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Dario Liberona (Eds.)

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Editors

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Editors
Lorna Uden
Staffordshire University
Stoke-on-Trent, UK

Dario Liberona
Seinajoki University of Applied Science
Seinajoki, Finland

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Preface

The 11th International Workshop on Learning Technology for Education Challenges (LTEC 2023)

Post Pandemic Learning Technology Challenges. Srinakharinwirot University, Bangkok, Thailand from July 24–27, 2023.

The conference was preceded by one day of free tutorials for participants who wished to learn the state of the art of research relating to the topics of LTEC. The tutorials were held on the 24th of July, 2023. The conference itself commenced on the 25th of July, 2023.

The education sector today is going through an unprecedented period of change with the sudden shift away from the classroom in many parts of the world to online learning because of the COVID pandemic. The effect of the pandemic on our teaching and research is far from uniform or wholly negative. We have experienced many new lessons gained from the use of online learning, but the fundamentals regarding the use of technology for learning remain. The question is, how can we use technologies that push the boundaries of the learning experience, engage students more deeply, and produce learning outcomes that live up to the high expectations of society?

Educators and schools around the world are increasingly using the knowledge, techniques, and programs developed from a new understanding of how our brains learn by applying neuroscience in their classrooms. Educational neuroscience (also known as mind, brain, and education [MBE] or neuroeducation) is an emerging scientific field that has gained momentum in the last few years. It has important implications for learning and teaching.

In this conference, we wanted to focus not just on the impact of COVID on education, but on the pedagogical innovations that help us to advance education research. Besides the technological advances, there is also a need for Innovative Pedagogy. Some aspects of Innovative Pedagogy include: Playful learning; Learning through wonder; action learning; making thinking visible; cloud technology; nano learning; artificial intelligence in learning, social media in learning; Virtual studios; and others.

LTEC 2023 brought together academic research and practical applications of education from all areas, and sought to bring top research and proven best practices together in one location, for the purposes of helping practitioners find ways to put research into practice, and for researchers to gain an understanding of additional real-world problems. The aim was to provide a platform for research in the very broad area of educational technology that bridges theory, research, practice, and policy.

The proceedings consist of 27 papers that were selected following a double-blind review process. Each submission was reviewed by at least 4 members of the Program Committee. The selected papers cover various aspects of technologies for learning, including:

Serious games and virtual learning environments
Learning technologies
Learning practices and methodologies
Learning technologies performance
Learning methodologies and models

Authors of the papers come from many different countries and territories, including Austria, Chile, Colombia, Finland, Germany, Greece, Indonesia, Japan, Malaysia, Palestine, Singapore, Slovenia, Spain, Taiwan, Tunisia, and the UK.

We would like to thank our authors, reviewers, and program committee for their contributions, and Srinakharinwirot University, Bangkok, Thailand, for hosting the conference. Special thanks to the authors and participants at the conference. Without their efforts, there would be no conference or proceedings.

July 2022

Lorna Uden
Dario Liberona

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Gamification Based on Disaster Education in Reducing Disaster Risk for Students in Disaster Prone Areas: A Systematic Review of Research

Fajar Wulandari[1,2(✉)], Budijanto[2], Syamsul Bachri[2], and Dwiyono H. Utomo[2]

[1] STKIP Singkawang, Singkawang, Indonesia
fajar.wulandari.2107219@students.um.ac.id, fajarwulandari3@gmail.com

[2] Department of Geography, Faculty of Social Science, Malang State University, Malang, Indonesia
{syamsul.bachri.fis,dwiyonohari.fis}@um.ac.id

Abstract. Disaster education that uses gamification in applications and learning processes is the right thing to provide awareness for students in dealing with natural disasters that can occur at any time. This study aimed to access the diversity of research approaches, variables, data collection techniques, and analysis, as well as research subjects used in various articles related to gamification and disaster published in indexed journals from 2019 to 2022. This is because in the three-year span educational inequality at all levels due to the impact of distance and limited learning. The design uses content analysis, namely eighteen articles. That meets the criteria based on the keywords entered in the PoP application, which are then analyzed. The results showed that the most frequently used types, variables, data collection techniques, data analysis, and research subjects were quantitative (quasi-experiment) and RnD, development of gamification media, use of questionnaires, N-gain, cognitive learning outcomes, and students were subjected. In addition, there are also findings that several studies use different data analyses. It is suggested that future researchers analyze disaster research related to the development of media or teaching materials in disaster studies.

Keywords: Gamification · Disaster Education · Disaster Risk Reduction

1 Introduction

Natural disasters endanger life and cause damage to property and loss of life. Natural disasters occur all over the world and have a negative impact that brings difficulties to society. Indonesia is a disaster-prone country with both tectonic and volcanic activity [1–7]. In Australia [8], forest fires, storms, earthquakes floods also often occur. In Pakistan [9], the impact of these disasters is quite large, affecting all groups, up to schools. Based on this, the importance of disaster education is to be implemented at all levels of education in disaster-prone areas, including schools in Indonesia.

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Natural disasters pose a serious threat at the global level, which are devastating, such as education centers, health, and transportation infrastructure to economic problems, up to [10–12] deaths. Students are a group in society that is physically and mentally vulnerable and has a high risk of disaster due to a lack of knowledge and experience of disasters [13]. School institutions to tertiary institutions have a role in maintaining their students' safety, so the main preventive action is needed, namely through education.

Disaster education is forming, instilling, and changing each individual's thoughts and behavior in acting according to the guidelines for rescue actions before, during, and after a disaster occurs. According to [14] said that disaster education is still a new study. Even though natural disasters are happening more frequently nowadays, it is felt important to implement disaster education for all people in various educational units. Natural disasters include emergencies and are increasing worldwide [15], so the application of knowledge and education that discusses disasters is considered a very effective way of reducing the negative impact of disasters.

Climate change contributes to disasters in various parts of the world that threaten people's security [16–19]. On the other hand, disaster education in various countries is still limited, one of which is in Australia [20] said that school-based disaster education is still limited even though this is important to increase awareness among students and the community to encourage preparedness actions for preparedness for natural disasters. Disaster education has an important role in preparing students and communities who are resilient in dealing with natural disasters, which can occur at any time, namely by learning from an early age through materials and learning media such as gamification in the teaching and learning process in class.

Learning as an interactive activity between students and teachers in implementing the transfer of knowledge and knowledge requires facilities to be easily conveyed so that the learning objectives in providing an understanding of disasters can be realized. In line with this statement [21, 22] explains that the learning process requires methods and media to achieve learning objectives easily. The development of electronic media in education has greatly helped encourage learning, especially in the disaster section, which can stimulate students to be active and can directly know various forms of natural disaster events presented in the form of video, audio, and even games.

Gamification in learning helps students to learn actively in a fun and exciting way [23], besides that the features displayed are unique so that students' attention is more interested compared to conventional learning [24]. Gamified learning can influence behavior and attitudes related to learning [25], especially in this study aimed at providing students with an understanding of disasters and appropriate actions during and after a disaster. Games in learning can involve students to be active in the learning process [26]. Games presented in learning media must be adapted to the needs and designed as well as possible so that students are interested, can understand the subject matter [27–29] motivated, and have a passion for learning. In the end, the purpose of using the learning media used in this study is to prepare students to be active and able to make decisions when using the media provided so that learning objectives can be achieved optimally.

Research related to gamification-based disaster education is deemed necessary for students to provide knowledge related to disaster material and appropriate actions in dealing with disasters. Today, the development of science and technology is developing rapidly; research with learning media such as gamification has begun to be implemented but related to disaster education, and disaster material is still rare, so this is deemed necessary so that it can help students to take action, always be prepared in case of a disaster. Nature happens anytime.

Based on the explanation above, it is known that research on learning media that examines disaster material is still very rare. It is deemed necessary to apply complex disaster material in the form of games that can help students think and learn.In line with the statement above, using games in Turkey [30] can bring pleasure and provide psychological and cognitive benefits. Learning media that utilize games show achievement in obtaining learning objectives and student learning completeness [31]. The teaching and learning process leads students to success and obtains learning objectives. Still, the main thing is to change students' behavior habits in choosing the right decision when a disaster occurs. Through games, students will learn from mistakes when they use the media, so they will try to choose and do their best. This study aimed to analyze the effectiveness of disaster education-based games and the relationship between knowledge and student behavior after using learning media.

2 Literature Review

2.1 Disaster Education

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential in terms of spirituality, self-control, personality, intelligence, and skills needed by themselves, the people of the nation, and the state [32]. On the other hand, education is a process of forming and maturing someone who has many benefits through stimulus, such as how to make decisions before, during, and after a disaster occurs. Knowledge about disasters can be obtained through education from academic units, which is important for everyone. Disaster education, part of the important education sector [14] is given to students for emergencies [33, 34]. Disaster education is very appropriate in countries and regions with high disaster risk. The proper implementation of disaster education is intended for students in educational institutions from an early age [35] to tertiary institutions; it is hoped that they will be able to think and act quickly, right when facing natural disasters.

Disaster education builds individual awareness that starts with knowledge, understanding, and actions that encourage preparedness, prevention, and recovery. Current natural conditions are changing, causing natural disasters to become more extreme. Disaster risk education or disaster education is also a process of outreach, understanding of science (natural phenomena), and developing skills towards safety, accompanied by building awareness of natural disasters [36]. Disaster education can be inserted into subjects to lectures aimed at preparing students to face disasters.

This disaster education aims to provide an overview and reference in the learning process of disaster preparedness. Teachers and principals receive education and training to apply disaster preparedness education and skills. Through this education, students are expected to be able to think and act quickly, precisely, and accurately when facing a disaster. An attitude of empathy for disaster victims is also built so that students can help others. The education provided does not cover social disasters such as riots and brawls, only natural disasters. Disaster education can be carried out in three ways. If the school needs only knowledge, then the teaching materials will integrate with the subjects.

Humans must learn to live with nature, not try to control it. However, they must begin to get used to preparing themselves and their surroundings so that they require mitigation efforts whose focus is on trying to avoid and minimize hazards through various technological engineering [37]. Disaster education is necessary for every human being to change knowledge, attitudes, and skills about a disaster.We must coexist with nature and phenomena that can become disasters anytime. Therefore, studying disaster education can change a person's mindset to be more concerned about the environment and know prevention efforts and rescue actions.

2.2 Disaster Risk Reduction

Disaster risk reduction is an action, approach, and evaluation effort to reduce and identify risks caused by disasters. Disaster risk reduction in schools is not easy because the activities are sporadic without clear strategies and programs, in addition to the lack of trained teaching staff in the field of disaster plus the problem of funding for disaster risk reduction education in schools is not supported, especially in countries prone to natural disasters [38]. Awareness of disaster risk is needed, especially since school. Japan, which is in a disaster-prone area, makes schools a vessel and part of a strategy to promote disaster risk reduction [39] with the main objective of fostering children as agents of change, increasing the capacity of students to create a disaster-resilient society [40, 41].

Disaster risk reduction is an approach seeking to reduce vulnerability and increase the capacity of vulnerable groups and communities to be prepared and overcome, prevent or minimize losses to loss and damage to property and the environment and accelerate recovery after a disaster. Disaster management has four phases: prevention/mitigation, preparation, response, and recovery [42].

First, prevention/mitigation is an effort to reduce disaster risk with two activities, structural mitigation and non-structural mitigation [43]. A series of efforts to prevent and reduce disaster risk through physical development, awareness, and capacity building in dealing with disaster threats. Efforts are being made to prevent disasters (if possible by eliminating hazards), for example, prohibiting forest burning in cultivation and stone mining in steep areas. Second, preparedness is a series of activities to anticipate disasters through organizing and appropriate and efficient steps. Preparedness is also an action aimed at and prepared for before and when a disaster occurs [2, 3], for example, preparation of communication facilities, command posts, preparation of evacuation sites, contingency plans, and dissemination of disaster management regulations/guidelines. Third, the response is a series of activities carried out immediately at the time of a disaster to deal with the negative impacts that have arisen, which include activities to rescue and evacuate victims, and property, fulfillment of basic needs, protection, management of refugees, rescue, and restoration of infrastructure and facilities. Fourth, recovery is the process of emergency recovery of the condition of a community affected by a disaster by re-functioning infrastructure and facilities that are ready to be used again. The activity acts as an effort that can be used as a warning for all people always to be prepared in the face of disasters that can occur at any time.

2.3 Educational Gamification

Educational gamification is a game-based learning concept used in learning media to stimulate students to understand the subject matter easily. Gamification is also a strategy that involves game elements in the educational environment [44]. Researchers have carried out various studies on game elements, and many have looked at the effects of gamified in education, such as increasing student involvement in learning, user retention, and knowledge to student cooperation in groups [31, 45]. On the other hand, research [46] states that gamification in education raises doubts about its benefits in obtaining learning objectives. The use of game media in learning, especially in disaster education which discusses disaster material, is appropriate regardless of the results of previous studies. This can be conveyed because a disaster categorized as a problem requires an appropriate solution or solution. In line with the previous statement, [47] games are directed at learning, making it easier for students to learn, so they are happy to participate. Games applied with disaster material that discusses these problems and impacts are presented with good resolution challenges in dealing with natural disasters. Students are trained to solve the right problems to survive and avoid the negative impacts of these natural disasters.

3 Research Methods

This research is a content analysis using scanning documents related to research literature. This content analysis uses a quantitative approach by examining literature about learning games based on disaster education for students, then to get an overview of the content without researchers' intervention [48]. In this study, the articles analyzed were based on searches with the Publish or Perish application to find attachments or relationships. The keywords used are gamification, learning, and disaster education.

Searching the PoP application in Fig. 1 above, with the keywords "gamification, disaster education, learning," obtained 997 articles from 2019 to 2022. Articles were identified from the education database (ProQuest), Google Scholar, Scopus, and IEEE-indexed international seminars. The PoP application is used to obtain related articles with keywords which are then analyzed and filtered according to the research needs. Based on the keywords entered, 997 were obtained, which studied distance learning without discussing disaster education, and 18 articles related to keywords. This study discussed gamification in learning, especially in disaster education, for disaster risk reduction. Below we present in Table 1 a list of related articles analyzed in the study.

Based on the results of articles related to this research, six aspects are analyzed in this research. Each selected article was analyzed and classified based on six aspects, namely (i) research approach (4 categories), (ii) the variables investigated (7 categories), (iii) data collection techniques (6 categories), (iv) data analysis techniques (9 categories), (v) research subjects (5 categories) The categories in this study adopted from previous studies of [49–51]. The categories contained in the study were recorded based on the 18

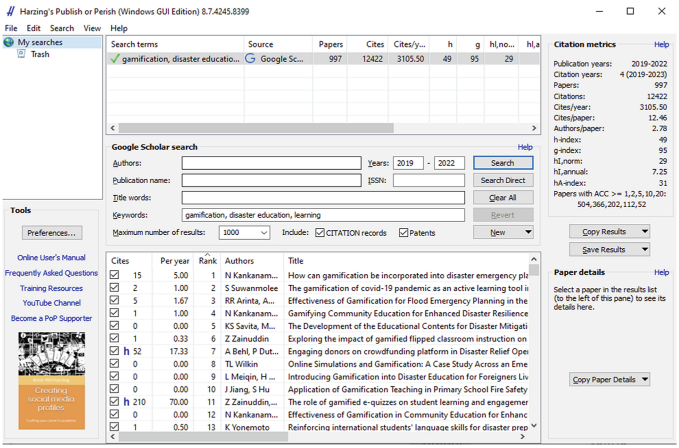

Fig. 1. The results of the article analysis are related to the PoP application.

Table 1. List of articles analyzed in the study

No	Author	Title	Year
1	Hanny Haryanto, Rahmatsyam Lakoro, Umi Rosyidah, Sendi Novianto dan Acun Kardianawati	Model Appreciative Learning untuk Perancangan Aktivitas dalam Serious Game Mitigasi Bencana	2021
2	Georgios Lampropoulos, Euclid Keramopoulos, Konstantinos Diamantaras and Georgios Evangelidis	Augmented Reality and Gamification in Education: A Systematic Literature Review of Research, Applications, and Empirical Studies	2022
3	Seyedeh Fatemeh Mirsoleymani, Kourosh Fathi Vajargah, Kambiz Pushaneh, Ali Akbar Khosravi, Mojtaba Vahidi-Asl	The Effect Of Earthquake Preparedness Training Courses Through Gamification on The Students' Knowledge Level	2022
4	Nayomi Kankanamge, Tan Yigitcanlar and Ashantha Goonetilleke	Gamifying Community Education for Enhanced Disaster Resilience: An Effectiveness Testing Study from Australia	2022
5	Meng-Han Tsai, Yu-Lien Chang, Susan Shiau, Shun-Mei Wang	Exploring the effects of a serious game-based learning package for disaster prevention education: The case of *Battle of Flooding Protection*	2019
6	Rania Rizki Arinta, Suyoto, Andi W.R. Emanuel	Effectiveness of Gamification for Flood Emergency Planning in the Disaster Risk Reduction Area	2020
7	Seung-woo Ha, JeaYung Choi	The Learning Effect of Simulation Game Activities in Geography Classes: Focus on urban flood	2020

(*continued*)

Table 1. (*continued*)

No	Author	Title	Year
8	Diki Wahyudi, Ma'rif Hidayatullah	Disaster Risk Reduction for Natural Disaster using Mobile Learning Application to Improve the Students Disaster Mitigation Literacy in Elementary School	2022
9	Steven Hawthorn, Rui Jesus, Maria Ana Baptista	Review of Digital Serious Games for Tsunami Risk Communication	2021
10	Mohamad Javad Moradian1, Zahra Mehraein Nazdik	Game versus Lecture-Based Learning in Disaster Risk Education; AnExperience on Shiraz High School Students	2019
11	Raiya YAMAMOTO, Asaka KITAOKA & Kei INOUE	Prototyping of an Earthquake Evacuation Learning Game with VR Reproducing the Environment That Is Familiar to Learners	2019
12	Yusuf Sermet, Ibrahim Demir, Marian Muste	A serious gaming framework for decision support on hydrological hazards	2020
13	Anthony Viennaminovich Gampell, J.C. Gaillard, Meg Parsons, Loïc Le D´e	Exploring the use of the Quake Safe House video game to foster disaster and disaster risk reduction awareness in museum visitors	2021
14	Zarkhuan Zainol, Mohd syaubari Othman	The Relationship Between Gamification Implementation And Student Involvement	2022
15	Denghui Ma, Yuxin Shi, Guai Zhang, Jun Zhang	Does theme game-based teaching promote better learning about disaster nursing than scenario simulation: A randomized controlled trial	2021
16	A. Teague, Y. Sermet, I. Demir, M. Muste	Serious Gaming for Water Resources Planning and Hazard Mitigation	2021
17	Yogi Udjaja, Sabrina Lailany	Wacana Bencana: Android-Based Natural Disaster Simulation Game	2022
18	Gary Foo Xiang G; K. S Savita; Maythem K. Abbas; Jebul Suroso; Susana Widyaningsih; SriSuparti	The Development of the Educational Contents for Disaster Mitigation in Indonesia	2021

Source: Research data management (Publish or Perish) 2023.

articles produced in Table 1 as raw data, which were then processed and analyzed into the percentages of each category.

4 Results and Analysis

Various researchers will find research useful if the work's publication process has been carried out because all groups can reach it. The quality of research is important and measurable if it is to be published by a journal in a country. This study examines research in the field of education related to gamification, disaster education, and the implementation of learning therein. There are 18 articles related to studies carried out by previous researchers from 2019 to 2020. It is hoped that by analyzing related articles, they can also be useful as important information for future researchers who will research the field of education.

4.1 Percentage of Research Approach Categories

The percentage of the research approach in this study helped answer and facilitate the need for realizing the research objectives, which are explained in Fig. 2. Based on the graphs presented, 18 articles were selected according to the studies in the study. Most recorded research is developmental and quantitative (experimental) research, respectively (39%). Next is qualitative research (5%). In addition, there were (17%) of the studies needed to meet the criteria for the research approach category.

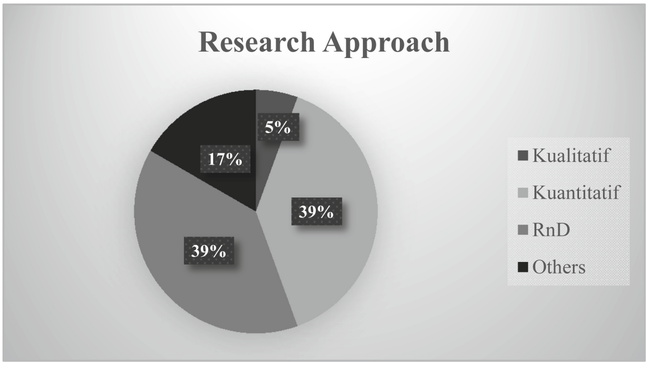

Fig. 2. Gamification research division based on disaster education is based on the research approach

Research trends in various countries have differences. The quantitative approach and development research became the dominating research in this study. In line with this statement, based on Pawel and Egmir [52, 53] most educational research uses quantitative descriptive statistics. However, [49] gave a different statement: RnD research is used more often than qualitative and quantitative methods. Disaster-based research is part of research in geography education that is important to do, especially for students who are in areas that have a high disaster risk. The use of media such as gamification can stimulate students to think more actively and understand the material more easily [54].

4.2 Percentage of Research Variable Categories

Each study uses variables to support the completion of the research. Based on the graphs presented in Fig. 3. Explains the diversity of research variables used in disaster education-based gamification research. Research knows the most about learning outcomes (39%). Furthermore, the teacher training program (17%) was followed by three variables with the same results: assessment and evaluation, learning models/strategies, and thinking skills/literacy, respectively (11%). At the same time, the least is discussing thinking skills and other research (6%), rarely found in research from 2019 to 2022.

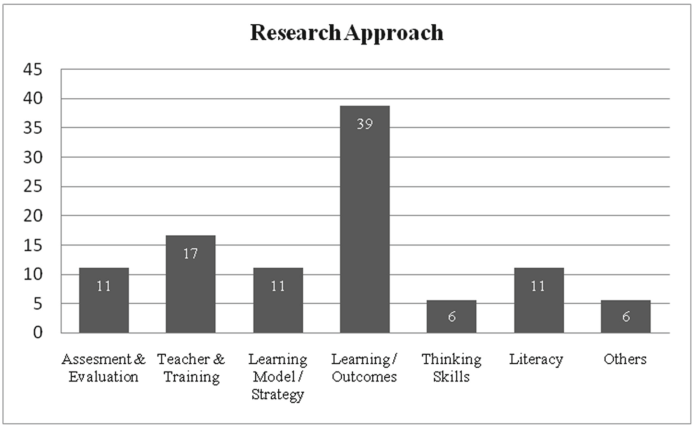

Fig. 3. The distribution of disaster education-based gamification research is based on research variable

The research variables studied varied; quantitative research and RnD, which focused on research to identify, improve, develop or influence student learning outcomes, were the most commonly found studies. This information is consistent with research from [52, 53, 55]. Apart from developing gamification learning media, published research development, and quantitative research are also to find out the effect of using the media on student learning outcomes, especially in disaster education [56–59].

4.3 Percentage of Data Collection Techniques

Collecting data in a study to obtain the information needed to answer research objectives. Various data collection techniques used in the articles analyzed in this study are further explained in Fig. 4.

Based on the graph in Fig. 4, the most frequently used data collection technique is the test (44%), considering that the most widely used research approach is quantitative, so this is synchronous. Followed by a questionnaire (22%), others (17%), observation (11%), and documents (6%). Other data collection techniques consist of systematic literature reviews and learning packages that still need to be found in research.

