to challenges in obtaining essential documents such as academic credentials. In light of this, the current study aims to analyze

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 164–169, 2023.
https://doi.org/10.1007/978-981-99-5961-7_19

the academic credential distribution system in a Philippine Higher Education Institution (HEI) and identify existing deficiencies. By laying the groundwork for future improvements, this research seeks to address the complexities associated with processing and distributing credentials in the digital recruitment era.

2 Related Literature

Universities play a vital role in shaping individuals' future by providing education and credentials that demonstrate their knowledge and skills. Academic records, such as TOR and diplomas, serve as proof of achievement and are essential for employment applications. The adoption of Electronic Record Management Systems (ERMS) has greatly improved the efficiency, accuracy, and security of processing and distributing academic records [5]. ERMS reduces reliance on physical storage, enables faster information sharing, and enhances data integrity [3, 6, 7]. However, successful implementation of technology in universities depends on factors like technical infrastructure, organizational culture, management support, and staff training [2, 4]. Inadequate record management systems can negatively impact students' career prospects, leading to delays and loss of academic records [9]. Addressing challenges in infrastructure, staff training, policies, and resource allocation is crucial for improving ERMS efficiency [8, 10].

This study focuses on Mariano Marcos State University, a medium-sized university situated in the City of Batac, Ilocos Norte, Philippines. It is classified under the Carnegie Classification for universities and recognized as a State University and College (SUC) by the Commission on Higher Education (CHED). With 11 colleges spread across three campuses and two satellite campuses, the university offers a comprehensive range of academic programs from pre-school to graduate school. Mariano Marcos State University has gained recognition as a Center of Excellence in Teacher Education and a Center for Development in Agriculture, Biology, Forestry, and Information Technology Education [11].

This research aims to characterize the current academic credential distribution system of Mariano Marcos State University. The specific objectives of this study are the following:

1. To characterize the current process of credential management of the University
2. To Assess the current technical infrastructure of the university with regards to supporting the academic record management system.
3. To Assess the current technical and skill capabilities of the personnel in charge of the academic record management system.
4. To Identify the challenges associated with the process of distribution of academic credentials.

3 Methodology

To collect data for this study, two methods were utilized. Firstly, document analysis of the university's official Process Flowchart (2018) was conducted, providing insights into the university's policies and unique identity [13]. Secondly, a descriptive survey design using randomized sampling [12] was employed to understand the current capabilities

of the academic credential distribution system and assess respondent satisfaction with the Transcript of Record (TOR) acquisition process. The randomized sampling ensured equal representation of all respondents, classified into two main groups: Group A (university personnel) further divided into the Registrar's Office and Information Technology Center (ITC), and Group B (students and alumni). A total of 12 questionnaire responses were collected from Group A, with 4 from the Registrar's Office and 8 from the ITC. Group B comprised 348 respondents, including 81 alumni and 267 students who had experienced the TOR or Certificate of Grades (COG) request process. The data collected were analyzed using a combination of Likert scale and multiple-choice questions (Table 1).

Table 1. Survey Demographic

	Group A			Group B		
	Registrar's Office	ITC Department	Total	Students	Alumni	Total
Frequency	4	8	12	267	81	348
Percent	33.33	66.67	100	79.6	20.4	100

4 Results and Discussion

4.1 University Academic Credential Distribution System

The University's process Flowchart from 2018 reveals that the current method for requesting and issuing academic credentials, such as TOR, is done manually. According to the flowchart, students or alumni requesting their TOR needs to obtain a university clearance, pay the necessary fees, and wait for the issuance of their TOR. Currently, the university requires the physical presence of the requester when applying and receiving the document due to data privacy concerns. However, authorized representatives can request on behalf of the requester. Moreover, the university is in the process of developing an online system that will allows students and alumni to request their academic credentials through a secure web portal with online payment options.

The IT infrastructure plays a crucial role in supporting the academic credential distribution system. It encompasses two main aspects: hardware and software capabilities. After analyzing the data, it was evident that the respondents strongly agreed on the university's provision of essential equipment such as physical servers, desktop computers, printers, scanners, and network infrastructure to support the Electronic Records Management System (ERMS). They also acknowledged the availability of cloud-based servers and backup power. Additionally, the staff members expressed satisfaction with the existing hardware components that support the ERMS. Moreover, the IT team perceived the current software infrastructure, including an up-to-date operating system, database management system, and student information management software, to be capable of

supporting the ERMS. They also acknowledged the presence of security features within the system. In conclusion, based on the respondents' perceptions, it can be inferred that both the hardware and software infrastructure of the university are deemed capable of supporting the existing academic credential distribution system.

The proficiency of personnel in using and resolving technical issues with a technology is also a factor in the efficiency of a system. It is essential for personnel to possess the required expertise to effectively manage and operate the system, as well as address student inquiries and technical difficulties. To assess the current technical and skill capability of the personnel responsible for the management of records, a survey questionnaire was utilized. The personnel were divided into two groups: ITC personnel and Registrar's office personnel. The survey revealed that the technical team and clerical team strongly agreed that they possess the necessary technical and clerical/administrative skills, respectively, to perform their duties effectively. Furthermore, they also indicated that they have received adequate training. Based on this evaluation, it can be concluded that both the personnel in the ITC department and the Registrar's office have the requisite technical competency and skills to proficiently use and troubleshoot the existing system.

4.2 Challenges of Academic Record Distribution

A survey questionnaire was administered to both students and alumni to understand the challenges they faced in obtaining their academic records. The collected data was analyzed by determining the mode for each category. The findings indicated that a majority of the respondents, accounting for 90.52% out of the total 348, requested their academic credentials in person at the registrar's office. Only a small percentage, 8.05%, requested them online through email, and an even smaller fraction, 1.15%, opted for mail requests. In terms of processing time, 37.07% of the respondents waited for 1–3 business days, while 36.21% waited for 4–5 business days. A smaller percentage, 12.07%, received their credentials on the same day, while 11.78% experienced a waiting period of 2–3 weeks, and 2.87% had to wait for more than 4 weeks to receive their academic records.

The survey also aimed to gauge respondents' satisfaction with the current service and process of obtaining academic credentials. Mean ratings were calculated to analyze the data, revealing that respondents were generally content with all aspects of the survey. This encompassed the speed and accuracy of transcript processing, ease of submission, confidence in record security and confidentiality, availability of technical support, and overall record management system of the university. However, upon closer examination, it was observed that some respondents faced challenges during document processing, with long wait times for in-person requests being the most prominent issue. This delay can significantly impact students' employability, potentially resulting in missed job opportunities and prolonged financial difficulties (Table 2).

Table 2. Frequency of the different problems encountered by the respondents

Problem encountered	Frequency	Percentage of the total sample population
Long wait times for in-person request	134	32.9%
Difficulty accessing the online system	28	6.9%
Confusing instructions or information	24	5.9%
Technical difficulties with the online system	20	4.9%
Unresponsive staff	18	4.4%

5 Conclusion

The COVID-19 pandemic has accelerated the adoption of e-recruitment, requiring universities like Mariano Marcos State University to adapt their academic credential distribution system. This study assesses the university's technical infrastructure, personnel capabilities, and the distribution process. Overall, the university's hardware and software capabilities are sufficient, and personnel in both the ITC department and Registrar's office have the required skills. Students and alumni express satisfaction with the current service. However, challenges remain, such as issuing paper transcripts and handling on-site requests due to data privacy and security concerns. Students face issues with long waiting times, technical difficulties, and confusion regarding processing instructions. To address these challenges, the university should prioritize faster processing and the issuance of authenticated digital copies of academic credentials. This will enable students to more effectively apply to e-recruitment portals and support their transition into their desired careers.

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Analysis of Factors Influencing the Use of Social Media Chat Applications for Learning During Covid Pandemic Based on the Stressor-Strain-Outcome Framework

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Abstract. The increase in internet use, including social media chat during the pandemic has had a distinct impact on students. Students use social media chat applications for learning and socializing activities. Several previous studies were carried out under normal conditions and situations, this research was carried out when the covid condition was still ongoing. One of the situations causing stress. The research was conducted using quantitative methods with Structural Equation Model and Partial Lease Square. The 202 respondents from several cities in Indonesia. The study found; WhatsApp chat application was most widely used by students. The factors connectedness (17.0%), feasibility (29.4%), and support (41.2%) influenced effectiveness. Connectedness (37.4%), feasibility (15.8%), support (22.2%) influences the motivation factor. Effectiveness (16.2%influencesility (24.5%), Motivation (16.1%), and Support (20.0%) influence the use of social media chat for learning. The Connectedness factor has no effect on the use of social media chat applications for learning.

Keywords: Social Media Chat Application · Learning Support · Stressor Strain Outcome Framework · Structural Equation Model

1 Introduction

The COVID 19 pandemic has altered many settings, including the order of learning. Learning activities cannot be carried out normally or face to face, so various media are used to aid the course of learning activities, one of which is social media chat applications. The increase in internet use including social media chat during the pandemic has had a distinct impact on users, especially students [1]. Students use social media chat applications for learning and socializing activities [2–4]. Several previous studies were carried out under normal conditions and situations. Social Media used by local and foreign student learning [2], explore positive and negative impact uses social media by student [3], social media use for information verification news [4]. Previous research

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 170–178, 2023.
https://doi.org/10.1007/978-981-99-5961-7_20

conducted during the Covid pandemic took place looking at the factors of interaction, motivation, course structure, instruction, knowledge and facilitation [5], social media support for online learning and blended learning [6] and other research during the post pandemic covid regarding online education [7]. According to previous research, no one has used the Stressor-Strain-Outcome framework in their research, and factors that can cause stress, such as connectivity issues, real-time support, and feasibility issues, so this study will focus on this factor.

The quantitative method used in this study is the Structural Equation Model and Partial Lease Square (SEM-PLS). While the pandemic was still ongoing, data was collected using the Snowball sampling technique and Google Form. A total of 220 people completed the questionnaire, but 18 of them were deemed invalid or outliers, so only 202 people's data were used in this study. The SmartPLS application was used to process the data, and it was discovered that the independent factors (connectedness, feasibility, and support) influence the dependent factors (effectiveness, motivation, and actual use). Effectiveness is 50.2% influenced by Connectedness, Feasibility, and Support factors, while Motivation is 38.2% influenced by Connectedness, Feasibility, and Support factors, and Actual Use is 46.4% influenced by Connectedness, Feasibility, and Support factors. The research result shows the connectedness factor has a 17.0% effect on effectiveness and a 37.4% effect on motivation. The feasibility factor influences actual use by 16.2%, motivation by 15.8%, and effectiveness by 29.4%. The support factor has a 41.2% effect on the effectiveness factor, a 22.2% effect on the motivation factor, and a 20% effect on the actual use factor. The effectiveness factor has a 16.2% influence on the actual use factor. The motivation factor has a 16.1% effect on the actual use factor. The connectedness factor had no effect on the actual use factor in this study. In this study, it was found that there were differences in the use of social media chat applications by students where WhatsApp was the application most used by the second respondent, Telegram, and the last LINE.

2 Literature Review

2.1 Stressor-Strain-Outcome (SSO) Framework

The stressor-strain-outcome (SSO) model includes three key aspects: stressors, which are behavioral and emotional stimuli that can have negative effects on individuals, strain, which are negative emotions or states experienced as a result of stress, and outcomes, which are the effects of the strain on the individual's performance [8]. This framework is used because it is based on previous research that the use of social media as a medium for learning has a stressful impact on students [1], and the situation when collecting data during the Covid-19 pandemic, when students' conditions were uncertain due to limited social activities.

2.2 Variables

Connectedness Factor (CON), the connectedness factor basically talks about the sense of belonging users are to social media chat for learning. There are three core elements

that distinguish this factor, those are: socializing, social support, and sense of belonging. Research shows that these components of social connectedness will have impacts on users' wellbeing, physical and mental health, labor market outcomes, and educational outcomes. Certain groups of people may have different social connectedness outcomes, some maybe lower and others higher. For instance, older people or single parents will be at risk of having lower social connectedness outcomes [9].

Feasibility Factor (FEA). Feasibility generally refers to the capability of completing or carrying out a task. It talks about the possibility, capability, or likelihood of accomplishing something. In studies or research, the word "feasibility" is usually associated with the word "study". The higher the feasibility, the more likely goals or targets are to be accomplished. Feasibility is usually used for something that still withholds uncertainties. For example, when conducting research, statements or hypotheses made are still assumptions therefore it needs feasibility factor [10].

Support Factor (SUP). In general, a support factor functions to provide assistance to those in need. Because social support is a multidimensional construct that includes physical and instrumental assistance, attitude transmission, resource and information sharing, and finally emotional and psychological support, assistance can take many forms. Emotional, instrumental, informational, and appraisal support are the four types of social support. Each serves a distinct purpose. Emotional support, for example, serves primarily to express empathy, whereas instrumental support is defined as tangible aid and provided services [6].

Motivation Factor (MOT). The word "motivation" comes from the word "motive". It is a general desire or willingness to do something specific. It essentially describes why a person does something. Motivation enables people to shed their burdens or pushes them to strive for more and achieve their goals. It is made up of the biological, emotional, social, and cognitive forces that influence human behavior. Motivation is important because it influences how someone thinks about e-learning content. In summary, social media learning content is associated with motivation [11].

Effectiveness (EFF). In general, the ability to succeed and produce the desired results is defined as effectiveness. In this case, social media chats are deemed effective if they achieve all targeted learning objectives. A variety of parameters can be used to assess effectiveness. Stability, security, dependability and responsiveness, ease of use, and personalization are just a few examples. Aside from parameters, several factors are used to assess the effectiveness of e-learning. Interactivity, collaboration, motivation, a network of opportunities, and pedagogy are the top five factors [12].

Actual Use Social Media Chat for Learning (USE). The use of social media by students for social activities, learning, business, and even to validate the news they receive is widespread [4]. As a result, students' use of social media is extremely beneficial, including for learning support [2–5].

2.3 Research Model

Figure 1 describes the development of the model used in this study. The research hypothesis is as follows.

- H1 Connectedness (CON) affects Effectiveness (EFF)

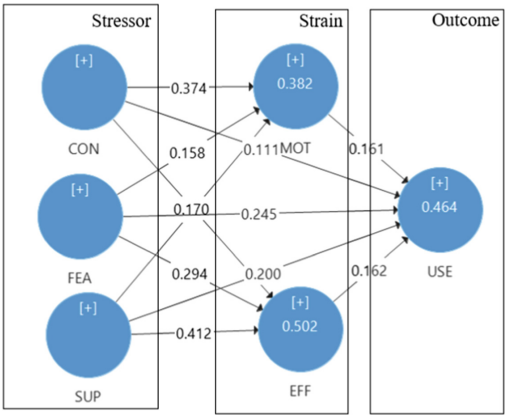

Fig. 1. Research Model with Calculation Result

- H2 Connectedness (CON) affects Motivation (MOT)
- H3 Connectedness (CON) affects Actual Use (USE)
- H4 Effectiveness (EFF) affects Actual Use (USE)
- H5 Feasibility (FEA) affects Effectiveness (EFF)
- H6 Feasibility (FEA) affects Motivation (MOT)
- H7 Feasibility (FEA) affects Actual Use (USE)
- H8 Motivation (MOT) influences Actual Use (USE)
- H9 Support (SUP) affects Effectiveness (EFF)
- H10 Support (SUP) affects Motivation (MOT)
- H11 Support (SUP) affects Actual Use (USE)

3 Result and Discussion

3.1 Data Respondent and Research Result

According to Hair total respondent should be 10 times of variable used, in this case minimum respondent is 60 respondents [13, 14] however the total respondent used in this study is 202 respondents. The total number of respondents, 202 were male (45%) and 112 were female (55%). Respondents by domicile, with Bali having 3 respondents (1.5%), West Java having 77 respondents (38.1%), Jakarta having 35 respondents (17.3%), Central Java having 42 respondents (20.8%), East Java having 19 respondents (9.4%), Kalimantan having 4 respondents (2.0%), Sulawesi having 3 respondents (1.5%), and Sumatra having 19 respondents (9.4%). The top three chat applications used by respondents, with WhatsApp being used by 199 respondents (98.5%), Telegram being used by 142 respondents (70.3%), and LINE being used by 117 respondents (57.9%).

Outlier data was checked using the Excel application prior to data processing using the SmartPLS application, and 18 respondents were found to be outliers, so the 18 data were deleted and not used in the calculations [14].

3.2 Research Result, Validity, Reliability, and Good of Fit (GoF)

Research Result. Figure 1 illustrates the final result of the SmartPLS calculation as well, and the discussion can be seen in the next paragraph.

Table 1. Cross Loading Calculation Result

Variable Indicators	Value	Variable Indicators	Value	Variable Indicators	Value
CON		EFF		FEA	
CON1	0,750	EFF1	0,751	FEA1	0,705
CON2	0,721	EFF2	0,738	FEA2	0,769
CON3	0,664	EFF3	0,758	FEA3	0,761
CON4	0,760				
MOT		SUP		USE	
MOT1	0,882	SUP1	0,734	USE1	0,744
MOT2	0,858	SUP2	0,798	USE2	0,747
		SUP3	0,776	USE3	0,795

Table 1 shows the validity results for each indicator used in this research, and it can be concluded that all indicators used are greater than 0.6, or that the indicators used are valid [15, 16].

Table 2. AVE and Cronbach's Alpha

Variable	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
CON	0,701	0,815	0,525
EFF	0,609	0,793	0,561
FEA	0,601	0,789	0,556
MOT	0,680	0,862	0,757
SUP	0,655	0,813	0,593
USE	0,639	0,806	0,582

Table 2 shows that all of the factors used are valid because their AVE values are greater than 0.5. While the reliability of all factors is greater than 0.6, it can be concluded that all factors used are reliable [16, 17].

Table 3 shows how the independent factors (connectedness, feasibility, and support) influence the dependent factors (effectiveness, motivation, and actual use). Effectiveness is 50.2% influenced by Connectedness, Feasibility, and Support factors, while Motivation

Table 3. R Squared Value

Variable	R Squared
EFF	0,502
MOT	0,382
USE	0,464

is 38.2% influenced by Connectedness, Feasibility, and Support factors, and Actual Use is 46.4% influenced by Connectedness, Feasibility, and Support factors. The Good of Fit (GoF) value for this study was calculated by taking the square root of multiplying the average AVE by the average R2, yielding a value of 0.511. The GoF value is greater than 0.36 (Large), indicating that the model in this study is good [18, 19, 21].

Table 4. Bootstrapping Calculation Result

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
CON - > EFF	0,170	0,171	0,056	3,045	0,002
CON - > MOT	0,374	0,370	0,083	4,507	0,000
CON - > USE	**0,111**	**0,108**	**0,079**	**1,405**	**0,160**
EFF - > USE	0,162	0,162	0,072	2,259	0,024
FEA - > EFF	0,294	0,293	0,068	4,323	0,000
FEA - > MOT	0,158	0,160	0,070	2,258	0,024
FEA - > USE	0,245	0,248	0,068	3,581	0,000
MOT - > USE	0,161	0,158	0,069	2,341	0,019
SUP - > EFF	0,412	0,412	0,068	6,070	0,000
SUP - > MOT	0,222	0,224	0,069	3,230	0,001
SUP - > USE	0,200	0,199	0,074	2,702	0,007

According to Table 4, the connectedness factor has a 17.0% effect on effectiveness and a 37.4% effect on motivation. The feasibility factor influences actual use by 16.2%, motivation by 15.8%, and effectiveness by 29.4%). The support factor has a 41.2% effect on the effectiveness factor, a 22.2% effect on the motivation factor, and a 20% effect on the actual use factor. The effectiveness factor has a 16.2% influence on the actual use factor. The motivation factor has a 16.1% effect on the actual use factor. The connectedness factor had no effect on the actual use factor in this study.

Table 5. MGA Calculation Result

	Path Coefficients Original (Male)	Path Coefficients Original (Female)	p-Value (Gender (1.0) Male)	p-Value (Gender (2.0) Female)
CON - > EFF	0,114	0,195	0,306	**0,001**
CON - > MOT	0,391	0,366	**0,001**	**0,004**
CON - > USE	0,108	0,118	0,419	0,215
EFF - > USE	0,125	0,229	0,248	**0,027**
FEA - > EFF	0,280	0,328	**0,017**	**0,000**
FEA - > MOT	0,139	0,165	0,159	0,099
FEA - > USE	0,269	0,204	**0,009**	**0,036**
MOT - > USE	0,185	0,135	0,130	0,150
SUP - > EFF	0,453	0,378	**0,000**	**0,000**
SUP - > MOT	0,270	0,184	**0,004**	**0,048**
SUP - > USE	0,167	0,217	0,139	**0,034**

3.3 Multi-Group Analysis (MGA) by Gender

The influence of gender-based factors can be seen in Table 5. According to the findings of this study, the connectedness factor only had a 19.5% effect on female users, while on motivation it affects men by 39.1% and women by 36.6%. The connectedness factor has no influence on the actual use factor. Only female respondents are affected by the efficiency factor by 22.9%. Men (28.0%) and women (32.8%) are both affected by the feasibility factor. Motivation is unaffected by the feasibility factor. On factual use factors, men (26.9%) and women (20.4%) are affected by the feasibility factor. The motivation factor has no effect on the use factor. The support factor influences men (45.3%) and women (37.8%) on the effectiveness factor. Support factors affect men (27.0%) and women (18.4%) on motivation factors. Finally, the support factor affects only women (21.7%) on the actual use factor.

3.4 Discussion

A difference was discovered in the use of the chat application, with the WhatsApp application being widely used by students for study compared [20] to who discovered the LINE application being more widely used. According to the findings of the same study, motivational factors will increase students' actual use of social media for learning [11]. Previous research has found that live chat can have a positive impact on learning, particularly due to the real-time response (connectedness), feasibility, and as a tool that supports learning activities. However, it was discovered in this study that connectedness had no effect on actual use; this could be happened due to the unstable infrastructure conditions (communication disconnected) that occurred during the COVID-19 pandemic [6]. Previous research stated that social media can be used as an effective connecting medium [3], but different results were found in this study, no effect was found on the

use of social media for learning during the covid pandemic, this happened to both male and female respondents.

4 Conclusion

The results of this study can be concluded that there is a shift in the use of social media chat for learning from the LINE application to the WhatsApp application. It was also found that during the pandemic, communication infrastructure was an important supporting factor. From this study, the connectedness factor has no influence on the actual use factor, this situation occurs because of problems with communication services. Effectiveness factor is a factor that is found to be very helpful in learning to use social media chat. Other factors that were not included in this study are still needed to address the study's limitations. The research's implications for e-learning scientific development, specifically the use of social media chat.

Further research can be conducted by adding factors not included in this study and employing a larger number of respondents.

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Empowering Higher Education: A Comprehensive Review of Artificial Intelligence Integration

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Abstract. This study explores a comprehensive AI-empowered higher education review through literature analysis, focusing on research methods, research themes, and key barriers. By reviewing literature from 2012–2022, the results reveal a growing preference for quantitative (45%) and mixed-methods (20%) approaches, as well as computational techniques (5%), indicating an increasing focus on evidence-based insights. Prominent research themes include personalized learning (36%), intelligent tutoring systems (ITS) (24%), learning analytics (20%), and the ethical, legal, and social implications of AI (12%), reflecting evolving research priorities. Lastly, we discuss key challenges in implementing AI technologies in higher education, such as technical infrastructure, data privacy and security, pedagogical integration, budget constraints, resistance to change, effectiveness evaluation, and ethical concerns. Addressing these challenges necessitates robust infrastructure, proper data management, educator training, cost-benefit analysis, stakeholder support, and attention to fairness and equity.

Keywords: artificial intelligence · higher education · intelligent tutoring system

1 Introduction

AI has emerged as a research hotspot in computer science, undergoing rapid development in recent decades. Improved AI algorithms have increased reliability and accuracy in fields like language translation and facial recognition, nearing or surpassing human capabilities. AI applications in industrial manufacturing and transportation are revolutionizing industries and societies. Given AI's potential to reduce human resource costs, enhance teaching efficiency, and empower learning processes, the integration and development of AI and education has become a prominent topic in educational circles [1]. Although the exploration of AI applications in basic education is very rich, researchers in Chinese universities have just begun to explore the scope and direction of AI empowerment due to the characteristics of learners and the positioning of educational products [2]. Based on this, this study starts from the perspective of AI empowerment in education and, through the practical analysis of AI research in higher education, elucidates the dilemmas of AI empowerment in higher education and proposes corresponding solutions.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 179–184, 2023.
https://doi.org/10.1007/978-981-99-5961-7_21

2 Research Design

2.1 Research Question

In order to delve more comprehensively into the application of AI within the realm of higher education, the research question of this study focuses on:

- RQ1: What are the research methods used in AI-empowered higher education studies?
- RQ2: What are the research themes in AI-empowered higher education studies?
- RQ3: What are the key challenges and barriers to implementing AI technologies in higher education?