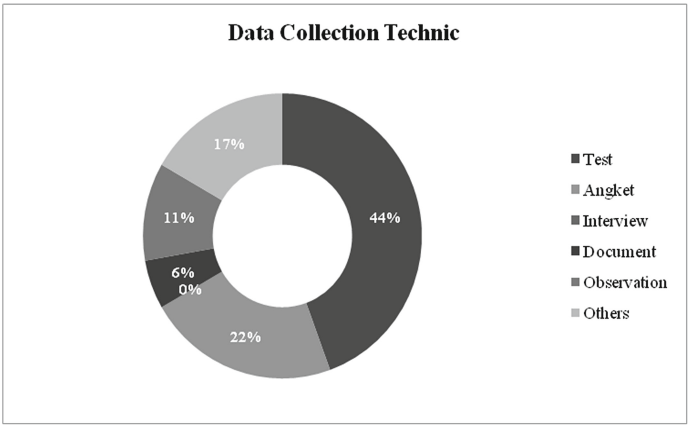

Fig. 4. The distribution of disaster education-based gamification research is based on data collection technique

4.4 Percentage of Data Analysis Techniques

Data analysis techniques are an important process in research based on data obtained after the data collection process. The diversity of data analysis in the articles analyzed in this study is presented in Fig. 5 below.

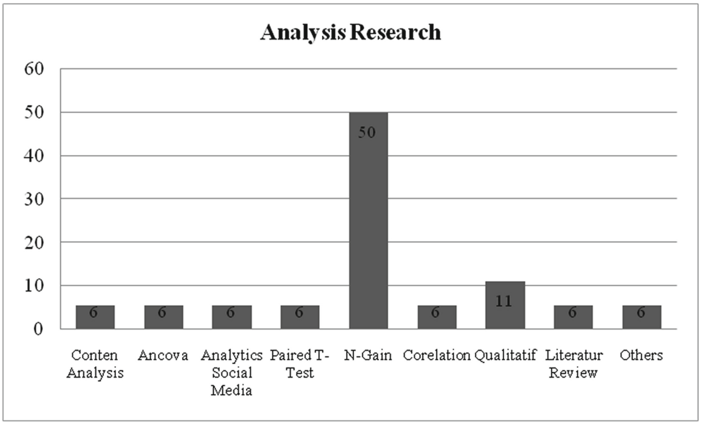

Fig. 5. The distribution of disaster education-based gamification research is based on data analysis technique

Based on the graph shown in Fig. 5, the most used data analysis technique is N-Gain (50%), followed by other analyzes (6%). Following the results of the analysis on previous research objectives, which explained that quantitative research and learning outcomes were the most found in disaster education-based gamification learning media research. Thus, data analysis often uses descriptive statistics to describe the research results obtained.

4.5 Percentage of Research Subjects

The research subjects are used to answer the research objectives, with the number of samples adjusted to the research needs that will be further studied. Based on Fig. 6 shows that most research uses students as research subjects is more than 50%. The second and third positions are the community/society and undergraduate students, respectively, by 30% and 10%.

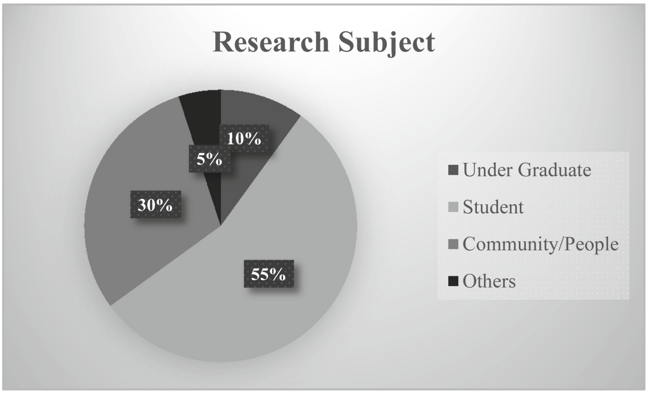

Fig. 6. The distribution of disaster education-based gamification research is based on Research Subject

5 Conclusion

This research is a content analysis study of articles in the field of education that focus on the gamification of media used in disaster education published in various indexed journals. Various approaches, variables, data collection techniques, data analysis techniques, and research subjects are used in the various articles that have been analyzed in this study. Based on the results of the research analysis, the quantitative and RnD are the most frequently found approaches in published articles. Quasi-experimental research, development of gamification media, use of questionnaires, N-gain, cognitive learning outcomes, and students were the most chosen data collection, analysis, and research subjects.

On the other hand, there are findings that the development of gamification in disaster material or education has provided massive awareness and preparedness for students about natural disasters in vulnerable areas. Furthermore, several studies use different data analyses. Therefore, it is suggested that future researchers conduct disaster research related to the development of media or teaching materials in disaster studies so researchers can add to the literature in education.

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QRdice: QR-Based Gamification Tool to Gamify Formative Assessment in Higher Education

Mohamad Firdaus Che Abdul Rani[1,2](✉), Melor Md Yunus[2], and Vinothini Kasinathan[1]

[1] School of Computing, Asia Pacific University of Technology and Innovation, Kuala Lumpur, Malaysia
firdaus@apu.edu.my
[2] Faculty of Education, Universiti Kebangsaan Malaysia, Bangi, Malaysia

Abstract. Formative assessment is an important part of learning because it allows educators to evaluate student progress and provide feedback for improvement. However, the exclusion of grades in formative assessments may reduce student motivation and engagement. This study investigates the potential of using dice-based gamification features in formative assessment activities for higher education students to address this issue. A pilot study was conducted among undergraduate students majoring in Information and Communication Technology (ICT) to gather their perspectives on the efficacy of using dice as a teaching tool in increasing engagement and motivation in class, as well as to investigate the potential of using dice as a gamification tool in gamified formative assessment. The design of gamified formative assessment using QRdice has also been discussed, with a focus on its primary workflow and an illustration of how that workflow corresponds to the various gamification mechanics. Future work could include the development of the QRdice platform to expand the gamification tools available to educators in the future.

Keywords: Gamification · Gamification Mechanic · Higher Education · QRdice

1 Introduction

In education, gamification encompasses both game design ideas and game-like learning experiences. Gamification has the capability of influencing cognitive, affective, and social learning. Gamification is the process of using game-like aspects to motivate and engage students in their educational pursuits (Navarro-Espinosa et al. 2022; Oliveira et al. 2022; Restrepo-Calle et al. 2019). Dice are a common component of games, and each face of a regular dice includes a different number of dots, ranging from one to six. When the dice is rolled, its upper surface will rest with a random integer between one and six, with an equal chance of occurrence for each value. Dice are a common item that can be used in any classroom activity, regardless of whether the students are in school, college, or universities (Horak and Horak 2020). Language learning activities are one example of how dice can be used in an educational setting. The educator can design a set

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of dice with different colors or symbols to represent various activities such as vocabulary practice, grammar drills, conversation starters, or role-playing scenarios. Students can then roll the dice to determine which activity or topic they need to discuss with their classmates. This adds an element of chance and excitement to the learning experience, making it more engaging and interactive (Girardelli et al. 2016).

Formative assessment is a critical aspect of teaching and learning as it enables educators to evaluate student progress and provide ongoing feedback that can be used to enhance instruction and by students to improve their own learning (Blondeel et al. 2022; Iglesias Pérez et al. 2022; Treve 2021). While formative evaluations can assist students in identifying their strengths, weaknesses, and problem areas, in most cases, there is no grade associated with formative assessments, which may discourage students from completing the assignment or engaging with it fully (Black and Wiliam 2018; Irons and Elkington 2021; Mannion 2022). One way to address this issue is through gamification, which has been shown to be a useful tool for formative assessment and can increase student engagement during game-like formative assessment Nah et al. (2014). As QR code is not a new thing especially post Covid-19 pandemic (Nakamoto et al. 2020), adopting it as a medium for the gamification interaction for formative evaluation could have the same impact and, if successful, improve the students' interest in attempting the formative assessment.

The purpose of this paper is to discuss the design of QRdice, a QR code-based tool for gamifying formative assessment in higher education, by addressing the following questions: (1) What are the current approaches used in higher education for formative assessment?; (2) What are the students' perception on gamified formative assessment using dice and QRdice?; (3)Which gamification mechanics can be used in the gamification tool for students in higher education?

2 Rationale

As motivation is a precondition for learning, formative evaluation has been suggested as a possible strategy for enhancing students' motivation (Kerekovic 2021). The techniques of formative assessment enhance student motivation, yet they may place greater demands on educators than more conventional teaching methods. In most instances, there is no grade connected with formative assessment because its main purpose is to provide feedback on student learning and to help students improve their understanding and skills (Irons and Elkington 2021; Šteh and Šarić 2020), which may discourage students from completing them or interacting with them fully. Numerous studies have demonstrated that employing a game-based learning framework enhanced students' desire, confidence, and dedication to studying (Chytas et al. 2022; Fu et al. 2022; Jääskä and Aaltonen 2022), hence leading to better learning outcomes.

3 Literature Review

3.1 Gamification Mechanics in Game-Based Learning

Gamification refers to the process of incorporating elements of interactive game design into applications that are not games; it has recently gained popularity in the educational institutions (Bennani et al. 2022). Gamification mechanics commonly include elements found in games such as points, badges, leaderboards, and progress tracking. Gamification mechanics can be used in education and learning to make course content more interactive and engaging, increase motivation and student engagement, and promote active learning (Kasinathan et al. 2018; Popova 2021; Saxena and Mishra 2021). Gamification is effective not just because it encourages students to keep participating to win more points or rewards, but also because it generates genuine and powerful human feelings such as joy, mystery, excitement, and fulfilment (Dakroub et al. 2022; Spahrbier et al. 2022). This is in addition to the fact that gamification simply encourages students to learn more. Table 1 summarizes the common game mechanics and a description of how they function in game-based learning.

Table 1. Common game mechanics and how they function in game-based learning.

Game mechanic	Description
Turn taking	Turn-taking can be used to organize the learning process and promote active participation from all students in game-based learning. For instance, a turn-taking system may be used in a game-based learning environment to enable students to progress through a lesson or activity in a planned, orderly fashion. As they must wait their turn and concentrate on the subject at hand, this can serve to keep kids engaged and focused (Shi et al. 2019)
Scoring points/Scoreboard	A scoreboard can be used in game-based learning to track students' progress and demonstrate their mastery of the material. This can foster a competitive environment, encouraging students to work harder to improve their scores and climb to the top of the leaderboard. This can boost their motivation to keep learning and show them how far they've come (Raab et al. 2021)
Dice-rolling	Dice can be used in game-based learning to randomly select questions or activities for students to complete. This can add an element of surprise to the learning experience and help students stay engaged and motivated (Silva et al. 2020)
Levels and progressions	In game-based learning, levels and progressions can be used to give the learning experience a sense of structure and progress. This structure makes it easy for students to keep track of their progress and see how far they've come, which can make them more motivated and interested in their work (Rahimi et al. 2021)
Badges and rewards	A badge is a digital symbol that is given to a user when they reach a certain goal or meet certain requirements. On the other hand, users get rewards for doing certain things or reaching certain milestones. In game-based learning, badges and rewards can be used to motivate students to complete lessons (Whittaker et al. 2021)

3.2 QR Code in Education

QR codes are defined as "two-dimensional barcodes that can contain any alphanumeric content and typically contain URLs that direct users to websites that provide information about an object or location" (Coleman 2011). QR codes have been used in a variety of industries and contexts, including museums (to provide visitors with additional information about artwork), airlines (to provide passengers with boarding passes) and retail (to keep track of inventory and provide product information to customers). The use of QR codes has also increased during the COVID-19 pandemic. It is primarily used for contact tracing, where everyone is required to scan the QR code at any time and in any location (Nakamoto et al. 2020). Many restaurants, for example, have begun to use QR codes to provide customers with menu access while minimizing their contact with shared surfaces (Gursoy et al. 2021).

In higher education, QR codes are beneficial for a range of teaching and learning tasks. QR codes can be quickly generated by the educators and linked to a variety of online information, including maps, charts, graphs, audio or video clips, images, quizzes, surveys, PDF documents, websites, and collaborative works (Atherton 2022). There are endless opportunities for adding QR codes into courses of any discipline. QR codes also open up a vast array of opportunities as they facilitate students' access to instructional resources and contribute to the development of more interactive and engaging learning experiences.

3.3 Formative Assessment in Higher Education

Formative assessment necessitates educators gathering data on student learning throughout the learning process rather than at the end. Educators can assist students in excelling at an exhilarating rate by focusing on areas for improvement during the learning process (Irons and Elkington 2021). According to Asamoah et al. (2022), educators used more formal than informal formative assessment techniques during the learning process, with paper and pencil tests being the most common. The pandemic of COVID-19 has had a significant impact on higher education, with many institutions shifting to online learning. Online formative assessments have grown in importance in this context because they enable educators to continue assessing student learning and providing feedback from a distance (Blondeel et al. 2022; Sudakova et al. 2022).

Many Higher Education Institutions around the world use Learning Management Systems (LMS) platform such as Moodle for teaching, learning, and assessing their students in all courses because of its flexibility, customization, and security provided at no extra cost (Cabero-Almenara et al. 2019; Garcia-Murillo et al. 2020; Makruf et al. 2022). Without a doubt, the platform can effectively administer the activities related to formative assessment, but students may find it tiresome to complete the assessment in a somewhat formal setting without or with limited interaction from educators and other classmates. As a result, finding an alternative to make formative assessment interesting, such as applying the gamification concept to formative assessment activities, is necessary. Table 2 summarises several approaches to using online formative assessments in LMS.

Table 2. Several approaches to using online formative assessments in LMS.

Formative Assessment	Description
Quizzes and Tests	Online quizzes and tests can be used to evaluate students' comprehension of course material. These questions can be multiple choice, short answer, or essay in nature (Gamage et al. 2019)
Self-assessments	Students can use online self-assessments in LMS to assess their understanding of course material and identify areas for improvement (Iglesias Pérez et al. 2022)
Group work	Online group work allows students to collaborate on projects and receive feedback from their educators and classmates (Iglesias Pérez et al. 2022)
Discussions and forums	Students can use online discussion boards or forums for formative assessment by sharing their thoughts and receiving feedback from their peers and educators (Smadi et al. 2021)
Presentations and Projects	Online presentations and projects can be used to evaluate student learning and skills in a hands-on, practical setting (Koris and Pál 2021)

3.4 Gamifying Formative Assessment

Formative Assessment occurs before, during, and after the learning session. Previous research has demonstrated that formative assessment enables educators to monitor student comprehension and decide whether class objectives are being reached (Asamoah et al. 2022; Lu and Cutumisu 2022; Veerasamy et al. 2022). The learner will also be able to determine their strengths, shortcomings, and improvement areas through formative testing. Black and Wiliam (2009) identified five factors that students, their peers, and educators consider when conducting formative assessments (see Fig. 1). In addition to promoting engagement by creating challenges and tracking users' progress as they learn, gamifying formative assessment is an easy way to cover all aspects of formative assessment. This is because educators can engage students more effectively through gamified assessment than through traditional assessment method. Furthermore, the use of gamification in formative assessment has been shown to increase student motivation and engagement specifically in this context. For example, in a study of a gamified formative assessment tool in a higher education setting, Minton and Bligh (2021) and Saad Abdul Rahim et al. (2020) found that students who used the tool were more motivated and engaged than those who did not and were more likely to use the tool to improve their learning.

By adopting gamified formative assessment, educators may offer low-stakes, fun environments for the students to understand where they need assistance (Atherton 2022; Zhyhadlo 2022). In addition, it can be used to test and monitor a variety of abilities, from communication to critical thinking, especially when students are undertaking the gamified formative assessment. Gamification modifies the assessment process by providing adaptive tools and access to information resources to students, allowing them

<table>
<tr><th></th><th>Where the learning is going</th><th>Where the learner is right now</th><th>How to get there</th></tr>
<tr><td>Teachers</td><td rowspan="3">1. Clarifying and negotiating learning intentions and criteria for success</td><td>2. Engineering effective discussions and other learning tasks that elicit evidence of student understanding</td><td>3. Providing feedback that moves learners forward</td></tr>
<tr><td>Peers</td><td colspan="2">4. Activating students as instructional resources for each other</td></tr>
<tr><td>Learners</td><td colspan="2">5. Activating students as owners of their own learning</td></tr>
</table>

Fig. 1. Formative Assessment aspects, adapted from (Black and Wiliam 2009)

to demonstrate their learning and take responsibility for immediate feedback (Atherton 2022; Ranieri et al. 2021). Additionally, gamification helps organize data regarding student learning, which makes it more effective, precise, and accessible for educators, parents, admins, and policymakers to use.

4 Result and Discussion

4.1 Students' Perception on Gamified Formative Assessment Using Dice and QRdice

In order to explore the potential of using dice as a gamification tool in gamified formative assessment, a pilot study was conducted among undergraduate students majoring in Information and Communication Technology (ICT). The study aimed to gather their perceptions on the effectiveness of using dice as a teaching tool in enhancing their engagement and motivation during the learning process. The pilot study had a total of 53 participants who were asked to respond questions related to their experiences and perceptions of using dice in educational settings. Figure 2 provides a visual representation of the comparison between conventional dice and QRdice.

The findings imply that the use of dice as a gamification tool in formative assessment may increase student engagement and motivation during the learning process, particularly while undertaking formative testing. Descriptive analysis for each of the four key questions in the pilot study are as follows:

The question in Fig. 3 was designed to establish whether or not students were familiar with utilising dice in educational contexts. The majority of respondents indicated that they have never used dice to determine the outcome of an activity or task in other classes or assessments. This question's mean score of 0.37 indicates that, on average, around

Fig. 2. Conventional Dice (a) and QRdice (b)

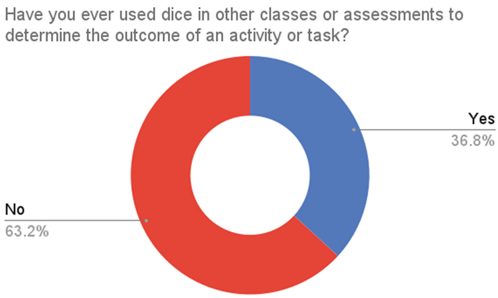

Fig. 3. Have you ever used dice in other classes or assessments to determine the outcome of an activity or task?

37% of respondents had used dice in past educational settings. The standard deviation is 0.50, indicating a moderate distribution of responses around the mean. In general, the results indicate that while some students are familiar with utilising dice in educational contexts, it is not a widely utilised assessment technique.

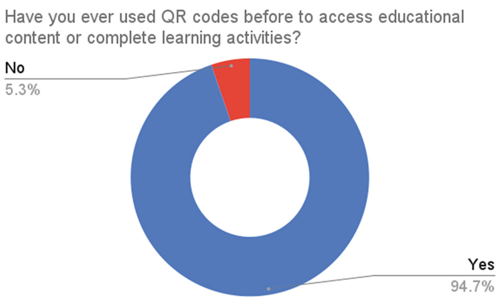

Fig. 4. Have you ever used QR codes before to access educational content or complete learning activities?

Based on the result from question in Fig. 4, majority of respondents are familiar with QR codes, suggesting that adding them into a gamified formative assessment would not pose a substantial barrier. This question's mean score is 0.95, indicating that, on average, the majority of respondents had previously utilised QR codes. The standard deviation is 0.22, indicating that replies were rather variable, with some respondents being more acquainted with QR codes than others. This question gives valuable information on the respondents' prior experience with QR codes, which can be used to drive the design and implementation of a gamified formative assessment employing QR codes.

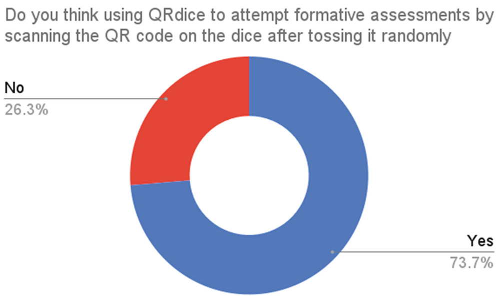

Fig. 5. Do you think using QR dice to attempt formative assessments by scanning the QR code on the dice after tossing it randomly would improve your engagement in class?

The majority of respondents indicated in Fig. 5 that using QRdice for formative assessments will increase their classroom participation. The mean response was 3.74, and the standard deviation was 0.69. The comparatively high mean score shows that the majority of respondents supported the use of QR dice for formative assessment, while the low standard deviation indicates that the responses were relatively consistent. The majority of respondents supported the use of QR dice for formative assessment, indicating that this strategy could be a successful tool for increasing student involvement in the classroom. To confirm these findings and examine the possible benefits and limitations of this method, however, additional study and testing is required.

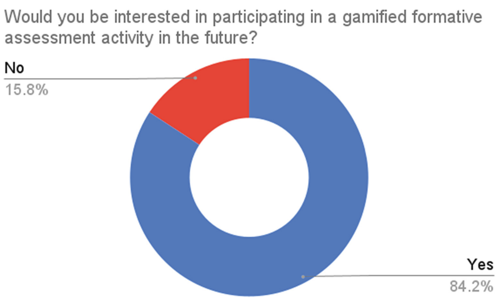

Fig. 6. Would you be interested in participating in a gamified formative assessment activity in the future?

According to Fig. 6, 84.2% of respondents expressed an interest in engaging in a gamified formative assessment activity in the future, while only 15.8% indicated they were not interested. The mean score for this question was 4.21 with a standard deviation of 0.84, showing that the majority of respondents were interested in engaging in gamified formative evaluations. The result demonstrates that the majority of respondents were interested in participating in gamified formative assessment activities in the future, with a high level of consensus. The mean score and standard deviation provide further information regarding the level of agreement and variation in the responses.

4.2 Gamifying Formative Assessment by Using QRdice

Formative assessments are typically brief and focused, and they are used to assist educators in determining what the students already know and what they still need to learn. In higher education, gamification is one of a popular approach for making formative assessment more engaging and interactive (Chung et al. 2019; del Carmen Pegalajar Palomino 2021; Hernández-Horta et al. 2018). Gamified formative assessments can help students improve their understanding and mastery of course material by providing a more dynamic and effective learning experience. Gamified assessments can also give students instant feedback on their performance, allowing them to see what they did well and where they need to improve. Table 3 summarizes the steps Rivera and Garden (2018) proposed for educators to take to improve student learning and engagement in higher education by gamifying formative assessment.

Table 3. Steps to gamify formative assessment in higher education (Rivera and Garden 2018)

Step	Description
1. Identify the learning outcomes	Determine what students must learn and what skills and knowledge they must acquire
2. Choose the right game format	Choose the game formats that correspond most closely with the learning objectives and course material
3. Design game rules and challenges	Determine the rules of the game and the challenges that students will face. Ensure that the challenges are related to the learning objectives and that students receive immediate feedback
4. Integrate assessment into the game	Incorporate formative evaluation questions within the game to provide quick feedback on student performance
5. Evaluate the effectiveness of the gamification	Evaluate the effect of gamification on student motivation and learning and make any necessary adjustments

Step 4 of gamifying the formative assessment can involve the usage of dice. Conventional dice with dots representing the numbers 1 through 6 on each face of the dice is commonly used in both educational and non-educational games. The notion of QRdice is slightly different from the conventional dice because each face of the QRdice is printed with a unique QR Code, and those codes will eventually be linked to a web-based management system that managing the learning activities and serve as a question bank.

Educators will have access to a user interface within the web-based system that will allow them to manage the formative assessment question bank and also the gamified formative assessment session. Before the gamified formative assessment session begins, the educator needs to share the QR Code with the students, and the students must scan the QR code to participate in the game. Once the session begins, students must roll the QRdice, then use their smartphones to scan the QR Code that appears on the top side of the dice, and finally respond to the randomized quiz question that appears on their phones' screens. The use of a projector in the classroom allows for the projection of a live scoreboard, which encourages students to rack up as many points as possible throughout the activity. Before the session officially ended, the educator could bring it to a close by providing feedback and a recap of the learning outcomes. The educators also can determine the appropriate reward for students' efforts and accomplishments after the session. Rewards can serve as potent motivators and aid in maintaining student engagement and motivation. The overall workflow of the QR-based formative assessment session that corresponded to the gamification mechanics of the scoreboard, turn taking, and dice rolling is shown in Fig. 7.

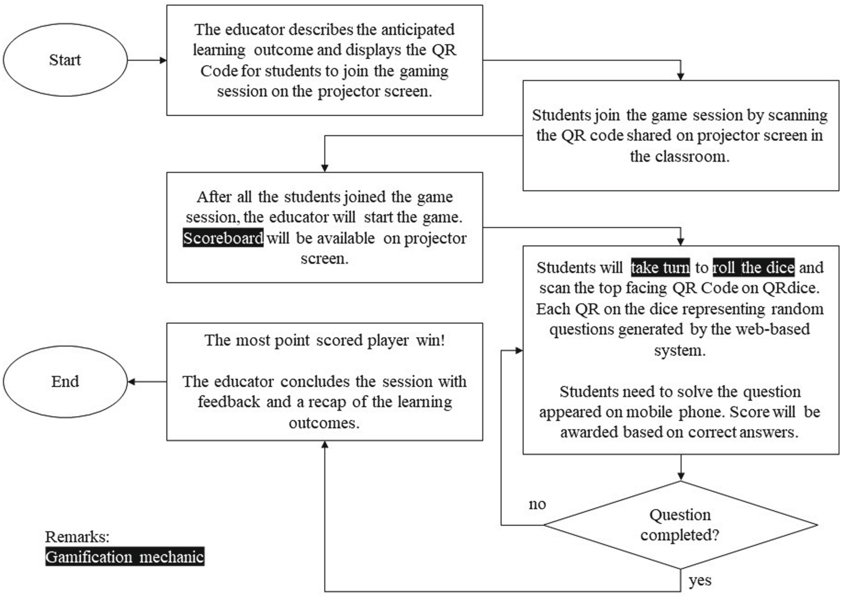

Fig. 7. Workflow diagram for gamified formative assessment using QRdice

5 Conclusion

To ensure the effectiveness of the teachings, it is essential to retain the students' interest and eagerness to participate in any learning activities even if there is no mark associated with the assessments, which may deter students from completing the assessment or completely interacting with it. Gamification is recognized as a technique that can promote a student's desire to study and learn in a pleasurable and interactive manner; hence, a gamification concept utilizing a QR Code to boost students' engagement while attempting the formative assessment is discussed. The development of the QRdice platform could be part of the ongoing work for this project in the future. This would increase the variety of gamification tools that educators will have access to in the future.

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Virtual Campuses with Social Learning Environments: A Future Alternative for Traditional Campuses

Dario Liberona[1(✉)], Aravind Kumaresan[2], Lionel Valenzuela[3], Giovanny Tarazona[4], and Meija Lonhinova[5]

[1] Seinajoki University of Applied Sciences, Seinäjoen Ammattikorkeakoulu, Seinajoki, Finland
Dario.liberona@seamk.fi
[2] University of Vaasa, Vaasa, Finland
[3] Department of Business Administration, Universidad Tecnica Federico Santa Maria, Santiago, Chile
Lionel.valenzuela@usm.cl
[4] Universidad Distrital Francisco Jose de Caldas, Bogota, Colombia
gtarazona@udistrital.edu.co
[5] Oulu Univestiy of Applied Sciences, Oulu, Finland

Abstract. Covid 19 has been a tremendous impact on all the modern society, the 21st century has been shaped by its implication, digital transformation of all business have been accelerated and stress, but what is the Higher Education reactions and how its processes will be transform.

It has been more than two decades since the concept of distance learning was implemented, there have been several online Universities in the world.

A few year ago, there were big arguments about the credibility and quality of remote education with systems. E learning platforms were on the rise, and MOOCs, Massive online Courses were given all over the place, then some sort of disbelief and other factors were slowing the advocacy of this emerging educational technologies.

Then Covid came, and suddenly all Higher Education in the World is remote, with e-learning platforms and has been for the last two years, half of the education of all professionals has been remote.

One of the aspects of distance learning is their more isolated learning mode and little social interaction, an experiment of three different student exchange programs were conducted making groups of students from different universities work together on a virtual campus with avatars.

The results were a very positive response to having virtual social interaction tools and activities, the level of technology has advance enough to use these virtual worlds and students satisfaction is very high, however big efforts on customization of programs and environments must be made.

Keywords: Virtual Campuses · Virtual Worlds · Avatars · virtual exchange programs · virtual learning

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1 Introduction

Distance Universities are a reality, early attempts were made back in 1728 when Celeb Phillips develop a weekly mailed lesson program, by 1840 Sir Isaac Pitman, using post-cards has the remote media channel for the courses, forming the Sir Isaac Pitman College with a similar initiative in 1873 in the USA denominated the Society to Encourage Stud-ies at Home, and in 1894 the Wolsey Hall in Oxford was the first distance college learning in the United Kingdom (Kett 1994), by 1906 more than 900,000 distance students were in the US (J.J. Clark 1906), they have just changed the technique of sending one short content episode at a time (paper-covered pamphlets) into full volumes of the courses and give them the opportunity go with the course paste of their own paste, by that time they have already recognized that the self-learning text book and manuals could not be the same has the text uses for presence students, this change on the process technology for teaching plus direct sales an interviews growth considerably the amount of distance students, especially for the International Correspondence School, more than one hun-dred years ago, the types of education with traditional regular technical school or college with a more broad education; versus this distance schools that on the contrary wanted to educate students along some particular specific knowledge or skill, this approach has continue in some countries like Finland, German and Netherland that have applied science Universities versus traditional universities.

At the beginning of the 19th century, it was hard to go to universities in presence mode, this was the way to do adult education and technical education in the world. University of Chicago had some sort of blended programs where you did some parts on presence mode and the others in correspondence mode.

The correspondence mode was the methodology applied for many decades until the creation of the open universities.

In 1969, the Open University (OU) was established has a British public research university that was devoted mainly to distance learning students and with time has become the largest University in England in terms of number of students; it provides many programs both undergraduate and postgraduate, based in London and initially using the television studios and editing facilities which had been vacated by the BBC, it has grown over the year and now has around 175,000 students, it uses TV broadcast has a new technology for education and digital distance education advanced.

Soon after the University of Hagen was founded in Germany in 1974, also now the biggest university in Germany by enrollment (around 80,000 students), founded with the idea to provide higher and continuing education opportunities through a distance education system in Germany, but started to develop a virtual university plan since 1996 addressing the problems of social interaction and group awareness.

In the last two decades many online open Universities have been appearing all over the world, but now, what will the next stage of distance learning, over the past years tools like gamification have been incorporated (Hericko 2021), video conferencing platforms have growth fast and quickly became very important for all universities, the quality of learning with distance universities was some how question for a while just like at their time was mail learning degrees, but now online open universities have incorporated many academic evaluation tools (Gaytan 2004, Kaplan 2021, Lassoued 2020).

During the last decades and thanks to the advances of the education technologies (broadband internet, digital platforms, moodle and others), with the Internet penetration and advances in media communications, bandwidth, online learning has become a new important trend in higher education, the need to mitigate the expansion of COVID virus has force higher education all over the world to move into distance and online learning (Tam 2019).

Many Universities have adopted blended teaching modes, with presence courses programs and online programs, but this is not necessarily distance university teaching, the main difference between online and distance learning is the intention of the teaching strategy, online learning uses technologies such has e-learning to complement the class learning experience, basically all universities in the world provide online learning since 2010, but distance education learning is a method for delivering instruction solely online, not as a variation in your teaching style, giving lectures in video calls through any current platform is not distance learning but rather replicating the regular classroom class using another technology mean, in the case of distance education the learning experience is design to be solely remote.

In Table 1 we can review the evolution of distance learning in universities through the years, there is a Covid 19 stage regarding the two years of the pandemic where the distance learning and online learning where force by protection government measures to be massively use by schools and universities, some effects were the reduce time for studying in online learning, parents expend more time with students, universities improved their technological infrastructure, mobile learning accelerated adoption by students, multiple related training for university professor in order to impart online learning courses or hybrid courses, increased adoption of supporting technologies for online learning and distance learning, program were adapted to fit new teachings formats (Gomez L., Velez R. Lopez L. 2022; Ghada R. El Said 2021; Gorey J. 2021).

At Table 1 we can estimated that by 2019 at least around 33% of Higher Education students were involved in some form of distance learning, before the pandemic, with around seventy five million students around the world and close to twenty million were already in full distance learning programs, this virtualization or online learning adoption process accelerated during the pandemic, and number rise to around two hundred million higher education students enrolled in some form of distance learning in a dramatic fast adoption of new technologies.

Table 1. Evolution of higher education formats. (Own elaboration, multiple sources, Statista, CB insights, Knoema, getapp.com, Thinkimpact, Education data, World economic forum)

Period	Type of University	Distance Learning Virtualization Stage	Examples of Universities	Characteristics	Technologies	Estimated number of Students
1100 - 1299	**Old Kingdom Universities**	**None**	Univerity of Bologna, University of Salamanca, University of Oxford, University of Cambride, University of Lleida, University of Paris, Universtiy of Padua, University of Montpellier	Establish mainly by Kings, mostly for rich young people, woman were not part of the learning	Libraries, Books, Many Religious professors	10 000
1300 - 1799	**Old Traditional Universities**	**None**	University of Harvard, University of Milan, University of Chile, University of Buenos Aires, University of Lyon, University of Barcelona, University of Madrid, Yale University, University of Notre Dame, Princteton University, University of Pisa, University of Prague, University of Dublin, University of Vienna, University of Glasgow, Royal Academi of Abo	Many Religious professor	Libraries, Books, Laboratories, Industrial Worlshops, Guide Books	300 000
1800 - 1949	**Traditional Modern Universities**	**Basic distance learning**	Oslo University, Universtiy of Berlin, University of Maryland, Ghent University, Saint Louis University, Saint Petersburg University, University of Buenos Aires, University of Toronto, Zurich University, Athens University, Boston University, University of Notre Dame, Manchester University, Penn State University, MIT, Amsterdam University, Stockholm University, Stanford University, Wales University, Federico Santa Maria Technical University, ETH Zurich, Munich Technical University,	Woman join Higher Education, in some Universities since 1830 and in many universities by 1890	Libraries, Books, Laboratories, Industrial Worlshops, Guide Books	5 000 000
1950 - 1999	**New Universities**	**New Universities Very little distance learning, some pilot programs with distance learning characteristics, many experiments and trials.**	University of Salzburg, Aalborg University, University of Oulu, University of Tampere, University of Vaasa, University of Angers, University of Nantes, Tech. University of Berlin, Universtiy of Bremen, University of Essen, University of Flensburg, University of Seinajoki, University of Piraeus, Cork Institue of Technology, University of Brescia, University of Verona, Polytechnic University of Bari, Maastrich University, Eindenhoven University of Technology, University of Zilina, University of Navarre, University of Alicante, University of Leon, Umea University, University of Sussex, Lancaster University	Many Religious professors, new carriers, new skills, mostly traditional teaching practices.	Libraries, Books, Many Laboratories, Industrial Worlshops, Guide Books	10 000 000
1840 - 1960	**By mail educational Institutions**	**Mailing distance Universities**	Sir Isaac Pitman College, The International Correspondence School, University of Queensland, University of South Africa,	More vocational type of schools. Very specific or narrow courses programs	Mailing assignments, postcards, other by mail school material such as program books or some pamphlet type prints	100 000
1969 - 1989	**Distance and open Universities**	**Distance Learning basic platforms and Beginning of Virtualization**	University of Hagen (83.000 Students), England Open University (175.000 Students)	Are the largest Universities in Germany and England by number of students. Have evolve into online programs	Mailing assignments, Books and Material by mail. Also TV studios and broadcasted their programs.	300 000
2005-2019	**New online e-learning/distance Universities**	**Midium level of Virtualization**	Open University of Caluna (OPC), Open UK University (150,000), University of Phenix Arizona (315,000) , IVY Tech Community College, American Public University, Liberty University, . National Bangladesh Open University (650,000), Pakistan Open University (1,400,000), Indonesia University Terbuka (646,000), Nigeria National Open University (515,000), India Ambedkar Open University (450,000), University of Hagen (76,000), Pakistan Virtual University (100,000), University of People (117,000), National Centre for distance Eucation (120,000), India Madhya open University (150,000), South Korea National Open University (210,000), UNIR International University of la Rioja, the university in Internet (45,000).	Follows open-door academic policy, with minimal to no entry requirements. Offers Flexible programs, a 3 year program could be finish in 6 years. Use of technology is a must. Internet allow this Universities to operate internationally has never before.	Internet main Access, Personal Computers use at home, Basic e-learning Platforms, Moodle or equivalent platforms, digital books, youtube videos, basic simulation games, Use of Cases	20 000 000
2010-2019	**Blended Teaching Universities**	**Blended Universities, embracing distance Learning , Higher level of Virtualizacion /**	Miami Dade College (99,000), Indira Gandhi National Open University (7,140,000). National , Turkey Anadolu University (1,974,000), United States Laureate University (875,000), South Africa University (420,000), Iran Payame University (400,000), Spain National University of Distance Education (260,000), United Kingdom Open University (173,000), Sapienza University (147,000), Norte do Parana University (130,000), UniMinuto System (117,000), Liberty University (110,000), University du Quebec (101,000)	This blended way of teaching does not have specific characteristics, there are universities of all types, but mostly universities founded after 1950, but a few cases like University of Sapienza founded in 1300.	Internet, e-learning platforms, content management systems, mobile learning, youtube and other videos streamming, simulation platforms, digital Labs, MOOC technologies	75 000 000
2020 - 2022	**Universities during pandemic. Covid forces masive Full Onine programs**	**Virtualizacion becomes an emergency norm**	75% to 85% of all Higher Education institutions in the World were in Oline Mode. Most of the Universities in the world become online/distance universities.	All universities in the world affected by Covid 19 switch learning mode to distance learning and then incorporate technology to do support their programs, speally online meetings and break out room.	High speed internet access, e-learning platforms (advanced such as Moodle, Black board), virtual meetings technologies (Zoom, Google Teams, Microsoft , Virtual Campuses, Avatars, Virtual Reality, Simulation Games, Youtube content, Digital Books, break out rooms, virtual campuses, digital avatars, mobile learning and applications	200 000 000
Since 2040 or 2050	**Universties of the Future**	**Many new technologies/ Full Virtualization**	In process but version of higher education content like Cursera, Linkedin Learning, Udacity, Google University (youtube), Cloud Academy, Edx, CBT Nugget, Skillsoft, and initiatives from Stanford, MIT and other universities.	Not clear characteristics in the making process	Many new technologies, Virtual Reality, Augmented Reality, Virtual Campuses, Inmersive technologies	500 000 000

2 Evolution of Distance Technologies

Clearly the distance learning technology in 1800s and beginning of 1900s was the mail and postcards. There were some experiments with TV and radio broadcast on the 1960s and 1980s, E-learning in the 1990s.

Even though sending emails was possible in the 1980s, they were not very use for distance learning, and the internet got a quick development during the 1990s, during this period the internet became part of everyday life in higher education institutions, however the dial up confections were very limited.

The 2000s years were e-learning and most of the current distance online educational learning technologies were develop, By 1999, one of the first fully online universities—Jones International University—was able to get full accreditation from the Higher Learning Commission (HLC). The technologies use here were video conferencing, phone calls, and other online education e-learning tools available at the time.

The e-learning term was first mentioned in professional context by Elliott Masie during the TechLearn conference at Disneyworld in 1999, soon after e-learning platforms became available during 2000s, with many new concepts, Content Management Systems, Intranet platforms, use of online videos, video streaming, Moodle 1.0 was released on in 2002, Moodle 1.9 was released in 2008 with 20 million users already.

In 2008 a new technology concept was developed the MOOC learning; Massive Open Courses were implemented all over the world by many Universities.

2010s was the year of the Social Media technologies applied to education, many new technologies were applied to online learning such as serious games, mobile learning, wearable education technology, artificial intelligence, analytics technologies, next generation LMS, blockchain in education, robotics and Virtual reality.

By 2012 "The year of the MOOC" (Pappano 2012) companies like Cursera a main online learning platforms was founded by Andrew NG and Daphne Koller from Stanford University, at this stage MIT has a long history of e-learning projects and two other successful online learning platforms were founded, Udacity and edX, two years earlier Udemy was founded.

2020s has been the years of COVID pandemic and has forced and accelerated the adoption of online distance learning technologies and has ignited the transformation of distance learning.

Most of the learning technologies matured during this time and a new concept was develop the Virtual World/Virtual Campus concept.

This technology allows companies and Universities to develop virtual environments that will resemble entire campuses with avatars and physical world characteristics.

Before 2020, the growth of distance learning was gradual and on pace with technological advancements, there were still concerns about the quality of the learning, but with the pandemic situation all educational systems across the world had to make rapid implementations of online learning for their students, this has been implemented for the last two and a half years and now Universities have to decide on how they will go on next semester.

In this period video conferences technologies like Zoom, Google Meet and Microsoft Teams were widely incorporated and perfected across the World.

3 Virtual Campuses

During 2010s many companies were already developing virtual world technologies, Virbela was one of this platforms among others like.

A virtual Campus, or Virtual space or World, is a computer-simulated environment which may be populated by many users who can create a personal avatar and move around the virtual area, often with many places and virtual buildings, all this people or participants avatars can move and communicate with each other freely in this virtual campuses. This avatars can have different clothing, movements and communications abilities, direct speech, text, signs and other options.

The avatars can manipulate elements of the modeled world and thus experience a degree of presence. In the professional Virtual Campuses like Virbela, most of the rules of the real world apply, you can seat, walk and talk to people that is close to you, turn around and see them move stand or leave (Virbela.com 2022).

The European commission defines Virtual campus in an extended way has a Cooperation between higher education institutions in the field of e-learning, considering aspects such as: design of joint curricula development by several universities, agreements for the evaluation (Erasmus 2022), validation and recognition of acquired competences, subject to national procedures; large–scale experiments of virtual mobility in addition to physical mobility and development of innovative dual mode curricula, based on both traditional and on-line learning methods.

This is a very broad definition and today with virtuality at the next stage post covid, the possibility of having join campuses with students from many universities in the same courses and interacting with each other is also a real possibility, now universities can merge or work closely together without having to merge their physical campuses or resources, this EU broad definition helps to develop collaborative projects and activities considering e-learning platforms, which is different than a virtual campus.

In the middle of the pandemic, most of the exchange students programs in the world were severely reduce due to the complicated aspects of travelling and getting special documents during this period. In this scenario a serious of virtual exchange program were conducted by the University.

The needs of a virtual exchange program required more than attending the same e-learning class, it required special spaces for the students to share with each other, to meet at will, to sit to talk or to join social events just has well has classes, a digital platform virtual campus world was set up for this purpose on a collaboration among universities during three consecutive terms. The first period with four universities from Europe, the second one with seven universities and the third one with twelve universities from three continents.

Fig. 1. Examples of different virtual world rooms and avatars.

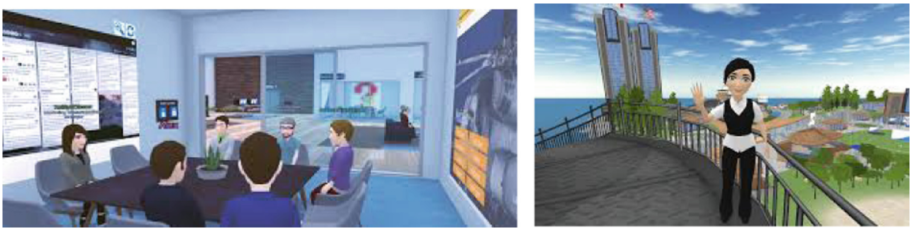

Fig. 2. Examples of avatars and the interaction

Virbela campus environment use in the programs, defines itself has the first virtual world platform built specifically to solve the challenges of remote collaboration. Meet, host events, hold classes, and service your entire remote workforce all in an immersive and engaging 3D world (Virbela 2022). In Figs. 1, 2, 3, 4, 5 and 6 we can see examples of different views of the remote learning virtual campus platform.

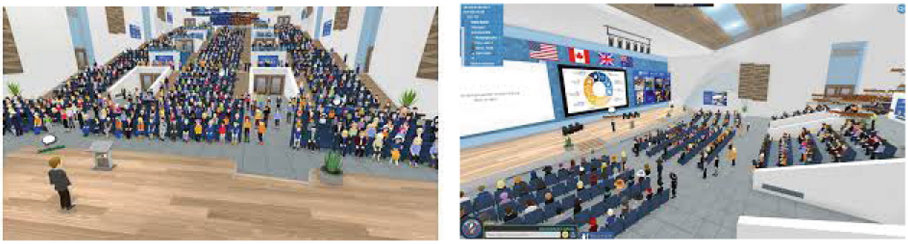

Fig. 3. Examples of big auditorium events with hundreds of participants.

Fig. 4. Example of teacher giving presentation to Student's avatars

4 Methodology

During the pandemic three pilot programs with virtual exchange courses were conducted with students from multiple universities.

The programs were conducted during one year from October 2020 to October 2021.

The three programs consisted mainly in the use of a Virtual Campus with auditoriums for the students, and multiple meetings rooms assigned to groups of four students usually from at least three or four different universities. The students working in groups with task related to a circular economy simulation game with multiple levels of complexity and on a competing environment.

Every new pilot program incorporated more learning modules and learning aspects from the previous experiences, but the class contents were very similar.

Since the second pilot sharing activities were develop on the virtual world with contest and gathering activities.

Table 2. Characteristics of the Virtual exchange programs.

Program	Universities	Number of Students	Level	Continents	Virtual Campus	Other Technologies	Observations	Duration of program (weeks)
First Exchange	4	35	Undergraduate	Europe	Virbela	Circular Economy Simulation tool	Circular Economy basic program	4
Second Exchange	11	75	Undergraduate	Europe, America	Virbela	Circular Economy Simulation tool	Circular economy program with grades	8
Global Master Exchange	3	35	Graduate (MBA)	Europe, America	Virbela	Circular Economy Simulation tool	Time difference, Circular economy and Entrepreneurship program	2
Total	14	145						14

After the program questionaries and personal interviews were conducted in order to obtain freedback from the 147 students. The questionnaires consisted in 17 questions using survey monkey tool and 14 personal interviews.

The experience of the students is somehow similar to other virtual worlds created in the pass, Club Pinguin was very popular until 2018 and Second life is still use by millions of users, but this more academic or event virtual world campuses are more controlled, more stable and with functionalities that are develop for academic or conference events.

5 Students Experience in Virtual Campuses Findings and Discussion

In Table 2 we can see that the use of the Virtual Campus was done on three separate events considering a total of 145 students, from which 72% answered the surveys.