2.2 Literature Retrieval and Screening

To clarify the overall landscape of AI in higher education application research, and analyze its inherent evolutionary logic and internal mechanisms, this study examines and sorts through the literature on higher education AI research from the past ten years (2012–2022). The process of literature retrieve and screening was shown in Fig. 1. The databases used in the study include the Web of Science Core Collection, Springer, and Science Direct. Searches were conducted using the following search terms ("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning" OR "Natural Language Processing" OR "Learning Analytics" OR "Adaptive Learning" OR "Intelligent Tutoring Systems" OR "Student Modeling" OR "Personalized Learning" OR "Collaborative Learning") AND "Higher Education" in the title, abstract, and keywords. From the searched literature, unrelated documents to the education field were identified and excluded. Finally, a total of 95 articles were retrieved and used as the data source for this study. Judging from the number of published papers (Fig. 2), the years 2017 and 2018 show the highest number of publications, with another peak in 2020. It can be inferred that the application of AI in higher education has been a hot topic from 2017 to 2020.

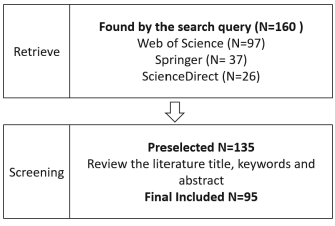

Fig. 1. The process of literature retrieve and screening

3 Results and Discussion

3.1 The Research Methods Used in AI-Empowered Higher Education Studies

To answer the research question: "What are the research methods used in AI-empowered higher education studies?", we can analyze the statistical data to understand the methodological landscape in this field. The research methods can be observed in the Fig. 3. Based

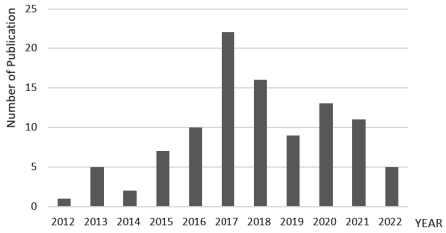

Fig. 2. The trend of the number of publications in the past 10 years

on the data, we observe a diverse distribution of research methods in AI-empowered higher education studies. The majority (45%) of studies employ quantitative methods, suggesting that researchers are increasingly interested in measuring AI's impact on higher education using numerical data. Qualitative methods account for 30% of studies, highlighting the importance of in-depth understanding and contextual insights.

Mixed-methods research, which combines both quantitative and qualitative approaches, constitutes 20% of the studies, reflecting the value of a comprehensive understanding of AI's impact on higher education. This approach allows for a more nuanced exploration of the topic, capturing the complexity of real-world educational settings. Lastly, a smaller proportion (5%) of studies employ computational and data-driven techniques, demonstrating the growing interest in leveraging advanced data analysis methods to investigate AI's role in higher education.

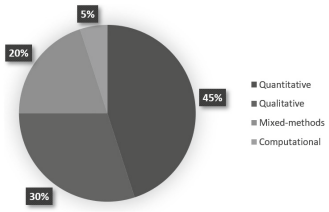

Fig. 3. The distribution of research methods used in AI-empowered higher education studies

3.2 The Research Themes in AI-empowered Higher Education Studies

To answer the research question: "What are the research themes in AI-empowered higher education studies?", we can analyze the data to understand the evolving focus of research topics in this field (Fig. 4). The research themes can be observed from the data. Personalized learning (36%) is a prominent theme, highlighting AI's potential to tailor educational content for individual students. ITS (24%) emphasize AI-powered tutors' ability to enhance learning and engagement, underlining the value of intelligent support in education. Learning analytics and data-driven decision-making (20%) illustrate the importance of utilizing data to inform higher education practices and policies. AI's role in curriculum design (8%) reflects a consistent interest in its impact on developing effective and relevant curricula. Lastly, ethical, legal, and social implications of AI in higher

education (12%) reveal a growing awareness of challenges and risks associated with AI implementation, stressing the need for responsible adoption.

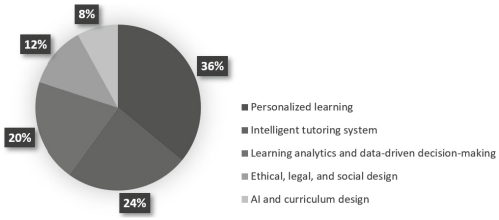

Fig. 4. The research themes in AI-empowered higher education studies

The identified research themes emphasize the multifaceted nature of AI-empowered higher education studies, encompassing aspects from personalized learning and ITS to ethical, legal, and social considerations. This diversity underscores the necessity for a comprehensive understanding of AI's impact on higher education and addressing the complex challenges and opportunities it offers.

3.3 The Key Challenges and Barriers to Implementing AI Technologies in Higher Education Institutions

Based on an analysis of the literature, key challenges and barriers in implementing AI technologies in higher education institutions for management purposes may include:

- Technical infrastructure: To successfully implement AI technologies, higher education institutions need to have a robust technical infrastructure in place [3]. This includes reliable internet connectivity, sufficient computing resources, and the ability to maintain and update AI systems [4].
- Data privacy and security: AI systems often rely on large amounts of data to make accurate predictions and recommendations [5]. Ensuring the privacy and security of students' data is a critical concern for higher education institutions [6]. Proper data management practices and policies need to be in place to address these concerns [7].
- Teaching strategies and pedagogical integration: The integration of AI in teaching requires a shift in pedagogical approaches [8]. Educators need to be trained to incorporate AI tools effectively into their teaching strategies and curriculum, which may necessitate a change in traditional teaching methods [9].
- Budget constraints: Developing and implementing AI systems can be expensive, and higher education institutions may face budget constraints that limit their ability to invest in AI technologies [10]. Institutions need to carefully consider the costs and benefits of AI implementation before moving forward.
- Resistance to change: Some educators and administrators may resist the adoption of AI technologies due to concerns about job security or a lack of understanding of the potential benefits of AI in education [11]. It is crucial to provide training and support to help stakeholders understand the potential of AI and address their concerns.

- Evaluating the effectiveness of AI: It is essential to assess the impact of AI on student outcomes and learning experiences [12]. Implementing AI without proper evaluation may lead to suboptimal results, and institutions need to establish metrics and evaluation methods to ensure the effectiveness.
- Personalization and ethical concerns: AI-based personalized learning systems can improve student outcomes, but they also raise ethical concerns about fairness and equity in education [13]. Institutions need to ensure that AI systems do not exacerbate existing biases or contribute to unfair learning experiences for certain student groups.

4 Conclusion

This study offers insights into AI-driven higher education research developments, examining research methods, evolving themes, and challenges and barriers to AI implementation. The findings inform the future of AI in higher education, highlighting the importance for researchers, educators, and policymakers to stay updated on trends and developments, enabling informed decisions regarding AI technology adoption, integration, and addressing associated challenges and risks.

Future research in this area could build upon these findings by examining specific case studies of AI-empowered higher education initiatives, as well as exploring the perspectives of various stakeholders, such as students, educators, and administrators. By deepening our understanding of the intricacies of AI in higher education, we can work towards developing more effective, equitable, and innovative educational solutions for the 21st century.

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Factors Driving Vietnamese University Students' Adoption in a Smart Learning Environment: The Application of Self-determination Theory and Technology Acceptance Model

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Abstract. Scholars have been able to take advantage of new technologies to investigate what factors influence the level of participation by college students in smart classroom settings. This study aims to provide a combined model of accepting and motivating variables for predicting students' behavioral intention to use smart learning environments through Self-determination theory and Technology Acceptance model. This study contributes to a deeper understanding of the patterns of interaction and learning when students are motivated to learn in a smart learning environment.

Keywords: Smart learning environment · Self-determination theory · Technology acceptance model · Vietnamese university students

1 Introduction

Exponential technology has enabled the advancement of instrumentation, networking, and intelligent design across various domains. "Smart learning environments (SLE)" not only provide learners with the freedom to access and engage with digital resources and learning systems from anywhere at any time, but also actively provide the necessary learning guidance, hints, supportive tools, or learning suggestions when and where they are needed [1]. However, there exist research gaps in understanding the adoptions implications and effectiveness of these technologies, particularly in the context of SLE. While previous studies have explored the concept of smart education and highlighted the benefits of seamless connectivity and natural contact with students, there is limited research that incorporates factors such as motivation and the adoption of technology frameworks like the Technology Acceptance Model (TAM) and Self-Determination Theory (SDT) [2]. Furthermore, while some research projects, such as those by (Bdiwi *et al.*, 2019 and Qazi *et al.*, 2021), have explored intelligent learning environments by introducing innovative platform for SLE or incorporating technological factors in explore how students aware of SLE, the incorporation of established adoption frameworks like the TAM which is investigate the behavioral intention to use technology has been limited [3, 4].

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 185–190, 2023.
https://doi.org/10.1007/978-981-99-5961-7_22

Therefore, there is a need to investigate the motivational aspects of technology acceptance and incorporate factors such as autonomy, competence, and relatedness into the TAM to better understand their influence on perceived ease of use, perceived usefulness, perceived enjoyment, and behavioral intention to use.

To address these research gaps and make learning more accessible to a wider range of students, this study aims to explore the motivations of Vietnamese college students in adopting digital tools for education. By incorporating the motivating components of autonomy, competence, and relatedness from SDT into the TAM, the effects of these factors on perceived ease of use, perceived usefulness, perceived enjoyment, and behavioral intention to use will be examined. The findings of this research will contribute to the understanding of technology acceptance in smart learning environments and provide insights into the design and implementation of effective educational technologies.

2 Hypotheses Development and Conceptual Framework

Autonomy, as defined by Ryan & Niemiec (2009), refers to the degree of control individuals have over their own actions [5]. Building upon psychological theory, Gagné et al. (2019) support this notion, emphasizing that contextual autonomy support enhances perceived usefulness [6]. In fact, autonomy has been found to be associated with both perceived usefulness and ease of use [6]. Thus, the hypotheses are:

H1. Autonomy positively affects perceived usefulness.
H2. Autonomy positively affects perceived ease of use

According to Ryan and Niemiec (2009), perceived competence refers to an individual's belief in their ability to effectively perform a specific task or behavior [5]. In the context of e-learning, digital competence becomes essential. Gagné et al. (2019) indicate that perceived competence serves as a measure of confidence in using e-learning technology [6]. Once students possess the necessary competence, they are more likely to value the e-learning systems, engage in their usage, and enjoy the learning experience. Thus, the hypotheses are:

H3. Competence positively affects perceived ease of use
H4. Competence positively affects perceived usefulness
H5. Competence positively affects perceived enjoyment

Perceived relatedness, as defined by Deci et al. (1991), refers to the sense of identification or connectedness that an individual experiences with other human beings [7]. In the context of learning, perceived relatedness has been found to have positive correlations with perceived usefulness and playfulness. Qazi et al. (2021) supports this relationship, indicating that when students perceive a sense of connection with others in their learning environments, it enhances their perception of usefulness and enjoyment in the learning process [4]. Thus, the hypotheses are:

H6. Relatedness positively affects perceived usefulness of the SLE
H7. Relatedness positively affects perceived enjoyment of the SLE

In the context of SLE, student satisfaction is influenced by their perceived ease of use, perceived usefulness, and perceived enjoyment of the technology [8]. When the technology is perceived as intuitive and user-friendly, it reduces barriers and frustrations, enhancing satisfaction. Additionally, the perceived enjoyment of using the technology contributes to satisfaction [1]. Thus this study proposes the hypotheses:

H8. Perceived ease of use positively affects satisfaction.
H9. Perceived usefulness positively affects satisfaction.
H10. Perceived enjoyment positively affects satisfaction.

Learning satisfaction, as defined in this study, refers to the perception of success and positive feelings regarding the outcomes of the learning process, drawing upon [9]. It is worth noting that satisfaction plays a crucial role in shaping learners' behaviors, including self-regulation in SLE. Gharbaoui et al. (2023) found that perceived satisfaction positively influences learners' intention to engage in further learning activities [10]. Moreover, trust serves as a fundamental factor underlying all social interactions, including virtual ones. Dang et al. (2022) and H. Nguyen & Nguyen (2021) have conducted research focusing on trust as a mechanism to reduce concerns and promote the acceptance of new systems [11, 12]. Thus, this study hypothesizes:

H11. Satisfaction positively affects behavioral intention to study in the SLE
H12. Trust positively affects behavioral intention to study in the SLE

The proposed framework is presented in Fig. 1.

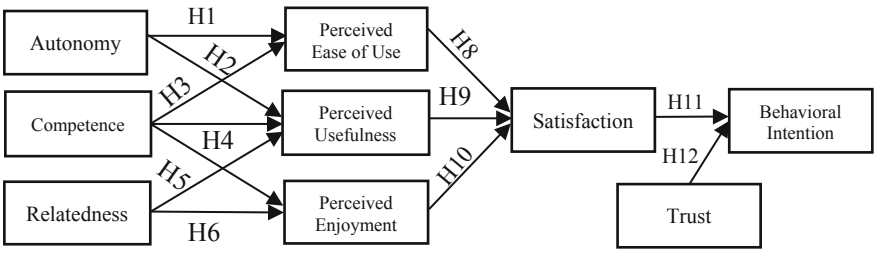

Fig. 1. The proposed framework

3 Research Methodology

Vietnamese students made up the main part of the selected population. Ho Chi Minh was selected as the location for data collection as it has the highest concentration of prestigious universities in Vietnam. A qualifying question was used to conduct the convenient sampling. The instrument has two parts: the demographic form and the scale items. There is a personal information section followed by a section with 44 items that are evaluated on a 7-point likert scale (1 = strongly disagree; 7 = strongly agree). G*Power version 3.1 was used to determine the minimal sample size with the following

parameters: 0.8 power, 0.05 error, 0.15 effect size, and 8 predictors [13]. 350 participants were Vietnamese students who have been utilized smart learning to participate in the study. The data was analyzed using a structural equation modeling (SEM) strategy. In order to estimate the two parts of a causal model—the measurement and structural models—SEM is a powerful second-generation multivariate technique, as described by [14]. Confirmatory factor analysis was used to examine the precision and accuracy of the measurement model's underlying constructs. The significance and direction of the relationships between constructs were then analyzed using the structural model.

4 Results, Discussions, and Conclusions

4.1 Measurement Model Assessment and Structural Model Assessment

The reliability and validity of the measures were assessed by examining factor loading, cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) [11]. The results, indicating that the Cronbach's alpha, CR and AVE met the criteria established in the literature [15]. Moreover, Discriminant validity (DV) was also examined using the Heterotrait-Monotrait (HTMT) ratio of correlations [13]. Based on the results, discriminant validity was established as all HTMT values were below the threshold criterion of 0.85 (HTMT < 0.85). This indicates that the constructs in the study have sufficient discriminant validity, suggesting that they measure distinct aspects of the phenomena under investigation. The study proposed twelve direct hypotheses examining the relationships between different constructs. The statistical significance of the predicted pathways was determined using the SmartPLS bootstrapping function. Based on the analysis of the path coefficients reported, nine out of the twelve hypotheses were found to have significant at p-value < 0.05. These relationships correspond to H1, H2, H3, H5, H6, H7, H9, H11, and H12. On the other hand, the predictors of H4, H8, and H10 were not supported as they did not demonstrate a significant relationship (p-value > 0.05).

4.2 Discussions and Conclusions

This study focuses on investigating the relationship between intrinsic and extrinsic motivation and acceptance intention of SLE, using the framework of SDT and TAM. Specifically, the study explores how autonomy, competence, and relatedness factors influence students' motivation and intentions to use SLE. The constructs of perceived usefulness (PU), perceived ease of use (PEOU), and perceived enjoyment (PCE) from the Technology Acceptance Model (TAM) are utilized to operationalize intrinsic and extrinsic motivation.

The findings of the study suggest that SDT provides a useful framework for understanding the motivational factors of students. When students feel a sense of autonomy, competence, and relatedness in the context of SLE, they are more likely to enjoy and engage in the learning process. An autonomy-supportive environment enhances both extrinsic and intrinsic motivation, making students perceive SLE's enhancing their studying performance and more aligned with their learning goals. Furthermore, the need for perceived relatedness is positively correlated with both perceived competence and perceived usefulness. This suggests that in a SLE that fosters a sense of connection and

relatedness, students are more inclined to use smart learning systems. Additionally, when students perceive the system as useful, it further enhances their satisfaction to use it. The study also demonstrates that trust plays crucial roles in predicting and determining student intention to use with SLE. Students who are satisfied and trust the system are more likely to continue using SLE.

This study aimed to investigate the factors influencing students' usage of SLE, drawing on the theoretical foundations of self-determination theory (SDT) and the Technology Acceptance Model (TAM). Overall, the findings of this study shed light on the interplay between intrinsic and extrinsic motivation, autonomy, competence, relatedness and usefulness in the context of SLE. Understanding these factors is essential for designing effective and engaging learning environments that promote student motivation and satisfaction.

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A Study on Influencing Factors of Online Learning Effect

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Abstract. This study constructed an online learning behavior framework consisting of two dimensions: knowledge processing and learning context. A C program practice APP named D-quiz was used to track the learning behavior of 543 freshmen over one semester. The collected data were then transformed into seven indicators that corresponded to the online learning model. Using five machine learning algorithms, this study analyzed the factors that impact online learning. Results demonstrated that both knowledge processing and learning context significantly impact online learning, with the Random Forest algorithm achieving the highest F1 Score of 0.743. Furthermore, the feature importance ranking indicated that learning context exerts a stronger influence on online learning effect than knowledge processing.

Keywords: Online learning · Learning context · Knowledge processing · Learning behavior · Machine learning

1 Introduction

Recently, online learning has received much attention from academics for its potential to change the way that people learn. Learners can participate in learning for no minimal cost because of its openness and scale, regardless of location and time. Contrary to initial expectations, there is growing worry that online learning has not had a significant or immediate influence on education. In order to address this concern, it becomes crucial to comprehensively understand the factors contributing to learners' performance in online learning, to better understand student behavior, improve the quality of instruction, and create more effective online learning environments. This paper put forward an online learning behavior framework and take the online C program course as a case, using five machine learning algorithms to investigate the factors that influence learning effect.

2 Literature Review

Online Learning has collected a massive quantity of data on how students' behaviors change over a course, how students interact with peers, how they perform on their quizzes and exams, and other learning activities. Increasing number of researchers are

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 191–196, 2023.
https://doi.org/10.1007/978-981-99-5961-7_23

using these data to explore the relationship between students' indicators and learning performance. For example, Conijn, Van, and Cuijpers [1] demonstrated that students who spend more time on learning perform better, but no convincing correlation was found between the sequence of activities and student performance. de Barba, Kennedy and Ainley [2] suggested that the strongest predictor of performance was participation, followed by motivation. Alario-Hoyos et al. [3] found that there is a moderate positive correlation between the number of posts students submit and their overall performance. These findings suggest that engagement is necessary for effective online learning.

Other studies have also emphasized the significance of timely and consistent study habits for online courses. You [4] investigated the detrimental effects of academic procrastination on learning achievement. These findings support the notion that learning behavior related to time management strategies should be considered.

One of the key characteristics of online learning is the fragmentation of learning time. In an online learning environment, students often study in a "learning-interval-learning-again-interval" pattern. According to several research, learning information and concepts over the course of several, spaced-out sessions improves our ability to retain it. On the one hand, learners forget earlier knowledge during learning intervals cause students. They must participate in recurrent memory processing by going over what they have already acquired [5] or fine-grained knowledge processing by establishing connections between new and old knowledge in order to preserve long-term memory [6]. Some studies, on the other hand, believe that learning intervals cause changes in the learning context. According to the contextual background hypothesis proposed by Karpicke [7], knowledge is retained in memory with the learning context, and the learning process consist of identifying meaningful signals from a succession of cues pointing to the target event, recalling, and extracting the target information.

Above all, the purpose of this study was to use a quantitative method to investigate the impact of learning interval-related factors on online learning.

3 Method

3.1 Participation and Learning Platform

The participants in this study were freshmen enrolled in a C program course and majoring in non-computer science, such as psychology, chemistry.

The course lasted for 16 weeks. During the course, participants practice C programming using an online learning platform named D-quiz. D-quiz [8] consists of three modules: the practice page, discussion board, and personal hub. The practice page provides two choice questions to students daily, with options to view the answer, detailed explanation, and view related information below each question. The discussion board allows students to engage in knowledge change, ask and answer questions, while the personal hub facilitates students in monitoring their learning progress by providing them access to their performance data. All students' learning behavior data was recorded by D-quiz in log files.

Observing the log files revealed that some students either did not engage in the learning process at all or abandoned it halfway. There were instances of abnormal data among certain students. Consequently, students with behavior data anomalies and those

who tried less than 100 questions were excluded from the study, resulting in a final dataset including learning behavior data from 543 students.

3.2 Online Learning Behavior Framework

This study constructed a framework of online learning behavior based on the findings on the impact of learning interval on online learning effect and the behavior data collected, as shown in Table 1.

Table 1. Online Learning Behavior Framework

Dimension	Sub-dimension	Indicator	Description
Knowledge processing	Fine knowledge processing	Sequential practice interval	Time interval between current practice and the previous practice
	Repeated knowledge processing	Same knowledge point practice interval	Time interval for practicing the same knowledge point quizzes
Learning context	Retrieval practice context	Practice times	Total number of quizzes practice
		View answer times	Total number of the answers view
	Learning support context	View explanation times	Total number of the explanations view
		View related information times	Total number of the related information view
	Interactive context	Interaction times	Total number of to post, reply and like in discussion board

3.3 Learning Effect Measurement and Algorithm Model

The study used students' practice accuracy which was derived from the D-quiz to characterize the learning effect. Data were normally distributed using the Kolmogorov-Smirnov test According to the data distribution, the accuracy was divided it into three levels: high, indicating the practice accuracy exceeding 70%; medium, denoting the practice accuracy ranging between 60% and 70%; and low, indicating the practice accuracy below 60%.

The study used five classification algorithms including Random Forest, Decision Tree, Logistic Regression, Naive Bayesian, and Bayesian Network, to predict students' practice accuracy. To enhance the accuracy of prediction, a 10-fold cross-validation approach was employed to construct prediction models using the aforementioned algorithms. Numerous experiments have demonstrated that the use of 10-fold cross-validation often leads to more accurate estimates of error.

4 Results

4.1 Indicator Descriptive Analysis

Data from 543 students were analyzed using descriptive statistics tests to extract information regarding student learning behavior. The minimum, maximum, mean, and standard deviation values for each indicator are presented in Table 2. The table showed that students are energetically engaged in practicing questions, viewing answers and explanations to improve understanding, but show a relatively lower number of related information views and interaction times.

Table 2. Descriptive statistics of indicators

Indicator	Minimum	Maximum	Mean	SD
Sequential practice interval	0.289	5.527	2.814	0.883
Same knowledge point practice interval	0.707	18.221	7.874	3.365
Practice times	10	510	141.720	101.371
View answer times	1	570	73.720	59.482
View explanation times	2	467	87.870	53.782
View related information times	1	65	10.690	9.411
Interaction times	0	223	9.020	28.437

4.2 Algorithm Model Prediction

F1 Scores were used to evaluate the prediction performance of five classification algorithm models. Table 3 displays the results. According to the data, Random Forest has the highest F1 Score value of 0.743. Previous research indicated that an F1 Score of around 0.7 is acceptable [9]. As a result of the findings, it turned out that knowledge processing and learning context could predict student performance.

4.3 Algorithm Model Prediction

The Random Forest feature importance technique was used in the study to evaluate the value of behavioral indicators and determine the major influencing factor. The greater importance of the feature is indicated by a larger value. The important ranking result is illustrated in Fig. 1.

In Fig. 1, the most significant impact factor is the student's practice time which is an indicator in the retrieval practice context. It can be concluded that learning context is significantly positively related to online learning effect than knowledge processing.

Table 3. Descriptive statistics of indicators

Algorithm Model	F1 Score
Random Forest	0.743
Decision Tree	0.662
Logistic Regression	0.650
Naive Bayes	0.636
Bayesian network	0.610

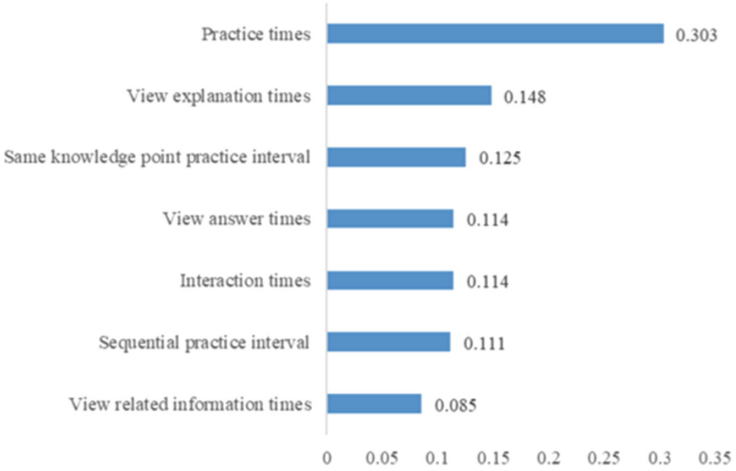

Fig. 1. Feature Important Ranking

5 Conclusion

This study created a framework for online learning behavior in terms of both knowledge processing and learning context. The online learning effect was predicted using five machine learning classification algorithms techniques. The results demonstrated that changes in knowledge processing patterns and learning contexts have a significant impact on the online learning effect. The key factor was the retrieval practice context. These findings provide valuable insights into understanding the dynamics of online learning and highlight the significance of improving learning contexts for enhanced learning outcomes in online educational settings. Educators should consider enriching the learning context in online learning environment by implementing various strategies such as switching up the way knowledge is presented, using different media, and employing other techniques to facilitate learning performance and memory retention.