The use of a Virtual Campus was appreciated by students in general, we were able to learn from the experiences and have implemented the following upgrades in the program:

- Virtual social events were implemented during the program (Welcome event, social activity, closing event).
- There was a session of training on the platform with coaches

- An activity was develop where attendants were encouraged to find information on the other exchange students.
- Virtual prices for social activities were incorporated.
- Tour around the campus was implemented (Other activities like going to a Virtual Island, Virtual beach, roof of buildings, and walking around other areas).
- Personalization of rooms with real pictures of group members
- Digital banners in public spaces
- An information Kiosk during some activities
- Permanent videos related displays in some sections
- Activities that will interchange members of the groups
- Logos, signs and clear writing indications

The third experience with the Virtual Campus was for the Master Global MBA program which is an exchange program with MBA students from the United States, Germany and Finland who shared for over a week a thematic program regarding Entrepreneurship and Circular Economy, every year they all meet in a different country, since COVID was a main issue in 2021 the program was done virtually utilizing a campus simulation Platform call Virbela, with a digital simulation program related to Circular Economy and other entrepreneurial innovation matters, the students were able to participate in activities in the Virtual platform and complete a program of six simulations rounds.

This was the most successful implementation using all the feedback suggestions from feedback from previous sessions.

The results of the Virtual Campus platform were very positive, most of the students liked the program with a final 88% positive response to the use of the platform, declaring that it was a good learning experience.

71,43% declared that the virtual campus helped in many levels to the learning process.

Regarding the credits, many students declared that 3 credits are not enough for the amount of work necessary for the programs, but having credits was very important (Table 3).

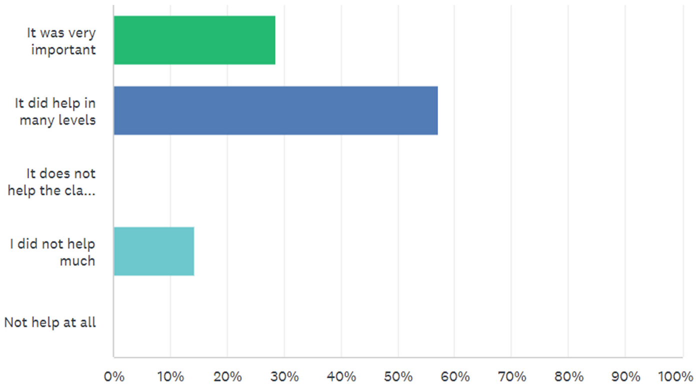

Fig. 5. How much did the Virtual Campus helped the realization of the course (85.71% positive)

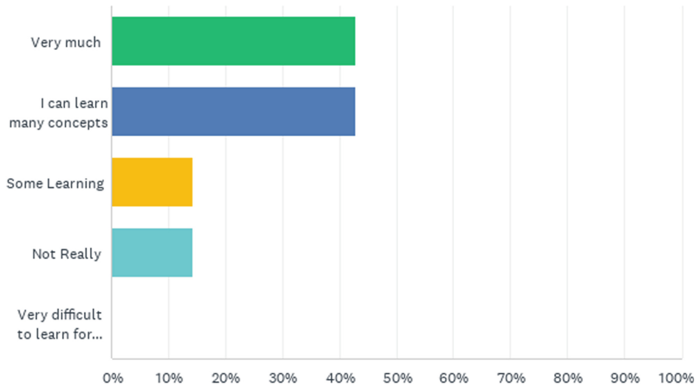

Fig. 6. What was the level of learning provided by the overall experience.

Table 3. Evaluation of the Virtual Campus in every program.

Virtual Exchange Program	How would you grade the Virtual Campus (0 to 100)	The Virtual Campus was Very Important	The Virtual Campus was important	The Campus did not help but was fun	It did not help much	The Virtual campus was Not Help at all	Overall Evaluation of the program (0 to 100)
First Exchange	68	28,57 %	57,14 %	0,00 %	14,29 %	0,00 %	83
Second Exchange	74	9,52 %	71,43 %	14,29 %	0,00 %	4,76 %	85
Global Master Exchange	81	17,1 %	71,4 %	8,6 %	2,9 %	0,00 %	88

The experience was very positive, this platform was use even before the pandemic by Stanford University graduate business school (Burke 2019), after during the lockdown times their students develop another similar initiative call "Club Cardinal" a gamified virtual campus (Matchar 2020), this are examples of the positive reaction of students to virtual campuses.

Our goal for the use of a virtual campus was not only that the participants will get the academic content that could have been delivered by online meetings platforms such as Zoom and Teams, but also to get to know other students from other countries in a more interactive and personal way, to have a better interaction with their peers and connect with other people and have the perception that they went somewhere and meet people there, this objective were clearly achieved with the use of this platform.

6 Conclusions

During the Covid Pandemic, online education had an incredible boost, in a matter of week Universities implemented distance and online programs like never before, 70% to 80% of all students in the world were on distance mode, for some, initially intended to do it for a few months has a palliative measure then it become a norm all over the world since the two-year duration of the pandemic.

During this transition time, Universities embraced online learning, the year 2020 they use basic online tools, by 2021 and 2022 universities tryed and use many new technological tools, they increased their digital infrastructure and quickly implemented online and distance learning.

One of these solutions was the use of Virtual Campuses that are able to replicate some of the human aspects of being on a campus, the experience is really positive, but it demands to re-format the courses and create additional activities that will benefit from the use of the technology and give opportunity to students to interact and create deeper relationships while walking or talking in virtual places.

Distance universities could benefit of using virtual campus platform by making their academic experience more like a presence mode campus learning. Traditional online and distance teaching methods tended to be isolated, virtual campus could offer a more social experience and some benefits of direct interaction and communication.

Many universities will continue with the blended teaching mode, there is no way back for some institutions, many students have declared that they don't want to go to formal traditional education, many students realized that they do not have to leave their countries in order to have a good education, and many teachers have embraced the comfort of teaching from home and saving many travelling hours a week.

Virtual Campuses are technologies that will support the online education format, their technology is improving very rapidly, the platforms are on the making, immersive learning will continue improving and now the question is how institution will incorporate this technology and at what scale, e-learning took a few decades to become mainstream in higher education, virtual campuses are on their early stage.

Future research could be related to the analysis of technological tools that could enhance the virtual campus experience and the relationship with the concept of metaverse.

The challenge seems clear, democratized higher education, doubling the number of higher education students in the world will require facilities for 200 million additional students, in this scenario, virtual campuses seems like a good support for distance education that will give access to any content/program, anytime, anywhere, anyhow and with an intense use of new technologies that will facilitate the virtual experience, the learning and probably will lower the cost of higher education.

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Knowledge Management Model in Virtual Classrooms to Measure Learning Through Gaming

Víctor Hugo Medina García[1](✉), Dario Liberona[2](✉), Valentina Pulido Diaz[1](✉), B. Cristina Pelayo Garcia-Bustelo[3](✉), and Lina María Medina Estrada[1](✉)

[1] Faculty of Engineering, Universidad Distrital "Francisco José de Caldas", Bogotá, Colombia
{vmedina,lmmedinae}@udistrital.edu.co, vpulidod@correos.udistrital.edu.co

[2] Seinajoki University of Applied Sciences, Seinäjoki, Finland
Dario.Liberona@seamk.fi

[3] Departament of Informatic, Universidad de Oviedo, Oviedo, Spain
crispelayo@uniovi.es

Abstract. In order to improve the level of learning in students of basic education or primary level in schools of the Capital District of Bogotá, a knowledge management model was proposed that allows measuring and evaluating student learning through games, taking into account that, through play, children learn to forge bonds with others, and to share, negotiate and resolve conflicts, in addition to contributing to their capacity for self-affirmation and building leadership skills. In addition, a Web architecture was projected, which makes it easier to provide educators with technological tools to implement pedagogical strategies to improve learning. Within the scope of the architecture of the management Web platform, the projection of the applicability for students from grades 1 to 5 in a primary education institute was established, as a pilot test.

The applied methodology was based on the bibliographic compilation on the subject, to understand the theoretical bases that support the importance of the game in the learning process and the knowledge that an infant must acquire according to its age; then a survey focused on different levels of training or courses was applied in order to analyze their results and project the continuity of the investigation.

Keywords: Virtual classrooms · game · learning · knowledge · knowledge management · measurement

1 Introduction

Information and communication technologies constitute a set of increasingly effective tools for creating and transmitting knowledge, as well as for harnessing it for the benefit of society. Nowadays, the development of these technological skills is indispensable to achieve greater success in the different actions that are developed, particularly in education.

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In the wake of the Covid-19 pandemic, the education system was forced to migrate from face-to-face classes to distance education, so digital literacy and comprehension skills are important competencies for the 21st century and educational institutions must ensure that students master them. The measurement of these competencies is fundamental to implement pedagogical strategies for improvement and must be enjoyable and experiential to build solid educational processes.

The following article aims to explore the relationships between the processes of knowledge acquisition, utilization, assimilation, construction and extension and their effect on learning processes. Proposing a model of knowledge management in virtual classrooms for elementary school students that allows measuring learning through games focused on specific topics associated with the areas established by the Ministry of Education and allows teachers, parents or people with the role of educator to implement pedagogical strategies for improvement.

2 Background in Virtual Classroom

In order to address the object of research, a series of concepts and terms are described below to support the proposed model.

2.1 Virtual Classroom

Virtual classrooms as technological supports for teachers' teleworking are spaces where it is possible to teach in a ubiquitous, omnipresent way. They are not new spaces, nor are they the only ones where teaching and learning take place in virtuality, but they are institutional [1], they arise from the incorporation of information and communication technologies (ICTs) to the teaching-learning processes; and are configured in scenarios of educational innovation characterized by their flexibility, comprehensiveness, versatility, potential and diversity, in which the teacher manages content, shares information, uses pedagogical resources, encourages skills and competencies in students through activities, promotes cooperative learning and strengthens independent work [2].

2.2 Learning

Learning is the process of assimilation of information that reveals a relatively permanent change in behavior, which occurs as a result of experience. These are changes that occur in a relatively brief period of time that allow the learner to respond more appropriately to the situation.

2.2.1 Learning Conditions

Learning is a process of individual and social construction that the learner must regulate [3] argues that four conditions are necessary for learning:

- Well-structured knowledge base.
- Appropriate motivational context, by the teacher, stimulating environments to increase the likelihood of learning.

- Activity on the part of the student, in other words, experimentation, feedback, practice, belonging and configuration.
- Interaction with others to improve the learning process.

2.2.2 Effective Learning

Effective learning can be ensured by addressing the following aspects:

- Learner needs: Learning can only take place in response to learner student's needs. When the learner's need is strong enough and defined goals for achievement are set, learning will be more effective.
- Readiness to learn: Readiness to learn is fundamental to effective learning. Specific learning will not occur until children are ready for it.
- Situation: The type of situation available to the learner determines the quality and speed of learning. Informal learning situations are found in the home environment, environment, and school environment. Formal learning situations can be provided by the teacher to make learning systematic [4].
- Interaction: The learner, with his or her needs and goals, learns through interaction in the learning situation. It is nothing more than an interaction and a process that responds to a situation. The more numerous and satisfying the interactions are, the better the learning will be.

2.3 Knowledge

It is a set of data and information (seen from an Information Technology point of view) and a combination of know-how, experience, emotions, beliefs, values, ideas, intuition, curiosity, motivation, learning styles, attitude, ability to gain confidence, ability to deal with complexity, ability to synthesize, openness, networking skills, communication skills, attitude to take risks and have an entrepreneurial spirit that ends up in a valuable asset that can be used to improve the ability to act and support decision making [5].

2.3.1 Types of Knowledge

It is possible to recognize three types of knowledge: Explicit, tacit and embedded [6].

Explicit knowledge is knowledge that can be written down and transferred relatively easily from one person to another (codified, directly accessible). Tacit knowledge, on the other hand, is more difficult to articulate because it usually arises from experience (not directly accessible). And finally, implicit knowledge is action-oriented and only partially explicit, it is associated with "know-how".

2.3.2 Knowledge Management

The knowledge could be defined like the information set that lets me to do an action or to generate value added to a process, that is why we listen knowledge is 'how to do the things', 'how the process and the people interact in the organization. With the knowledge definition clear can say management is the process that make things possible, it can also be said that to manage is generating value added through administrative processes (planning, direction, organization, control) with the goal of achieve a specific objective, then it is possible to say that knowledge management is the process that ensure to get and to energize knowledge, ergo it is of profit for the organization [7].

2.4 Game

The game as a fundamental element in the strategies to facilitate learning, is considered as a set of pleasant, short, fun activities, with rules that allow the strengthening of values: respect, group and intergroup tolerance, responsibility, solidarity, self-confidence, security, love for others, encourages companionship to share ideas, knowledge, concerns, all of them - the values - facilitate the effort to internalize knowledge in a meaningful way [8].

2.4.1 Learning Games

Games should be considered as an important activity in virtual classrooms, since they provide a different way for students to acquire knowledge. Games allow orienting the participant's interest towards the areas involved in the ludic activity. It should be considered that the games should be adapted to the interests, needs, expectations, age and learning pace.

Carmen Minerva [8] proposes two stages for the implementation of games to promote the construction of knowledge and make learning more meaningful:

- Stage 1: Recommend simple games, where motor skills come first. Imitation and hunting and chasing games should predominate at this stage.
- Stage 2: Recommends competitions and sports. It is common for the child to lose interest in class when subjected to extended periods of work where attention and little movement are demanded.

2.4.2 E-Learning and Gaming

E-Learning and technology have allowed learning processes to evolve, thanks to the speed, interactivity and possibility of collaborating and interacting remotely with others, through various tools and channels. ICTs have promoted a new educational model, more participatory, interactive, enjoyable, and collaborative in which the game becomes a protagonist and contributes to the transformation of education into a more interesting and fun activity [9].

2.5 PIaget's Stages

The age established by the Ministry of Education [10] for a student to be admitted to primary school is from 6 to 11 years old, without considering extra-age. For this reason, we will focus on the concrete operations stage of Piaget's theory of cognitive development, as presented in Table 1 below:

The author states that by this age, the infant begins to use mental operations and logic to reflect on the facts and objects in his environment. The three types of mental operations

Table 1. Jean Piaget's theory of cognitive development [1, 11].

Stage	Age	Characteristics
Sensorimotor active child	Birth to 2 Years	Children learn purposeful behavior, means- and ends-oriented thinking, object permanence
Preoperational intuitive child	2 to 7 Years	The child can use symbols and words to think. Intuitive problem solving, but thinking is limited by rigidity, centralization, and egocentrism
Concrete operational practical child	7 to 11 Years	The child learns the logistic operations of seriation, classification, and conservation. Thinking is linked to phenomena and objects of the real world
Formal operational reflective child	12 years and up	The child learns abstract systems of thought that allow him/her to use propositional logic, scientific reasoning, and proportional reasoning

that the child uses to understand the world at this stage are: seriation, classification, and conservation. So, it is these stages that the games will be aimed at.

- Seriation: For this stage it is important to know the concepts of number, time, and measurement. Elementary school children can order the concepts of time from magnitude, so 20 min is not the same as 200 min.
- Classification: The requirements for mastery of this classification are as follows: a) understand that an object cannot be a member of two opposite classes, b) work out a class criterion, e.g., shape and objects have similarities under this criterion, c) know that a class can be described by listing the elements that comprise it, d) understand the different levels of hierarchy. To work on this stage with primary school children, they can be asked to group objects according to a simple dimension, for example, all the apples on one side and the pears on the other.
- Conservation: During this phase, the child no longer bases his reasoning on the physical appearance of objects, he recognizes that they can transform their appearance and still be the same object. Working with numbers, liquids, substances, length, and volume.

3 Methods/Methodology

The model presented has been designed under a prospective study, that is, it is a longitudinal study in time that is designed and begins to be carried out in the present, but the data are analyzed after a certain period in the future. This type of study was chosen due to the nature of the study, because in terms of data collection it is the best way to collect information and considering that the target population is elementary school children between the ages of 5 and 11 years old, this range is classified in the stage of concrete operations of Piaget's theory of cognitive development [1, 11].

In order to apply the model, the San Isidro Sur Oriental School in Bogotá, Colombia was chosen as the study environment, and to delimit the scope, it was decided to study only the morning session, which consists of 225 students; therefore, this is the sample size. It should be kept in mind that these 225 students are divided into 5 grades and 8 courses, which are classified as follows (Table 2):

Table 2. Distribution of students by grade and course.

Grade 1	Amount
1A	22 students
Grade 2	Amount
2A	28 students
Grade 3	Amount
3A	30 students
3B	28 students
Grade 4	Amount
4A	29 students
5B	29 students
Grade 5	Amount
5A	30 students
5B	29 students

The following is the logo of the application created, which is called "Apprender Jugando" (Fig. 1) and the architecture of the application (see Fig. 2). This application is presented to implement the knowledge management model in virtual classrooms through the game, the design is user friendly and consists of 6 interfaces. Two main ones have been defined under the criterion of usefulness to collect information, and these correspond to the administrative interface and the course interface.

Fig. 1. Logo "Apprender Jugando".

In the course interface there is a characterization of the students by course and a control of attendance, number of times the student activates the microphone and time of the last entry to the platform. On the other hand, within the same interface, the teacher can choose among the different types of games proposed, that is, he/she has direct access to the database of games with four categories: reinforcement, evaluation, explanation, and practice.

In the administrative interface you can find a database with the parents' e-mail addresses and a space to perform the quarterly performance evaluation, which is the data required to provide feedback to the model in the evaluation phase of the learning measurement.

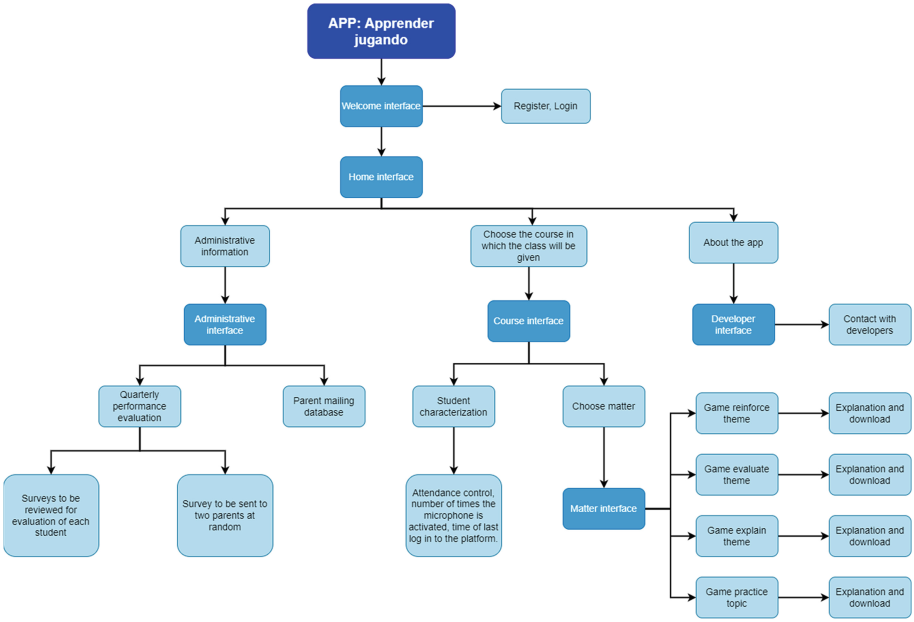

Fig. 2. Application architecture "Apprender Jugando".

The measurement method designed consists of providing teachers with a survey to evaluate the performance of each of the students in their course. The questions are focused on the improvement acquired after the implementation of the model in the different areas (linguistic communication, mathematical reasoning, digital competence and information processing, social and citizen competence and interaction with the physical and natural world) and collecting information on the following axes: interest in the subject matter, level of attention, level of active participation, interpersonal relationships, and ease of learning.

On the other hand, two students per course are randomly selected to apply a less structured survey to parents to obtain feedback and calculate the level of satisfaction with the applied model. All this can be found in the application, in the quarterly performance evaluation section.

Once this information is compiled, using graphs, the opportunities for improvement in the different areas can be analyzed based on real data. If it is evident that there is no progress in a certain area, we can review why and what modifications can be applied to improve in the following quarter.

4 Knowledge Management Model in Virtual Classrooms

The following is the proposed model for knowledge management in virtual classrooms to measure learning through the game (Fig. 3). This is because, due to the current situation, most students take their classes virtually, and because digital literacy is highlighted as one of the competencies for the 21st century.

We want to make visible each of the stages through which knowledge goes through as a function of learning, using the pedagogical tool of the game, in order to measure knowledge based on the following standards, which in turn are the measurement indicators:

- Knowledge identification
- Knowledge classification
- Knowledge transfer
- Learning assessment
- Knowledge feedback
- Determination of the impact of results
- Continuous improvement

The conceptual model is represented in the following figure where the rectangles represent the facilitators or mechanisms between one process and another and are associated with each arrow.

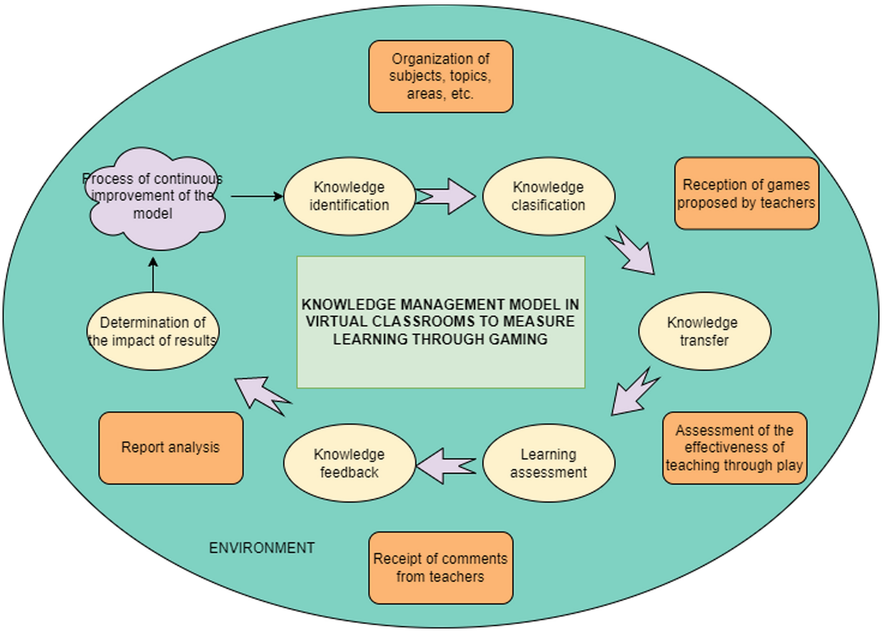

Fig. 3. Knowledge management model in virtual classrooms to measure learning through games.

The first two nodes, identification, and classification of knowledge are related because the information must first be identified and then classified according to subject, topic or area. This process is carried out by the project design area, based on information already structured by the educational institution to which the model will be applied.

As the next stage, knowledge transfer, the games are received from the teachers because they have the theoretical basis to determine the appropriate game according to the subject to be studied. The web platform will organize the games according to grades and will be easily accessible so that users can interact easily.

Once the games are applied to the children, an evaluation must be made to determine whether the knowledge was transferred satisfactorily or not, and thus assess the quality of the learning process.

The feedback node is important for the research because it is here where observations are received from teachers and administrative personnel of the institution, and from this feedback it is possible to analyze reports that will lead to achieving the final objective of the model, which is the determination of the impact of results.

Finally, as with any process, continuous improvement of the model is always sought. Although the model is designed for a specific use case, it is expected that continuous improvement will allow the model to be improved to take it to more schools and increase the scope of the research.

5 Results of the Applied Interview

Taking into account that the scope of the model did not include the implementation of the web application, a list of expected results was defined. For this purpose, an interview was designed and applied to the coordinator of the primary school, Clara Inelda Díaz Vivas,

where he was asked his opinion and expectations of the investigation, among other questions. And he highlighted the importance of the 5A course improving class participation by 30%.

The results after the applied interview are summarized as follows:

- At the beginning it may be difficult to adapt to the change and learning about technology.
- Increased student interest in the classes, as they are more engaging due to the virtual component.
- Improvement in the level of attention in class, active listening and following instructions.
- Considerable increase in the level of active participation.
- Healthy interpersonal relationships.
- Easier learning through games.

Table 3 present the expected improvement for the different courses in certain components:

Table 3. Expected improvement for courses.

Component	Expected improvement (%)
Course 1A	
Interest in topics	10
Attention level	12
Participation level	0
interpersonal relationships	5
Ease of learning	10
Course 2A	
Interest in topics	15
Attention level	15
Participation level	5
interpersonal relationships	12
Ease of learning	10
Course 3A	
Interest in topics	12
Attention level	12
Participation level	20
interpersonal relationships	25
Ease of learning	15
Course 3B	
Interest in topics	10
Attention level	10
Participation level	15
interpersonal relationships	30
Ease of learning	15
Course 4A	
Interest in topics	20
Attention level	15
Participation level	20
interpersonal relationships	25
Ease of learning	20
Course 4B	
Interest in topics	20

(*continued*)

Table 3. (*continued*)

Component	Expected improvement (%)
Attention level	20
Participation level	20
interpersonal relationships	20
Ease of learning	20
Course 5A	
Interest in topics	22
Attention level	25
Participation level	25
interpersonal relationships	25
Ease of learning	25
Course 5B	
Interest in topics	15
Attention level	15
Participation level	20
interpersonal relationships	30
Ease of learning	15

6 Verification/Discussion

According to the results and expected improvements, the following aspects stand out: For example, it should be considered that in 1a children are very quiet, therefore participation levels are expected to increase by a very low percentage.

1A: The children are 5–6 years old, it is expected that the interest in the topics and the ease of learning will increase by approximately 10%, since the use of games makes the class very attractive for students at this stage. On the other hand, it is estimated that the levels of participation do not increase and if they do increase, they do so to a very small extent, since the games do not have a communication focus, to make them discuss or participate (opportunity for improvement).

2A: Participation levels are expected to increase a little with respect to the first grade, as well as interpersonal relationships, since the children have more confidence after having studied together for a year. As for interest in the topics and the level of attention, an increase of 15% is also expected for both components because, according to the expert Clara Inelda, the games sound quite interesting and striking specifically in this grade.

3A: A significant increase (25%) in interpersonal relationships is expected because at this age, 8.9 years, the tendency of infants is to develop friendship and companionship skills, and it is precisely this characteristic that creates a high level of participation in classes and considerable ease of learning.

3B: Results are expected to be very similar to those of course 3A, except that as the coordinator says, these students have an even higher tendency to develop friendship and companionship skills, which may affect the other components such as interest, attention level and participation in class. The children are dispersed.

4A: A similar situation occurs with 3B, in the sense that the children are a little scattered, with an estimated increase in interpersonal relationships of 25% and an attention level of 15% (less than what the model intends to achieve for this grade).

4B: Children are around 9–10 years old and have developed a sense of responsibility and respect for each other's words, and therefore listen more attentively to the teacher. High levels of increase are expected in all five components (20%).

5A: Situation similar to 4B. High levels of increase are expected in four of the five components, where the highest expected increase is attributed to this course.

5B: There is a deficit of attention in the classroom and less sense of responsibility in this course specifically. Interpersonal relationships are expected to increase by 30% but in the rest of the components there is evidence of a decrease compared to 5A.

7 Conclusions

This research allowed to synthesize the following conclusions:

- The success of the implementation of the model is directly related to the personality of the students, so, factors such as dispersion, sense of responsibility, companionship and listening skills greatly impact the expected results.
- The methods used (interview) indicate that the model is attractive, innovative and meets the needs of San Isidro Sur Oriental school.
- It is worthwhile to carry out a pilot implementation to perfect the model and, if possible, apply it to more educational institutions in Bogotá.
- Research confirms that play can improve children's abilities to plan, organize, get along with others, and regulate their emotions. Also, the game helps with language, math and social skills and even helps children cope with stress.

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Virtual Lab Workspace for Programming Computers – Towards Agile STEM Education

Paul Wu Horng-Jyh(✉), Casey How Kiam Cheng, Bryan Lim Yong Tah, Toh Hong Lie, Justin See Tiong Beng, Roy Ong Ban Guan, Jane Tan Jing Yi, Liu Ziwen, Conejos Sheila Maria Arcuino, Luke Peh Lu Chang, and Zhu Yongqing

Singapore University of Social Sciences, Singapore, Singapore
{paulwuhj,caseyhowkc}@suss.edu.sg

Abstract. Lab-based teaching and learning is essential for STEM education as proficiency in the practice of programming is critical; be it for the development or operation of software applications or the provisioning of cloud services. This enables learners to practice conceptual understanding by applying it to solve real-world problems. In the face of rapid advancement and disruptions of technologies, computer lab curriculum needs to be agile to keep pace with ever changing education landscape. In this paper, we describe a case study on the journey taken by the STEM programme of Singapore University of Social Sciences to evolve its lab teaching via developing virtual lab infrastructure and continuously adapting it to teaching needs via the DevOps process. First, lab environments are migrated to cloud-based virtual machines, providing continuous access within or outside of the physical labs. Infrastructure-as-code and automation are applied to continuously develop and to deploy incremental adaptation through containerized apps in a unified workspace. These apps are customized to suit the specific requirements of the lab curriculum, be it for programming, analytics, database management or even cloud computing. Next, special purpose interactive lab guides are developed to provide automatic and interactive feedback to students who are engaged in the lab exercises. Finally, all online activities in the unified workspace are captured for analysis to assess the pedagogical and operational effectiveness of the unified lab workspace. As of date, the virtual lab infrastructure supports around 3500 students in 14 STEM courses annually.

Keywords: Virtual Lab Workspace · Cloud Computing · Agile STEM Education · Authentic Online Learning and DevOps

1 Introduction

The 2019 COVID pandemic had shifted most classes online, and with that a disruption to STEM (Science, Technology, Engineering, and Math) education in many ways. As the pandemic situation improves, more classes are going back to campus. Despite this, online classes continue to be popular with many tertiary institutions incorporating it into a hybrid approach of course delivery. Moving forward, one of the main challenges that many universities face is the problem of providing a cost-effective, yet authentic online lab-based education to their students in this new normal.

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https://doi.org/10.1007/978-3-031-34754-2_5

In our university, the Virtual Lab Infrastructure (VLI) project aims to leverage cloud technologies to provide students anytime and anywhere access to virtualized lab workspace that persist outside of the constraints of physical labs. The VLI project is motivated to address the needs of all stakeholders, including the students, course instructors, pedagogical researchers and technical support. Although there have been many other VLI initiatives rolled out in institutions worldwide, the novelty of our solution is the simultaneous adoption of both virtual machines (VM) based and container-based technology to enable a flexible and scalable VLI that can on the cloud without any complex setup requirements.

In the remaining part of Sect. 1, we elaborate on the importance of lab-based teaching and learning for students enrolled in STEM education, specifically computer science, the goals of the VLI project, issues encountered in the development and usage of the VLI and the required critical success factors. In Sect. 2, we document our approach to the deployment of cloud computing services and innovation for virtual lab environments. In Sect. 3, we update on the deployment status, issues and solutions of VLI. We conclude our work and share some future initiatives in Sect. 4.

1.1 Importance of Lab-Based Teaching and Learning in STEM Education

For STEM students and especially in computer science, having hands-on practice is essential to the understanding of programming and technical concepts through participation in real-world problem solving in lab environments. [1] has identified that placing learners in genuine professional environments where they can learn, observe, practice and reflect on the skills which they are studying is key to achieving the learning outcomes of the course. In addition, [2] observes that learners that receive coaching and mentoring from the instructor in the professional environment enhance learners' confidence level and capabilities.

Although it can be challenging to replicate the desired experiences mentioned above to a virtual platform, there are several pedagogical approaches that can enhance authentic lab learning online. For example, virtual labs can provide learners with a safe and controlled environment to conduct experiments in. It is also trivial to reset this environment, and allow learners to conduct repeated trials which further enhances their understanding of the programming and technical concept.

1.2 Critical Success Factors for Virtual Lab Platform

The success of any virtual lab platform ultimately depends on three main groups of stakeholders: students, instructors and technical support.

As elaborated in the previous section, hands-on practices provide opportunities for active learning, where students can directly engage with the subject matter, work through real-world problems and apply scientific concepts and engineering principles to find solutions. However, a survey [3] had shown that 66% of college and graduate students expressed that online classes are not as effective as traditional classroom teaching. Another study [4] had also suggested that students in online programs perform worse on nearly all test score measures relative to their counterparts in on-campus programs.

Some of the negative factors which affect user satisfaction were identified in these studies. These include poor accessibility and reliability, lack of support in navigating and using course and lab content, poor collaboration support and so on.

Instructors are responsible for designing the lab exercises and teaching the concepts to students. One of the pressing issues many instructors face is the difficulty in assessing student learning as they may not be able to observe students' work directly. This can make it difficult to evaluate students' mastery of the material and provide feedback that is meaningful and actionable [5].

Technical support plays an important role in providing virtual lab deployment, platform maintenance, user support and addressing concerns related to the usage of the virtual lab platform. Thus, they are a key stakeholder in ensuring the success and sustainability of the virtual lab platform. As virtual labs rely heavily on technology, software and hardware to function effectively, without effective technical support, virtual labs may experience technical issues like crashes, connectivity problems or other errors. If this is not managed properly, these issues can disrupt the learning experience and cause frustration among students. Furthermore, many virtual lab infrastructure requires technical support staff to perform manual deployment and management. This imposes high workload on staff managing the platform and further degrades the quality of support provided to students and instructors.

It is important to address the above issues before the virtual lab platform can become a viable alternative to the traditional physical lab. We identify the following critical success factors for achieving this. Firstly, the virtual lab must be easily accessible and reliable for students to use. It should be highly available with minimal downtime or technical issues. The platform should also be accessible from different devices and operating systems, so that students can use it regardless of their location or device. The requirements strongly suggest the deployment of the online lab on a cloud-based platform.

Secondly, the quality of the lab experience on the virtual lab platform is crucial for its success. For the students, the platform should provide a similar experience to a physical lab, with realistic simulations, experiments, and data analysis. Collaboration and mentoring are an important part of the learning process; thus the platform should provide opportunities for students to interact with lab instructors or peers. It should also have a variety of lab options, covering different topics and skill levels, so that students can be scaffolded into a learning path that align with the cognitive development of programming concepts and skills. For the instructors, the virtual lab platform should also make it easy to keep track of the work done by students through real-time monitoring, data analytics and interactive dashboards. Based on the data, instructors will be able to mentor the students more effectively [6, 7, and 8].

Thirdly, the workload imposed on the technical support staff in the deployment and management of labs on the platform should be minimized. The amount of time and effort that the technical support staff spent on deploying and managing the labs on a virtual platform should be comparable or even less to that of a physical lab.

To achieve the critical success factors as mentioned above, we identify several desirable features the virtual lab infrastructure should possess:

- Remote access and persistent lab environment to provide seamless access in and out of the physical labs for students and instructors

- Facilitating self-assessment and collaboration for students
- Provide access to student learning metrics for instructors or pedagogical researchers
- Adopt automation to reduce the amount of time and effort in deploying and managing labs for technical support staff

2 Deployment of Cloud Computing Services and Innovation for Virtual Lab Environments

The model for delivering the virtual lab environment is given in the following diagram.

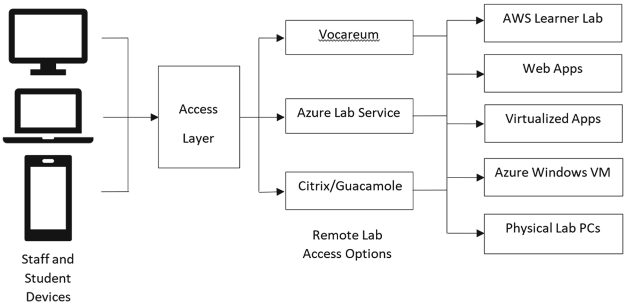


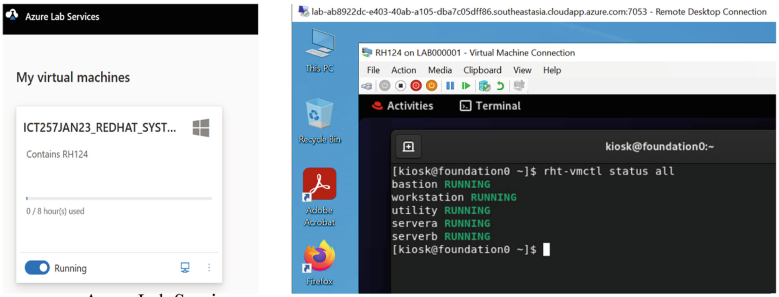
Fig. 1. Virtual lab environment delivery model

2.1 Virtual Machines in the Cloud: Azure Lab Services (ALS)

The first step of the revamping of lab-based teaching is to migrate the lab environments to the cloud. The target courses have rather complex requirements for supporting either nested virtualization environments (Linux virtual machines running inside Windows Virtual Machines) or interface between two application software. ALS-provisioned virtual machines that can meet these requirements. It has also developed an application layer for setting up classroom teaching. Students can be enrolled in a classroom with a template machine that was configured by the lab support team with required tools on the virtual machines. Students access the virtual machines by logging into the ALS portal using their university credentials as shown in Fig. 2 below.

The classroom application layer also allows students' usage of the Lab resources to be managed by a quota system, and when the quota is exhausted the virtual machine will be shut down automatically. We have also set up an application environment through RDP shadowing to allow students and instructors to access the virtual machine concurrently for co-debugging purposes as shown in Fig. 3.

Migrating lab environments to virtual machines is good for replacing physical labs with remote access and on-demand usages, and with interactive co-debugging capabilities, a satisfactory level of interaction between students and instructors is maintained to a similar level to that which is achievable in a physical session in a physical lab.



a Azure Lab Service Portal

b Students' VM with Nested Virtualization

Fig. 2. The Azure Lab Services Portal for Students to Access their own Virtual Machines

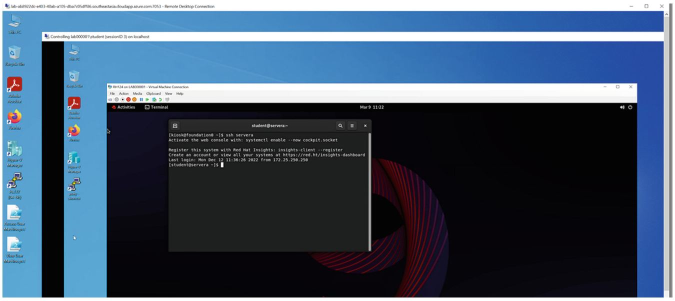


Fig. 3. Co-debugging session deployed on Azure Lab Services.

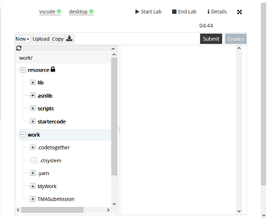
2.2 Containerization of Applications: Vocareum Container Lab

While VMs are a popular way to implement VLI, containers are more agile technologies that provide lightweight virtualization and efficient resource utilization. Furthermore, containers offer a portable and reproducible way of packaging software dependencies and configurations, enabling rapid deployment and orchestration of microservices-based architectures which can be more suitable for Linux based courses.

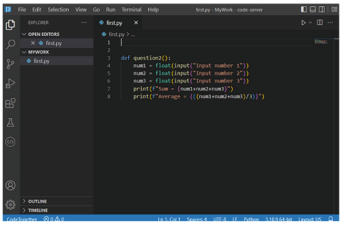
For our project, the most prevalent container used for lab teaching would be the virtual desktop container. The virtual desktop container provides the GUI to easily perform typical desktop operations, such as creation of folder structures and copying or moving of files as well as running installed applications. Next is the Integrated Development Environment (IDE) container where students use to develop and debug their programming solutions. As shown in Fig. 4, a foundational programming course is being provisioned with VS Code IDE and Linux Virtual Desktop. We also show snippets of docker files that are used to configure the IDE and Virtual Desktop containers on the fly in Fig. 5.

2.3 Cloud Computing as a Service: AWS Learner Lab

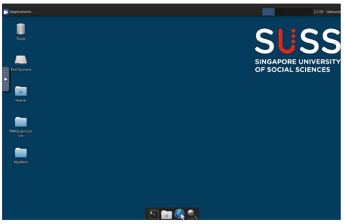
In the current age of Cloud computing, lab learning for computer science education would not be complete without the access to Cloud services. AWS Learner Lab is the classroom



a Entry to IDE and Desktop

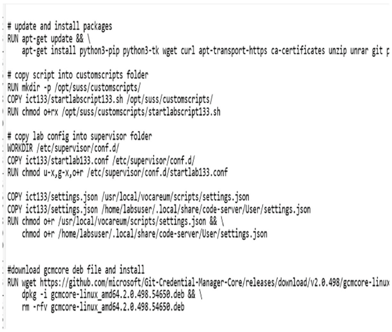


b VS Code IDE



c Linux Virtual Desktop

Fig. 4. The virtual lab environment that consists of 4.a Entry to IDE and Desktop, 4.b VS Code IDE, and 4.c Linux Virtual Desktop containers



```
# update and install packages
RUN apt-get update && \
    apt-get install python3-pip python3-tk wget curl apt-transport-https ca-certificates unzip unrar git p

# copy script into customscripts folder
RUN mkdir -p /opt/suss/customscripts/
COPY ict133/startlabscript133.sh /opt/suss/customscripts/
RUN chmod o+rx /opt/suss/customscripts/startlabscript133.sh

# copy lab config into supervisor folder
WORKDIR /etc/supervisor/conf.d/
COPY ict133/startlab133.conf /etc/supervisor/conf.d/
RUN chmod u-x,g-x,o+r /etc/supervisor/conf.d/startlab133.conf

COPY ict133/settings.json /usr/local/vocareum/scripts/settings.json
COPY ict133/settings.json /home/labsuser/.local/share/code-server/User/settings.json
RUN chmod o+r /usr/local/vocareum/scripts/settings.json && \
    chmod o+r /home/labsuser/.local/share/code-server/User/settings.json


#download gcmcore deb file and install
RUN wget https://github.com/microsoft/Git-Credential-Manager-Core/releases/download/v2.0.498/gcmcore-linux
    dpkg -i gcmcore-linux_amd64.2.0.498.54650.deb && \
    rm -rfv gcmcore-linux_amd64.2.0.498.54650.deb
```

a Docker file for VS Code

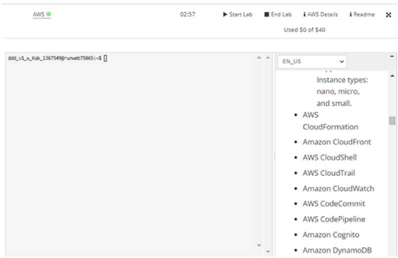
```
#delete jenkins
RUN rm -rf /etc/apt/sources.list.d/jenkins.list

#change screensaver password
RUN echo "labsuser:labsuser" | chpasswd

# update and install packages
RUN apt-get update && \
    apt-get install python3-pip python3-tk wget curl apt-transport-https ca-certificates unzip gedit unrar thunar-a
    apt-get remove code -y

#set the timezone to SGT
RUN rm -f /etc/localtime && ln -s /usr/share/zoneinfo/Singapore /etc/localtime

#copy and set wallpaper
COPY ict133/official_suss_wallpaper.png /usr/share/backgrounds/xfce
WORKDIR /usr/share/backgrounds/xfce/
RUN mv xfce-teal.jpg xfce-teal-back.jpg && mv official_suss_wallpaper.png xfce-teal.jpg
RUN chmod u-x,g-wx,o+r xfce-teal.jpg

#copy lab config to supervisor folder
#prevent these services from running
WORKDIR /etc/supervisor/conf.d/
COPY ict133/startdesktop.conf .
RUN mv elasticsearch.conf elasticsearch.conf.bak && \
    mv kibana.conf kibana.conf.bak && \
    mv postgresql.conf postgresql.conf.bak && \
    mv jenkins.conf jenkins.conf.bak && \
    mv mongodb.conf mongodb.conf.bak && \
    mv mssql.conf mssql.conf.bak && \
    mv mysql.conf mysql.conf.bak && \
    chmod o+r startdesktop.conf

#copy startlabscript to customscripts
RUN mkdir -p /opt/suss/customscripts/
COPY ict133/startdesktopscript.sh /opt/suss/customscripts/
RUN chmod o+rx /opt/suss/customscripts/startdesktopscript.sh

#Fix Voc files
RUN rm -rfv /usr/share/vocareum/xfce4/xfce4_config/user-dirs.dirs && rm -rfv /usr/share/vocareum/vdi/xstartup
COPY buggy_desktop/user-dirs.dirs /usr/share/vocareum/xfce4/xfce4_config/user-dirs.dirs
COPY buggy_desktop/xstartup /usr/share/vocareum/vdi/xstartup
RUN chmod 775 /usr/share/vocareum/vdi/xstartup && chmod 755 /usr/share/vocareum/xfce4/xfce4_config/user-dirs.dirs
```

b Docker file for Linux Virtual Desktop IDE

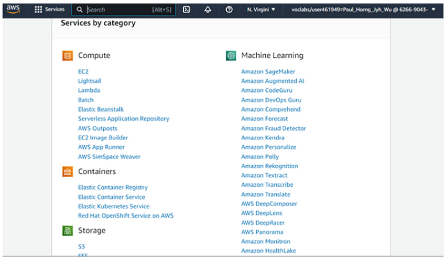
Fig. 5. Docker file that configure IDE and Virtual Desktop containers on the fly

application layer over AWS cloud services. Like ALS, this provides an application layer for quota control over the cloud access that an enrolled student can consume. It also provides a gateway to AWS and for each enrolled student, it provisions a corresponding Identity and Access Management (IAM) to access pre-configured and authorized cloud services. For instance, for an AWS Cloud foundation training course, the provisioned AWS Learner lab will be able to access resources such as EC2, RDS and EBS, and so on many other services (Fig. 6).

However, typical gateway service to cloud services lacks the capability for students to build on their work progressively. The virtual lab environments could support such functions through a virtual machine (VM) disk or a network file system to store away the artifact of students' work. In a typical cloud computing course, the artifact of the students'



a AWS Learner Lab landing page



b AWS console for cloud services

Fig. 6. AWS Learner Lab

work is that various provisioned cloud services itself, which is typically removed after a lab session by default. For the work to be persistent we need to create an artifact of the students' work to start with. Fortunately, Infrastructure-as-Code affords us to do exactly this. In the case of AWS, CloudFormation allows Cloud architect to program the provisioned cloud service in a JSON- or YAML-document. We introduce such practice to the virtual lab environment for cloud services so that lab work can be persistent through capturing it in a CloudFormation template, we could do the same in other templates such as Terraform as well.