Although it was already discovered in this study that students' performance in online learning might be influenced by knowledge processing and learning context. It is unclear how or why they play such an important part in the online learning effect. It is a difficult issue that requires more research.

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Learning English via Virtual Charades with Google Assistant: The Correlates Between Smartphone Self-efficacy, Interactive Fun, Flow Experience and Learning Outcomes

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Abstract. The potential of using an intelligent personal assistant (IPA) to enhance learning has received attention. However, little research has explored how embedding Charades into Google Assistant can facilitate English vocabulary learning. This study introduces a Charades mechanism in Google Assistant called Guessing-Fun to investigate the influence of smartphone self-efficacy (SSE) on learners' interactive enjoyment, flow state, and subsequent learning outcomes. Data from 146 7th-grade junior high school students were analyzed using structural equation modelling. Results showed that SSE positively predicted interactive enjoyment and flow, which in turn were positively associated with learning outcomes. These findings provide guidelines for incorporating Charades into other IPAs to promote learner engagement in foreign language learning.

Keywords: Charades · Smartphone self-efficacy · Flow experience · Google Assistant · English learning

1 Introduction

Charade games used in teaching are defined as guessing games [1]. Inductive reasoning and expression of guesses are encouraged in these games while learning a second language (e.g., nouns, verbs, adjectives) [2]. Additionally, they provide enjoyment for the participants. For instance, English language learning becomes enjoyable through interactive experiences and communication among classmates during gameplay [1]. Originally, Charade games were physical activities suitable for all age groups, facilitating word memorization and self-understanding through the guessing process [3]. However, there have been limited studies incorporating Charades into a smartphone app for virtual second language learning among children. Thus, the present study has developed a Charades mechanism in Google Assistant, allowing students to engage socially with a virtual agent in their learning process.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 197–202, 2023.
https://doi.org/10.1007/978-981-99-5961-7_24

According to achievement emotion theory, emotions are triggered by meaningful situations, impacting individuals' feelings, behaviors, and physiological states [4]. These emotions are closely tied to learning, achievement, and one's psychological state [5]. Hence, this study aims to examine the influence of the Guessing-Fun app on participants' achievement emotions, exploring the associations among self-efficacy, interactive fun, flow experience, and learning outcomes. The findings can provide insights for enhancing chatbot design and delivering a unique learning experience.

2 Method

2.1 Research Model and Hypotheses

Inductive reasoning is the inference and conclusiveness of reasoning from details or events in one's experience (McAbee et al. 2017). This study relied on features such as specific color, size, herbivorous/carnivorous, and body parts (arms, two/four legs, tail). For example, Mammals could be referred to as a feature of animals when players were engaged in dialogue with the virtual agent (Table 1).

Table 1. Examples of Dialogue

Category	Players	Virtual agent
Adjective learning	Is it……? e.g., big; furry; yellow; brown; heavy; fast; lazy; ferocious; carnivorous; dangerous	Yes or No
Noun learning	Does it have……? e.g., four legs; fur; ears; claws; a tail; paws; a mane	Yes or No
Verb learning	Can it……? e.g., roar; swim; climb; climb trees; eat meat; hunt; bite; fight	Yes or No

2.2 Procedure and Participants

A total of 176 students participated in this experiment, including six trials over a period of 2 weeks. First, (1) researchers demonstrated how to interact with Guessing-Fun via Google Assistant, and (2) participants tried out by using their own iPads. Second, participants interacted with Guessing-Fun and engaged Google Docs to test how much vocabulary they had learned in the six trials. The questionnaire was distributed to the participants after the final trial and after they had completed the learning outcome test.

Considering ethical issues, we followed the ethical guidelines for university researchers throughout the research process. All participants were informed of the research objectives and could withdraw from this experiment if they wanted to.

This study focused on seventh-grade students from a junior high school in Taipei City. Considering students' ability to interact with Google Assistant, purposive sampling was used to select a total of eight classes within the junior high school.

At the end of the experiment, 167 students returned their questionnaires, but 21 were incomplete and so were deleted. Finally, 146 (87.4%) useful data were subjected to statistical analysis. Among those useful data, 65 (44.5%) were males and 81 (55.4%) were females. The average age was 12.5 (±0.46).

3 Result

3.1 Model Fit Analysis

In this study, model fitness was used to examine the merit of the research model. After analysis, the fit index values of this study were $\chi^2/df. = 1.32$, RMSEA = 0.05, GFI = 0.93, AGFI = 0.89, NFI = 0.92, NNFI = 0.98, CFI = 0.98, IFI = 0.98, RFI = 0.91, PNFI = 0.74, and PGFI = 0.63. Those data all met the thresholds suggested by Hair [6].

3.2 Path Analysis

This study used the software AMOS 20 to verify the hypotheses. Figure 1 shows that SSE was positively related to interactive fun ($\beta = 0.75$, $t = 6.40$***, $p < .001$); SSE was positively related to flow experience ($\beta = 0.95$, $t = 6.84$***, $p < .001$); interactive fun was positively related to learning outcome ($\beta = 2.06$, $t = 5.20$***, $p < .001$); and flow experience was positively related to learning outcome ($\beta = 1.59$, $t = 4.17$***, $p < .001$). The indirect effects in this study are: the path coefficient of SSE on learning outcome is $\beta = 0.75$** ($p < 0.01$), and the CI value is between 0.62 and 0.83, indicating that H5 was positively supported.

According to Cohen et al. (2018), Fig. 1 shows that the explanative power of SSE on interactive fun was 57% ($R^2 = 0.57$) with a high effect size $f^2 = 0.76$; on flow experience, it was 44% ($R^2 = 0.44$) with a high effect size $f^2 = 0.37$. The explanative power of interactive fun and flow experience on learning performance was 39% ($R^2 = 0.39$) with a high effect size $f^2 = 0.32$.

4 Discussion

Achievement emotions are a multiplicative function predicted by self-efficacy [7]. According to Zimmerman's [8] research, student self-efficacy is a key predictor of their choice of activities and their emotional reactions to difficult situations. That is, if students feel capable of using smartphones to interact with Google Assistant, they are more likely to have positive emotions; on the other hand, if they feel incapable of such interaction, they will experience more negative emotions regarding the Guessing-Fun English learning activities. Exploration of those relationships showed that H1 and H2 were positively verified in this study, indicating that SSE in using Google Assistant to interact with Charades can positively trigger participants' interactive fun and flow state.

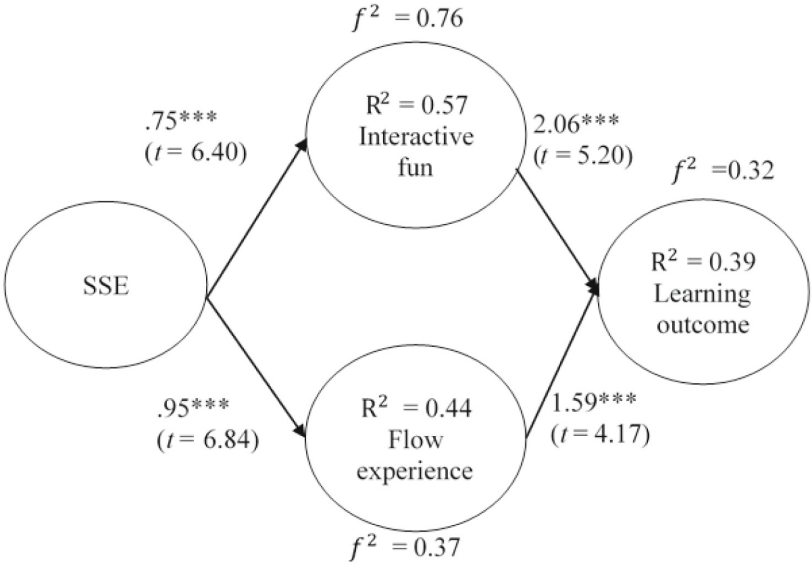

Fig. 1. Verification of the Research Model

There is previous evidence that emotional elements can regulate students' long-term achievement and general flourishment. According to Coban and the other's theory [9], students' learning devices affect how they approach learning activities in virtual environments and influence their learning outcomes. Therefore, how the Charades mechanism in Guessing-Fun as the context of social learning affected players' psychological state and reflected their learning outcomes was explored in this study. H3 and H4 were positively verified. Students with the activation of their psychological state have been found to show increasing persistence, and then have better learning outcomes [10].

Conforming to achievement emotions theory, recent empirical investigations have provided support for the basic process of multiple and sequential mediation effects involving academic self-efficacy and achievement emotions in various learning contexts. Dewaele and MacIntyre [11] highlighted flow state and enjoyment as the two faces of Janus co-associating with learning outcomes. H5 was positively verified, indicating that the flow state positively mediated the relationship between learning self-efficacy and learning outcomes in EFL learning [12].

5 Conclusion

In the present study, Guessing-Fun, based on the game of Charades, was adopted as a virtual social learning tool for children to learn a second language. A correlation research model was employed to assess the effectiveness of student learning with a virtual agent. The results from the SEM analysis indicated that SSE (Self-efficacy, Interactive Fun, and Flow Experience) played a significant role in activating participants' enjoyment

and flow state during their interaction with Guessing-Fun, ultimately impacting their learning outcomes.

5.1 Implications

Intelligent personal assistants (IPA), like Google Assistant, serve as virtual assistants and offer benefits in language learning. The study's findings highlighted the effectiveness of incorporating Charades within dialogues with Google Assistant to enhance students' learning outcomes. Teachers can encourage students to engage in social learning by verbally responding to questions through an IPA. While the present study focused solely on animals as the domain knowledge for interacting with Google Assistant, teachers have the flexibility to utilize existing content covering various topics such as fruit, balls, and more.

5.2 Limits and Future Study

Denies et al. [13] investigated the gender gap in language learning across countries and concluded that gender primarily relates to social factors rather than biological ones. However, the present study focused on social learning through dialogues with Google Assistant and did not address gender. Future research could examine gender differences in emotional factors and learning outcomes during gameplay of Guessing-Fun.

Acknowledgements. This work was financially supported by the "Chinese Language and Technology Center" of the National Taiwan Normal University (NTNU) from The Featured Areas Research Center Program within the framework of the Higher Education Sprout Project by the Ministry of Education (MOE) in Taiwan.

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A Successful Way to Teach Literature Survey in Blended Learning – An Efficient Methodology and Applications

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Abstract. During the Covid-19 pandemic, Sri Lankan state universities promoted e-learning, increasing demand for courses like Literature Surveys. Academics proposed a 15-h blended mode course methodology involving content delivery, assessment marking, and session plan evaluations with well-defined rubrics. The procedure was tested, revealing the achievement of most intended learning outcomes (ILOs). The proposed teaching method, combined with applications and web resources through this study, was recommended for its effectiveness in achieving learning outcomes.

Keywords: Literature Survey · Teaching Methodologies · Intended Learning Outcome · Online Teaching · Continuous Assessments · Teaching Applications

1 Introduction

The COVID-19 pandemic has transformed higher education from face-to-face to online and hybrid delivery modes, requiring lecturers to adapt their teaching methods. Teaching literature analysis in Hybrid mode is a crucial discussion topic for research training programs. This shift presents challenges, including a flipped classroom model, synchronous discussions, and technology-enhanced learning experiences. However, lecturers must ensure access to technology, resources, and asynchronous communication to maintain cohesion and community in the classroom. This experience report aims to share a productive approach for teaching and evaluating students in blended mode, focusing on systematic literature surveys and practical applications to achieve course modules' in-tended learning outcomes (ILOs).

2 Literature

Online teaching has recently become increasingly popular and relevant, especially after the COVID-19 pandemic. As a result, there has been a significant increase in research on best practices for online teaching. Some of the key findings and recommendations

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 203–208, 2023.
https://doi.org/10.1007/978-981-99-5961-7_25

from the general concept and the literature of online education and teaching literature survey course include; Establishing clear communication and expectations with students before the start of the course [1], Utilize multimedia tools, Use a learning management system, Provide feedback, encourage collaboration, and encourage peer learning to keep students engaged [2]. Encourage active learning by using problem-based and case-based learning activities [3]. Use synchronous online sessions for live lectures, discussions, and office hours, use asynchronous online sessions for self-paced activities and assessments [4], Provide clear and detailed instructions for assignments and assessments, Utilize formative assessments to monitor student progress and adjust teaching accordingly [5], Encourage self-reflection and metacognition through regular self-assessment activities [6], Foster a sense of community among students through online discussions and group projects, Ensure that online course materials are accessible and meet accessibility standards, Provide opportunities for students to give feedback on the course and teaching [1], Encourage students to seek out additional resources, such as online forums and library databases, Use data analytics to track student performance and adjust teaching strategies accordingly, Use social media platforms to facilitate student engagement and collaboration [7], Provide regular updates on course progress and upcoming assignments through email and announcements, Continuously evaluate and update the course materials and teaching methods to improve student outcomes, Help students develop effective note-taking strategies [8], Encourage students to engage with the literature by asking them to write summaries, critiques, or reflections [9], Discuss ethical considerations related to literature survey, such as plagiarism and bias [10], Provide opportunities for students to present their literature survey findings to peers or the wider community, Help students develop effective search strategies for finding relevant literature, Provide opportunities for students to practice their literature survey skills through multiple assignments.

There is no complete guide on teaching and evaluating literature survey courses in blended mode. This article proposes a productive approach for systematic literature survey courses, introducing practical applications to achieve intended learning outcomes (ILOs).

3 Methodology

The degree offered for our students, which contains this Literature Survey course module, is a four (04) years study. This Literature Survey module is 15 h taught course with a well-defined syllabus developed for IT-based 3rd-year a total of hundred students. The course plan [11] details the intended learning outcome, teaching hours, module syllabus, lecture and assessment schedule. The teaching and evaluating methodology are designed to make students easily understand, follow lectures, and conduct systematic literature analysis. The course is taught in five online sessions via Zoom, each lasting three hours. For evaluation and grading purposes, a series of connected continuous assessments (CA), like three individual take-home assignments (CA-1, CA-2, and CA-3) and one in-class quiz, were conducted for fifteen (15) marks in the final grade. Each take-home assignment relates to the other assignment, like CA-2 for the topic chosen for CA-1 and is evaluated using well-defined rubrics. We prepared a well-defined evaluation rubric for CA-1 [12], CA-2 [13], and CA-3 [14] and have made it publicly available for all.

Students receive constructive feedback from the lecturer after each take-home assignment. The course is taught in five online sessions via Zoom. After session 1, students are encouraged to choose a research topic in their interest and post it in a general discussion forum via Virtual Learning Environment (VLE) for feedback and approval from the lecturer panel. In session 2, they are introduced to resource-finding places like Scopus, Web of Science, PubMed, ERIC, IEEE Xplore, ScienceDirect, Directory of Open Access Journals (DOAJ), JSTOR, Emerald, ProQuest, ACM Library, Taylor & Francis, Springer, and Mendeley for reference management. Students were asked to find at least twenty reliable resources such as research papers, books, patents, and reliable web resources and document them using the Mendeley tool as CA-1. Useful Artificial Intelligence tools such as Scholarcy, CAQDAS, Paraphrasing tools (Quillbot and Wordtune), chatGPT, Grammarly, and Turnitin are introduced. Students are advised to gain deep knowledge of the pros and cons of using each tool in their work. For CA-2, students are asked to write a systematic literature review in IEEE conference format, and for CA-3, a recorded video of their literature work is presented. The lecturer panel evaluates CA-1 and CA-2 according to the rubrics, while peers evaluate CA-3 using workshop mode in Virtual Learning Environment (VLE). Lecture sessions are recorded and shared with students via VLE, and lecture materials are shared as Google slides. At the end of the course module, an end-semester one-hour online examination for 40 marks is conducted with multiple-choice shuffled questions. Students are graded according to Table 01 for cumulative marks of all assignments and marks of the end-semester examination based on the following equation

$$\begin{aligned} &\textit{Final marks for } 100 \\ &\quad = \textit{Marks for } CA-1 + \textit{Marks for } CA-2 \\ &\quad + \textit{Marks for } CA-3 + \textit{Marks for } Quiz-1 \\ &\quad + \textit{Marks for end semester examination} \end{aligned}$$

The study analysed the results of assignments and final grades to evaluate the effectiveness of the proposed methodology. The results led to a success story of teaching a Literature Survey online with new strategies during the pandemic. Meanwhile, the Sri Lankan pandemic has been managed, and state universities' academic progress has normalized from online to onsite. So, we would also like to recommend new strategies through reflection to teach and learn this course effectively in a blended mode practised with the next batch and suitable for the country's current state. The course can be taught in hybrid mode, with five sessions per session, each for three hours. At the end of each session, a group task can be given to the students, as described below in Fig. 1. Group tasks will not carry marks but will provide good practice and on-time feedback from the lecturer.

This hybrid strategy is more effective in a smart classroom equipped with advanced technology and digital tools, offering benefits such as flexible learning, personalized learning experience, collaboration, time-saving, excitement, engagement, accessible education, interactive lessons, and improved teacher efficiency. The study recommends this hybrid strategy for a new success story in the Sri Lankan state.

- GrT - 01 Group Task 1 - Finding a Research topic by each group

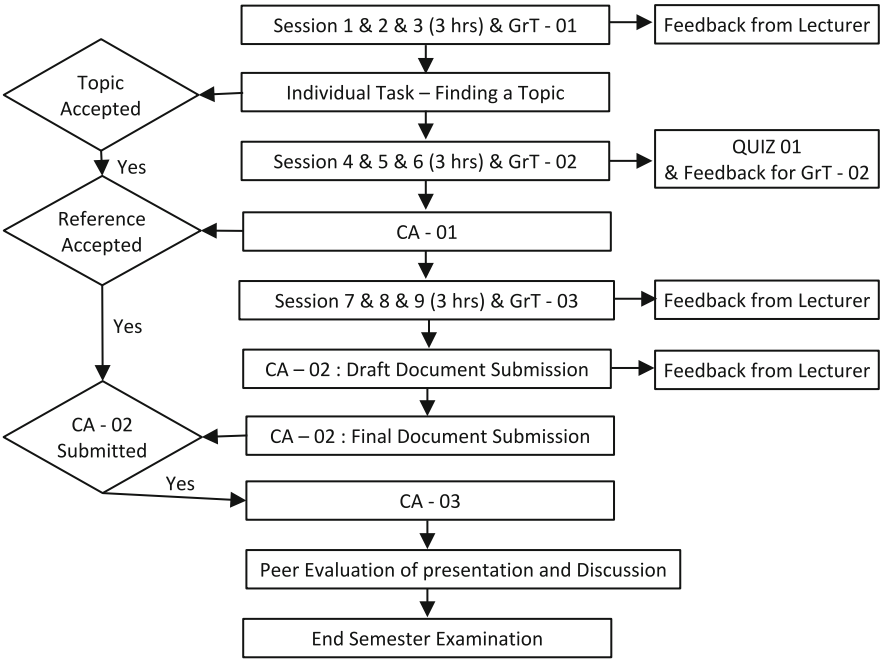

Fig. 1. Recommended teaching strategy for hybrid mode

- GrT - 02 Group Task 2 - identifying ten Reliable Resources for the topic chosen for GrT 1 and documenting them using a tool
- GrT - 03 Group Task 3 - Read and Extract the information from the reliable resources
- GrT - 04 Group Task 4 - Present the literature Review done by the group

4 Results and Discussion

The study analyzed the outcomes of assessments, including CA-1, CA-2, CA-3, a quiz, and final grades with the previous batch of students to determine the efficacy of the proposed methodology. It also collected anonymous student feedback to ensure the course was engaging, effective, and meeting their needs. The quiz evaluated ILOs 1–3, and 96.9% of students scored above the passing grade C. CA-1 evaluated ILOs 3 and 4, and 92.8% of students achieved a grade above the passing grade C. 80.9% exceeded expectations and scored above grade A.

CA-2 assessed ILO 5, and 89.5% of students passed with a grade above C. Six (06) students collected over 20 papers and wrote systematic analyses for publication at peer-reviewed conferences or journals. 97.6% of students received results above passing marks for the final continuous assessment of the presentation for ILO 6. However, some students struggled to perform well in the presentation, possibly due to fear of public speaking, lack of confidence, fear of failure, lack of preparation, fear of attention, cultural differences, or learning disabilities. Table 1 shows that all eligible students received grades above the passing mark of C, with 63.9% of eligible students achieving a grade of A or above

as their final grade for the proposed teaching methodology. On the other hand, in the previous batch, 71.4% of students passed with grades above C, but none performed better than a grade of B+.

The analysis demonstrates that the proposed methodology has successfully achieved all intended learning outcomes, and positive student feedback confirms its success. Students appreciate the step-by-step teaching and evaluation method, the manageable time frame for completing assessments and lectures, and well-organized teaching with clear explanations. The skills and knowledge gained will serve them well in future endeavours.

Table 1. Summary of the results of four (04) continuous assessments

Marks Range	Grading criteria	for Proposed Methodology					Grades of the Previous batch
		Quiz	CA-1	CA-2	CA-3	Final Grade	
90–100	A+	54	49	3	0	13	0
75–89	A	5	19	16	4	42	0
70–74	A-	0	5	14	21	9	0
65–69	B+	0	1	11	28	13	0
60–64	B	4	0	18	18	4	1
55–59	B-	0	0	0	0	3	1
50–54	C+	0	0	10	10	2	3
45–49	C	0	4	5	0	0	10
40–44	C-	2	3	4	0	0	5
35–39	D+	0	0	0	0	0	0
30–34	D	0	0	2	0	0	0
0–29	E	0	3	3	2	0	0
Absentia	AB	41	22	20	23	0	0
Total		**106**	**106**	**106**	**106**	**106**	21

5 Conclusion

In conclusion, the study analysed the outcomes of various assessments and collected anonymous feedback from students to evaluate the efficacy of a proposed methodology for online teaching the Literature survey course during the pandemic. The study demonstrated that the introduction of novel techniques for teaching was fruitful and enabled the successful attainment of all the intended learning outcomes. The positive feedback from students and the lecturer's observations confirms the success of the proposed methodology. The study follows most of the best practices for online teaching and teaching the literature survey course. Moreover, this study also recommends new strategies to lead to a success story in blended mode.

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AR and VR Enhances Learning

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Abstract. AR and VR technologies hold significant potential for enhancing learning by creating captivating and interactive environments. AR overlays digital information onto the real world, while VR generates fully simulated settings, offering realistic scenarios and simulations that are challenging to replicate physically. This improves engagement and information retention. Furthermore, AR and VR personalize learning experiences based on individual needs and styles, and they facilitate collaborative learning by connecting students across locations, fostering communication and exposure to diverse perspectives. The integration of AR and VR in education can revolutionize the learning process, making it interactive, engaging, and effective. As advancements continue and accessibility increases, we can expect more innovative and impactful applications of AR and VR in enriching learning experiences.

Keywords: Augmented Reality · AR · Learning · Virtual Reality · VR · Education

1 Introduction

Augmented Reality (AR) is a technology that superimposes digital information onto the real world, enhancing the user's perception of their environment. AR has the potential to revolutionize learning by creating immersive and interactive educational experiences. For example, AR can help students visualize complex concepts, bring static texts and illustrations to life, and make learning more engaging and memorable [1]. AR can also provide instant feedback and assessments, allowing for personalized learning and adaptive instruction. The use of AR in education is still in its early stages, but its potential as a learning tool is vast and promising [2].

2 How Effective Are AR Used for Learning?

The degree to which the use of augmented reality (AR) for educational purposes is successful is dependent on a number of aspects. These elements include the nature of the instructional material, how the AR experience is designed and implemented, and the learning objectives. It is generally accepted that augmented reality (AR) is a form of

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 209–214, 2023.
https://doi.org/10.1007/978-981-99-5961-7_27

technology-based learning that integrates virtual objects into the natural learning scene. This type of learning has the potential to help fill in the educational gaps that exist in the real world by encouraging constructive knowledge and active autonomy, both of which support practical learning [3]. This approach is often constructed on the basis of experiences that are gained via practical reflection in several educational contexts, in addition to the inclusion of one's own emotion, appraisal, and the merging of newly acquired experiences with previously held ones (Fig. 1).