As shown in the following figure, it is an example of the CloudFormation template to provision a RDS and Elastic Beanstalk service (Fig. 7).

```
AWSTemplateFormatVersion: '2010-09-09'
Description: Sample Template to build RDS
Parameters:
  VPCID:
    Type: 'AWS::EC2::VPC::Id'
    Description: ' VPC ID of your existing VPC'
Resources:
  myRDS:
    Type: 'AWS::RDS::DBInstance'
    Properties:
      Engine: mysql
      AllocatedStorage: '20'
      DBInstanceClass: db.t3.medium
      MasterUsername: admin
      MasterUserPassword: password
      PubliclyAccessible: true
      StorageType: gp2
      VPCSecurityGroups:
        - Ref: rdsSG
  rdsSG:
    Type: 'AWS::EC2::SecurityGroup'
    Properties:
      GroupDescription: Allow external access to RDS
      SecurityGroupIngress:
        IpProtocol: tcp
        FromPort: '3306'
        ToPort: '3306'
        CidrIp: 0.0.0.0/0
      SecurityGroupEgress:
        CidrIp: 0.0.0.0/0
        IpProtocol: tcp
        FromPort: '3306'
        ToPort: '3306'
      VpcId:
        Ref: VPCID
Outputs:
  outdbEndpoint:
    Value:
      'Fn::Join':
        - ':'
        - - 'Fn::GetAtt':
              - myRDS
              - Endpoint.Address
          - 'Fn::GetAtt':
              - myRDS
              - Endpoint.Port
    Description: Endpoint of the RDS instance
```

a CloudFormation template for RDS

```
AWSTemplateFormatVersion: '2010-09-09'
Description: Sample Template to build ElasticBeanstalk
Resources:
  myApplication:
    Type: 'AWS::ElasticBeanstalk::Application'
    Properties:
      Description: Python Flask Demo with Beanstalk
  myApplicationVersion:
    Type: 'AWS::ElasticBeanstalk::ApplicationVersion'
    Properties:
      ApplicationName:
        Ref: myApplication
      Description: Python Flask Demo Application Version
      SourceBundle:
        S3Bucket:
          'Fn::Sub': pythonflaskdemo
        S3Key: MyApp.zip
  myConfigurationTemplate:
    Type: 'AWS::ElasticBeanstalk::ConfigurationTemplate'
    Properties:
      ApplicationName:
        Ref: myApplication
      Description: My Application Configuration Template
      OptionSettings:
        - Namespace: 'aws:autoscaling:launchconfiguration'
          OptionName: IamInstanceProfile
          Value: LabInstanceProfile
        - Namespace: 'aws:autoscaling:launchconfiguration'
          OptionName: DisableIMDSv1
          Value: true
        - Namespace: 'aws:elasticbeanstalk:environment'
          OptionName: ServiceRole
          Value: LabRole
      SolutionStackName: 64bit Amazon Linux 2 v3.5.0 running Python 3.8
  myApplicationEnvironment:
    Type: 'AWS::ElasticBeanstalk::Environment'
    Properties:
      ApplicationName:
        Ref: myApplication
      Description: AWS ElasticBeanstalk Demo Environment
      TemplateName:
        Ref: myConfigurationTemplate
      VersionLabel:
        Ref: myApplicationVersion
```

b CloudFormation template for Elastic Beanstalk

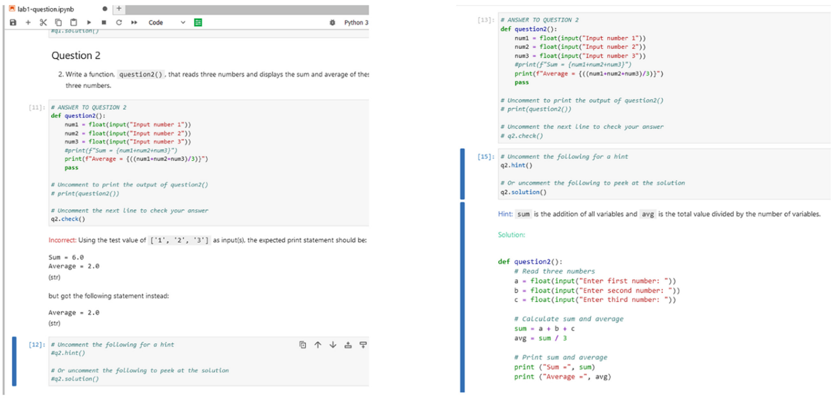
Fig. 7. CloudFormation templates for RDS and Elastic Beanstalk

2.4 Deployment of Interactive Exercise: ILabGuide

For any virtual lab platform to be effective, students need access to authentic assessment for evaluating their knowledge and skills through real-world tasks and activities that simulate the types of challenges they will face in their future careers. In the virtual lab setting, authentic assessment is first achieved by having an interactive lab guide that can auto grade students' submitted solutions.

iLabGuide adopts the learntools framework and packages by Kaggle and further develops customized auto gradable lab exercises according to the design of the instructors. Figure 8 illustrates that for every lab exercise, there is a question statement and a coding area where students can attempt to solve it through multiple iterations. During each iteration, students have the option to deselect certain statements to view the output and verify the accuracy of their solution. If their solution is incorrect, they will receive feedback indicating the input that was incorrect, the expected output, and the actual output obtained.

Figure 8 also shows that after several failed attempts, students may then decide to click on the hints and solution to view the hints and solution as a last resort. In summary, iLabGuide trains students' ability to self-study and practice their skills as a test to authenticate their understanding of the subject matter. Instructors can also design meaningful lab exercises to guide students in a learning path that builds on proper prior understanding of the subject matter. For technical support, iLabGuide is just another container app that can be agilely developed and deployed through the container lab architecture as shown in Fig. 9.

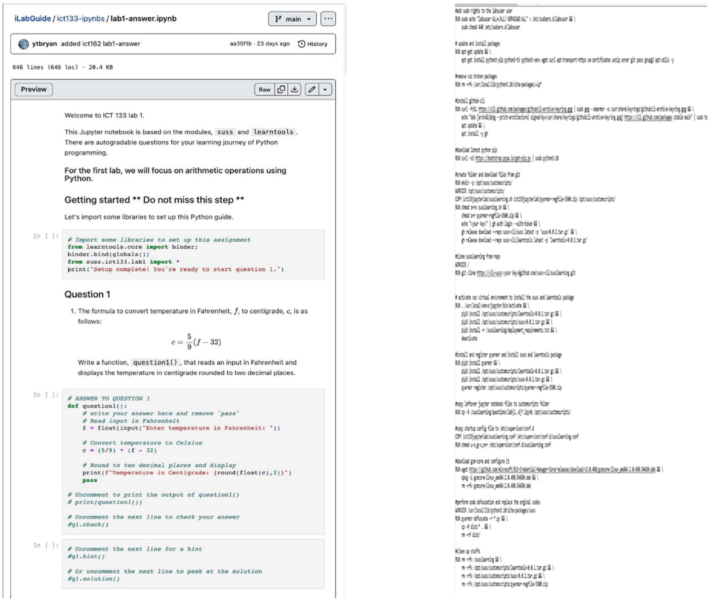


a Incorrect attempt with feedback

b Hints and solution as last resorts

Fig. 8. Interactive Lab exercises of using iLabGuide

Last but not the least, iLabGuide allows pedagogical researchers to collect progressive learning activity data that can be analyzed to better inform curriculum designers on issues that may be addressed. Learning activity data consists not only in terms of quantitative information on how many times, success or failures that students have attempted an exercise to demonstrate their understanding of a certain topic, but also qualitative data



a GitHub Repository for a programming lab exercise

b Corresponding docker file for deployment into iLabGuide workspace

Fig. 9. Source code for developing and deploying iLabGuide

of the source codes that have been submitted in the attempts. Through machine learning techniques, the content of the source codes could be mined to detect common programming errors or to predict positive or negative direction of progress that the students are making in their attempts. With the recent progress of AI chatbots like ChatGPT, there is even a possibility for iLabGuide to provide an artificial paired programmer that students could co-develop their solution with virtually.

3 Deployment Status, Issues and Solutions

3.1 Deployment Status

Table 1 shows the list of courses that are running on VLI as of December 2022. Information such as course title, tools used and the type of solution adopted is also provided. Due to differing course requirements and platform capability limitations, there are a multitude of platforms involved depending on specifics such as support for containers, VMs and OSes. This could lead to an issue known as platform fragmentation which we will further elaborate on and address in the future work section.

3.2 Managing Across Various Virtualization Solutions Using DevOps Tools

Establishing the DevOps practices within the VLI team itself is critical, as there is typically a lab environment design and deploy cycle followed by quick bug fixing cycles given

Table 1. Course title, tools used and solution type.

Course Title	Tools used	Platform
Structured Programming	VS Code, Jupyter Lab	Vocareum
Computer Architecture	Easy68K, Wine	Vocareum
Object Oriented Programming	VS Code, Python	Vocareum
Data Programming	VS Code, Jupyter Lab, MongoDB Compass	Vocareum
Operating Systems	Virtualbox with extension	Azure Lab Services
Red Hat System Administration	Red Hat Enterprise Linux System	Azure Lab Services
Cloud Computing: Business Case and Technical Models	Amazon EC2, Amazon Elastic Beanstalk	AWS Learner Labs
Big Data Computing in the Cloud	Amazon EMR	AWS Learner Labs
Web Application Development	VS Code, Code-Server, Flask, MongoDB Compass	Vocareum
Oracle Certified Associate	Oracle Database System, JAVA JDK, SQL Developer	AWS
Computer Networking	Cisco Packet Tracer	Vocareum
Database Management systems	SQL Server Express, Azure Data Studio, SQL Management Studio, ER Assistant	Azure Lab Services
Building Information Modeling for Facilities Management	Autodesk Revit, Archibus	Azure Lab Services
Information Security Offence Defence and Incident Management	Cacti, ELK, Nessus, OpenVAS	Azure Lab Services

there are many integration points in the multiple solutions adopted by the team. Thus, the VLI team adopts a suite of tools to support such DevOps practice over successive improved versions of the virtual lab environments.

New source code development is captured in a GitHub repository where the development and testing efforts can be coordinated among the team. Once a particular feature is ready to be rolled out, CI/CD processes will be kicked in to automate the process as much as possible. For instance, for Vocareum container lab, a continuous integration and continuous delivery (CI/CD) process can be implemented by starting a container building process using Dockerfile that in terms starts with cloning new development from Github directly.

Once the building process is completed, a new lab environment would have been deployed when students next try to access the lab environment. Similarly, CloudFormation templates for AWS VPC, EC2, RDS, Elastic Beanstalk and CodePipeline can deploy new applications continuously when GitHub update is detected by CodePipeline. There are other Infrastructure-as-Code (IaC) and automation tools to achieve CI/CD, such as those provided by GitHub Action and Ansible.

Once the application is developed and deployed, operational issues are tracked by MS-Teams message channels as well as VLI support email. With recurrent issues, improvement to the design will be initiated as stories in the Jira system, or new application ideas may be conceived to value-add to virtual lab environments as an Epics. Each story is systematically disposed into tasks to be performed and when it is ready resources will be deployed and a Sprint created to monitor the progress of the development with GitHub as source code control as discussed in the earlier sections.

3.3 Technology Adoption Issues and Resolutions

According to a survey conducted for the Red Hat system administration course, nearly 85% of students spend more than 20 h on lab time. On average, students spend approximately 3.3 h per week on lab time. This represents a greater than 50% increase in lab time compared to a traditional physical lab (Fig. 10).

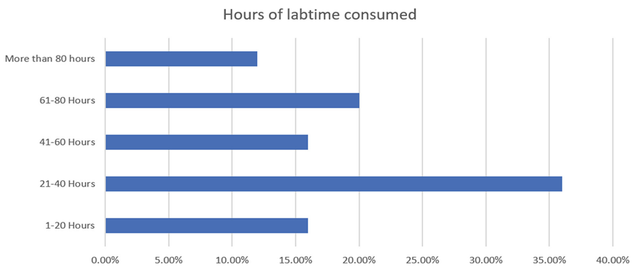


Fig. 10. Survey results of hours of lab time consumed

Over 75% of students gave positive feedback (rating 4 or 5) on the efficacy of the virtual lab, where a rating of 1 denotes highly ineffective and a rating of 5 denotes highly effective (Fig. 11).

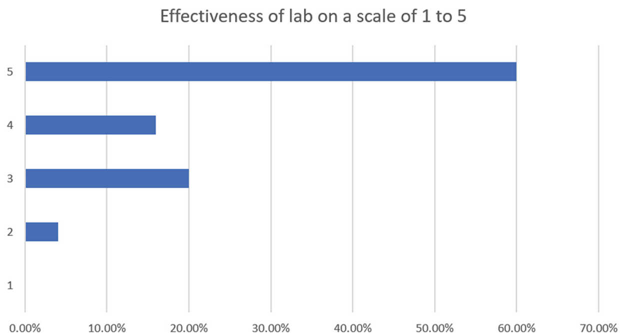


Fig. 11. Survey results of lab effectiveness

We conducted a survey to gather students' opinions on various aspects of the virtual lab, including their likes and dislikes. Many students appreciated the lab's accessibility, as it eliminated the need for physical presence. Additionally, some students found it convenient that they were not limited to specific times or devices for lab access. However, some students reported issues with the deployment of the lab. Specifically, some students found the virtual lab platform to be sluggish during peak hours, while others experienced sudden disconnection problems. This feedback suggests that improvements are needed to enhance the performance and reliability of the virtual lab platform.

The "Building Information Modelling (BIM) for Facility Management (FM)" course has also integrated the VLI platform, reflecting a growing trend accelerated by the global pandemic. The course leverages the VLI platform for lab sessions, aiming to equip undergraduate students with the necessary skills to navigate BIM and BIM for FM software, as well as impart comprehensive knowledge of the best practices and techniques in BIM that can enhance facilities management, including space management.

According to feedback from students and instructors, the adoption of the VLI platform for the "BIM for FM" course has been accompanied by several challenges. One issue that emerged was latency due to the high requirements of the BIM software and the VM specifications. However, this problem was resolved by subscribing to high-configuration VMs.

Another challenge was the dual monitoring requirement during lab sessions, where students needed to switch frequently between the instructor's screen and the VLI interface. To address this inconvenience, it is recommended that students use a second screen or a tablet to observe the instructor's screen and a computer to complete the lab exercises. Additionally, a significant amount of time was devoted to familiarizing students with the VLI interface and functions as many enrolled students had limited IT skills. To overcome this issue, the VLI guidelines were provided to help students better navigate the platform.

While the implementation of VLI in the course "BIM for FM" has proven to be an effective solution for facilitating remote teaching and learning, it has brought certain challenges that should be addressed to optimize the learning experience for BE students.

From what we can observe so far, challenges related to the adoption of technology in virtual lab environments can present obstacles for both institutions and students that can impact negatively on the effectiveness of virtual lab environments and, consequently, on the overall learning experience. We proposed several strategies to deal with these challenges. Firstly, institutions can provide technical support to students to ensure that they can access and use the virtual lab environment effectively. This can include providing tutorials, troubleshooting guides, and access to help desks or online forums.

Secondly, faculty and staff members can be trained to effectively use the virtual lab environment and provide support to students. This can include training on the use of the virtual lab environment, best practices for facilitating virtual lab sessions, and how to troubleshoot common technical issues.

Thirdly, encourage collaboration among students, faculty, and researchers using virtual lab environments. This helps to create a sense of community and support that can help to overcome technological adoption issues.

Finally, institutions can provide feedback to students on their performance in virtual lab environments. This can include feedback on their experimental technique, data collection, and analysis, as well as feedback on their use of the virtual lab environment itself.

Providing feedback can help to improve the effectiveness of virtual lab environments and the overall learning experience.

4 Conclusion and Future Work

In this paper, we have summarized the effort of the VLI project in our university to provide students with access to virtualized lab environments anytime and anywhere. As an ongoing project, the VLI has plenty of room for improvement. We specifically narrow it down to two categories: platform fragmentation and new features.

As seen in Fig. 1, differing course requirements to support containers, VMs, different OSes and so on can result in students having to navigate multiple systems with different interfaces, procedures, and requirements. This is known as platform fragmentation and which can lead to unnecessary cognitive load, reduced engagement, and limit the ability of students to focus on the core concepts and skills they need to master. Platform fragmentation also makes operational support unnecessarily complex and difficult to scale.

To resolve this, we plan to migrate to a single unified platform that supports both containers and VMs with different OS support. It should also have roaming profile support to maintain users' personalized settings, preferences and data across different devices and sessions. Finally, the unified platform should support a distributed file system to provide the storage, availability, performance, and security features necessary to support the complex and dynamic data requirements of virtual lab environments.

To provide more value-added services for learning support, we also identified additional features to be developed:

- Collection and analysis of online activity data for learning analytics [8]
- DevOps of value-added services such as assignment submitter
- Integrating student portfolio for computational competency via GitHub and GitHub Classroom

To conclude, our primary goal for the VLI project is to develop a high-quality and cost-effective platform for laboratory experiments, which offers a fully immersive and accessible experience for its users. In the long term, we hope to make a significant contribution to scientific research and education in our university through this project by engaging all stakeholders, including students, instructors, lab tech team and pedagogy researchers.

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Learning Practices and Methodologies

Online Examination – A Case Study

Viktorija Florjančič(✉)

Faculty of Management, University of Primorska, Izolska vrata 2, 6000 Koper, Slovenia
viktorija.florjancic@upr.si

Abstract. The COVID-19 lockdown forced higher education institutions to move all study activities to distance, including the examinations. The remote examinations raised several challenges, mainly related to exam credibility. The survey carried out among business school students showed that, if appropriate exam protocols are put in place, the examinations taken remotely are on a par with those taken in person. Taking remote exams is stressful for students and for teachers, but during the lockdown we found advantages of doing exams online. If remote examinations raise questions of authentication and identification, online exams taken in a computer classroom are more sustainable (no paper used), economical (easier to prepare and easier to revise), and more suitable for students nowadays, for whom handwriting might be a real challenge. E-examination established the same exam circumstances for all students.

Keywords: e-exams · online exams · Moodle · digitisation · higher education

1 Introduction

Digitalisation represents the process of integrating digital technologies into business.[1] Digital technologies support inclusive and sustainable economy growth, innovation, and process improvement [9]. Digital transformation of EU countries is followed by several indicators summarised in the Digital Economy and Society Index (DESI) [2]. DESI covers four areas: human capital, connectivity, integration technology and digital public services. At the top of DESI 2022 we found the Scandinavian countries. Among 28 EU countries, Slovenia moved from 17th place in 2017 to 11th place in 2022, which signifies a progress in digital transformation.

The national statistical office (SURS) collects different data about digital society transformation. Data from the SiStat database for 2021[2] show that 73.5% of large, 67.6% of medium-sized and 58.4% of small enterprises face problems with digital transformation of their business, while only less than a third of enterprises are undergoing a digital transformation without problems. In the past, SURS gathered mostly data about computer and internet penetration; recently, the range of other indicators of development in the field of digitisation has been expanded. SURS thus gathers data on how the Internet

[1] https://www.oecd.org/g20/topics/digitalisation-and-innovation/.
[2] https://pxweb.stat.si/SiStatData/pxweb/en/Data/-/2983503S.px/.

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https://doi.org/10.1007/978-3-031-34754-2_6

is used, what applications are used, what and how often online services are used etc. The security aspects of ICT use are included in the database as well. Data are collected separately for enterprises, individuals, and households. The data present the frequencies of online transactions between all economic agents, individuals/households, companies, and the government.

Digital transformation has an impact on education as well. The Internet is used for education and education-related activities. The proportion of young people between 16 and 24 who conducted learning activities over the Internet increased from 53.3% in 2019 to 63.2% in 2020. In 2021, this portion was even higher – 77.7%. In 2022 the portion of online learning activities slightly decreased (Table 1).

Table 1. Use of the Internet for educational purposes

Year	*% of population between 16 and 24*		
	Learning activities over the Internet	*Doing an online course*	*Using online learning material*
2019	53.3	2.8	50.9
2020	63.2	12.6	59.9
2021	77.7	23.9	50.5
2022	67.1	19.9	48.4

Data are undoubtedly linked to the COVID-19 epidemic, which, with the lockdown, forced educational institutions to carry out all learning activities online. In 2021, SURS expanded their data collection to data on the impact of the COVID-19 epidemic; due to the COVID-19, 74.9% of the population between 16 and 24 conducted educational activities over the Internet in the previous 12 months, 67.9% of them experienced distance learning and 26.4% were taking an online course in the last 12 months. In 2022 SURS collected additional data about learning activities in the population aged between 16 and 24 – 40.2% of the population use the Internet for communicating with educators or learners using audio or video tools and 55.3% of the population use the Internet for learning activities in formal education. It is obvious that COVID-19 influenced the digitalisation of many processes in educational institutions, with greater or lesser success.

The implementation of distance education at the time of school closures has meant educational institutions, particularly higher education institutions, facing the challenges of carrying out remote examinations and assessments. In doing so, several questions were raised, mainly related to the identification and authentication of students, as well as the threats of unauthorised exam access [4]. Higher education teachers faced the challenges in different ways. Some replaced written exams with oral exams, while others took different precautions. The electronically conducted exams (e-exams) have shown several advantages and opportunities for e-exams in classrooms, where proctoring may be done by a teacher or tutor. In the paper, we want to show the opportunities in digitising exams, which somehow lag behind the digitisation of other subprocesses (transmission of learning materials, submission and evaluation of written assignments, e-communication). The main purpose of the paper is to present the issues that a business school faced and to encourage other higher education institutions in their digital transformation.

2 Knowledge Assessment in Higher Education

Knowledge can be evaluated at the beginning of the learning process (testing pre-knowledge), during the learning process – in real-time (formative assessment) or at the end of the learning process (summative assessment) [4]. Evaluation may also not lead to assessment and is done when a teacher would like to verify the understanding of the material [5].

Knowledge can be verified and assessed orally or in writing. Learning outcomes achievement can also be demonstrated by presenting a product or project, or a student can present a performance.

Shraim [13] sees several advantages of e-exams over traditional exams, including the reliability of grading and efficiency (time, effort, and cost). However, a survey [13] among 342 undergraduate students in Palestine found that taking e-exams presents challenges regarding security, validity, and fairness. As a result, Shraim [13] presents e-exams as more suitable for formative than summative assessment.

The idea of replacing classical knowledge tests (exams) with e-exams is linked to the development of different learning management systems (LMS), such as Moodle[3] or Blackboard,[4] as well as the development of exam platforms [8, 13]. LMSs include tools for testing knowledge with different types of questions that enable learners to receive immediate feedback. Osuji [10] and Farzin [3] see in these the simplification of testing, especially in the case of large groups of students, as well as the possibility of a detailed analysis of the test results.

JISC [7] has discussed e-assessment practices for fifteen years. The first report, which presented technologies, policies, and practices for e-assessment in further education and higher education, was published in 2007 [6]. Technology-based examination and assessment provides learners with instant feedback on achievement, which is an important component of the learning experience [7]. Digital technologies make assessment more flexible and targeted, and they also encourage students to reflect on learning and to develop skills that are valued beyond the educational environment [7]. Today, it is already widely accepted and confirmed that opportunities for self-assessment and peer evaluation lead to deeper and more effective learning [1, 11, 12]. The development of e-assessment is linked to the development of e-learning, or rather is a developmental necessity, because the one cannot be done without the other.

The paper will present the opportunities for digitising formative and summative assessments. In the traditional examinations and assessments process a teacher prints (or reproduces) questions prepared on the computer in an appropriate number of copies. The teacher then reviews and evaluates the students' answers and formulates the exam grade. The exam results are communicated to students in different ways, mainly by entering exam grades into the school information system. In practice, some students

[3] https://moodle.org/.

[4] https://www.blackboard.com/.

do not come to exams. In this case, the printed exams must be destroyed, which is uneconomical but necessary. Students' handwriting is frequently hard to read, which makes it difficult to read answers and evaluate their correctness.

Today's exam preparation is digitalised, the same as in the final stage when grades are entered into a student information system, where all students' records are collected. The rest of the process is still non-digitised. By introducing e-examinations, we digitise the transmission of exam questions to students, the reviewing and grading of the exam answers, and the archiving of exams.

3 Exam Technologies

The COVID-19 epidemic encouraged teachers to find technological solutions for remote examinations. Teachers and faculty looked for solutions in the systems they already used (e.g. Moodle Quiz, MS Teams Forms or Google Forms) or for specialised exam platforms. We have studied the possibilities of using Moodle quizzes, but also searched for applications that support a specific study field's need (e.g. drawing graphs and charts). In finding an appropriate examination platform, we focused our search on European providers whose platform adopted the European General Data Protection Regulation (GDPR).[5] We arrived at exam.net,[6] Inspera[7] and TAO.[8] After careful review of the various platforms, we decided on the Swedish platform exam.net. The choice was based on the platform features that support different modalities of e-exams and, of course, its affordability.[9] The Moodle Quiz solution was utilised by teachers who had used Moodle Quiz before or already had an extensive question bank in Moodle. The exam.net platform has proven itself in cases where teachers have not used Moodle Quizzes before and were forced to give written exams remotely. The exam.net platform allows them to easily upload an existing exam in PDF format or to transmit questions (copy-paste) into the platform. Students can type their answers into the platform or handwrite answers on paper and then upload the photo of the handwriting onto the platform. In the exam.net platform, tools for writing equations and chart drawing are integrated, but students must be familiar with this feature before the exam. A drawing tool, integrated in exam.net, offers only basic options and is useless for serious use or complex charts.

During the epidemic, developers added new capabilities to exam.net. Teachers were able to prepare various closed-type auto-marked questions. In many ways, exam.net differs from Moodle Quiz; their use depends on the teacher's needs or on the needs (requirements) of the educational institution.

3.1 Exam.net Platform Features

The exam.net platform is designed specifically for online examinations, at a distance or in a computer classroom. At the university, the platform was discovered at the beginning of

[5] https://gdpr.eu/.

[6] https://exam.net/.

[7] https://www.inspera.com/.

[8] https://www.taotesting.com/.

[9] At the beginning the use of the platform was free of charge; from January 2021 its usage is payable. The cost of using the platform was €4 per student per year, which was acceptable.

the epidemic, when its use was still free. The platform was very welcome to teachers who had not used Moodle Quiz before or used it only occasionally. Those teachers, instead of printing the exam, just uploaded the exam PDF onto the platform (see example in Fig. 1). Students were able to split the window vertically (PDF is on the left side) or horizontally (PDF is on the top) (see Fig. 1). The exam in exam.net opens in Safe Exam Browser (SEB),[10] that prevents the usage of other programs, especially communication applications and web browsers. Students' typed responses are much easier to read than their handwriting.

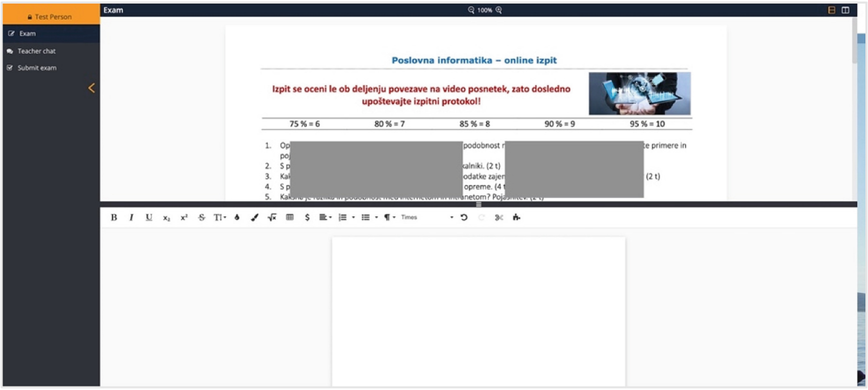

Fig. 1. Examination by exam.net

The teacher can write questions directly (or copy) onto platforms, which again eliminates the printing of exams. The platform was found to be unique for courses where students are expected to write their responses manually, such as writing equations or drawing charts. In these cases, a teacher uploads exam questions as a PDF document or enters the questions onto the platform. Students write their responses on a sheet of paper. At the end of the exam, students take a photo of each sheet with a smartphone and upload the images onto the platform. Individual sheet imaging is supported by a QR code that links the uploaded images to the student exam (Fig. 2).

The teacher can download the exams individually, or all together in PDF document(s). The exams are reviewed on a computer or tablet. The exams could also be printed, but this is not what we would like to achieve with exam digitisation. In the case of handwritten exams, some teachers prepared special paper sheets with a marked place for a student ID card which needed to be included in the process of uploading the exam sheet photo onto the platform. Conducting remote examinations required quite a few measures to ensure the exams' credibility and authenticity that goes beyond the content of our paper.

During the epidemic, the platform exam.net improved a lot, therefore it was not surprising that some teachers already using Moodle Quiz began flirting with it. The teachers were able to add different types of questions (e.g. multiple choice, simple answer, fill the gaps, match answers, free text, and answer with attachment). A few

10 https://safeexambrowser.org/.

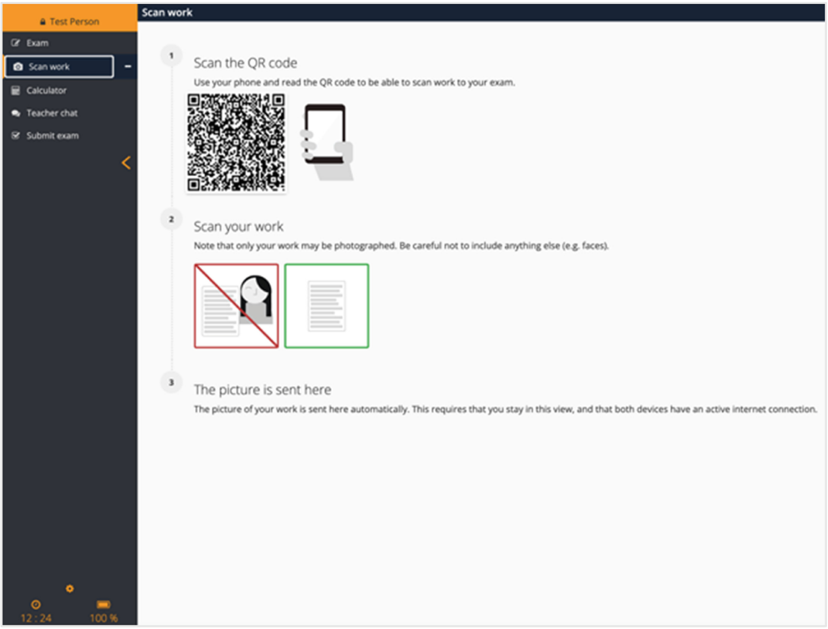

Fig. 2. Uploading the handwritten exam sheets

tools can also be inserted into the examination window to help the student during the examination.

We would like to highlight the following exam.net advantages:

- Easy transfer of existing (paper-based) exams onto the platform (PDF document).
- Included tools for equations writing, programming (JavaScript and Python) and graph drawing (GeoGebra[11] and Desmos[12] are included).
- Supporting tools: calculator, mathematical formulas, tables and formulas for chemistry, accessibility tools (text-to-speech, translations in some languages, English synonyms), etc.
- Support for handwritten exams.
- Real-time monitoring of student writing (the teacher sees what each student is typing at a certain moment).
- Communication with students takes place through exam.net, which does not disturb others.
- The student accesses the examination via a key (password) communicated by the teacher before the exam starts. A student will enter only the data requested by the teacher (e.g. first and last name, enrolment number). No student registration is required.[13] If a student who started the exam leaves the exam.net platform, they can

[11] https://www.geogebra.org/.

[12] https://www.desmos.com/.

[13] In the last year, the platform has offered the possibility to connect the exam with Google Classroom. This feature is still in the beta version.

resume the exam only with explanations why they have quitted, and the teacher will give the student a new password. This prevents anyone else from taking the exam when the exam has already been opened by a registered student.

- Downloading finished exams to one or more documents (PDF). In this way, we can create an electronic archive of all exams, which is useful if we want to collect all student exams taken during their studies.
- Possibility of forced exam submission of an individual student in the case of cheating.
- Adjusting the time for individual students during writing (students with special needs).

Of course, we also encountered exam.net disadvantages:

- Restricted set of auto-marked questions.
- All exam questions are displayed on the screen at once, which helps students to cheat if the system is used in a classical classroom or if two or more students are sitting very close.
- No connection to other systems (e.g. Moodle as an official faculty LMS).
- Manually calculating points given to open-ended questions.
- License or cost of usage.

3.2 Moodle Quiz

Moodle, as a learning management system, will not be presented specifically, as it is a system widely used all around the world, at different levels of education, as well as in the business environment. Moodle, as an open-sourced LMS, is used according to the GNU[14] license, which allows free installation and LMS adaptation to the user's own needs. There are several plugins available for Moodle, including those that improve the quiz preparation and use of the Moodle Quiz activity.[15]

Moodle is used to support the educational process. Through e-classrooms, as Moodle is named at the faculty, teachers provide students with all the information about the course, including study materials. Students submit their assignments, and all communication is done via e-classrooms. Moodle Forums are often used to support discussions on a specific topic. In some courses, teachers check and assess knowledge through the Moodle Quiz activity. Some teachers also use peer-to-peer assessment (Workshop activity). Until the epidemic, the Moodle Quiz activity was mostly used for weekly testing or as preparation for the final examination that was conducted traditionally, i.e. paper-based. With the epidemic, teachers who had used Moodle Quiz before saw in this activity an opportunity for taking the exams remotely. Some teachers continued this practice even after the epidemic.

We would like to highlight the following Moodle Quiz advantages:

- Knowledge testing (e.g. weekly test, mid-term, or final exam) is an integral part of the course, allowing a detailed overview of the student's activity, even after the course closure.
- Moodle Quiz offers different question types: multiple choice, true/false, matching, numerical, essay, calculated, drag and drop, embedded answers, random short answer matching and select missing words.

[14] https://docs.moodle.org/400/en/About_Moodle.

[15] https://moodle.org/plugins/?q=type:qtype.

- The questions can be shuffled, the same for answers in multiple choice questions.
- A teacher can prepare a large question bank from which questions are selected in random order – different questions are presented to every student, which decreases possibilities of cheating.
- The navigation though the Moodle Quiz can be limited – the student can only move forward through the exam's questions.
- The Moodle Quiz scores are summarised automatically; some answers are auto marked; the essay questions demand teacher revision and evaluation.
- The teacher can assess the essay question responses to decimals increments, as the total points are calculated by the system.
- Typed responses are much easier to read.
- After the exam time expires, all responses are automatically saved, and the exam is closed.
- Review and analysis of answers to individual questions (testing of closed-ended questions).

Moodle Quiz also has some flaws, especially compared to the exam.net platform:

- The student exam responses cannot be stored separately in the way that they are in exam.net (for the purpose of electronic archiving).
- Moodle Quiz does not support communication through the system, so loud reminders in the case of exam law violation are disturbing to other students.
- It is not possible to change predefined writing times for individual students (e.g. for students with special needs who are allowed extended exam writing time). In such cases, we have created two identical exams, with different timing.
- In the case of the remote examination, the SEB caused the closure of the Zoom video conference that was used for proctoring. Manually setting the SEB could override this flaw but for an average teacher it was too difficult to be done.
- Two or more users can sign into the Moodle Quiz with the same username, which opens the possibility of cheating. In part, this problem can be solved by limited exams per IP address, which is not always feasible.

3.3 Exam Digitisation in Practice

During the COVID-19 lockdown we used the exam.net platform for midterm and final examinations (weekly knowledge testing was done through Moodle Quiz), but after the lockdown we decided to unite all testing and examinations in Moodle. Our decision was based on the following Moodle Quiz features:

- Accessibility – Moodle has been used in our faculty for almost 20 years and is available free of charge.
- All testing (weekly, midterm and final exam) could be a part of other course activities; the students' achievements can be easily monitored through gradebook and other Moodle reports.
- Students receive a personalized set of questions based on a large question bank.

- Displaying one question per screen and limiting navigation additionally support our aim of decrease cheating opportunities.

To implement digital examinations, we needed to:

- Update software on all school computers in the computer classroom.
- Install the same version of SEB on all computers.
- Test all computers to confirm that SEB is working appropriately.

There are 40 computers in the computer classroom. Although the questions appeared in the exam randomly, we predicted that the exam would be taken by 20 students at a time. In the larger class the students were divided into groups. We made several copies of the same exam and distributed it to the group. The students in each group were able to access the exam dedicated to the group they participated in only on a specific day, at a specific time. Before the beginning of the exam, students received an exam password that allowed them to start the Moodle Quiz exam. The student's identity was verified at their entrance into the computer classroom.

During the examination, the teacher used the Veyon[16] application, installed on the teacher's computer, which provides easy insight into each student computer. Veyon was used for communication with the student (such communication is not disruptive to other students), as well as individual computer exclusion in the case of examination order violations (Fig. 3).

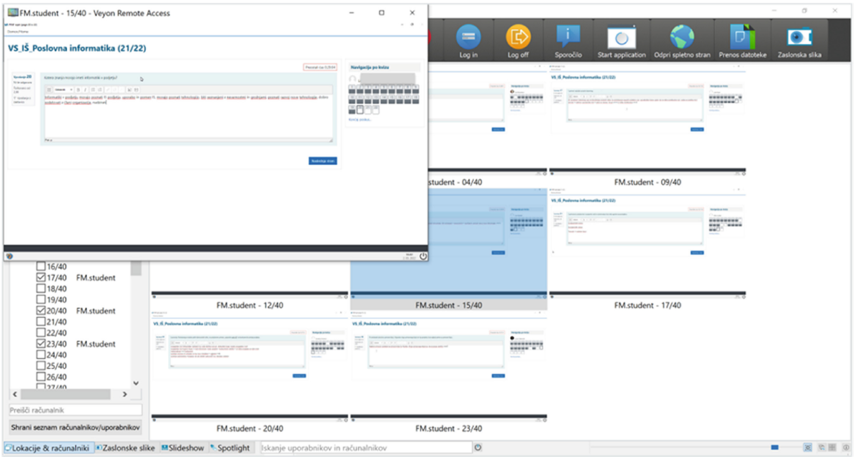

Fig. 3. Veyon – remote view of a student's computer screen

For weekly testing purposes we used closed-ended and self-marked questions. The midterm and final exams were composed of open-ended (essayistic) types of questions. We prepared a set of different essayistic questions, grouped into topics, and left the system to select the questions from the question bank randomly. For cheating prevention, we limited navigation through the exam – only one question per screen was presented and

16 https://veyon.io/en/.

a student had to answer it immediately. The essay type of questions requires a teacher's attention to review and evaluate the responses, which does not differ from the paper-based exams evaluation process.

The advantages of online examination from the teacher's point of view are:

- A set of questions can be reused more times, occasionally increased with new questions. Based on revision and evaluation of responses, some questions could be removed, replaced, or improved.
- Exam preparation is easier. A teacher needs to set up the Moodle Quiz activity, which can be reused many times, especially in the case of an extensive question bank.
- Online examination is cost efficient (no printing cost) and more sustainable.
- Each student receives their own set of questions that are presented one question per screen. The student can only move forward through questions. All these restrictions and exam time limits forced them to be more focused on the exam, which reduced the cheating opportunities significantly.
- The exam timing starts when the student opens the exam. If the student accesses the exam a bit later, they have the same time for responses as others. When the time is over, the exam is automatically closed, and all responses are saved.
- When giving the exam for different groups of students, the Moodle grouping feature is very useful. Grouping features allow the teacher to deliver activities (like Quiz and Forum) and resources to a particular group.
- When reviewing students' responses, the teacher does not waste time on unreadable handwriting, as all the responses are typed. The practise showed that students are better at typing than handwriting.
- The answers can be evaluated more accurately (to hundredths) since all points are automatically summarised by the system.
- The examination is an integral part of the other course activities, allowing a better overview of the student's performance in the course.

4 Students' Perceptions of Online Exams

4.1 Methodology of Data Collection and Processing

Students' opinions on online exams were collected at the beginning of the Business Informatics course, in 2021/2022. The course is taught in the 2nd study year, so the enrolled students experienced lockdown conditions (learning at a distance) in the final year of secondary education. The first year at the university was carried out remotely, including knowledge testing and examinations. Study in 2021/2022 was organised mostly in person, apart from shorter periods due to quarantines (student or teacher infections). Students from the academic study programme and students of the professional study programme (Table 2) participated in the study.

At the beginning of the course, we discussed how ICT impacts our lives, so our survey fits into the topic fully. Because of the number of students we could not do interviews; therefore we collected their opinions through open-ended questions, prepared by Google Forms. Students were invited to write their thoughts and opinions at the end of November 2021 (students enrolled in academic study programme – N = 24) and at the beginning

Table 2. Student responsiveness in online surveying

Study programme	No. students	No. respondents	Response
Academic	25	19	76%
Professional	47	47	100%

of the third quarter[17] (students enrolled in professional study programme – N = 47), the second part of February 2022.

Based on the collected data we would like to find answers to the following research questions:

- How do the students find the remote examinations?
- Do they find any issues that need to be discussed and considered if we implement online examinations in the post-epidemic era?
- Do they accept online examination modes, or do they prefer traditionally taken exams?

The students' answers collected by Google Forms were uploaded to a Word document for text analysis. We used comments to connect their thoughts to the research question. Using the DocTools ExtractData[18] macro helps us to extract the comments into a new document. After rereading all comments, we transferred the comments to Excel for further analyses. The responses were coded and categorised in a way to help us find the answers to the research questions, presented below.

4.2 Discussion

For distance examinations, we prepared protocols to minimise the possibility of cheating and to ensure the examination's credibility (identification and authentication). The exam protocol dictated the proctoring precautions: Zoom videoconference and recording the flow of the exam via the student's smartphone. During the exam, the student had to have the camera and microphone on.

The exam protocol put students in an uncomfortable and stressful situation as they were often worried about what would happen in the case of a power outage or an internet disconnection. They also speculated about whether the phone was recording or that it stopped recording. Remote examinations were stressful due to the technical requirements.

Written exams were mostly carried out using a secure browser window, which prevents students from simultaneously browsing the web or viewing learning materials. SEB also prevents usage of many communication tools (e.g. Skype or MS Teams) and remote access tools such as TeamViewer. Therefore, students considered cheating in the case of remote exams more difficult or even impossible (61% of students who expressed an opinion on the cheating issue). One tenth of them connected cheating to personal

[17] Subjects are taught in the faculty in quarters.

[18] https://www.thedoctools.com/word-macros-tips/word-macros/extract-comments-to-new-document/.

characteristics – those who cheat on classical exams will also do so in remote examinations. Students link the cheating issue to the course or to a teacher who does everything (or nothing) to prevent cheating (14.6%). Some students (14.6%) thought that cheating in remote exams is even easier. One student pointed out that cheating was easy at the beginning, but later, just because of the teacher precautions, it was quite difficult.

It was interesting that students find remote examinations more relaxed, because they were doing the exam in a quiet and secure home environment. Some students complained because of typing noise. On the other hand, they found typing more convenient.

4.3 Online Exams After COVID-19

As we saw from qualitative research results, remote examination is stressful, but online exams have several positive features. In 2021/2022 testing and exams have been done online, but in the computer classroom. Students do not need to worry about technical issues. At the end of the Business Informatics course, we asked students how they found online examinations conducted in school. 41 students responded (N = 68) to our survey. As a weakness of online examination, they expose inability to return backwards through to the previous questions (34.1%) and annoying typing noises (19.5%). But 68.3% of students accepted online exams positively. Students pointed out that typing does not cause a misunderstanding about what has been written. It was obvious that students type more than handwrite, as typing was more likely to suit them. Only one student wrote that he would rather write answers by hand.

5 Conclusion

Digitisation is the subject of many discussions, including the field of education. The biggest shifts in higher education digitalisation have undoubtedly been caused by COVID-19, as it has forced higher education institutions to shift their pedagogical process remotely.

After the end of the epidemic, the educational process is returning to its old orbits. This paper was created with the desire to ensure that some practices from the lockdown are preserved and adapted to teaching and learning in-person.

E-exams are not a novelty, but they are still a taboo in the Slovenian higher education area, as they are often associated with remote exams and doubts about the validity of exams. Research among students found that, with the correct approach and clear protocols, remote exams are equivalent to exams conducted in the classroom under supervision. The research also shows that distance exams are stressful for students, even if some experience the home environment as an environment that works for them and has made taking exams more relaxed.

Taking a distance exam is also stressful for teachers, not just for students [4]. Teachers were primarily concerned about the exam's credibility and exam surveillance. The latter concern can be eliminated by personal supervision in the computer classroom. Due to space limitations (small classroom) and with the aim to prevent cheating we limit navigation though the exam, which distracted one third of students. Some students complained about the typing noise, but in general the online exams taken in a computer room, within the school infrastructure, were well accepted.

From the institution's point of view, the transition to electronic examinations requires the provision of facilities – an available computer classroom with enough places. All software must be installed and maintained (updated). Typing noise could be eliminated by using more silent keyboards.

Online examination represents a small step toward a greener, sustainable, and digital university, which is the aim of many EU universities.

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Learning Loss Factors Dominance in Elementary School Students: Online Learning in Indonesia

Andi Mursidi(✉), Dina Anika Marhayani, Eka Murdani, Emi Sulistri, Evina Cinda Hendriana, Abdul Basith, and Insan Suwanto

STKIP Singkawang, Singkawang, Indonesia
andimursidi@hotmail.com

Abstract. This study aims to get an overview of the online learning process amid the Covid-19 Pademi and *the learning loss* that occurs. The population is all elementary school students in Indonesia. Probability sampling technique with the type of *Simple Random Sampling* is used in sampling in this study with a sample of 330 students in 33 regions throughout Indonesia. Student questionnaires were made with reference to the Circular Letter of the Minister of Education and Culture Republic of Indonesia number 4 of 2020 concerning Implementation of Education Policies in the Emergency Period of the Spread of *Coronavirus Disease* 2019 (Covid-19) and refer to Cardinal regarding the factors that dominate *learning loss*. This study uses a survey method with data analysis using data analysis from Creswell. The results of the study show that during online learning during the pandemic there were indications of *learning loss* in terms of the aspect of attendance, the aspect of collecting assignments on time, the enthusiasm for learning aspect, the aspect of learning outcomes in the realm of thinking (cognitive) processes, the aspect of learning outcomes in the attitude domain, and the aspect of learning outcomes in the skills domain. Learning objectives do not experience loss because the implementation of learning is in accordance with the learning objectives contained in the Learning Implementation Plan (RPP). The occurrence of *learning loss* is due to limitations in accessing learning applications, minimal interaction between teachers and students can affect the process of transferring knowledge and enthusiasm for student learning. The teacher does not deliver direct material causing a lack of students' understanding of the material being studied which has an impact on decreasing aspects of learning outcomes in the realm of thinking (cognitive) processes, aspects of learning outcomes in the realm of attitudes, and aspects of learning outcomes in the realm of skills.

Keywords: Learning Loss · Learning loss in online learning · Learning loss in elementary schools in Indonesia

1 Introduction

Corona Virus Disease 2019 (Covid-19) pandemic has had an impact on the world of education. As a result of the Covid-19 pandemic, various policies have been implemented to stop the spread of the Covid-19 virus in Indonesia. The Indonesian government is

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making various efforts, one of which is by implementing an appeal to the public to carry out *physical distancing*, namely an appeal to maintain distance between communities, stay away from activities in all forms of crowds, assemblies, and avoid gatherings that involve many people. This is done to break the chain of spread of the Covid-19 pandemic that is happening at this time. In addition to implementing *physical distancing*, the government is implementing policies namely *Work From Home* (WFH) for government and private agencies and *Learn From Home* for school and college students. This policy is an effort that is applied to the community so that they can complete all the work at home.