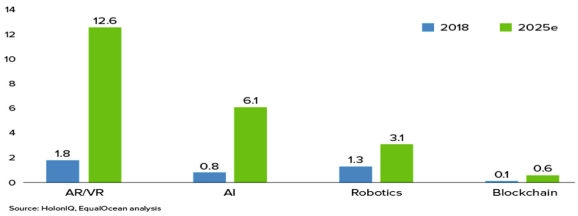

Fig. 1. Global Education Technology Expenditures in Billion US Dollars. Resource: https://appinventiv.com/wp-content/uploads/sites/1/2020/06/Global-education-technology-expenditure.png

While augmented reality has been successful in assisting learners in the process of visualising theoretical concepts, the option of measuring AR learning in comparison to the actual progress that has been made may now be expanded. It is possible to put this into practice to make educational experiences more fruitful and pleasurable, while also fostering collaborative learning in the context of a classroom environment. It has opened up learning possibilities relating to the improvement of educational procedures as they are used in the actual world [4].

Studies have shown that AR can be an effective tool for enhancing learning outcomes, particularly in subjects such as science, mathematics, and history. AR can help students visualize complex concepts, make learning more engaging and interactive, and increase motivation and interest in the subject matter [2, 5]. However, the effectiveness of AR for learning also depends on the quality and design of the AR experience. Poorly designed AR experiences can be distracting and may not effectively support learning goals [6]. It is important to ensure that AR experiences are well-designed, align with educational standards and learning objectives, and are used in conjunction with other instructional strategies. In general, AR has the potential to be a valuable tool for enhancing learning, but its effectiveness will depend on how it is designed, implemented, and integrated into the educational environment.

Virtual Reality (VR) has the potential to enhance learning in several ways:

1. Immersive experiences: VR allows for immersive learning experiences that can increase engagement and motivation.
2. Visualization of complex concepts: VR can make it possible to visualize and interact with complex concepts, making them easier to understand and retain.
3. Simulations and scenario-based learning: VR can provide simulations and scenario-based learning experiences, allowing students to practice and apply what they have learned in a safe and controlled environment.

4. Accessibility: VR can make learning accessible to people with diverse learning styles and abilities, including those with visual and auditory impairments.
5. Increased motivation and engagement: VR can make learning more fun and engaging, increasing motivation and interest in the subject matter.

However, the effectiveness of VR for learning also depends on the quality and design of the VR experience. Poorly designed VR experiences can be distracting and may not effectively support learning goals [7]. It is important to ensure that VR experiences are well-designed, align with educational standards and learning objectives, and are used in conjunction with other instructional strategies.

3 Successful Stories of VR and AR Applications

These are just a few examples of the successful use of VR in various fields. VR technology is continuously evolving and new applications are being developed, offering exciting possibilities for the future [12] (Fig. 2).

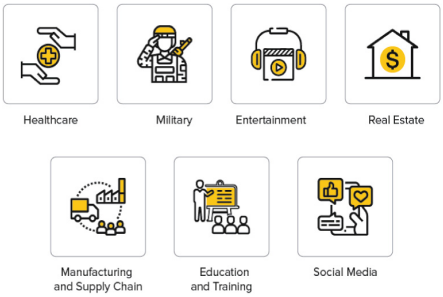

Fig. 2. Illustration of Industries using AR technologies. Resource: https://appinventiv.com/wp-content/uploads/sites/1/2020/03/Impact-of-AR-on-different-industries.png

These are just a few examples of the successful use of AR in various fields. AR technology is continuously evolving and new applications are being developed, offering exciting possibilities for the future [8]. Virtual Reality (VR) and Augmented Reality (AR) are relatively new technologies, and there is still much that we don't know about them. Here are a few areas where there is still much to be explored [9]:

1. Long-term Health Effects: While VR and AR technologies have been found to have many benefits, the long-term effects of prolonged use are still not fully understood. There are concerns about the potential for eye strain, headaches, and other health issues.
2. Effectiveness for Certain Applications: While VR and AR have been successful in certain applications, such as gaming, education, and therapy, their effectiveness for other applications is still not fully understood. For example, it is not yet clear how VR and AR can be effectively used in areas such as productivity and communication.

3. Interaction and Interoperability: VR and AR technologies are still in their early stages, and there is much to be explored in terms of how users can interact with virtual environments and digital objects. There is also much to be done in terms of creating standards for interoperability between VR and AR systems, devices, and content.
4. Ethical and Social Implications: VR and AR technologies raise important ethical and social questions, such as privacy, security, and the potential for addictive behavior.
5. Cost and Affordability: VR and AR technologies are still relatively expensive and not widely accessible to the general public. This creates barriers to adoption and limits their potential impact.

These are just a few examples of the areas where there is still much to be explored in terms of VR and AR technologies. As these technologies continue to evolve and mature, we can expect to learn much more about their capabilities and limitations in the coming years.

4 The Warning of Danger and the Future of AR and VR

Virtual Reality (VR) and Augmented Reality (AR) technologies, while offering many exciting possibilities, also raise some red flags and concerns that need to be addressed. Here are a few examples [10]:

1. Health and Safety: VR and AR technologies can have negative impacts on users' health, such as eye strain, headaches, and other physical symptoms. There are also concerns about the potential for accidents, such as tripping or colliding with objects while wearing VR or AR devices.
2. Addiction: VR and AR technologies have the potential to be highly addictive, particularly in the case of VR gaming. This can lead to excessive use and neglect of other important aspects of life, such as work, relationships, and self-care.
3. Privacy and Security: VR and AR technologies can collect and store large amounts of personal information, raising important questions about privacy and security. There is also the potential for VR and AR environments to be hacked or otherwise compromised, compromising users' personal information and privacy.
4. Ethical and Social Implications: VR and AR technologies raise important ethical and social questions, such as the potential for addictive behaviour, the impact on relationships and communication, and the impact on children and young people.
5. Cost and Affordability: VR and AR technologies can be expensive and may not be accessible to everyone, creating barriers to adoption and limiting their potential impact.
6. Accuracy and Reliability: VR and AR technologies rely on sensors and algorithms to generate virtual environments and experiences. There are concerns about the accuracy and reliability of these technologies, particularly in terms of their potential to generate false or misleading information.

As these technologies continue to evolve and mature, the possibilities will only continue to expand, and it will be interesting to see how they will be used in the future [11]. The potential for VR and AR to change our lives is only limited by our imagination. Students frequently benefit from the positive learning experiences that are considered to

be relative to the direct strategy application responses for the innovative viewpoints of the development, which are considered to be relative to the potential that helps regenerate VR and AR teaching and learning, which is considered to be quite efficient. The students are able to contribute their knowledge and skills in order to process the development of the content that is based on the techniques that make it less complicated to utilise in order to overcome obstacles and being able to satisfy the demands the expectations of the end-users. This content is based on the techniques that make it less complicated to utilise in order to overcome obstacles and be able to perform more appealing when conveying or providing information.

5 Conclusion

As a consequence of the world's movement towards modern information and technology, it has had a tremendous impact not only on educators but also on students, since it has produced new methods of teaching and learning. Together with the changes that have occurred, it seems that the characteristics of the learners and their knowledge of such material have also evolved through time. Nowadays, augmented reality is viewed as prevalent due to the fact that it is increasingly accessible to people through smartphones that process and show data on the practical usage of AR. This is one of the reasons why it is believed that AR is more practical. In addition, it is considered that the accessibility of these devices' contents and information has led to an improvement in learning experiences. Due to the information collected from such devices, this is the case.

The study on the application tends to emphasise that it is more mature since it has shown its positive impact on education across several disciplines and major developments. As enabling technologies for augmented reality (AR) have continued to advance, so has research on the application. It has been shown that the combination of augmented reality (AR) and training may improve people's performance in learning and operations, therefore enabling educators to better resource resources for high-level tasks. In addition, the students will discover that AR materials are believed to be creative tools that will have significant importance in the future since they can be utilised in a manner that helps both students and instructors acquire momentum and make learning gains. In addition, the students will realise that AR materials are regarded to be the most important future creativity tools.

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Navigating Generative AI (ChatGPT) in Higher Education: Opportunities and Challenges

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Abstract. Generative AI, exemplified by models such as ChatGPT, has recently gained prominence due to its potential to revolutionise various aspects of society, including higher education. While some envision these technologies as transformative forces in learning and teaching, others express scepticism and concern that they may compromise academic integrity in higher education institutions (HEIs) and undermine the educational system, leading to diminished motivation and abilities among students. As the use of ChatGPT-like Generative AI becomes increasingly popular, it is vital to understand its impact on higher education and identify strategies that may address potential risks. Therefore, this paper reviews the impact of generative AI on higher education through a desk analysis of existing literature. Key opportunities and challenges are highlighted, providing a holistic overview of the subject matter. The paper concludes with four key strategies for HEIs to better embrace the growing use of Generative AI while proactively responding to associated challenges.

Keywords: Generative AI · ChatGPT · Higher Education

1 Introduction

Upon its debut in the public domain, ChatGPT took the world by storm, becoming a trending topic across social media platforms, prestigious academic journals [1, 2], and high-quality news outlets [3]. This ground-breaking AI technology, known as Generative AI, boasts unparalleled capabilities in executing highly complex tasks such as crafting academic articles [4], stories, poems, essays [5], summarising or expanding text, adjusting content for alternative perspectives, passing professional qualification exams, and even writing and debugging programming code [6, 7].

The significant potential of ChatGPT-like AI systems in the realm of higher education has sparked a heated debate among educators and education researchers. While some view the introduction of Generative AI technologies as the future of learning and teaching, others express scepticism and concern that it may undermine the educational system, rendering teachers and students less motivated and with diminished abilities. With Generative AI garnering attention and becoming a popular tool among students, it is crucial to comprehend its impact on higher education and address potential risks. The pressing question arises: *Are Generative AI technologies a boon or bane for higher*

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 215–225, 2023.
https://doi.org/10.1007/978-981-99-5961-7_28

education? To explore this inquiry, this paper reviews both the advantages and potential drawbacks of utilising Generative AI in education, as well as the implications for higher education practices. Strategies that can help HEIs embrace opportunities and mitigate risks are provided.

2 Method

Due to the newness of the topic and the limited number of academic publications available, conducting a comprehensive and systematic literature review was not feasible for this enquiry. The information available from existing publications was insufficient for keeping up with the rapidly evolving landscape of Generative AI. As a result, a desk research approach [8] was adopted with an expanded scope of literature, while carefully considering the quality of information sources. This approach facilitated the synthesis of recently published articles and their key findings while also covering the most updated information and emerging developments on the topic. Therefore, this paper offers valuable insights to researchers, practitioners, and policy-makers for addressing the impact of Generative AI in higher education.

The literature search was conducted on 15 April 2023. The databases searched in this review included those identified as reputable sources that index research relevant to AI and education. More particularly, as Generative AI in higher education may be considered as the interplay between science and social sciences domains, relevant literature was therefore identified by searching on the ERIC, CiteSeerX, ScienceDirect, Web of Science, ProQuest, JSTOR, Scopus, SpringerLink and Google Scholar electronic databases. Platforms for self-archiving of preprints of manuscripts such as ResearchGate, arXiv and SSRN were also searched. As the ChatGPT and the notion of Generative AI are relatively new, the selection of papers was therefore not restricted to peer-reviewed journal papers but included reports from reputable sources as well as high-quality media articles in the English language published up to the time when this review was being conducted.

A title search with the terms "ChatGPT" and "Generative AI" was performed. The title and abstracts of the search results were further assessed for relevance and value. To be eligible for this desk review, articles had to discuss ChatGPT/Generative AI in an educational context without constraints on specific settings. With the identification of the distinct articles that met the eligibility criteria, content analysis [9] was then carried out to generate themes for further analysis.

3 Findings

3.1 Opportunities

Generative AI as a Teaching Aid. AI-generated content can be invaluable for HEI teachers when it comes to preparing course materials and stimulating classroom discussions. By using ChatGPT, educators can generate discussion questions, case studies, or problem sets tailored to their specific teaching objectives. This enables teachers to create a more dynamic learning environment that caters to diverse student interests and

abilities. ChatGPT can also serve as a valuable partner in curriculum design. Teachers can consult AI for ideas on designing or updating curricula, creating assessment rubrics, or setting specific goals, such as increasing accessibility for diverse learners. For example, Megahed, Chen, Ferris, Knoth, & Jones-Farmer [10] asked ChatGPT to generate a course syllabus for an undergraduate statistics course. They noted that its results could be adopted without the need for major changes. This collaboration significantly improved the efficiency of HEI teaching staff preparing their courses. ChatGPT can help HEI teaching staff generate exercises, quizzes, and scenarios for student assessment [11]. Low-stakes tests are considered academically beneficial as assessments for learning [12]. Crafting well-structured questions, supplying scores and feedback, and making sure questions align with students' anticipated knowledge demands substantial time and effort. Generative AI can come to the aid by producing practice questions and offering focused feedback. While Al-Worafi, Hermansyah, Goh, & Ming [13] cautioned that the assessment tasks suggested by ChatGPT might not cover all targeted learning objectives, they are, if used with caution, found effective in guiding HEI teaching staff to prepare assessments [14]. Generative AI has been employed to facilitate collaboration and peer learning in educational settings. Wang, Li, Feng, Jiang, & Liu [15] investigated the use of AI-generated content to encourage collaborative problem-solving and found that students exhibited improved critical thinking and teamwork skills. Generative AI models have been found to improve student-teacher interactions. In a study [16], AI-powered chatbots were used to assist teachers in providing real-time feedback and support to students. The results indicated that AI-enhanced interaction led to a more efficient and engaging learning experience. Generative AI can also enhance active learning by transforming the teaching and learning paradigm. For instance, Rudolph, Tan, & Tan [17] proposed using the flipped learning approach, which requires students to prepare for lessons by studying pre-class materials with ChatGPT. This method allows for more class time to be dedicated to learning activities such as group discussions and problem-solving. The adaptability of generative AI models has proven beneficial for teaching students with special needs. In a study [18], AI-generated content was used to create accessible learning materials for students with visual impairments, resulting in enhanced engagement and learning outcomes.

Generative AI as Learning Companions for Students. One of the most promising applications of generative AI is personalised tutoring for students. For example, ChatGPT can provide students with immediate feedback on their work, identify areas for improvement, and suggest targeted resources or exercises. By working in tandem with human instructors, generative AI can make learning more effective. A study [19] investigated the application of AI-based content generation in e-learning, finding that AI-generated materials led to higher engagement and satisfaction among learners. Similarly, another [20] explored the use of GPT for personalised tutoring, observing improved learning outcomes compared to traditional teaching methods. Generative AI can help students navigate through complex concepts by providing support and additional resources. Acting as a "guide on the side," this technology can offer explanations, examples, and analogies to facilitate a deeper understanding of the subject matter. As a virtual tutor, ChatGPT can assist students in independent study by answering their questions [21]. This is especially beneficial for students who may struggle with certain topics or need

extra reinforcement. Several studies [22, 23] suggest that students can benefit from using ChatGPT as a scaffolding tool for their initial draft, and then refining the draft by correcting errors and adding references to the final versions of their written assignments. Gilson et al. [24] noted that ChatGPT's initial answer could prompt further questioning and encourage students to apply their knowledge and reasoning skills.

3.2 Challenges

1) Insufficient Content Accuracy and Lack of Contextual Understanding. Generative AI models may occasionally produce misleading or incorrect information, which raises concerns about the quality and reliability of AI-generated content. ChatGPT exhibits limited comprehension of the meaning behind the words it processes [25]. While it recognises patterns and produces seemingly plausible responses, the system is not able to fully grasp the underlying concepts [26]. This shortcoming may result in responses that lack depth and insight [27] or veer off-topic [28], particularly when addressing tasks that demand a nuanced understanding of specialised domain knowledge [29]. ChatGPT's ability to assess the credibility of its training data is also limited, as it lacks the human capacity for critical evaluation [30]. This constraint affects its ability to gauge the accuracy of the information it generates [31]. As a result, ChatGPT sometimes writes plausible-sounding but erroneous or illogical responses [10]. Furthermore, ChatGPT currently possesses limited knowledge of world events beyond 2021 [2]. As knowledge continues to expand, this limitation might occasionally result in the delivery of outdated or inaccurate responses [32]. For instance, when prompted to provide up-to-date references, ChatGPT may fabricate seemingly plausible citations that do not correspond to genuine sources [22]. The limitations in understanding context and discerning the true meaning behind words may hinder their effective use in educational settings. For instance, when employing ChatGPT for personalised learning, the AI system might lack an in-depth grasp of national and school-based curricula, individual students' learning styles, and the cultural context in which they live. This could lead to generated content that is ill-suited for the learners, sometimes being excessively challenging or overly simplistic. Another concern relates to the use of ChatGPT for essay grading. The AI system may not possess the necessary context and background knowledge to accurately evaluate and grade a student's work. These examples emphasise the importance of considering the limitations of Generative AI systems when integrating them into educational environments.

2) Data Privacy, Transparency and Security Concerns. Generative AI models often rely on vast datasets that may include sensitive student information like demographics, academic performance, and behavioural patterns. Some academics have expressed their concerns with increasing integration of AI systems into educational settings such as excessive surveillance and monitoring of students [33]. Ensuring the privacy and security of data is crucial, as unauthorised access, data breaches, or misuse can result in severe consequences, including identity theft and unjust labelling. The decision-making processes of generative AI models can be intricate and challenging to comprehend, potentially limiting the transparency of AI systems [34]. Establishing transparency and accountability is vital for fostering trust among educators, students, and AI systems.

This includes providing lucid explanations of the AI model's functioning, the data it employs, and the rationale behind it. In April 2023, Italy became the first nation to ban ChatGPT due to privacy concerns. The country's data protection authority highlighted the lack of a legal basis for collecting and storing the personal data used to train ChatGPT. Furthermore, ethical concerns were raised about the tool's inability to determine a user's age, potentially exposing minors to age-inappropriate content. This case brings attention to the wider concerns related to the types of data collected, the organisations responsible for acquiring it, and the manner in which it is employed in artificial intelligence systems. OpenAI, a private company, provides both free and subscription-based access to ChatGPT. Despite this, questions arise regarding profit-driven motives and the potential commercial use of data in the future. Italy's decision accentuates the necessity for well-defined legal frameworks to oversee the handling of personal data within AI systems while addressing the privacy and ethical implications that emerge.

3) Algorithmic Bias and Discrimination Risks. AI algorithms may unintentionally reproduce biases [35, 36]. For example, Lucy & Bamman [5] reported gender and representation bias in GPT-generated stories. Several factors contribute to this issue, including pre-existing biases in training data, algorithmic design, and societal context. Generative AI models derive their knowledge from the data on which they are trained. In accordance with the 'garbage-in-garbage-out' principle, if the training data contains biases or inaccuracies, the AI system may inadvertently perpetuate or amplify these biases [37, 38]. Consequently, it can result in disparate treatment of specific student groups and potential social prejudice/discrimination based on factors such as race, gender, socioeconomic background, or learning abilities as AI generate content.

4) Accessibility and Digital Divide Issues. The incorporation of generative AI in education may exacerbate extant disparities between students with access to advanced technologies and those without. There are two primary concerns regarding generative AI's accessibility. The first concern pertains to the limited availability of the tool in certain countries due to government regulations, censorship, or other internet restrictions. These constraints may hinder the adoption and utilisation of ChatGPT in regions where its potential benefits could be significant. The second concern relates to broader issues of access and equity, specifically the unequal distribution of internet availability, cost, and speed. According to data from ITU [39], roughly 66 percent of the world's population have access to the Internet, and there is a substantial digital divide between developed and developing countries. This disparity in connectivity presents challenges for the equitable distribution of AI tools like ChatGPT, as individuals in regions with limited internet access may not be able to take advantage of the technology. Moreover, those with limited access to the internet and AI technology may face additional disadvantages due to insufficient exposure to AI tools and a lack of skills in using them effectively—posing a "second level" digital divide.

5) Challenges to Current HEI Practices. The rapid advancement of Generative AI has raised concerns about the potential displacement of human educators and the subsequent undermining of learning outcomes [40]. The influence of ChatGPT on teachers could manifest in various ways. One major concern is the potential alteration of student-teacher interactions, as students might completely rely on AI-generated content for learning,

rather than seeking genuine guidance from teachers. This shift could result in a diminished human element – which many argue is highly critical – in the educational process. Another critical issue stemming from the growing prevalence of ChatGPT in higher education is its potential impact on academic integrity. Educational institutions and educators have raised concerns about the increased likelihood of plagiarism and cheating [41]. These systems possess the capability to generate essays or complete exams based on specific parameters or prompts. Consequently, students might misuse these systems to submit assessments that are not the product of their own efforts [17, 42]. Such actions not only undermine the core objectives of higher education but also threaten to devalue academic degrees. This concern is particularly relevant in disciplines that predominantly rely on essay-based assessments [43]. An associated issue is the risk for some students to gain an undue advantage over others. By utilising AI systems to generate high-quality written assignments, these students may secure a competitive edge over their peers who do not use AI systems. This inequitable use of AI tools could compromise the fairness and integrity of academic evaluations. Distinguishing between a student's original writing and responses generated by AI systems can be challenging [44]. Academic staff may struggle to accurately assess a student's comprehension of the material when they rely on a chatbot application to provide answers to their questions. This difficulty arises because students' work from AI-generated content may not genuinely represent the student's actual level of understanding, potentially compromising the assessment process. Existing plagiarism-detection tools may not effectively identify cases of academic misconduct involving ChatGPT-generated text [45, 46]. Although Turnitin announced that the company has developed an AI-detection model that claims to be able to identify 97% of GPT-authored writing, the actual effect would still require validations in practice. For example, a recent research paper suggests that GPT detectors tend to misclassify non-native English writing as AI-generated [47]. In response to these academic integrity concerns, some institutions worldwide have banned the use of ChatGPT, while others have adapted their assessment methods to focus on in-class or non-written assignments. Current plagiarism-detection tools, mainly designed to recognise similarities, may have difficulty identifying instances where ChatGPT has been used. The unique nature of AI-generated content, which may not directly mimic pre-existing sources, adds to the challenge. In light of the potential risks to academic integrity, numerous institutions have implemented prohibitions on the use of ChatGPT. Alternatively, other institutions have chosen to modify their assessment methodologies, placing a higher emphasis on in-class participation, presentations, or other non-written tasks. Through these measures, they aim to mitigate the possible misuse of AI-generated content and uphold a high standard of academic integrity.

4 Discussions

McMurtrie [48] contends that instruments such as ChatGPT will inevitably integrate into daily writing practices, much like calculators and computers have become essential in math and science. Indeed, when handheld calculators first emerged, there was significant apprehension about the potential decline of people's numeracy skills. Today, however, they are indispensable for teaching mathematics and can be found on every smartphone.

Students and academics routinely use spell and grammar checkers, thesauruses, and Wikipedia. As tools like ChatGPT are becoming increasingly pervasive, with recent integration into Microsoft Office and online search engines, we must inevitably embrace their presence and utility. As such, Sharples [49] proposes involving students and educators in the development and utilisation of AI tools to enhance learning instead of prohibiting students from using them. HEIs need to build the capacity for greater Generative AI incorporations. The following four key strategies should therefore be considered.

1) Establishing Clear Policies for Generative AI at HEIs. HEIs need to update academic integrity policies and/or honour codes that include the use of AI tools. Establishing clear guidelines for Generative AI use at HEIs is crucial to promote responsible and ethical applications of such technology in academic settings. HEI teaching staff should explicitly state in the course syllabus or assessment guidelines how and in what ways Generative AI tools can be used, provided students adhere to specific instructions and guidelines. For example, students must critically evaluate AI-generated content for relevance and accuracy, properly citing sources and acknowledging any AI assistance in their work. Moreover, submission requirements may include a list of their queries with AI and a reflective write-up. Assessments involving AI-assisted tasks should incorporate presentations to verify comprehension and understanding. It is essential to maintain a balance between human-generated content and AI assistance while adhering to the university's academic integrity policies. HEI teaching staff play a pivotal role as gatekeepers, taking appropriate actions as needed. By implementing these specific policies and guidelines, HEIs can encourage the responsible use of AI tools while maintaining a high standard of academic integrity and allowing students to benefit from the efficiency and convenience offered by Generative AI systems.

2) Revisiting Assessment in Higher Education. The issues involved in ChatGPT provide a golden opportunity to revisit assessment in higher education. Perhaps future assessments should focus on higher levels of Bloom's taxonomy, such as application, analysis, and creation, as suggested by Stutz et al. [50]. Meanwhile, HEI teaching staff can implement various strategies to address the criticism surrounding the use of ChatGPT and other AI language models in higher education. By focusing on the positive aspects of these tools, teaching staff can create an environment that fosters skill development, collaboration, and academic integrity. One approach to counter the criticism is to emphasise the role of ChatGPT and similar AI tools as supplementary resources that enhance students' learning experiences. HEI teaching staff can design assessments that require students to demonstrate critical thinking, problem-solving, and communication skills while also utilising AI assistance for research and idea generation. This balanced approach ensures that students apply their knowledge and skills while benefiting from technological advancements. HEI teaching staff can also promote proper citation and referencing practices to ensure academic integrity when using ChatGPT or other AI language models. By teaching students how to accurately acknowledge the sources used in their research, including AI-generated content, academic honesty is maintained, and the validity and reliability of research are supported. Another strategy to address criticism is to integrate AI language models into the curriculum to encourage collaborative learning. By incorporating ChatGPT as a tool for brainstorming, idea generation, or even providing feedback on drafts, students can engage in group discussions or presentations

and learn from each other. This collaborative approach enables students to harness the benefits of AI assistance while also fostering critical thinking and independent learning. Moreover, HEI teaching staff can implement open-ended assessments that foster creativity and originality, discouraging overreliance on AI language models like ChatGPT. By challenging students to think critically and independently, teaching staff can ensure the development of essential skills required for academic and professional success**.**

3) Teacher Professional Development. As Generative AI becomes more prevalent in education, there is a growing need for teacher professional development (TPD) that equips HEI teaching staff with the knowledge and skills required to effectively integrate AI into their teaching practices. Educators need support in identifying and implementing pedagogical strategies that effectively integrate AI tools into their teaching practices. TPD programs should facilitate discussions and workshops on innovative ways to use generative AI to enhance curriculum delivery, student engagement, and assessment. Given the ethical challenges associated with generative AI, TPD should address issues such as data privacy, algorithmic bias, and fairness. Educators should be equipped with the knowledge to foster digital citizenship and ethical AI use among their students. TPD programs should emphasise the importance of ongoing evaluation of generative AI tools, including monitoring their impact on student learning outcomes and adjusting teaching practices accordingly. Educators should be encouraged to engage in reflective practices and share their experiences with their peers to promote continuous improvement.

4) Developing Student Literacy for Responsible Use of Generative AI. It is essential to educate students about academic integrity policies and the consequences of academic misconduct. By promoting ethical standards, policymakers can help maintain the credibility of educational achievements and preserve the value of university education. It is also crucial to introduce students to the limitations of ChatGPT, such as its reliance on biased data, limited up-to-date knowledge, and potential for generating incorrect or fake information. HEI teaching staff should stress the importance of using high-quality sources while exercising caution with substandard sources, misinformation, and disinformation [51]. Encouraging a well-informed and discerning approach to research ensures the reliability of the information being incorporated into students' work. HEI teaching staff could teach students to make good use of other authoritative sources to verify, evaluate, and corroborate the factual correctness of information provided by ChatGPT. This can be supplemented by promoting reading widely and voraciously to improve critical and creative thinking skills, as exposure to diverse perspectives and ideas fosters intellectual growth and stimulates innovation. HEIs should further encourage students to develop digital literacy and master AI tools, as suggested by Zhai [38], since such mastery can provide a competitive edge in the job market and enhance employability. Integrating AI tools into the writing process can foster creativity and enhance critical thinking, as long as students use these tools as a means to improve their learning in an appropriate manner, rather than merely copying and pasting text. Moreover, HEI leaders should encourage incorporating generative AI into curricula to guide student learning with these tools. Additionally, providing opportunities for students to practice using generative AI like ChatGPT to solve real-world problems effectively can demonstrate their practical utility and help develop a deeper understanding of the capabilities and limitations of such tools.

5 Conclusion

Generative AI, particularly ChatGPT, has shown tremendous potential to revolutionise higher education. To fully realise its potential in enhancing learning and teaching, it is crucial to ensure ethical, responsible, and inclusive use of generative AI in higher education settings. This study reviews the opportunities and challenges of Generative AI in higher education. A total of four key strategies for effectively navigating the integration of generative AI within HEIs are subsequently given. By adopting these suggested approaches, HEIs can harness the transformative power of generative AI while fostering a responsible and informed academic environment that benefits both students and educators alike.

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Comparative Research on Online Teaching Behavior Based on Data Mining

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Abstract. Effective teacher-student interaction is the key to improving the quality of online education, and Lag Sequential Analysis method can help objectively reflect classroom interaction. The article uses 10 international Chinese online teaching videos as the research sample, collects 8607 sample data, and analyzes novice teachers and mature teachers from the teaching behavior, teaching media and TPACK dimensions using Lag Sequential Analysis. The data found that novice teachers were more proficient in mastering technology, and mature teachers were more adept at using diverse technologies for teaching; novice teachers excelled in pedagogical knowledge, and mature teachers focused on using technological pedagogical content knowledge to enhance teaching effectiveness; both types of teachers lacked student activities in their online classrooms. The article proposes strategies to promote innovative changes in online education.

Keywords: Lag Sequential Analysis · online teaching behavior · information technology application

1 Introduction

In 2019, eleven departments including the Chinese Ministry of Education jointly issued the Guidance on Promoting the Healthy Development of Online Education, emphasizing that online education is an important part of education services. We should have clear recognition of the current state of online teaching. This study uses Lag Sequential Analysis method to explore the interrelationship between online teaching events and to improve the effectiveness of online teaching.

2 Research on Lag Sequential Analysis Overview

Sackett (1978) proposed Lag Sequential Analysis (LSA) in 1978, which was used to test whether there was a statistically significant probability of one behavior occurring after another in teaching. Li, S. et al. (2017) collected course learning data of 2131 students in Moodle platform and used correlation analysis, lag sequential analysis and cluster analysis to conduct the study of online learning behavior sequences and participation patterns; Feng, Y. C. et al. (2022) used the LSA method to compare the differences in

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 226–231, 2023.
https://doi.org/10.1007/978-981-99-5961-7_29

teaching decision-making behaviour between novice and core teachers. Fewer studies have been geared towards collecting behavioural data for online classrooms and conducting lag sequential analysis studies. Therefore, this study explores two questions: (1) What are the significant series characteristics of novice teachers and mature teachers in online teaching? (2) How can we intervene to improve the effectiveness of online teaching?

3 Research Design

This study selected 10 international Chinese online course videos from 5 novice teachers (0–5 years of teaching experience) and 5 mature teachers (over 10 years of teaching experience) as research samples. The research is based on the OKC software and framework of CTE-DNA developed by Zhang, H. et al. (2020a, b) for data collection, as shown in Table 1. Considering that in addition to the coding table dimension, OKC software also includes two dimensions: Composite Media (CM) and Non-media, these are included in classroom teaching behavior coding.

4 Lag Sequence Analysis Results

Encode classroom teaching videos based on framework of CTE-DNA. To ensure the reliability and validity of the encoding, a coder first encoded the classroom teaching video, collecting a total of 8607 sample data. Then, another coder randomly selected 100 encoded data for consistency testing, with a Kappa value of 0.801. The results showed good consistency. Using GSEQ software to analyze sample data, generate a behavioral sequence frequency table and if Z-score > 1.96, it indicates that the behavior sequence has statistically significant (Bakeman R, 1997). Based on the adjusted residual table, draw the online teaching behavior patterns of different teacher groups, as shown in Fig. 1 and Fig. 2.

4.1 Analysis of Significant Behavior Sequence in Online Teaching

Novice teachers tend to have shallow conversations with students, while mature teachers are good at asking in-depth questions. Novice teachers often encourage, interact, promote, explain, and pursue students' speeches after questioning, ultimately forming a questioning loop. It should be noted that the interaction level between novice teachers and students is often at a low level, and students' responses are mostly manifested as mechanical responses, echo responses, etc., lacking deep thinking. Compared to novice teachers, mature teachers are more able to consciously guide students to conduct speeches and ask more open-ended questions. After the mature teacher asks a question, a short period of silence or confusion is a noteworthy sequence of behavior. It is noteworthy that there are almost no student-centered online learning activities such as student collaboration, independent use of educational resources, and creation of work in the two types of teacher behavior sequences, and the teaching-led instruction is more obvious.

Table 1. Framework of CTE-DNA.

Dimension	Event Code	Content forms	Type
Teaching behavior	A1	accept positive feelings	Teacher control
	A2	praise or encourage	
	A3	accept or use student's opinion	
	A4	ask questions	
	A5	give explanation	
	A6	give instruction or orders	
	A7	criticize or maintain authority	Both control
	A8	practice with media or teaching aids	Student control
	A9	interaction, promotion, or emphasis	
	A10	passive to speak up	
	A11	active to speak up	
	A12	speech or demonstration	
	A13	collaboration	
	A14	use educational resources independently	
	A15	create works	
	A16	silence or confusion	Uncontrolled
Instructional media	IL	narrative media with ICT	ICT Media
	II	interactive media with ICT	
	IC	corresponding media with ICT	
	IA	symbolic intelligent media	
	IX	computing intelligent media	
	IP	productive media with ICT	
	ID	media debugging	
	TI	traditional interactive media	Traditional media
	TL	traditional narrative media	
	TP	traditional productive media	
	Verbal	only verbal, no other media	No media
TPACK	CK	content knowledge	Core component
	PK	pedagogical knowledge	
	TK	technological knowledge	

(*continued*)

Table 1. (*continued*)

Dimension	Event Code	Content forms	Type
	PCK	pedagogical content knowledge	Compound element
	TCK	technological content knowledge	
	TPK	technological pedagogical knowledge	
	TPACK	technological pedagogical content knowledge	

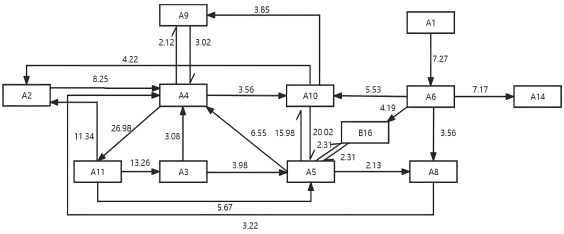

Fig. 1. Novice Teacher Online Teaching Behavior Mode

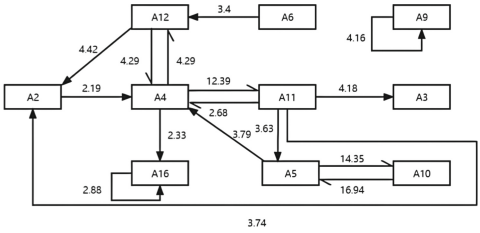

Fig. 2. Mature Teacher Online Teaching Behavior Mode

4.2 Analysis of Information Technology and Curriculum Integration

Novice teachers are proficient in single technologies and mature teachers are able to use multiple technologies to teach. The behavior sequence reflects that mature teachers' continuous media debugging (ID) behavior is more significant ($Z = 4.8$), while novice teachers have less continuous media debugging behavior in their classrooms, indicating that novice teachers have a more proficient mastery of technology; However, compared to novice teachers, mature teachers use composite media more frequently and continuously, reflecting their ability to adopt flexible and diverse technological methods for online teaching. In addition, the continuous use of narrative media with ICT (IL) sequences by both types of teachers in the classroom was significant, and the main instructional behavior corresponding to this sequence was teacher give explanation (A5).

4.3 Analysis of Teacher TPACK Structure

Among the two types of teachers' TPACK structures, TCK and TPACK appear most frequently. TCK mainly corresponds to teacher-controlled behavior and teacher-student-controlled behavior at the same time. Based on the adjusted residual table, it was found that novice teachers' PK and TPACK sequences formed a bidirectional flow. The continuous mature teachers' TPACK sequence ($Z = 19.71$) was particularly significant, revealing that mature teachers are able to effectively integrate content knowledge, pedagogical knowledge and technological knowledge to enhance teaching efficiency.

5 Optimization Strategies to Enhance the Effectiveness of Online Teaching

The lag sequential data reflects many problems in online teaching, such as the obvious teaching oriented teaching, shallow integration of information technology and curriculum, and frequent media debugging and classroom silence. The series of problems exposed are precisely the key points of innovation and transformation in online teaching. Therefore, it is necessary to explore effective paths to leverage the unique advantages and educational value of online teaching from the perspectives of learning science, technology integration, and teacher development.

5.1 Learning Science Perspectives: Reinforcement and Breakthrough for Learning Subjects

Research in learning science has confirmed that passive learning - active learning - constructive learning - interactive learning is the evolutionary chain and that interactive learning works best (Sheng & Ni, 2021). Analysis of the data revealed that the online classrooms of both types of teachers behave conservatively, lacking student-oriented learning activities such as hands-on inquiry and group collaboration, and are more dominated by teacher explanation and questioning. Teachers need to develop inquiry-based, project-based and collaborative online learning activities to activate students' sense of agency and active learning.

5.2 Technology Integration Perspective: Innovation and Transformation of Teaching Media

Through data analysis, it was found that teaching media is more used to support teachers' teaching and less to support students' learning. Teachers should be proficient in digital education platforms and information exchange tools, etc. They should use a variety of technological tools to create open, flexible and free learning interaction scenarios for students, collect learner process data, realise personalised resource recommendations and learning feedback, and achieve innovative changes in the teaching mode empowered by technology.

5.3 Teacher Development Perspective: Construction and Improvement of Training Mechanisms

Data reflects teachers' digital literacy needs to be improved and it is urgent to build and improve teacher training mechanisms. Building online teaching resource platforms to provide teachers with scientific digital teaching tools, operational training courses and teaching application cases to help teachers update their knowledge structure and solve practical problems in real scenarios. Based on the National Smart Education Training Platform, collecting process data of teacher training, monitoring data of teachers at different training stages, accurately promoting online resources, typical cases, etc., and comprehensively improving teachers' digital competence.

6 Conclusion

The application of LSA method in online classroom teaching behavior analysis provides a strong basis for teachers to perspective the classroom behavioral, deepen reflection, and improve teaching. In future research, Lag Sequential Analysis method can also be used to compare the teaching behaviour of different teachers and course types and to analyse students' learning behaviour, thus providing a scientific basis for improving the quality and effectiveness of teaching.

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Academic Achievement Synthesis to Complete Graduation Strategies for Mathematics Students with Educational Data Mining and Learning Analytics

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Abstract. Nowadays, the educational technology environment is constantly changing and evolving in response to the rapidly advancing communication technology and telecommunication technology. Therefore, this research aims to apply artificial intelligence technology to promote and develop a quality education system. There are three objectives: 1) to study the academic achievement context of students in the Bachelor of Science Program in Mathematics at the Faculty of Science and Technology, Rajabhat Maha Sarakham University, which has emerged over the past decade, 2) to develop a predictive model for learner achievement to serve a learning style appropriate for learners' potential, 3) to evaluate the model's performance and determine its implementation. The population and research samples were 193 datasets of students. The research tools use popular machine learning algorithms to build models for training and testing performance. The results of the development of the Academic Achievement Model (AAM) showed that the model had a high level of efficiency. The future goal is to promote and use it in other educational organizations who are interested in applying artificial intelligence technology to further improve the quality of education.

Keywords: Academic Achievement Model · Educational Data Mining · Learning Analytics · Student Model · Technology-Enhanced Learning

1 Introduction

Our world today is increasingly interconnected without borders. However, humanity faces complex, interrelated challenges requiring multidisciplinary solutions [1, 2]. In addition, today's most pressing issues are sustainable education, single health, digital threats [1–3], etc. It thus affects the problematic lifestyle and the problem of finding and building a sustainable career in the future. One of the processes necessary for improving the quality of humanity is education and understanding the knowledge generation process [4]. It has appeared enormously in learning analytics and educational data mining [4–7], known as "Educational Data Science".

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 232–237, 2023.
https://doi.org/10.1007/978-981-99-5961-7_30

A new stage where data scientists have come to influence education management is the study of learner learning behavior and constructing learning strategies [8–11]. The creation of a learning model that is consistent with the potential of the candidate has attracted enormous interest [11]. Inspiration and Motivation are the behavioral science educators use to develop learners' potential through purposeful analysis [8]. It is acceptable to manage hybrid learning to integrate different methods and facilitate education provision [9, 12]. It has brought artificial intelligence technology to drive learners and has student problem detection to prevent dropouts [6] and many other examples.

The researcher thus aimed to respond to the trend of changing education management processes with three critical objectives. The first objective is to study the academic achievement context of students in the Bachelor of Science Program in Mathematics at the Faculty of Science and Technology, Rajabhat Maha Sarakham University (RMU), which has emerged over the past decade. The second objective is to develop a predictive model for learner achievement to serve a learning style appropriate for learners' potential. The third objective is to evaluate the model's performance and determine its implementation. From the context of importance and situations that have changed due to world conditions that affect learner behavior. The researchers firmly believe this research will drive and improve the quality of higher education learners.

2 Materials and Methods

The population of this study was students who had enrolled and received academic achievements from the Bachelor of Science Program in Mathematics at the Faculty of Science and Technology, RMU. A vital goal of this sample selection was to study the impact of past instructional management changes during the COVID-19 pandemic on student learning achievement. The research sample was determined by the purposive selection method of 193 students from 2013–2020 in Table 1.

Table 1 shows a summary of battle data gatherings. Important issues include that the 2013–2016 academic year had a similar proportion of graduates (10.88%) and non-achievement students (7.25%); the 2014–2017 academic year had more missed-schedule graduates (9.33%) than those who had graduated on schedule (4.15%). Moreover, the student's overall academic achievement (GPA) appeared to be moderate, with a mean equal to 2.27 of 4.00. With that in mind, it is necessary to develop predictive achievement models to prepare learners at risk of failing to achieve further academic achievement.

2.1 Research Methodology and Tools

This research process is conducted according to CRISP-DM principles for the most influential research goals. It consists of business understanding, data understanding, and data preparation. The researcher prepared the data through the research ethics and regulations of RMU. Regarding model development, researchers selected six supervised learning techniques to develop the most effective model: Artificial Neural Network (ANN), Decision Tree, Generalized Linear Model (GLM), k-Nearest Neighbor (KNN), Naïve Bayes, and Support Vector Machine (SVM). The instrument used for the model's performance metrics is the Confusion Matrix, with four key metrics: accuracy, precision,

Table 1. Data Collection.

Criteria	Academic Year					
	2013–2016	2014–2017	2015–2018	2016–2019	2017–2020	Overall
GPA						
- Minimum	0.43	0.71	0.22	0.44	0.68	0.22
- Maximum	3.54	3.14	3.45	3.36	3.11	3.54
- Mean	2.06	2.35	2.14	2.38	2.33	2.27
- Mode	0.47	2.12	0.22	2.39	2.50	2.39
- Median	2.39	2.32	2.26	2.38	2.50	2.37
- S.D	0.90	0.50	0.83	0.53	0.63	0.67
Graduated						
- On schedule	21	8	13	35	26	103
- Not on schedule	0	18	3	17	1	39
Dropped out	14	4	7	10	9	44
Resigned	2	3	1	0	1	7
Total:	37	33	24	62	37	193

recall, and f1-score. It was used to determine the predictive potential and performance of the model.

2.2 Research Analysis and Interpretation

An essential step in finding an acceptable model is to test the model performance to determine the appropriate model implementation. In this section, researchers divide into two main phases: data preparation for model development and model testing, using the 10-fold cross validation. Then extract some data to build the model, known as the training set (90%), and the testing set (10%).

This research found that the context of students enrolled in the Bachelor of Science Program in Mathematics at the Faculty of Science and Technology, RMU was diverse and exciting. Issues that need to be addressed in the context of learners include the grade point average (GPA) and the problem of student dropout from the education system. From the data collected, the overall learning achievement was moderate. It presents an overview of the Faculty of Science and Technology students who deserve to be encouraged and increase their academic skills. Program administrators and instructors must be aware of this problem and prioritize solving it. At the same time, the data shown in the GPA reflects the concern of dropping out of the system with a very high number and proportion of students. Therefore, it is necessary to develop alternatives; in which researchers have developed a model to predict the risk of dropping out of the educational system.

2.3 Risk Prediction Model of Mathematics Students

Table 2. Risk prediction model of mathematics students.

Classifier	Indicators				
	Accuracy	S.D.	Precision	Recall	F1-Score
Artificial Neural Network	81.46	±7.7			
- Graduated on schedule			82.72	87.01	84.81
- Graduated not on schedule			66.67	63.16	64.86
- Dropped out			94.12	91.43	92.75
- Resigned			80.00	66.67	72.73
Decision Tree	73.79	±7.39			
- Graduated on schedule			71.70	98.70	83.06
- Graduated not on schedule			83.33	26.32	40.00
- Dropped out			84.85	80.00	82.35
- Resigned			20.00	16.67	18.18
Generalized Linear Model	76.96	±7.22			
- Graduated on schedule			78.65	90.91	84.34
- Graduated not on schedule			65.52	50.00	56.72
- Dropped out			83.78	88.57	86.11
- Resigned			0.00	0.00	-
k-Nearest Neighbor	83.50*	±8.9			
- Graduated on schedule			83.53	92.21	87.65
- Graduated not on schedule			75.00	63.16	68.57
- Dropped out			96.77	85.71	90.91
- Resigned			62.50	83.33	71.43
Naïve Bayes	74.21	±10.37			
- Graduated on schedule			79.01	83.12	81.01
- Graduated not on schedule			55.26	55.26	55.26
- Dropped out			83.78	88.57	86.11
- Resigned			0.00	0.00	-
Support Vector Machine	76.33	±10.58			
- Graduated on schedule			72.82	97.40	83.33
- Graduated not on schedule			81.25	34.21	48.15
- Dropped out			83.78	88.57	86.11
- Resigned			0.00	0.00	-

Table 2 shows the models developed. The researchers found that the model developed with the k-Nearest Neighbor approach had the highest accuracy, equal to 83.50%, which the researchers selected for future applications. In addition, the following model performance reports section presents details in Table 3.

Table 3. Model performance reports.

	True RES	True GOS	True DPO	True GNS	Class Precision
Pred. RES	5	0	3	0	62.50%
Pred. GOS	0	71	0	14	83.53%
Pred. DPO	1	0	30	0	96.77%
Pred. GNS	0	6	2	24	75.00%
Class Recall	83.33%	92.21%	85.71%	63.16%	

GOS = Graduated on schedule, GNS = Graduated not on schedule, DPO = Dropped out, RES = Resigned

Table 3 presents the Confusion Matrix technique's discriminant model performance analysis results. The researchers found that the assessed results for each metric showed that the model was reasonable to apply as all metrics had the highest values for all metrics.

3 Discussion and Conclusion

This research discussion focuses on research objectives, categorized into three key areas: learner context, predictive model selection, and model efficacy. Researchers found various characteristics in the context of learners. A high-grade point average was GPA = 3.54. Some learners failed their studies with a grade point average of 0.22. Moreover, the average GPA of all data showed that most learners received an average GPA of 2.27. It implies that most learners have moderate academic skills and that those in charge of the curriculum must find ways to improve. In addition, it shows concern over the high proportion of student dropouts, with 22.80% failing to achieve academic achievement and 20.21% students who graduated not on the schedule. This research has focused on predicting the risk of students dropping out.

The model developed in this research was constructed from supervised learning. The researchers found that the model developed with the k-Nearest Neighbor approach had the highest accuracy. This model is reasonable to apply to solve the problem of student dropout and graduation not on schedule. It was chosen as the tested performance. The comprehensive performance test of the selected model was satisfactory. It was found that the dropped-out class having the highest precision and F1-Score, and the graduated-on-schedule class having the highest recall.

The researchers found the context of students that learners are heterogeneous and diverse, comprising high-potential learners and those requiring specialized care. These findings led to the development of a model to predict the risk of dropout, which is

consistent with the second objective. The researchers hope that the research results will support learners and can be a guide to solving the problem of students dropping out of the Thai education system.

Acknowledgements. This research project was supported by the Thailand Science Research and Innovation Fund and the University of Phayao (Grant No. FF66-UoE002). In addition, this research was supported by many advisors, academics, students, and staff. The authors would like to thank all of them for their support.

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Factors Influencing the Effectiveness of Online Learning in Relation to Corporate Performance

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Abstract. During the Covid-19 pandemic, companies still conduct employee training and development; however, the activity needs to be completely rearranged to make it safe for trainer and trainee without losing its objective of training. In general, industries highly depends on employee training to update regulation and business practise. The study used quantitative correlational approach in determining correlation between variables which are perceived training opportunities (PTO), perceived investment in employee development (PIED), technology readiness (TR), and training environment (TE) as independent variables on corporate performance (CP) variables as dependent variables with employee self-efficacy (SE) as the intervening variable. An online questionnaire with 5 points Likert scale was used to collect data from companies in Jakarta, using systematic random sampling, 102 respondents from May 2022 to July 2022. Results of the study show that only PIED have significant effect on CP whereas employee SE does not have significant effect as intervening variable to CP.

Keywords: Learning · Online · Pandemic · Corporate · Performance

1 Introduction

The industry must consider learning and development as its most important business aspect. Meanwhile, a study found that online training can help reduce turnover in a company [1]. Although human resources research has shown that online learning can increase job satisfaction, it still needs a lot of fine-tuning to be implemented effectively in the real world.

We conducted this study intending to determine whether the characteristics influencing online learning are still relevant in today's environment, which, due to the pandemic situation, makes online learning the only method of learning and development. This study aims to answer the following research questions: 1) How do the factors that influence the effectiveness of online learning contribute to company performance?

2 Literature Review

PTO is "employees' perception of their participation in existing training opportunities" [2]. The values provided by training and development will improve task performance and behavior possessed by employees [3].

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 238–241, 2023.
https://doi.org/10.1007/978-981-99-5961-7_31

H1: Perceived training opportunities in online training (PTO) will affect corporate performance significantly

PIED is defined as "Employees' perceptions of their employer's dedication to assisting them in identifying and developing new skills" [4]. Workers should also interpret investment as signalling that they have a long-term, trust- based connection with their company and, as a result, should put out greater effort to improve the company's success because of this understanding [5].

H2: Perceived Investment in Employee Development (PIED) will affect corporate performance significantly

By providing a variety of learning approaches and applications for knowledge exchange and skills growth, e-learning enhances and promotes education and learning [6, 7].

H3: Technology Readiness in Online Training (TR) will affect Corporate Performance significantly.

In a more traditional training environment, trainers, equipment, facilities, training methods, and so on can all be considered as the aggregate constraints in a training environment, just as in a virtual training environment. An employee-friendly social environment can be achieved if employees think the company will provide them with opportunities and reinforcement to practice the skills learned and apply the knowledge acquired through training [8] (Fig. 1).

H4: Training environment in Online training (TE) will affect corporate performance significantly.

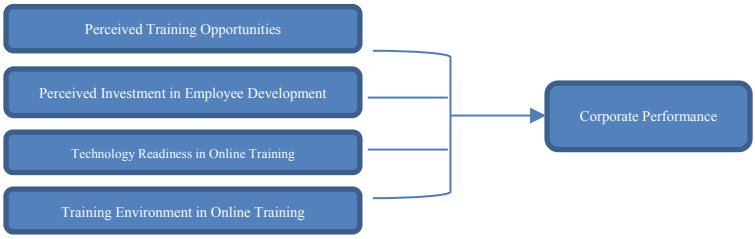

Fig. 1. Research Model

3 Method

This study used a random sampling approach to collect data. In this study, we assigned 102 respondents. This research collects data through the distribution of web-based questionnaires, where one sample question per variable is as follows: 1) PTO - I feel certain that I will get the necessary training and development to solve any new tasks I may be given in the future, 2) PIED - By investing time and money in employee development,

my organization demonstrates that it invests in its employees, 3) TR - I like the idea of doing business via computers because I am not limited to regular business hours, 4) TE – Within the training environment, I feel that Others in the group help me learn. In order to analyze the model, we used the PLS-SEM approach, and Smart-PLS was used as a tool. Data analysis techniques obtained from the results of distributing questionnaires refer to two things, namely measurement model measurement and structural model assessment.

4 Results and Discussions

The results of the survey collection can be illustrated by the profiles of our respondents, who are mostly staff and took online training mostly one month ago (during the time this research was conducted). The validity test results showed that all indicators are valid because the AVE of each indicator is above 0.5. Then discriminant validity also passed all the criteria. Then this model can explain the phenomenon as much as 58.1%, which is reflected through this research model. Then when bootstrapping is done, the results show that only one hypothesis is supported. Namely, Perceived Investment in Employee Development has a significant effect on Company Performance (t-statistics: 3,534 > 1.96; P-Values: 0,000), but other results are not supported because all P-Values > 0.000 and t-statistics < 1.96.

This study found that PTO in online training has no significant effect on company performance. This finding is inconsistent with previous research who said perceived training opportunities had a significant positive relationship with firm performance and proved that providing high-level training opportunities would not always improve task performance. We also found that PIED in online training significantly influences company performance positively. Our findings align with previous research that found company investment in employee development should encourage employees to try harder to increase company success. Furthermore, we found that TR does not significantly affect firm performance. This finding is different from the findings from previous research that technology readiness is needed to effectively use new technologies, which will ultimately improve company performance. Finally, TE only significantly affects company performance. Our results differ from previous research who say that environmental preferences should impact motivation before training and skills transfer during training.

5 Conclusions

Our study contributes to findings. Where we found that a greater scale of online training that is pushed forward has a positive effect on corporate performance. This finding is in line with previous study with a much smaller case of online training in its infancy. We believe that, regarding the rapid advancement of information and technology all these years, online learning may have become viable to be implemented on a larger scale.

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Optimizing Learning Outcomes and Retention in MOOCs with AI-Generated Flashcards

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Abstract. This study introduces a generative AI-based Flashcard Bot, utilizing natural language processing (NLP) for flashcard creation within the Massive Open Online Courses (MOOCs) context. By leveraging the pre-trained T5 model, the system transforms the extracted text content of a business intelligence MOOC from Moodle into flashcards. These AI-generated flashcards, aimed at enhancing learners' memory through testing effect and spaced repetition, are evaluated based on quality, relevance, accuracy, and fluency. Comparisons are made with existing flashcard tools, and student perceptions are assessed through a survey. The results illustrate comparable quality between AI-generated and human-created flashcards, signifying the potential of generative AI and NLP in transforming educational technology and augmenting online learning experiences.

Keywords: Flashcard · MOOC · Assessment · Automatic Question Generation · Generative AI · Natural Language Processing

1 Introduction

Massive Open Online Courses (MOOCs) are increasingly popular for distance learning [1]. Despite their advantages, a key challenge for MOOC learners is retaining and recalling the vast course content. Flashcards have proven to be an effective self-assessment and revision tool [2], yet their generation from course content remains limited. In response, we propose a method using natural language processing (NLP) techniques to create high-quality flashcards from MOOC material.

Various studies have demonstrated flashcard's effectiveness in improving learning outcomes, including traditional paper and augmented reality (AR) flashcards [3], particularly in special education [4]. Digital flashcard tools like FlashCram, Anki, Quizlet, and Cram offer enhanced features like spaced repetition and auditory accompaniment [5–8].

Researchers have begun to incorporate NLP techniques in flashcard creation to automate the process [9]. Particularly, advancements in question generation and answering models such as T5 have shown promising results in this context [10, 11]. However, it is crucial to address potential biases like high lexical overlap in their outputs [15]. Techniques like synonym replacement-based approach and QA-augmented BART-based frameworks like QA4QG help mitigate such biases and improve performance [12].

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 242–247, 2023.
https://doi.org/10.1007/978-981-99-5961-7_32

Our research aims to leverage these advances in NLP to generate high-quality flashcards from MOOC content, thereby improving the learning experience of MOOC learners. By building on existing knowledge and advancements in NLP and flashcard research, we seek to make a meaningful contribution to the development of interactive learning tools for MOOCs.

2 Methodology

In this section, we will describe the methodology we used to collect the MOOC content from Moodle and how we processed the text to generate flashcards. We will also describe the tools and techniques we used to implement the code as seen in Fig. 1.

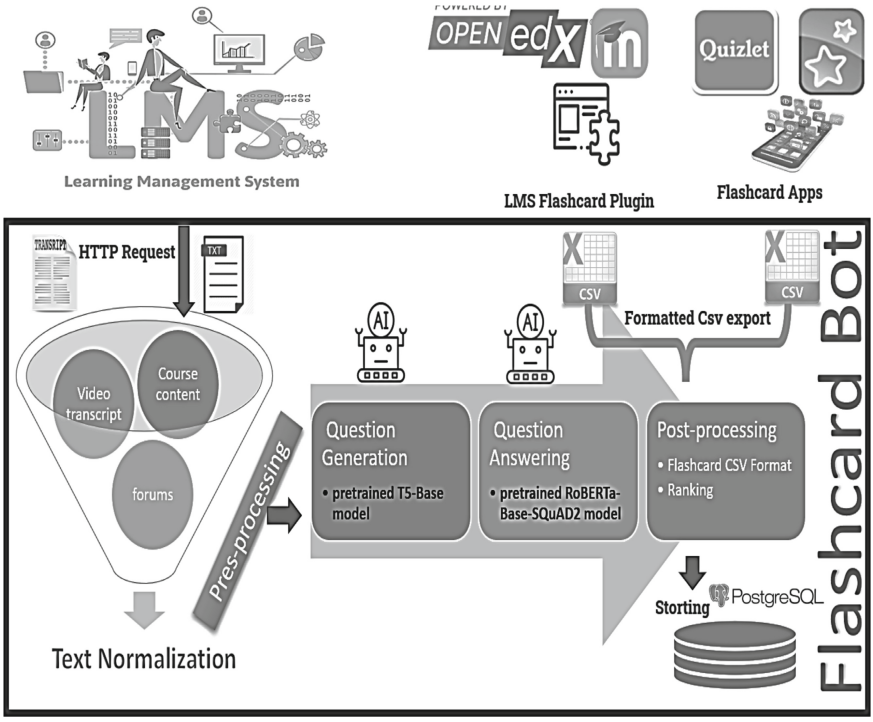

Fig. 1. The proposed system architecture

We selected the MOOC "MPPBIE" [13] hosted on the Moodle platform. The course has eight modules, and each module has multiple lessons. We collected the text content of each lesson, including the title, description, and main body, by scraping the website using Python's BeautifulSoup library. We stored the text content in a JSON file.

We performed several preprocessing steps to clean and prepare the text data for the flashcard generation. First, we removed any HTML tags, special characters, and punctuation marks. Next, we tokenized the text into sentences and removed any stop

words. We also lemmatized the words to their base form and performed part-of-speech tagging to identify the nouns, verbs, adjectives, and adverbs.

We used the Hugging Face's transformers library to generate flashcards from the preprocessed text data. We used the pre-trained T5 model, which is a transformer-based language model capable of performing various text-to-text tasks, including question generation. We fine-tuned the T5 model on our MOOC text data using the "text2text" training approach, where we trained the model to generate a question from a given sentence.

We employed a two-step approach for generating and answering questions.

- Question Generation (QG):
  To generate questions, we utilized the end-to-end QG pipeline from the question generation library, which we adapted to our specific needs. The library was refactored to contain less than one hundred lines of relevant code. We employed a pre-trained T5-Base model, which had been trained on Squad 2.0 and was available on HuggingFace, to generate questions.
- Question Answering (QA):
  For question answering, we explored several off-the-shelf baselines, including DistillBERT and BERT-tiny. After evaluation, we selected the pre-trained RoBERTa-Base-SQuAD2 model, also hosted on HuggingFace, for its superior performance.

3 Experiment

In our study, fifty students and ten instructors from the MPPBIE MOOC participated. Participants, randomly selected from 780 enrolled students, were introduced to the study's aims, and encouraged to use our flashcards for learning. The instructors' task was to evaluate the effectiveness of these flashcards on students' learning.

We conducted an online survey to gather feedback from both students and instructors about the flashcard's utility, relevance, and quality. The survey consisted of ten questions, focusing on understanding student perceptions.

The survey data was examined using descriptive and inferential statistics to summarize the results.

4 Results and Discussion

In this study, we implemented a flashcard generation pipeline using Python and Django. We collected text content from a business intelligence MOOC, preprocessed it, and generated flashcards using a pre-trained T5 model. The quality of the flashcards was evaluated by instructors, who rated their accuracy and fluency on a scale of 1 to 5. The results (Table 1) showed that the average accuracy score was 4.1, indicating that the flashcards were generally accurate in conveying the course content. The average fluency score was 4.2, indicating that the flashcards were easy to read and understand.

We received responses from forty out of fifty students and all ten instructors. The survey results provided insight into the perceptions of the flashcard's usefulness, relevance, and quality.

Table 1. Flashcard Quality Evaluation

Flashcard Number	Accuracy Score	Fluency Score
1	3.5	4.0
2	4.5	4.5
3	4.0	4.0
…	…	…
50	4.0	4.0
Average	4.1	4.2

From the survey data in Table 2, it is evident that the flashcards developed from MOOC content were well-received by both students and instructors.

Most students had prior experience using flashcards as a study tool, and they often incorporated them into their learning routine. Their perceptions of the flashcard's helpfulness, relevance, and understandability were notably positive.

The data further indicates that the flashcards were effective in aiding students' memory retention of the course material. An overwhelming majority would recommend these flashcards for this course. Overall satisfaction regarding the quality, variety, and usefulness of the flashcards was also high among students.

Instructors echoed these sentiments, showing even stronger endorsement for the use of flashcards. Their overall satisfaction with the flashcard's quality, variety, and usefulness was also noteworthy.

Nevertheless, while the responses were positive, the slightly lower scores for flashcard variety among students hint at potential areas for enhancement. This suggests future iterations could focus on introducing greater diversity in the types of flashcards generated to further improve the student learning experience.

Limitations exist with automated flashcard production. Inefficient studying methods and struggles with vocabulary retention can curtail the benefits of flashcards [7, 8, 14]. Also, the lack of personalization and potential ineffectiveness of pictorial flashcards pose challenges [7]. Issues with complex language can hamper NLP methods, necessitating further research into automated flashcard production.

Our survey showed positive student feedback regarding flashcard's quality, diversity, and usefulness, and suggested further enhancements, like the inclusion of multimedia elements. Our research, which employs NLP for the creation of high-quality educational flashcards, also stresses the importance of considering student perspectives when designing instructional tools. The use of NLP-generated flashcards can promote online learning and academic achievement by assisting students in learning and retaining course materials.

Table 2. Survey Results Summary

	Measure	Students	Instructors
1	Used Before (%)	60%	70%
2	Frequency of Use (Mean, SD)	3.8, 1.0	4.2, 0.8
3	Helpfulness (Mean, SD)	4.1, 0.9	4.5, 0.7
4	Relevance (Mean, SD)	4.2, 0.8	4.6, 0.5
5	Understandability (Mean, SD)	4.4, 0.7	4.7, 0.5
6	Helped Memory (%)	75%	80%
7	Recommend (%)	85%	90%
8	Satisfaction - Quality (Mean, SD)	4.0, 0.8	4.3, 0.7
9	Satisfaction - Variety (Mean, SD)	3.8, 1.0	4.1, 0.6
10	Satisfaction - Usefulness (Mean, SD)	4.2, 0.9	4.4, 0.5

5 Conclusion

This paper presented the implementation of a Flashcard Bot, a generative AI system utilizing natural language processing (NLP) and question generation. The survey results highlight an optimistic acceptance among learners, strengthening the argument for AI's role in enhancing the online learning experience.

While our method produced promising results, we recognize that there is room for further improvement. As a pathway forward, future research could delve deeper into more extensive applications of generative AI in education, focusing on optimizing the model for heightened learner engagement and understanding.

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The Determination of Preservice Teachers' Opinions on Alternative Assessment Activities in Online Context-Based Learning During Covid-19

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Abstract. The fact that many things in everyday life is basically simple events can be transmitted to pre-service teachers in online learning through using alternative assessment activities. In this research, the aim was to teach Context-based learning course included in teacher education curriculum with using alternative assessment activities in online learning during Covid-19. The special online context-based learning courses were designed. Within the scope of the training, pre-service teachers designed their own course materials in their houses. The purpose of the courses; pre-service teachers, the importance of context-based learning and alternative assessment the use of education is to be knowledgeable. The participants of this research were 10 pre-service teachers. The qualitative content analysis was employed. This research results also illustrates the need for practices such as Context-based learning and alternative assessment activities. However, the limited studies on Context-based learning and alternative assessment activities poses a significant problem for online teacher education.

Keywords: Alternative assessment activities · Context-based learning · Pre-service teachers · Covid-19

1 Introduction

The worldwide repercussions of everyday-life-based teaching have slowly reached our country, too. For example, when the old and the new curricula used in our country are compared, it can be seen that the new curriculum includes comparatively more everyday life connections [1, 2]. The one of the reasons for developing a new curriculum is expressed as follows: "pre-service teachers should be able to use their knowledge in solving problems they face in daily life, and courses should be run by relating the topics to real life cases. The aim of new teaching curriculum is to train pre-service teachers, who are equipped with basic knowledge, skills and attitudes to teach at secondary level; have embraced the ethical values of teaching; keep up with the age of informatics; have physics literacy and scientific process skills; follow and transfer to students the developing science and technology; are able to relate the learnt knowledge with real life;

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 248–253, 2023.
https://doi.org/10.1007/978-981-99-5961-7_33

build field-related interdisciplinary bridges; possess the creative and critical thinking skills; are sensitive to the relationship between science, society and environment; and are open to changes [3]. However, it has been revealed in the studies conducted hat students are unable to apply scientific knowledge they have acquired to real-life situations [4, 5]. This is not surprising, because in traditional approaches, it is highly unlikely for students to be able to apply knowledge to everyday life and responsive learning in science education [6]. Although students may sometimes find associations between everyday life and the information, they acquire in learning environments based on traditional learning, this association cannot go beyond mere association be-cause students cannot fully adapt their knowledge to everyday life [7]. The fact that many things in everyday life is basically simple events can be transmitted to pre-service teachers in online learning through using alternative assessment activities. When the studies conducted to reconcile everyday life and science are examined, it can be seen that there are many interesting learning-teaching activities designed with items frequently used in daily life [8, 9]. Because one cannot think of Context-based learning without assessment, the process of designing alternative assessment activities is a highly important one. Having classes that are associated with everyday life and intensifying science knowledge by striking alternative assessment activities from daily life are all done to integrate science subjects and everyday life [10]. Providing students with useful information that they can use in their daily lives can make them aware of the relationship between science and daily life, and this can cause them to prefer using their science knowledge in interpreting the phenomena they encounter in their daily lives [11]. Thus, this study is significant for adding a new alternative assessment activity to the al-ready existing ones. Due to such study, new alternative assessment activities can be designed in the future. This study aims to determine the preservice teachers' Context-based learning using alternative assessment activities in their online university education during Covid- 19. To this end, the research sought answers to the following questions: 1. What are the expectations of pre-service teachers from online context-based learning During Covid-19? 2. What are pre-service teachers' gains from online context-based learning using alternative assessment activities during Covid-19? 3. What are the necessary conditions for practicing alternative assessment activities in context-based teaching according to pre-service teachers?

2 Method

The participants of this research were 10 pre-service teachers. The online learning of pre-service teachers was collected through alternative assessment activities prepared according to the context-based learning. Context-based Learning course aims to acknowledge students about the importance and objectives of context-based education. In the curriculum of the faculty of education, the context-based learning course is carried out for two hours a week. This course is an elective course. Within the scope of the course, information about context-based learning is given during the four courses. For the next weeks, pre-service teachers design alternative assessment activities in context-based teaching. Pre-service teachers choose topics, prepare for the alternative assessment activities according to context-based teaching method. After the lesson, pre-service teachers evaluate themselves with a self-assessment form. Each pre-service teachers are given

one week to fill out this form. The data obtained from the self-assessment form were analyzed by content analysis. Content analysis allows individuals to create indicators of worldviews, values, attitudes, prejudices, and views and compare them among communities [12]. The data of the research were collected with written responses. This form is a self-assessment form. Data collection tools used in the study were also worksheets, and evaluation reports. The worksheets were prepared by the pre-service teachers during the courses. The alternative assessment activities were reflected in the worksheets by focusing on the context-based teaching. Evaluation reports contain notes taken by pre-service teachers throughout the implementation process. It was observed that pre-service teachers, in their evaluation reports, reflected their views about the applicability of alternative assessment activities in context-based teaching and the contributions of alternative assessment activities in context-based teaching practices. The worksheets were kept by the researcher. The self-assessment form and evaluation reports reflect pre-service teachers' views on themselves and their activities. The self-assessment form included questions about pre-service teachers' expectations, and the alternative assessment activities in online context-Based Learning implementation process. The self-assessment form was sent to the pre-service teachers as Google forms, and they were given a week to fill out the form. In the study, alternative assessment activities that can be conducted and are easy to do in online in Context-Based learning were designed. However, some preliminary studies were also done. Prior to the pre-service teachers' practices, the researcher delivered an 8-h in online training course on the context-based learning and alternative assessment activities for volunteering pre-service teachers working.

The Special Online Context-Based Learning Courses: The courses encompass online context-based learning during Covid-19 using alternative assessment activities in teacher education. The purpose of the courses; pre-service teachers, the importance of context-based learning and alternative as-assessments the use of education is to be knowledgeable. The course was carried out by researcher in online learning during Covid-19. As a result of the studies carried out in online education, alternative assessment activities that can be done by using everyday materials were prepared. These activities were designed according to Context-based learning for courses and the new curriculum principles. The University has a Distance Education Program for students. Within Program, studies aiming at diploma, certificate and distance education programs and their dissemination are carried out. Program teaches the content of online classes to pre-service teachers according to the course's principles in an applied manner. The special online context-based teaching courses were applied within Program.

3 Results

Regarding the opinions, 72% of the pre-service teachers stated that they had positive expectations from alternative assessment activities in context-based teaching practical lesson. It is thought that pre-service teachers' course-related expectations from alternative assessment activities in context-based teaching are mostly to arouse interest. Pre-service teachers stated that they expected context-based teaching to arouse interest in pupils. The expressions for this question are as follows.

"The students mostly give importance to the subjects about which there may be questions in the university entrance exam. I want to use alternative assessment activities in online context-based teaching to motivate pupils [PT3]."

"I hope that these alternative assessment activities in context-based teaching will attract the attention of the pupils and provide them with the necessary motivation. [PT8]"

The answers given to the question about gains was positive opinions, 84% of the pre-service teachers stated that they were satisfied gains. The following answer included the form of pre-service teacher, who stated that he had learned new alter-native assessment methods as a result of the on context-based teaching:

"Giving examples from daily life was something I already knew about, but now I can use also alternative assessment methods. [PT2]"

"While new developing alternative assessment activities, I started to consolidate what I had learned on context-based teaching. [PT1]"

"I think that I have made the activities well, but the parts of evaluating them could have been planned and done better. [PT9]"

It was revealed that pre-service teachers' opinions (90%) on the applicability of alternative assessment activities in context-based teaching differed from the be-ginning to the end of the process.

"Yes, we are now able to do alternative assessment activities in context-based teaching. I can teach in online environment by making alternative assessment activities. [PT2]"

In the research, 88% of the pre-service teachers stated that the alternative assessment activities in online Context-based teaching was good. They consider using the alternative assessment activities in Context-based teaching method. In the form, pre-service teachers stated that alternative assessment activities in Context-based teaching could be applied.

"We already give examples of daily life in our homework's. [PT1]"

"First of all, I prepared my alternative assessment activities accordingly context-based learning. First of all, I will let students know what I will tell about con-text-based learning and then I will explain the alternative assessment activities, then I planned to give homework. [PT2]"

4 Discussion and Conclusion

It is pleasing to see that everyday life-based approach has come to the for compared to other approaches and has been attached more importance. Nevertheless, because the studies examining the definitions related to these concepts and approaches or the related research findings, it is seen that they are not known as much as they should be [13]. For this reason, pre-service teachers should be capable of carrying out their university education courses by taking the context-based teaching approach into consideration. First,

there should be applications toward the goal of letting the pre-service teachers gain this capability in their online education process [14]. This study aimed to investigate the expectations and gains of the pre-service teachers who designed and used alternative assessment activities in their houses during Covid 19 Pandemic and to reveal their views on the applicability of this teaching approach. In this research, pre-service teachers prepared the alternative assessment activities in context-based teaching them-selves. The pre-service teachers evaluated the applicability of alternative assessment activities in context-based teaching process. As a result, it was concluded that pre-service teachers believed that alternative assessment activities in online con-text-based instruction increased preservice teachers' motivation. According to Pilot and Bulte [15], comparing the results of traditional education and everyday-life based education is possible only to some extent because it is not possible to compare the learning outcomes and objectives of these two methods. When compared, it is revealed that every day-life based education programs have a better way of promoting students' interest, motivation, and success [16]. Also, preservice teachers stated that their competencies in alternative assessment activities in context-based teaching had improved after practicing it. The answers given to the question about gains was positive opinions, of the pre-service teachers stated that they were satisfied gains. It is thought that pre-service teachers' course-related expectations from alternative assessment activities in context-based teaching are mostly to arouse interest. It was revealed that pre-service teachers' opinions on the applicability of alternative assessment activities in context-based teaching differed from the beginning to the end of the process. Because the lesson becomes more understandable and remarkable for students when the concepts are associated with daily life [17]. The limitedness of studies and alternative assessment activities in online Context-Based Learnings on everyday life science poses a significant problem for teacher education.

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Readiness for Smart Learning: Reflection on Challenges Faced by Students and Academics in Higher Education Institutions

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Abstract. Technology-based learning encompasses knowledge transmission, interactions, facilitation, evaluations, research, and monitoring. Smart learning at limited-resource higher education institutions presents significant challenges. We focus on five primary areas: learning evolution, learning technology, pedagogical competency gaps, assessment and feedback, and programme evaluation and monitoring. Unavailability and unfamiliarity with technical facilities, inability to manage and innovate with available resources to progress, deficiencies in prevailing pedagogical competencies unrelated to technological advances, and not using technology in assessments due to credibility, validity, and reliability concerns are highlighted as barriers. Smart learning technology demands careful evaluation of preparedness of students, academics and institutions, and conceptual development like 21st-century skills. To execute extended learning, attitudinal adjustments, resources, and multi-dimensional strategies are needed.

Keywords: Academic readiness · Smart learning · Challenges in smart pedagogy · Higher education institutions

1 Introduction

Smart learning improves learning and prepares students for work. Smart learning requires LMSs, digital content, and smart devices. Many students and teachers lack the pedagogical skills to integrate technology into teaching.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 254–257, 2023.
https://doi.org/10.1007/978-981-99-5961-7_34

Smart learning provides real-time feedback and monitoring [1]. However, assessment validity, reliability, and learning outcomes are concerns [2]. These challenges require a comprehensive approach and collaboration with multiple stakeholders to ensure equitable and adequate educational opportunities for all.

We critically examine and discuss the challenges students and academics face when integrating smart learning into higher education institutions, providing insights and recommendations for effective implementation.

2 Evolution of Smart Learning: Global vs Local Scenario

Smart learning is a current educational paradigm that leverages ubiquitous learning to personalise and engage [3]. It promotes self-directed learning, meta-learning, and student-centred learning. Singapore, the US, Finland, Australia, China, Korea, Japan, and the UAE use smart learning to develop 21st-century skills [4, 5]. However, developing countries like Bangladesh, Nepal, and Sri Lanka are at the early stage of adopting [5]. With 1.5 billion learners affected, COVID-19 mandated adopting a smart learning [6]. Distance learning was aided by video conferencing and LMS. Despite the expense, infrastructural, and stakeholder resistance, Sri Lankan institutions built smart classrooms and virtual labs. However, Sri Lanka needs multi-stakeholder cooperation to build a sustainable environment that promotes the establishment and integration of smart learning platforms that are evolving and progressing to create learning cantered education supporting lifelong learning and inclusive and equitable quality education (Sustainable Development Goals No:04). Such an approach would be conducive to harness the holistic value of smart learning rather than considering it as a mode of learning during a crisis.

3 Technology for Smart Learning: Best and Essentials

AI, Machine Learning, Adaptive Learning Systems, Learning Analytics, Multimedia, and Interactive Content are the leading smart learning technologies. Smart learning requires digital devices, stable internet, an LMS, and digital literacy. Educator training, cooperation, continual assessment, and technological partnerships may maximise resources. In addition to the digital divide, a fixed mindset could be considered a significant challenge in enabling smart learning.

Eliminating the fixed mindset requires prioritising accessible resources, pedagogical skills, and flexible teaching methods above sophisticated technology. To overcome technological restrictions, a growth mindset encourages ingenuity and inventiveness. Addressing technological limits needs study and multidisciplinary collaboration among educational researchers, technology professionals, and practitioners to build and modify smart learning procedures.

4 Pedagogical Competencies: How Smart Learning Can Help

It has become essential for students and academics to be abreast with technological advances of smart learning while accomplishing a much-needed deep understanding of effective pedagogical approaches required to fulfil the educational needs of modern

society. Smart learning has become a part of pedagogy and a tool for pedagogy. It should support the accomplishment of ICT skills, subject-related learning, soft skills, and meta-learning. Adopting educational theories such as cognitivism and constructivism should be promoted through smart learning.

However, the common complaint of missing face-to-face interactions is a reality due to the gap between Generation Y and Generation X. Constructivist approach can be promoted in smart learning by asking the correct question and promoting project-based learning. Facilitators must try to describe affective components vividly in an inadequately supported setting. Smart learning can promote social learning and a community of learners by creating interactive groups. Educationists must face the challenge of preventing students from becoming inactive technology dependent, passive learners and take AI as a blessing.

5 Smart Assessment and Feedback and Smart Programme Evaluation and Monitoring

Smart adaptation in summative assessment or "assessment of learning" (AoL) is a challenge, while formative assessment or "assessment for learning" (AfL) and "assessment as learning" (AsL) fit smart learning approaches. Smart learning uses authentic evaluations like ePortfolios, notably in language and health-related degree programmes. Smart learning allows personalised evaluations in Outcome-Based Education (OBE). Rubric-evaluated ePortfolios may help assess complicated skills and attitudes [7]. Smart proctoring, including AI-based advances, may combat cheating and academic dishonesty. Finally, if used properly, AI solutions like Grammarly®, QuillBot®, and Turnitin® may enhance education and overcome language hurdles.

The University Grants Commission (UGC-LK) governs Sri Lankan state institutions, which face rigorous quality assurance reviews under a World Bank programme, including Self Evaluation Reports (SER), Institutional Reviews (IR), and Programme Reviews (PR). UGC-LK monitors compliance with Sri Lanka Quality Framework (SLQF) [8]. The review process has become time-consuming and resource-intensive, possibly reducing quality and causing the "watermelon matrix effect" [9].

Smart learning may enhance academic quality assurance. Smart tools monitor process development and automate review. An inheritable template for tracking success with evidence might use the four-step Kirkpatrick pyramid programme assessment model [10]. Program evaluation and monitoring should be an ongoing, integrated process rather than a periodical snapshot approach.

6 Conclusions

Smart learning has revolutionised the education systems worldwide, particularly with the impact of the COVID-19 pandemic. This reflection has shown that higher education institutes worldwide are already introducing smart learning to promote meta-learning to create self-directed and lifelong learners. However, to achieve a sustainable and progressive learning environment, stakeholders must prioritize accessibility to resources,

pedagogical skills, smart assessment methods and flexible teaching and learning methods. Further, smart learning can enhance academic quality assurance with proper implementation and cooperation. It can create a learning environment that is learning-centred, inclusive, equitable and responsive to the challenges of the 21st century.

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The Emerging Technologies and Applications of Intelligent Learning for Sustainable Societies in Yunnan, China

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Abstract. The rapid development of emerging technologies, such as artificial intelligence, machine learning, and big data, has brought about significant changes in various aspects of society, including education, healthcare, and transportation. In particular, the integration of intelligent learning technologies in education has the potential to revolutionize the way we teach and learn and contribute to building sustainable societies. This paper tries to explore the potential of intelligent learning to support sustainable development in Yunnan China, with a focus on emerging technologies and applications that can facilitate its adoption. The paper also examines the challenges and opportunities associated with the adoption of intelligent learning for sustainable societies in Yunnan China and proposes recommendations for policymakers and educators to promote its effective implementation. Ultimately, this paper argues that intelligent learning, coupled with emerging technologies and applications, can be a powerful driver of sustainable development in Yunnan China and can contribute to creating a more equitable, resilient, and prosperous future.

Keywords: Emerging Technologies and Applications · Intelligent Learning · Sustainable Societies · Yunnan province China

1 Introduction

The concept of sustainable societies has gained increasing attention in recent years due to the challenges posed by climate change, environmental degradation, and social and economic inequality. The United Nations' Sustainable Development Goals (SDGs) provide a framework for achieving sustainable societies, including goals related to quality education, affordable and clean energy, and sustainable cities and communities. The integration of emerging technologies such as AI and machine learning in education has the potential to contribute to achieving these goals and building sustainable societies.

Yunnan is a province in southwestern China known for its rich cultural diversity and natural resources. This paper explores the emerging technologies and applications of intelligent learning in Yunnan province, such as intelligent tutoring systems, and personalized learning in education, and how they contribute to building sustainable societies. The paper also examines the challenges and opportunities of intelligent learning

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 258–264, 2023.
https://doi.org/10.1007/978-981-99-5961-7_35

for sustainable societies in Yunnan province, including the need for a supportive policy environment, investment in infrastructure and human resources, and addressing ethical concerns.

Intelligent learning is one such technology that has the potential to support sustainable development in China. Intelligent learning refers to the use of artificial intelligence (AI), machine learning, and other advanced technologies to enhance the learning experience and improve educational outcomes. By leveraging these technologies, intelligent learning can help to create a more equitable and accessible education system, support lifelong learning, and promote innovation and creativity.

1.1 Objectives of the Study

1. To explore the potential of intelligent learning to support sustainable development in Yunnan China, with a focus on emerging technologies and applications that can facilitate its adoption;
2. To examine the challenges and opportunities associated with the adoption of intelligent learning for sustainable societies in Yunnan China and proposes recommendations for policymakers, educators, and practitioners to promote its effective implementation.

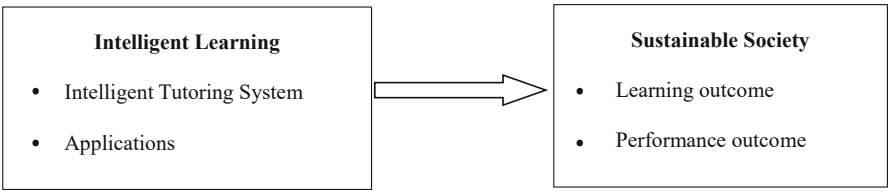
2 Literature Review

Constructivism Theory is a learning theory that was first introduced by the Swiss psychologist Jean Piaget in the 1920s. According to this theory, learners actively construct their own understanding of the world based on their experiences and interactions with their environment. In a constructivist learning environment, learners are encouraged to explore and experiment with ideas and concepts, and to collaboratively construct new knowledge through social interactions with others. The role of the teacher is to facilitate this process by providing guidance and support, rather than simply transmitting information to learners. Intelligent learning technologies can be designed to support constructivist approaches to learning by providing learners with opportunities to interact with digital materials and collaborate with others in virtual environments. For example, a digital simulation might allow learners to explore complex scientific concepts through interactive experimentation, or an online discussion forum might facilitate collaborative problem-solving among a group of learners.

Constructivism theory emphasizes the importance of learners actively constructing their own understanding and knowledge through their experiences and interactions with the world around them. This approach to learning encourages learners to be active participants in the learning process and to take ownership of their own learning. In an intelligent learning experience, this means that learners are encouraged to explore and experiment with concepts and ideas, and to connect new information to their existing knowledge in meaningful ways.

Situated Learning Theory is a learning theory that was first introduced by Lave and Wenger in 1991. According to this theory, learning is situated within a specific context and is influenced by the social and cultural environment in which it occurs. In a situated learning environment, learners are encouraged to engage in authentic, real-world tasks that are relevant to their lives and experiences. The role of the teacher is to facilitate this process by providing guidance and support, rather than simply transmitting information to learners. Situated learning theory emphasizes the importance of social interaction and collaboration in the learning process. Learners are seen as active participants in their own learning, rather than passive recipients of information. By working together in groups or communities of practice, learners can share their knowledge and experiences and support each other in their learning. Intelligent learning technologies can be designed to support situated learning approaches by providing learners with opportunities to engage in authentic, real-world tasks that are relevant to their lives and experiences. For example, a digital simulation might allow learners to explore complex scientific concepts through interactive experimentation, or an online discussion forum might facilitate collaborative problem-solving among a group of learners.

Situated learning theory emphasizes the importance of learning in context, and the role of social interaction and collaboration in the learning process. According to this theory, learning is most effective when it takes place in authentic, real-world contexts, and when learners are able to engage with others in meaningful ways. In an intelligent learning experience, this means that learners are encouraged to collaborate with others, to work on authentic, real-world problems, and to engage in reflective and critical thinking.



Conceptual Framework

The first element of the framework is the emerging technologies in the field of intelligent learning, which are changing the way we learn and work. The next element of the framework is the applications of intelligent learning. This refers to how the emerging technologies can be applied in education to create more sustainable and efficient societies. The third element of the framework is the learning outcomes of intelligent learning. This refers to how the emerging technologies can be used to improve knowledge, skills, and competencies. The final element of the framework is the performance outcomes of intelligent learning.

Intelligent learning allows for the personalization of learning experiences, which can be tailored to the individual needs and preferences of each learner. This means that learners are able to engage with content and activities that are relevant and meaningful to them, and that they are able to progress at their own pace. By incorporating the principles of situated learning into intelligent learning, we can create a learning environment that

is contextualized and relevant to the real-world needs and challenges of learners. This means that learners are able to engage with content and activities that are authentic and meaningful, and that they are able to apply their knowledge and skills in real-world settings.

3 Methodology

This paper adopts a qualitative research approach to explore the potential of intelligent learning for sustainable societies in Yunnan, China. The study focuses on the use of intelligent tutoring systems in primary and middle schools in Yunnan province. The research methodology involved conducting in-depth interviews with teachers, students, and education officials to understand their perspectives on the use of intelligent learning systems. The sample size consisted a total of 30 teachers, students, and education officials from various primary and middle schools in Yunnan province. Participants were selected based on their availability and willingness to participate in the study. The researcher reached out to schools and education officials to identify potential participants who were interested in taking part in the study. The sample included participants with expertise in the use of intelligent learning systems, including teachers who had experience using these systems in their classrooms, students who had been exposed to these systems, and education officials who had knowledge of the implementation of these systems in schools. The sample was selected based on its relevance to the research question and the objectives of the study. The participants were selected to provide insights into the potential of intelligent learning for sustainable societies in Yunnan, China, specifically in the context of primary and middle schools. The sample size is relatively small, but it is sufficient for a qualitative study that aims to provide in-depth insights into the experiences and perspectives of participants. The sample is also diverse, with participants from various primary and middle schools in Yunnan province, which can provide a range of perspectives and experiences.

4 Research Findings

1. In China, intelligent learning is already being used in various applications, such as intelligent tutoring systems, adaptive learning platforms, and personalized learning environments. However, the adoption of intelligent learning for sustainable societies in China is still in its infancy, and significant challenges remain. One of the key challenges of intelligent learning for sustainable societies in China is the lack of access to technology and infrastructure in rural and remote areas. According to a report by the National Bureau of Statistics of China, the internet penetration rate in rural areas was only 27.5% in 2020, compared to 71.6% in urban areas (National Bureau of Statistics of China, 2021). This digital divide creates significant barriers to the adoption of intelligent learning in rural areas, where access to quality education is already limited. Another challenge is the lack of integration between different sectors and stakeholders. Sustainable development requires a holistic approach that integrates social, economic, and environmental perspectives. To promote the adoption of intelligent learning for sustainable societies in China, it is essential to establish partnerships and collaborations between the education sector, the government, and the private sector.

2. Despite these challenges, there are also significant opportunities for the adoption of intelligent learning for sustainable societies in China. For example, the Chinese government has recognized the importance of technology and innovation for sustainable development and has launched several initiatives to promote the adoption of intelligent learning. The "New Generation Artificial Intelligence Development Plan" (AIDP), launched in 2017, aims to make China the world leader in AI by 2030 (State Council of the People's Republic of China, 2017). The COVID-19 pandemic has highlighted the importance of online and distance learning, creating new opportunities for the adoption of intelligent learning in China. According to a report by iResearch Consulting Group, the online education market in China is expected to reach RMB 543 billion ($83 billion) by 2022, up from RMB 251 billion ($38 billion) in 2019 (iResearch Consulting Group, 2021).

3. Intelligent learning has the potential to contribute to sustainable societies in Yunnan province in several ways. Firstly, intelligent learning systems provide personalized learning experiences for students, which can improve their learning outcomes and reduce the achievement gap. Secondly, intelligent learning systems can reduce the workload of teachers by automating tasks such as grading and providing feedback on student performance. This can free up teachers' time to focus on other aspects of teaching, such as lesson planning and student engagement.

By using ITS, teachers in rural schools in Yunnan province can provide students with personalized instruction and support, even when they are unable to provide one-on-one attention. The systems can also track student progress and provide detailed feedback to teachers, enabling them to identify areas where students are struggling and adjust their instruction accordingly. For example, the use of intelligent tutoring systems in rural schools in Yunnan province has led to significant improvements in student performance, particularly in subjects such as math and science. The use of ITS has also been found to improve student engagement and motivation, as the systems provide interactive and engaging learning experiences that are tailored to the student's individual interests and needs. Intelligent tutoring systems (ITS) are computer-based systems that provide personalized instruction, feedback, and support to learners based on their individual needs, abilities, and preferences. ITS uses AI and machine learning algorithms to analyze data on student performance, behavior, and engagement to adjust instruction and provide real-time feedback. ITS has been shown to improve student learning outcomes and engagement and has the potential to contribute to building sustainable societies by providing quality education to all learners.

Furthermore, the study finds that intelligent learning systems can help to address the challenges faced by schools in rural areas of Yunnan province. These schools often have limited resources and struggle to attract and retain qualified teachers. Intelligent learning systems can provide access to high-quality educational resources and support for students, regardless of their location.

4. While intelligent learning technologies have the potential to contribute to building sustainable societies, there are also challenges that need to be addressed. One of the main challenges is the need for a supportive policy environment that encourages the development and implementation of intelligent learning technologies. This includes

policies that promote innovation, investment in infrastructure and human resources, and address ethical concerns, such as data privacy and security.

Another challenge is the need for investment in infrastructure and human resources to support the development and implementation of intelligent learning technologies. This includes investment in technology infrastructure, such as high-speed internet and computing resources, and human resources, such as teachers and IT professionals with the necessary skills to develop and implement intelligent learning technologies.

5 Recommendations

Based on the research findings, the following recommendations are proposed for the effective use of intelligent learning systems in primary and middle schools in Yunnan, China.

1. Adequate training for teachers: Teachers need to receive adequate training on the use of intelligent learning systems to ensure that they can effectively integrate them into their teaching practices. This training should focus on both the technical aspects of the systems and the pedagogical approaches that can be used to optimize their use.
2. Customization of systems: The intelligent learning systems should be customized to meet the specific needs of each school and classroom. This will ensure that they are aligned with the curriculum and the learning objectives of the students.
3. Integration with traditional teaching methods: The intelligent learning systems should be integrated with traditional teaching methods to create a blended learning environment that maximizes learning outcomes. This will also ensure that students receive a well-rounded education.
4. Regular evaluation of outcomes: The outcomes of the intelligent learning systems should be regularly evaluated to assess their effectiveness in improving student learning outcomes. This will help to identify any areas that require improvement and guide future development of the systems.

6 Conclusion

The study identified several emerging technologies that have the potential to promote intelligent learning in Yunnan. These technologies include artificial intelligence, big data analytics, cloud computing, and the Internet of Things (IoT). These technologies can be used to develop intelligent learning platforms that can provide personalized learning experiences for students. Additionally, these platforms can be used to collect and analyze data on student performance, which can be used to improve teaching methods and curriculum development.

Intelligent learning, coupled with emerging technologies and applications, can be a powerful driver of sustainable development in Yunnan, China. By incorporating theories into intelligent learning, learners can be provided with opportunities to construct their own knowledge and skills in a way that is relevant to their personal experiences and interests. This can lead to better retention of information, increased motivation, and improved performance. Policymakers, educators, and practitioners should work together

to address the challenges and opportunities of intelligent learning for sustainable societies in Yunnan, China and promote its effective implementation. Ultimately, intelligent learning can contribute to creating a more equitable, resilient, and prosperous future for all in China.

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Gamification for Developing Media Literacy About Online Gambling Among University Students in Bangkok and Perimeter

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Abstract. This mixed-methods research study investigated the factors contributing to online gambling among university students in Bangkok and Perimeter. The study utilized small group discussions, in-depth interviews, and questionnaires to collect data from July 2022 to March 2023. The findings identified influential factors such as gender, age, place of study, motivation, emotional intelligence, and self-esteem that shape university students' knowledge, attitudes, and behaviors towards online gambling. The study proposed strategies to raise media awareness among students, including innovative gamification techniques for online gambling propaganda media literacy campaigns. By promoting media literacy and critical thinking, these strategies aim to equip students with skills to recognize and resist online gambling propaganda. The study's outcomes contribute to our understanding of online gambling among university students and provide practical recommendations for educators, policymakers, and stakeholders in addressing this issue.

Keywords: Gamification · Online gambling propaganda · Media literacy campaigns · Innovative games techniques · University students

1 Introduction

Rajanagarindra Institute of Child and Adolescent Mental Health, Thailand [1] conducted a study on adolescent gambling and found that online media and the internet significantly contribute to online gambling issues. The accessibility of online gambling and gaming advertisements exposes both male and female students to potential risks.

Therefore, it is crucial to shield college students from such content and increase their awareness of the dangers associated with gambling. By enhancing students' media literacy and awareness, they can develop resistance to the allure of online gambling, understanding that easy monetary gains are unrealistic. Empowering students with knowledge can render gambling apps' strategies ineffective and prevent them from becoming victims of online gambling.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 265–268, 2023.
https://doi.org/10.1007/978-981-99-5961-7_36

2 Literature Review

This literature review examines the complex topic of online gambling behavior among university students, with a focus on student characteristics [2], motivations, and related factors. The review acknowledges the diverse experiences and characteristics of university students [3], including the influence of societal expectations on male and female students [4], as well as the unique challenges faced by LGBTQ + students. Factors related to online gambling are explored, highlighting the relationship between knowledge, attitudes, and behaviors. Students with greater knowledge of the risks associated with online gambling tend to hold more negative attitudes towards it and are less likely to engage in such behavior. However, it is noted that some individuals may still participate despite being aware of the risks [5]. Motivation factors are identified as significant drivers of online gambling behavior among university students. Both intrinsic and extrinsic motivations, such as enjoyment of the game, social influence, and financial incentives, are found to predict participation in online gambling activities. The review draws on Abraham Maslow's hierarchy of needs theory [6] to understand the motivational aspects of online gambling. It suggests that students who struggle to meet basic physiological and safety needs may be more prone to engaging in risky behaviors [7] like online gambling. Additionally, once lower-level needs are fulfilled, students may turn to online gambling to fulfill higher-level needs such as self-esteem and self-actualization.

In conclusion, this literature review provides valuable insights into the characteristics, motivations, and behaviors of university students regarding online gambling. The findings have implications for educators, policymakers, and mental health professionals, emphasizing the need for targeted interventions and strategies to promote responsible behavior and address the potential risks associated with online gambling among university students (Fig. 1).

Fig. 1. The atmosphere of collecting research data (Source: Nattanun Siricharoen, 2023)

3 Research Result and Discussion

The researcher's analysis sheds light on important insights into students' perceptions of online gambling media and provides recommendations for addressing this issue. Key findings reveal that students are aware of various forms of online gambling advertisements but do not perceive them as scams. Instead, they view them as choices and willingly engage in online gambling due to their desire for new experiences and a lack

of perceived risks. Furthermore, students strongly believe in their freedom to engage in activities such as gambling, regardless of potential consequences. They see it as a means to acquire personal benefits, primarily financial gains. This perception poses a challenge for educators, as conventional teaching models are ineffective in capturing students' attention. To overcome this, the researcher suggests adopting interactive and engaging teaching models that can maintain students' interest while imparting important knowledge about online gambling. Incorporating "games" into the learning process is recommended to educate students about the dangers of online gambling. This approach not only helps create understanding and awareness but also adds an element of entertainment, making it more engaging than traditional lecturing. Real-life experiences, particularly those shared by well-known individuals such as celebrities, are seen as more interesting and convincing to students. By leveraging these experiences, educators can deliver lessons in a relatable and engaging manner. Interestingly, students do not believe that legal measures would effectively address online gambling among teenagers. They perceive online gambling as harmless and are primarily motivated by the potential high rewards, disregarding the consequences and benefits received by operators or designers. Based on these findings, the researcher proposes the use of gamification as a tool to enhance media literacy among university students. Gamification involves incorporating game elements and design into non-game contexts, such as education.

By utilizing gamification, students can develop a better understanding of the risks associated with online gambling, foster critical thinking skills, and navigate the media landscape more effectively. To recognize and avoid online gambling propaganda, individuals are advised to check the credibility of information sources, maintain skepticism towards exaggerated claims, seek balanced messages that address both benefits and risks, avoid being influenced by emotional appeals, consult multiple sources for information, educate themselves about the risks and benefits of online gambling, and practice responsible gambling. Implementing these strategies and promoting media literacy among students is expected to lead to better-informed decision-making regarding online gambling. The ultimate goal is to equip students with the necessary knowledge and skills to understand the risks involved and make responsible choices in their online activities.

4 Conclusion

Gamification and innovative games can be effective strategies for developing media literacy about online gambling among university students in Bangkok and the perimeter. Here's an example of how gamification can be applied to achieve this mission: Game Concept: "Media Literacy Quest".

"Media Literacy Quest" is a gamified educational game designed to promote media literacy among university students in Bangkok and surrounding areas. The game consists of multiple levels/stages with specific media literacy objectives, such as understanding online gambling basics, analyzing gambling advertisements, recognizing problematic behavior, and evaluating the credibility of online gambling information.

To play the game, students need to navigate through different scenarios and make informed decisions about media content. They will encounter real-world examples of news articles, social media posts, videos, and advertisements. Players will analyze these

media sources, identify potential biases, evaluate credibility, and assess the overall impact of the content.

By completing challenges successfully, students earn points and unlock higher levels. They can also collaborate with fellow players or compete against each other to achieve higher scores. Throughout the game, students will receive feedback and guidance to improve their media literacy skills.

The objective of "Media Literacy Quest" is to empower students with critical thinking abilities, enabling them to navigate the complex media landscape and make well-informed decisions about the information they encounter (Fig. 2).

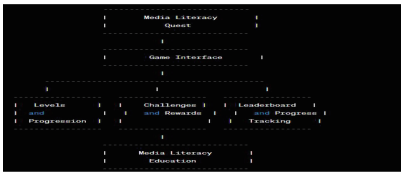

Fig. 2. The key components of the "Media Literacy Quest" game (Source: Nattanun Siricharoen, 2023)

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A Systems View of Values-Based Digital Games

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Abstract. We explore the potential of values-based digital games in value formation, habit formation and sustainable transformation of individuals, and ultimately sustainable organizations and societies. Literature suggests that "play" is the formation of values particularly in our early years. Play is often facilitated by digital games. Many digital games include violence, leading to aggressive behavior in real life, whereas playing prosocial digital games leads to kind and helpful behavior. We propose that this influence of digital games, if harnessed, can in the long-term lead to sustainable individuals. To demonstrate this long and broad view, including time delays in achieving the desired solution, we discuss values-based digital games from a systems view. We explore systems view at macro, meso, and micro levels using a combination of Causal Loop Diagrams and Stock and Flow Diagrams. The proposed models further reinforce the potential of values-based digital games in forming sustainable societies.

Keywords: Systems View · Values · Sustainable Transformation · Digital Games

1 Introduction

Some of the biggest challenges in the world today include the increasing levels of crime, mental health issues, drug addiction, and fraud in organizations. Each of these problems stem at an individual level i.e., the value system of an individual. An individual's decision making on a day-to-day basis is grounded in their value system. These decisions have consequences for them at an individual level, for the organizations within which they make decisions, as well as for the societies within which they live. This research proposes that the solution to these problems is to foster a positive and sustainable value system in individuals, a long-term feat. This is especially relevant in the young (children under 8 years old) as most individuals develop their value system, habits, and attitudes in their early years when they are most malleable [7].

This research presents a macro, meso and micro level systems view to discuss the role of values-based digital games in fostering positive and sustainable values system in individuals. Causal Loop Diagrams (CLDs) and Stock and Flow Diagrams (SFDs) are illustrated to demonstrate and explain the design and implementation of values-based digital games. The macro and meso CLD and SFD demonstrate the variety of factors driving entailed and the micro SFD forms the foundation for designing a game prototype.

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 269–274, 2023.
https://doi.org/10.1007/978-981-99-5961-7_37

The paper begins with an introduction, including the motivation for this research. Then, we discuss values-based digital games followed by the macro, meso and micro levels of systems view. This is followed by a discussion on the implication of the systems view on the design and implementation of values-based digital games.

2 Values-Based Digital Games

A value can be defined as a central desire or belief which guides our day to day actions, judgements and decision-making across situations [12]. A digital game refers to an activity supported by digital media, and primarily for entertainment, that follows rules, and can be played by one or more people.

There are several categories of games such as digital learning games, serious games, game-based learning, applied games, educational games, and edutainment games among others [5]. Regardless, at the heart of every digital game is either implicit or explicit learning. Young & Whitty [13] find that changes in a gamer's offline behavior is usually the need to seek psychological parity across virtual and real worlds. Digital games have therefore been labelled persuasive as well as instrumental in molding real world habits and values in players [1, 3]. This benign relationship between the virtual and real world is the point of commonality amongst the various categories of games.

This research proposes that digital games, particularly those for the young should therefore be designed with consideration of the values they pass on. Further, digital games may intentionally be designed and implemented to foster specific values. In the following sections, we explore a systems view of values-based digital games.

3 Macro Level Systems View: A Values Driven Sustainable World

We begin with the creation of a CLD to demonstrate the need for a positive values system in individuals. A CLD helps illustrate a dynamic problem, in this case the sustainable transformation of individuals, typically has an event that initiates the exploration, followed by understanding the patterns leading to the event, and the system structure and feedback loops leading to the patterns [9, 10].

The Macro CLD (Fig. 1) illustrates three main parts of the system. On the left hand side, we list the sources of education about values. These include People such as parents, teachers and friends, Activities such as spiritual activities, school events and sports, and Technology (digital and non-digital) such as stories, books and games i.e. the medium used to facilitate activities by people. Current digital games and values-based digital games are further illustrated independently as part of Technology to illustrate their effect on values-based education. Based on research, majority of current digital games are not values-based and often involve violence, result in aggressive behavior in the player [4, 11]. We propose that designing digital games with values will result in positive behavior.

This brings us to the second part of the macro CLD - the improvement in values-based education will likely result in the formation of new values, the formation of new

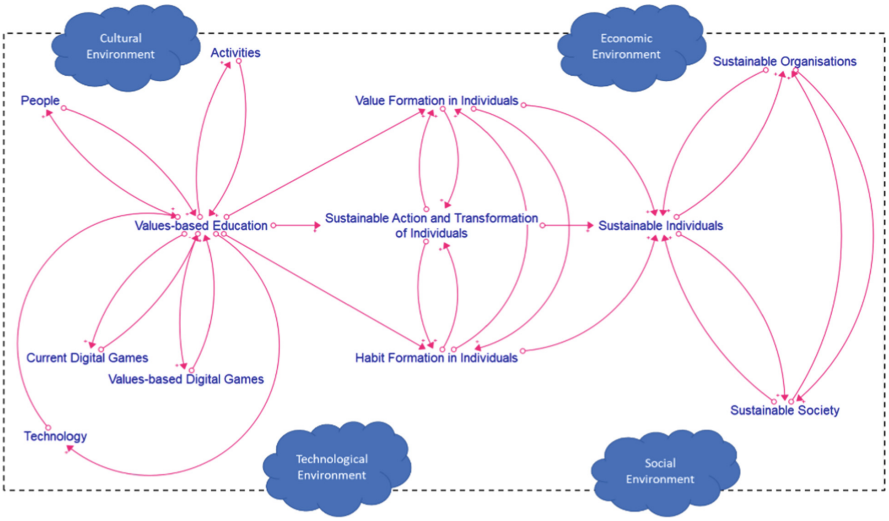

Fig. 1. Macro level view: Values-based Digital Games and Sustainable Transformation

habits, as well as sustainable action and transformation in individuals. The value formation, sustainable action and transformation, and habit formation are further interrelated, reinforcing one another.

The third part of the macro CLD illustrates that the improvement in sustainable action and transformation of individuals results in more sustainable individuals. These individuals then go on to positively influence the organizations they work for, and the societies they live in, resulting in an increase in sustainable organizations and societies. Finally, there is an implicit reinforcing feedback loop in the system – i.e. the increase in sustainable organizations and societies improve the quality and number of sources of desired values, reinforcing values-based education. Lastly, the CLD also illustrates that changing environments affect the macro level CLD such as cultural, social, technological and/or economic.

4 Meso Level Systems View: Values-Based Education, Decision-Making and Sustainable Transformation

In this section we discuss two meso level views of values-based digital games, also using CLDs. These are based on the macro level view illustrated in Fig. 1. The first meso CLD focuses on the sources of values-based education, i.e., the specific sources under each of the three categories of sources on the macro CLD. The second meso CLD focuses on the formation of values and the consequent sustainable transformation in individuals. It elaborates the relationship between values-based education and sustainable transformation. The various stages of decision-making involved in this relationship are explored. We find that having a values-based education first results in the creation of a values-based mental model design. The choices the individual makes are therefore based on this model, which they enact via the decisions they make. This process of

decision-making and experiencing the consequences of the decisions is what leads to the reinforcing of values and habit formation in individuals.

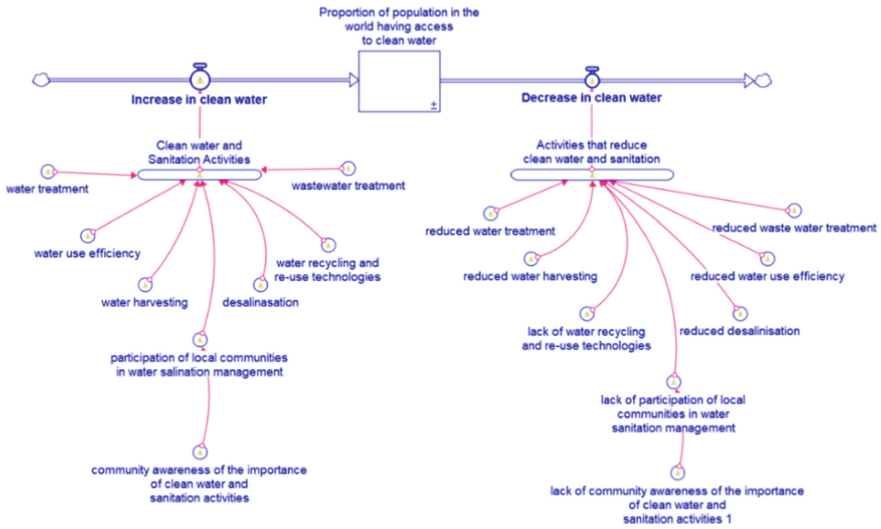

Fig. 2. Micro level view: Clean water and sanitation

5 Micro Level Systems View: Values-Based Education and Clean Water Scenario

In this section we discuss a micro SFD based on a general micro SFD focused on the sources of values-based education. The general micro level SFD can demonstrate how *values-based education* improves in quality and quantity when the sources of values are helping convey positive and desired values. Likewise, when the sources of values convey negative values, they can result in a decrease in an individual's positive values. This eventually influences the individual as a whole, making them less sustainable.

The micro level SFD (Fig. 2) illustrates a specific instance of the general micro level SFD. We explain the importance of the value of conserving clean water, drawn from UN sustainable development goal 6 – clean water and sanitation. The stock in this instance is the proportion of population in the world having access to clean water.

The SFD shows the various activities related to clean water and sanitation that result in an increase in clean water, as well as activities that reduce clean water and sanitation, decreasing the amount of clean water accessible to people in the world. The underlying factor influencing the activities on either side of the stock is the community awareness of the importance of clean water and sanitation activities, i.e. the value of conserving clean water.

6 A Systems View for the Design of Values-Based Digital Games

Some researchers have acknowledged and looked at mechanisms for a more values conscious design of digital games [1, 2]. Flanagan and Nissenbaum's [8] book on "Values at Play" is one of the more elaborate research discussing the existence of values in every digital game. They present a framework for identifying socially recognized moral and political values in digital games, and propose a general framework for designing games with values. There is however a paucity of research on *how* designing values-based digital games can help foster sustainable individuals. The systems view of values-based digital games discussed in this paper provides some insights into the *how*.

The macro level view provides an overview of all the variables at play, followed by the meso level view which expands on more specific aspects of the system. Lastly, the micro level view demonstrates an instantiation of a specific values – clean water and sanitation, which may be converted to an instantiation of a values-based digital game.

Stakeholders such as game designers, developers and researchers often lose the broader view of the impact of digital games in terms of values, as well as other factors at play. The systems view discussed in this paper helps them consider each of these factors in the design of specific values-based digital games.

7 Conclusion

This research discusses a macro, meso and micro level systems view of values-based digital games using Causal Loop and Stock and Flow Diagrams. The research demonstrates how values-based digital games can contribute to values-based education and the sustainable transformation of individuals, which in turn can help develop sustainable individuals, sustainable organizations, and sustainable societies.

We outline the key sources of learning values categorized into people, activities and technology, including digital games; and demonstrate the process of instantiation of a specific values-based game about conserving water, drawn from goal 6 of the UN sustainable development goals – clean water and sanitation.

The key contribution of this research include reinforcing the importance and process of designing values-based digital games, outlining the variables in the systems view models, and demonstrating the instantiation of a micro SFD to design a game. This is of value to game designers, developers and researchers.

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Applying the Text Similarity to Detect Plagiarism

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Abstract. Currently, in the era of rapid development of technology, resources can be easily searched on the internet. Copying texts, plagiarism, stealing ideas from theses, theses, scientific articles, etc. are very common problems. So how to detect the copying of documents, theses and articles have also been studied by many people. This paper proposes the application of a vector model to measure text similarity based on the method of using the Cosine measure in combination with the word order measure to increase the accuracy and help improve the comparison results between two Vietnamese documents. The performance results show that our proposed model gives more accurate results than applying the traditional Cosine measure, and gives a faster execution time than current methods.

Keywords: Text similarity · Plagiarism · Pointwise · Cosine

1 Introduction

Text similarity measures the degree of similarity between texts. To measure text similarity, studies often use string similarity, by using distance measures or semantic similarity measures to understand the meaning of text.

In Vietnam, the issue of plagiarism has also received much attention. However, Vietnamese semantics is very complicated, with many factors, so it is difficult to apply a semantic text comparison system with absolute accuracy. Therefore, studies need to exploit Vietnamese data stores to solve the most optimal semantic problem, although it is still more limited than the English language.

To evaluate the text similarity, the vector space model is the most popular. This model represents the text as a feature vector of terms/words that appear in the entire corpus. Feature weights are usually calculated using the TF-IDF measure. Some notable topics on comparing and assessing text similarity include from [1–4]. However, those methods proposed the calculating semantic similarity between two documents based on word-to-word similarity and word-specific frequency that does not consider the relationship of word/phrase structure, leading to still many cases where the test program gives incorrect results. Therefore, texts with high semantic similarity are not necessarily the same.

There are many tools to support the separation of sentences and words in Vietnamese documents, such as vnTokenizer, JVPTextPro. The most prominent is the study of author

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 275–278, 2023.
https://doi.org/10.1007/978-981-99-5961-7_38

Anh [5] with the Pointwise method with 98% accuracy and faster processing speed than vnTokenizer.

Some other studies use distance measurement method to calculate text similarity. Specifically, the studies of Aggarwal [6], Khatibsyarbini [7] and Leonardo [8]. Those studies presented various approaches for measuring similarity and distance, including distance metrics, similarity coefficients, and kernel-based methods. Although those approaches may be effective for certain types of text, they may not be ideal for detecting more sophisticated forms of plagiarism, such as text that has been paraphrased or reworded.

Several recent studies from [9–11] related to our paper on plagiarism detection. Their methods relied on analyzing sentence patterns rather than word usage, which they claim was more effective in identifying plagiarism. The authors used a support vector machine (SVM) classifier with a set of features such as sentence structure, conjunctions and comparisons. Those studies focussed heavily on the structure, with a sentences rather than specific words, which could limit its effectiveness in detecting plagiarism in certain contexts. For example, if a student rephrases a sentence with different words and retains the same grammatical structure, the method may not classify it as plagiarism, and it could go undetected.

Therefore, to check the similarity in both structure and semantics of the text, we propose to use the Pointwise word separation method and combining the Cosine measure [12] to compute the semantic similarity with the word order measure to increase accuracy and improve the results of comparing Vietnamese documents.

2 Method and Result

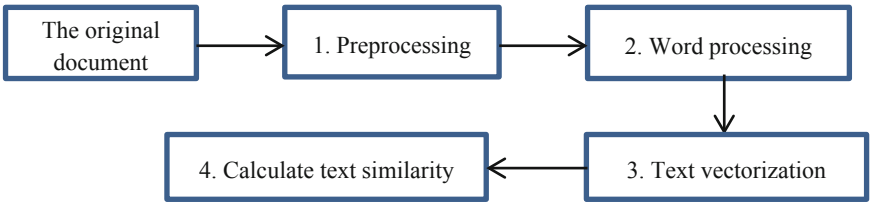

Fig. 1. Framework of the Vietnamese text similarity measurement system.

Our processing model consists of four main steps. The first step is preprocessing the text. This step is responsible for separating the text into words and sentences. Research using Pointwise word separation method, installation and testing results show that the program is quite accurate in separating words in the dictionary. This improves the accuracy of semantic similarity (Fig. 1).

The second step is word processing. This step is to remove the stop words based on the dictionary containing the stop words first, then for each word in the sentence, rely on the thesaurus to generate a list of synonyms.

Step three performs text vectorization and step four performs text similarity calculation. Algorithm to calculate text similarity as follows:

- Input: The given text set and the text to be checked
- Output: the similarity between the test text and the given text in terms of Cosine measure
+ Step 1: Preprocessing (separating sentences, separating single words, creating vocabulary lists…)
+ Step 2: Build a word/text weight matrix by calculating TF-IDF weights.
+ Step 3: Calculate the weight of the sentences in the text vector q according to the formula (1):

$$\text{Score}(S_q) = \sum_{j=1, j\neq q}^{m} \text{Sim}(S_q, S_j) \tag{1}$$

+ Step 4: Build the sentence weight vector for the test text q
+ Step 5: Calculate the weight of the sentence in the given text set D.
+ Step 6: Build the weight matrix of Sentence/Text for the entire text
+ Step 7: Calculate the similarity between two documents according to Cosine's formula (2):

$$Sim(D_{ij}) = \frac{\sum_{k=1}^{t} w_k^i w_k^j}{\sqrt{\sum_{k=1}^{t} (w_k^i)^2 * \sum_{k=1}^{t} (w_k^j)^2}} \tag{2}$$

The databases used in the program include: a dictionary for the word separation function with 31661 Vietnamese words and 6500 Vietnamese syllables. In order for the program to work, the minimum requirement for the program to run is that the computer must install the.NET framework, SQL Server.

The experimental installation program gets the database of journal articles of the Naval Science and Training Journal from 2010 to 2022, nearly 1500 articles with more than 3,600,000 words.

The interface of the program that simulates the Cosine measure combined with the word order measure is shown in Fig. 2.

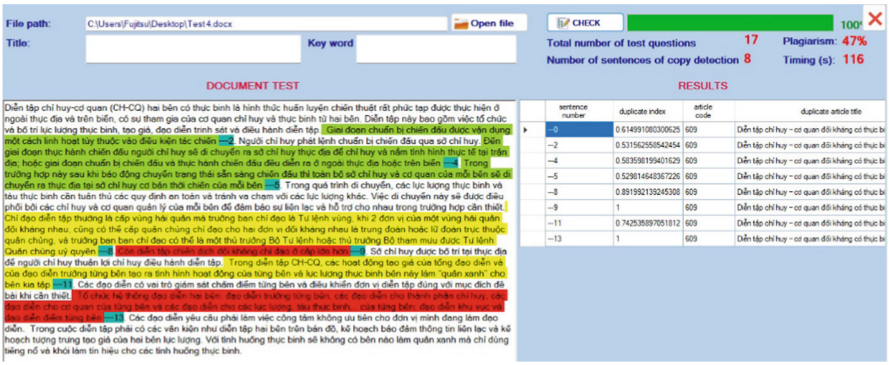

Fig. 2. The result screen after performing the text similarity measurement by combining the Cosine measure and the word order measure.

Experimental results show that the method of improving the Cosine measure combined with the measurement of the word order gives faster and more accurate results than the application of a Cosine measure.

3 Conclusions

The improvement of this study in the application of the Cosine measure and the combined methods of measuring the word order to produce high accuracy results and fast processing speed. With quite high accuracy, we think this model can be applied to check plagiarism at agencies with available databases such as schools, newspapers and magazines.

Currently, one of the limitations of the Cosine measure is its ability to distinguish words with similar meanings. Therefore, the results of using the Cosine measure may not be accurate in some cases. In addition, the Cosine measure can also be affected by the size of the data set and the input parameter values. Therefore, further research is needed to further improve the accuracy of the Cosine measure.

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An Analytic Hierarchy Process-Based Framework for Evaluating and Matching Coding Bootcamp Graduates with Industry Opportunities

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Abstract. This paper proposes a comprehensive assessment framework for evaluating coding bootcamp graduates, taking into account their job readiness for the tech industry, and addressing a gap in the existing literature. The framework utilizes the Analytic Hierarchy Process (AHP) for multiple criteria matching techniques, considering various aspects of student performance such as individual performance, team performance, gamification elements, assessments from teachers and teacher assistants, as well as assessments from companies providing real-world projects. By calculating a compatibility score, the framework aims to identify the suitability of each student for specific companies. The paper presents the initial research framework, the main criteria and sub-criteria together with the rationale for their inclusion. The proposed framework has potential implications for coding bootcamp educators, industry professionals, and researchers with plans for further validation and refinement in future studies.

Keywords: Analytic Hierarchy Process (AHP) · coding bootcamp graduates · assessment framework · multiple criteria matching · job readiness · tech industry

1 Introduction

In recent years, coding bootcamps have emerged as an alternative to traditional computer science degrees, providing intensive and focused training to prepare students for careers in the tech industry. As the number of coding bootcamp graduates continues to grow, there is a need for a comprehensive assessment framework that evaluates their job readiness and matches them with suitable companies based on their skills and strengths. This paper proposes an assessment framework using the Analytic Hierarchy Process (AHP) for multiple criteria matching, filling this gap in the field. This approach offers a well-rounded view of the graduates' skills, better aligning them with industry needs. The selection of the main criteria in our framework stems from a comprehensive review of the existing methodologies as well as feedback from industry experts. These criteria are identified as key indicators of job readiness, and hence are selected for evaluation

C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 279–282, 2023.
https://doi.org/10.1007/978-981-99-5961-7_39

in the proposed framework. The paper is organized as follows: background and related works, the criteria for evaluating coding bootcamp graduates, the proposed framework, and finally, the conclusion.

2 Background and Related Work

Coding bootcamps are short-term, intensive educational programs designed to teach programming and other technical skills to individuals seeking a career in the tech industry. These bootcamps have gained popularity due to their focus on practical, hands-on learning experiences and their ability to equip students with the necessary skills to succeed in the job market within a short timeframe. Assessing coding bootcamp graduates' job readiness is essential for understanding program effectiveness and ensuring students meet industry expectations. Key evaluation methods include coding assignments, code reviews, technical inter-views, portfolio development, and quizzes and exams. However, these methods often focus on individual aspects of performance. To develop a more comprehensive assessment framework, this paper proposes considering multiple criteria [1], such as team performance, gamification elements [2], assessments from teachers and teacher assistants, and real-world project assessments from companies. By integrating these factors, the paper aims to present a holistic approach to evaluating graduates' job readiness and matching them with suitable companies. The Analytic Hierarchy Process (AHP), introduced by Saaty in 1980 [3], is a multi-criteria decision-making (MCDM) technique that systematically evaluates a complex decision problem with multiple criteria. In this paper, AHP will be employed to evaluate coding bootcamp graduates using multiple criteria.

3 Criteria for Evaluating Coding Bootcamp Graduates

In this study, the Analytic Hierarchy Process (AHP) is applied to assess coding bootcamp graduates, considering multiple criteria and sub-criteria. The choice of criteria for evaluating coding bootcamp graduates is rooted in the multidimensional aspects of job readiness. The main criteria include individual performance (Criteria 1), team performance (Criteria 2), gamification elements performance (Criteria 3), assessments from teachers and teacher assistants (Criteria 4), and assessments from companies providing real-world projects (Criteria 5). Individual performance includes coding assignments, code reviews, technical interviews, portfolio development, and quizzes and exams [4]. Team performance is the ability to work effectively in a team is a highly sought-after skill in the tech industry [5]. Criteria for this measure include group projects, peer evaluations, team-based code reviews, and assessments of Scrum or Agile methodology applications. Gamification elements performance is widely used in educational contexts to increase student engagement and motivation [6]. Points, badges, leaderboards, levels, and challenges can provide a quantifiable measure of a student's engagement level. Assessments from teachers and teacher provide valuable insight into a student's performance, especially in formative aspects that may not be captured by other criteria [7]. It is evaluated using sub-criteria, such as formative assessments, summative assessments, rubrics and criteria, observations and informal assessments, and peer feedback

facilitation. Assessments from companies providing real-world projects provide a direct measure of a student's ability to apply their skills in a practical context [8]. It is evaluated using sub-criteria, including real-world project performance, industry feedback, performance evaluation, collaboration and communication, and post-bootcamp employment opportunities. The AHP method will integrate these criteria and sub-criteria to calculate each student's performance and compatibility score, thus determining the most suitable match between students and companies.

4 Proposed AHP-Based Framework

The framework consists of the following steps:

- Course Content Development and Bootcamp Setup - The bootcamp will last for three months on a part-time basis. A Learning Management System (LMS) will be established, incorporating all necessary features for the validation.
- Bootcamp Registration and Student Enrollment - The bootcamp will be opened for registration, Students will complete a survey to gather relevant information.
- Team Formation and Teacher Assistant Assignment - In the second week of the bootcamp, students will be grouped into teams, and each team will be assigned a teacher assistant to supervise their progress.
- Evaluation of Individual and Team Performance - The proposed framework will be applied from the first to the twelfth week to assess individual performance (Criteria 1). Criteria 2 will be assessed from the third to the twelfth week considering factors such as group project outcomes and peer evaluations.
- Gamification and Educator Assessments - Criteria 3 and Criteria 4 will be considered from the third to the twelfth week.
- Industry Collaboration - In the fifth week, companies will be invited to assign real-world projects to student teams. Each team will work on one project from one company. Companies will complete a survey to determine their employee requirements based on the provided criteria.
- Company Assessments and Performance Scoring - Criteria 5 will be evaluated from the sixth to the twelfth week. Performance scores will be calculated monthly using the AHP. This step will enable companies to identify students with compatible skills and strengths.
- Compatibility Matching and Result Presentation - At the bootcamp's conclusion, AHP will be used to compute a compatibility score for each student, factoring in all the criteria. The students' overall performance scores will be summarized, and a compatibility ranking will be generated to match students with suitable companies. This information will be presented to both students and companies for further consideration and potential recruitment.

5 Conclusion

This paper presents an innovative and comprehensive assessment framework that uses the AHP for evaluating coding bootcamp graduates. It offers a more rounded measure of graduates' readiness for the tech industry, taking into account individual and team

performance, gamification elements, and assessments from educators and collaborating companies. The proposed methodology provides a detailed approach to implementing the framework within a coding bootcamp. This proposed framework fills a significant gap in current systems, presenting potential implications for educators, industry professionals, and researchers. Future work will focus on validating this framework through pilot studies and large-scale implementations, gathering feedback from all stakeholders for continuous refinement.

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C. Anutariya et al. (Eds.): ICSLE 2023, LNET, pp. 283–284, 2023.
https://doi.org/10.1007/978-981-99-5961-7