Education in Indonesia is also one of the areas affected by the COVID-19 pandemic. The Ministry of Education in Indonesia issued a policy by closing schools and replacing the process of teaching and learning activities using an online system. The joint decree of the four ministers states that face-to-face learning is only allowed for schools in the green zone, while for the yellow, *orange* and red zones learning is still carried out online. Students can interact with teachers in online learning through applications such as *WhatsApp*, *Google Meet*, and *Zoom*. This makes it easier for students to carry out the learning process because it is not bound by place and time. In practice, students experience many obstacles in online learning related to the material, learning interactions, and learning environment. Thus, the learning process will not be maximized so that it will affect students' abilities and there will be gaps in learning outcomes. The gap caused by the loss of learning competence (*learning loss*) makes students do not master the competencies needed because they are unable to follow the material. Loss of learning competence (*learning loss)* has an impact on decreasing learning outcomes due to a lack of quality in online learning [1–10].

Global Study Save The Children July 2020 in 46 countries, especially in Indonesia that there are 8 of 10 children cannot access adequate learning materials [11]. Various ways are done so that students can understand the material conveyed by teaching properly. One of them is by giving assignments to make summaries or *resumes*, with the hope that students will read and study the material independently so that there is no loss of learning competence (*learning loss)*. Loss of learning competence (*learning loss)* is a loss of students' learning abilities and experiences. This is supported by an article written by Carlsson on the use of knowledge test and it is assumed that every 10 days missing from school is 1 percent of the standard deviation, so Swedish school students in 12 weeks or 60 school days they will lose 6% of the standard deviation [12]. Such conditions result in students' knowledge being disrupted in the future with more complex knowledge problems. Losing study time at school clearly ends in students losing their knowledge. This paper aims to examine the decline in learning outcomes resulting from loss of learning competence *during* online learning.

2 Literature Review

The Government of the Republic of Indonesia has issued a policy to deal with learning obstacles during the Covid-19 pandemic. One of the policies of the government is the Minister of Education and Culture explains that the Learning from Home Process is carried out under the following conditions: a) learning from home through online/distance learning is carried out to provide a meaningful learning experience for students, without being burdened with the demands of completing all curriculum achievements for grade promotion and graduation; b) learning from home can be focused on life skills education, including regarding the Covid-19 pandemic; c) learning activities and tasks for learning from home can vary between students, according to their respective interests and conditions, including considering the gap in access/study facilities at home; d) evidence or products of learning activities from home are given qualitative and useful feedback from the teacher, without being required to give a quantitative score/value [13]. Implementation in schools is measured by a questionnaire that refers to components from the Minister of Education and Culture coupled with loss learning components according to Cardinal. Loss of learning competence (*learning loss)* according to Cardinal is learning that was previously obtained and then lost [14]. School closures during online learning result in major and permanent learning losses as many students are left behind. Academic value and motivation tend to be lost when school closures. According to Cardinal, the main factors that can reduce learning loss *are* social competence, assessment, goal setting, skills, and learning environment [14].

3 Research Methods

This study used a survey method with the aim of getting an overview of the online learning process amid the Covid-19 Pademi and the learning loss that occurred. The research was conducted from June to August 2021 in elementary schools across Indonesia. The population is all elementary school students in Indonesia. *Probability sampling* technique with the type of *Simple Random Sampling* is used in sampling in this study with a sample of 330 students in 33 regions throughout Indonesia. Data collection techniques through questionnaires. Student questionnaires were made with reference to the Circular Letter of the Minister of Education and Culture Republic of Indonesia number 4 of 2020 concerning Implementation of Education Policies in the Emergency Period of the Spread of *Coronavirus Disease* 2019 (Covid-19). The Minister of Education and Culture explained in more detail the rules regarding distance learning points. This questionnaire also referred Cardinal to factors that predominate in learning competency loss [14]. The interpretation of the score (percentage) of the loss of learning competence questionnaire can be seen in Table 1 below:

In this study it was said that students lost learning competence if in a percentage of 20.1%–40% the criterion is low and the percentage is 0%–20% very low. Data analysis methods in this study used data analysis methods [16], including processing and preparing data for analysis, reading all data, analyzing in more detail by coding *data*, applying coding processes, qualitative reports, interpreting data.

4 Results and Analysis

This research was started by creating a questionnaire instrument. This questionnaire was created to find out students' learning loss *in* online learning carried out by the teacher. Online learning is carried out due to the increasingly widespread corona virus outbreak. In order to break the chain of transmission of the corona virus due to exposure from one

Table 1. Interpretation of the score (percentage) of the questionnaire for loss of learning competence

Percentage (%)	Criteria
80, 1–100	Very high
60, 1–80	Tall
40, 1–60	Currently
20, 1–40	Low
0–20	Very low

Source: Arikunto [15]

human to another, face-to-face learning in class or at school is abolished or closed and replaced with online learning from their respective homes. The existence of difficulties or obstacles experienced by teachers in conveying their learning material can be a potential for learning loss in the students being taught. The following shows the results of learning loss in online learning in Table 2 as follows:

Table 2. *Learning Loss* in Online Learning

No	Learning Aspects	Number of Respondents (people)		Percentage (%)		Criteria	Information
		Yes	No	Yes	No		
1	Presence	112	218	33,9	66,1	Low	*loss*
2	On Time Tasks	123	207	37,3	62,7	Low	*loss*
3	Eager to learn	120	210	36,3	63,6	Low	*loss*
4	Learning outcomes in the realm of thinking processes (Cognitive)	110	220	33,3	66,7	Low	*loss*
5	Learning outcomes in the realm of attitude	109	221	33.0	66,9	Low	*loss*
6	Learning outcomes in the realm of skills	114	216	34.5	65.5	Low	*loss*
7	Learning objectives	160	170	48.5	51.5	Currently	*No loss*

Based on the results of the questionnaire on the first aspect of learning loss in online learning, namely attendance. Students present in online learning by showing that students who answered yes were present as many as 112 respondents with a percentage of 33.9% and students who answered absent were 218 respondents with a percentage of 66.1% with low criteria, meaning that there was a loss in the aspect of student attendance. The second aspect of learning loss in online learning is assignments on time. During online learning, 123 students who submitted assignments on time answered yes with a percentage of 37.3% and students who answered did not submit assignments on time as many as 207 respondents with a percentage of 62.7% with low criteria, meaning that there was a loss in the aspect of collecting student assignments on time. The third aspect of learning loss in online learning is the enthusiasm for learning. Student enthusiasm for learning decreased during online learning, 120 respondents answered yes with a percentage of 36.3% and 210 respondents answered they did not have enthusiasm for learning during online learning with a percentage of 63.6% with low criteria, meaning that there was a loss in the aspect of student enthusiasm. The fourth aspect of learning loss in online learning is learning outcomes in the realm of thought processes (cognitive) that as many as 110 respondents answered yes there was an increase in learning outcomes in the domain of thinking processes (cognitive) with a percentage of 33.3% and 220 respondents answered not experiencing an increase in learning outcomes in the process domain thinking (cognitive) percentage of 66.7% with low criteria, it means that aspects of learning outcomes in the cognitive domain experience loss.

The fifth aspect of learning loss in online learning is the learning outcomes in the attitude domain. As many as 109 respondents answered yes, they experienced an increase in learning outcomes in the attitude domain, a percentage of 33.0% and 221 respondents answered that they did not experience an increase in learning outcomes in the attitude domain, a percentage of 66.9% with low criteria, this means that the aspect of learning outcomes in the attitude domain experienced a loss. The sixth aspect of learning loss in online learning is learning outcomes in the realm of skills. As many as 114 respondents answered yes, they experienced an increase in learning outcomes in the skills domain, with a percentage of 34.5% and 216 respondents answered that they did not experience an increase in learning outcomes in the skills domain, with a percentage of 65.5%. With low criteria, this means that aspects of learning outcomes in the realm of attitudes experience a loss. The seventh aspect of learning loss in online learning is learning objectives, that as many as 160 respondents answered that teachers carried out online learning according to learning objectives with a percentage of 48.5% and students who answered no were 170 students with a percentage of 51.5% with moderate criteria which means no experience a loss.

Learning carried out by teachers during online learning is learning based on digital platforms such as *WhatsApp* and *Google Classroom*. Online learning requires devices to access material from teachers. Students who do not have devices cannot take part in the learning process either via *WhatsApp* or *Google Classroom*. The results of Huzaimah, et al.'s research stated that students' obstacles in the online learning process included inadequate quotas, unstable connections, distraction at home, inadequate device capacity, difficulty understanding material, and difficulty communicating directly [17]. The same thing happened in Aminullah's research, et al. who suggested that one of the obstacles to the online learning process during the pandemic was the availability of learning facilities [18]. Student constraints in the online learning process have an impact on student attendance. Student attendance experienced a decrease or loss of 33.9%. This makes students lose time when learning online. Kuhfeld suggested that absence has a negative effect on end-of-year exam scores [19]. The negative effects of absences are linear, meaning that each additional absence leads to the same loss of learning no matter how many absences a student has acquired [20].

In online learning, the teacher requires students to be independent in finding explanations of the material provided by the teacher and independent in doing assignments. In addition to difficult internet access, it also has an influence on the timely collection of student assignments. Collection of assignments on time decreased by 37.3%. Students' delay in submitting assignments is also due to a lack of interaction between teachers and students so that students experience difficulties in doing assignments. Social interaction cannot be carried out freely when online learning becomes a burden on students, thus causing students to become stressed and depressed as a result of which their enthusiasm for learning decreases. The decrease in student enthusiasm for learning during the learning period was 36.3%. The difficulty in controlling the learning atmosphere makes students' enthusiasm for participating in online learning decrease. This is supported by Muzdalifa's research that grade 6 children, in one group there are 5–7 people who do not do the assignments given by the teacher, while the other children do the assignments even though they are not perfect, some are done some are not done. In addition, children seem to lose enthusiasm (ghiroh) to learn [21].

So far, the drawbacks of online learning are that teachers pay less attention to affective and psychomotor aspects. Bloom, Benjamin, et al. argues that educational goals must always refer to the three domains inherent in students, namely the realm of thinking processes (cognitive), the realm of values or attitudes (affective), and the realm of skills (psychomotor) [22]. Learning outcomes in the realm of thinking processes (cognitive), the realm of values or attitudes (affective), and the realm of skills (psychomotor) of students during online learning during the pandemic decreased by 33.3% in the realm of thinking (cognitive) processes, 33.0% in the realm of attitudes, and 34.5% in the realm of skills. This is because there is no delivery of material directly by the teacher causing a lack of students' understanding of the material being studied. This is due to the limited learning media used, namely only through *the WhatsApp group* and *Google Classroom.* This is supported by research conducted by Rajib & Sari that there is a decrease in learning outcomes during online learning at SMA Negeri 4 Polewali [23]. This is in line with the findings of Hotimah, et al. where during the pandemic, student achievement tends to experience a drastic decline [24].

In online learning the teacher has conveyed the learning objectives in accordance with the Learning Implementation Plan (RPP) so that there is no loss. The teacher has prepared a Learning Implementation Plan (RPP) before learning, although the teacher still has difficulty preparing a Learning Implementation Plan (RPP). A similar thing was experienced by teachers at SMAN 49 DKI Jakarta Provincial Office. Teachers have difficulty making lesson plans for online learning, caused by: 1) being unable to distinguish between online and face-to-face lesson plans, 2) having never participated in online lesson plans preparation, 3) difficulties in determining assessments, referrals, and online learning strategies [25].

Online learning that is carried out at home requires teachers to be creative in providing material, not to burden students with many assignments (homework) so that it makes students more stressed while studying at home which has an impact on the student's immunity (immunity) decreases and in the end they are easily infected or infected covid-19 virus. This condition must be improved to provide more interesting learning and innovative tasks for learning to be effective. The gap in learning outcomes caused by the loss of learning competencies makes students unable to master the required competencies because they are unable to follow the material or lose the basic competencies that must be learned. The existence of a learning achievement gap indicates that something is missing in learning.

5 Conclusion

Based on the results of this study, it can be concluded that during online learning during the pandemic there were indications of learning loss in terms of attendance aspects, aspects of collecting assignments on time, aspects of enthusiasm for learning, aspects of learning outcomes in the realm of thinking (cognitive) processes, aspects of learning outcomes in the realm of attitudes, and aspects of skills learning outcomes. In the aspect of student attendance, it decreased or lost by 33.9%, the aspect of collecting assignments on time decreased by 37.3%, the aspect of decreasing student enthusiasm for learning during the learning period was 36.3%. Aspects of learning outcomes in the realm of thinking (cognitive) processes, the realm of values or attitudes (affective), and the realm of skills (psychomotor) of students during online learning during the pandemic decreased by 33.3% in the realm of thinking (cognitive) processes, 33.0% in the realm of attitude, and 34.5% in the realm of skills. Learning objectives do not experience loss because the implementation of learning is in accordance with the learning objectives contained in the Learning Implementation Plan (RPP). The occurrence of learning loss in the aspect of attendance, aspects of collecting assignments on time, aspects of enthusiasm for learning, aspects of learning outcomes in the realm of thinking (cognitive) processes, aspects of learning outcomes in the realm of attitudes, and aspects of learning outcomes in the realm of skills due to limitations in accessing learning applications, interactions between teachers with minimal students can influence the process of knowledge transfer and student enthusiasm for learning. The absence of direct delivery of material by the teacher causes a lack of students' understanding of the material being studied which has an impact on decreasing aspects of learning outcomes in the realm of thinking (cognitive) processes, aspects of learning outcomes in the realm of attitudes, and aspects of learning outcomes in the realm of skills.

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Model Concept Sentence Learning Based on Multiethnic Daycare to Facilitate the Translation Ability Mathematical Representations of Junior High School Students

Mariyam[1], Rika Wahyuni[1], P. Nindy Citroresmi[1], Nurul Husna[1], Ahmad Yani[2], Masriani[2], and Andi Mursidi[1](✉)

[1] STKIP Singkawang, Singkawang, Indonesia
andimursidi@hotmail.com
[2] Universitas Tanjungpura Pontianak, Pontianak, Indonesia

Abstract. This study aims to determine the completeness of student learning outcomes individually and classically, increase students' mathematical representation translation ability, and determine the results of a character questionnaire with global diversity on the application of the concept sentence learning model based on multi-ethnic culture. The research design used a quasi-experimental design with a nonequivalent control group design. The population in this study was all 8th-grade students at SMPN 1 Singkawang, consisting of 5 classes totaling 160 people. The data collection instrument used was an essay test that contained indicators of students' mathematical representation translation ability and a character questionnaire with global diversity. The data analysis technique used in this study is quantitative analysis with statistics. The research results show that: 1) the students' mathematical representation translation ability in the experimental class achieves mastery learning individually and classically; 2) the improvement of the students' mathematical representation translation ability in the experimental class is better than that of students in the control class; and 3) the results of the character questionnaire with global diversity on the application of the concept sentence learning model based on multi-ethnic culture are classified as very good with an average percentage score of 85.28.

Keywords: Concept Sentence Learning · Mathematical Representations Translation · Multiethnic Culture · Global Diversity

1 Introduction

The education curriculum in Indonesia is developed with the refinement of a student-centered mindset, meaning that students must actively build or construct their knowledge independently through learning experiences. Students are required to have choices regarding the material studied and their learning style to achieve the same competence. In learning mathematics to gain learning experience, students are trained in several abilities, one of which is the ability to present ideas in various forms according to student

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understanding. This ability is known as a mathematical representation. The ability to express mathematical representation has always been an ability that students are expected to have, both in the 2013 curriculum and the independent learning curriculum currently implemented in Indonesia.

The National Council of Teachers of Mathematics (NCTM) states that "Representation is central to the study of mathematics. Students can develop and deepen their understanding of mathematical concepts and relationships as they create, compare, and use various representations. Representations also help students communicate their thinking [1]. From this statement, it is clear that with students having representation skills, they can develop and deepen their understanding of concepts and the interrelationships between mathematical concepts through making, comparing, and using representations. Not only is representation beneficial to students' understanding, but it also assists students in communicating their thoughts.

The ability to represent mathematically is important for students because it can be used as support in solving problems, especially when interpreting the meaning of images, symbols, or mathematical problems. Mathematical representation skills are needed to help students convey ideas so that they are contained in written form or change from abstract to concrete so that they are easier to understand. This ability to represent also helps to find and create a tool or way of thinking to convey these mathematical ideas [2]. Another opinion also mentions that the ability to use mathematical representation is very important for students because it is an expression of the ideas or mathematical ideas displayed by students in their efforts to find a solution to the problem at hand [3]. Thus, it can be understood that when students are trained and directed to develop representation skills, they can train themselves in changing one form of representation to another to build a concept so that, in the end, they can develop their understanding of the concept when solving a mathematical problem.

Given the importance of mathematical representation abilities for students, these abilities should start to become a focus of learning. However, some research results show that student achievement in representational abilities is still not good. Several research results over the last 3 years, such as the results of research [4] and [5], show that the results of students' mathematical representation abilities are still below 60%. Especially in geometrical materials, students have not been able to achieve indicators of representation ability in cube and block materials [6]. Researchers also conducted pre-research with schools, which showed that students had not been able to use their representation skills to solve problems. Based on the pre-research answers, it was found that when students were asked to describe the pictures in the questions as a start to solving the problem, their answers were not in accordance with the concept, so they ended up solving the wrong problem. Likewise, when students were asked to make meaning of a variable in an algebraic problem, almost 80% of students did not answer, and some students immediately took action by entering numbers, which ended in incorrect solutions.

Based on the results of interviews with students, it is known that the mistakes experienced by students in presenting an idea are because they are confused by questions that ask them to change the representation of images or story problems into representations of symbols while the images or presentations given are still unfamiliar to them. So one thing that is understood by researchers is that the difficulties experienced by students are the result of the process of changing forms from one representation to another so that in the end the results of the representation are wrong. In geometrical material that is abstract, students experience difficulties when presenting the given problems, which leads to wrong solutions. Thus, it can be concluded that in interpreting a problem presented in various representations, students' mindsets need to be directed to understand the process.

Translation between forms of representation and transformation in each form of representation is a process that occurs in representation [7]. Translation ability is a psychological process that occurs to transfer information from one representation to another, which can assist students in expressing problems and the ideas contained in them so that a solution is obtained [8]. The translation process is "the psychological processes involved in going from one mode of representation to another, for example, from an equation to a graph" [9]. This reveals that the translation process leads to activities or processes in mathematics when changing from one form of representation to another. Each student has a different way of solving problems. The more students have skills in the process of changing from one form to another, the easier it will be for them to understand material concepts and solve problems. Instructional strategies should focus on incorporating different modes of representation to meet the students' preferences for solution strategies since some students like to use graphs while others tend to use equations or some other numerical mode [10].

Following up on this matter, it is necessary to familiarize students not with the results of the representation or changing the form but with the process of changing the form. The role of the teacher in instilling students' representation abilities can be done by changing learning patterns that are accustomed to giving formulas and working examples into learning that actively involves students in representing their understanding of their concepts [11]. This habituation can be applied by providing students with learning experiences, namely the freedom to process. Junior high school-aged children are still in a transitional phase between the concrete operational stage and the formal operational stage. In theory, since children at this stage have not been able to fully learn something abstractly, there must be contextual learning assistance.

Contextual learning should be linked to environmental conditions around children, which can be used as a medium for gaining learning experiences, one of which is by utilizing local culture. In Permendikbud Number 35 of 2018, it is stated that philosophically, education is rooted in culture to build present and future national life and that students are heirs to creative national culture [12]. Thus, it is clear that the use of culture is part of the learning objectives to create creative national generations. In addition, the use of culture as part of the student learning experience indirectly aims to facilitate the character profile of Pancasila students. Learning by involving and empowering the potential of the environment as a source of learning, such as the existence of support from arts and culture activists, is one of the learnings that aim to strengthen the character of students with a community-based approach [13].

The concept sentence learning model based on multiethnic culture is a learning model developed by integrating local culture into the learning process. The people of Singkawang City consist of various ethnicities (multi-ethnic), with the three ethnic majorities being ethnic Chinese, Dayaks, and Malays. Each ethnic group has a variety of cultures with their own uniqueness. Singkawang City also gets the title of Tolerant City because people's lives are harmonious and there is mutual respect for diversity. Even on big days, there is always a celebration by displaying the characteristics of each ethnicity. This is, of course, a supporting factor for implementing culture-based learning. The results of Prihatiningtyas' research show that the concept sentence learning model based on multi-ethnic culture is effective in facilitating students' conceptual understanding skills and the character of social care [14]. Students in heterogeneous (multiethnic) groups work together and respect each other when expressing opinions about the appearance of material presented in various cultural forms, and then this initial knowledge is used together to understand the concept of the material.

This research is a continuation of previous research. Conceptually, there is a link between conceptual understanding and representational ability. Students who understand concepts tend to be able to read and interpret problems from various points of view, one of which is being able to present problems in various forms so that problem-solving solutions are obtained. But it can also be described the other way around: when students try to understand a concept, they will use various ways of interpreting a problem (one of which is a representation of various forms) so that understanding is obtained. Therefore, the purpose of this study was to see the completeness of student learning outcomes both classically and individually by applying the concept sentence learning model based on multi-ethnic culture and to compare students' mathematical representation translation ability between classes using concept sentence learning models based on multi-ethnic culture and classes that used the direct learning model.

Furthermore, as part of the realization of curriculum goals, namely the character profile of Pancasila students, the application of the concept sentence learning model based on multi-ethnic culture also aims to facilitate the development of student characters, one of whom is a character with global diversity. Ismail's research results show that strengthening character education in realizing Pancasila students is encouraging the birth of good human beings who have six main characteristics, namely critical thinking, creative, independent, faithful, pious to God Almighty, noble, cooperative, and global diversity, with the hope that students will have the ability to independently improve, use their knowledge, study, and internalize and personalize the noble character and moral values that can be manifested in daily behavior [15]. The main goal of a global diversity character is to maintain a noble culture and increase respect for and tolerance for diversity. This needs to be done bearing in mind that, with the development of the era and the development of technology, students, as the younger generation, are increasingly affected by negative things and are less concerned with the existing culture. The "moral" crisis that hit the Indonesian state and nation due to the influence of science and technology and globalization has resulted in a shift in the values that exist in people's lives, so that traditional values that highly uphold morality may shift along with the influence of science and technology and globalists [16].

On the other hand, the challenges of globalization also impact the process of absorbing foreign cultures. Not a few young people in today's Indonesia are easily lulled by worldly seductions and plunged into the negative currents of foreign culture. We, as successors and heirs of the Indonesian State, must be prepared for every challenge of globalization that is increasingly rampant by throwing away all the negative influences of foreign culture that will threaten identity and the nation's self [17]. Therefore, by applying the concept sentence learning model based on multi-ethnic culture, it is hoped that students will have a sense of love for culture and can cultivate mutual respect for differences. This is the meaning of the Indonesian national motto, "Bhineka Tunggal Ika, which means that even though we are different, in essence, the Indonesian nation still exists as one unit.

2 Research Methods

The type of research used is a type of quantitative research with experimental methods. Experimental research can be interpreted as a research method used to find the effect of certain treatments on others under controlled conditions [18]. The purpose of this experimental research is to investigate whether there is a causal relationship and how big the causal relationship is by giving certain treatment to the experimental group and the control group as a comparison. The experimental group was given treatment by applying the concept sentence model in which it was integrated with local culture, and this was a new learning strategy in Singkawang city.

This study used a quasi-experimental design with the nonequivalent control group design selected. The reason for choosing a quasi-experimental design is because in this study it is not possible for researchers to control all variables such as external variables that affect the course of the experiment. This study with a nonequivalent control group design used a pre-test and a post-test to see the difference in improvement between the groups given the treatment and the control group.

Before the research was carried out, each class carried out a pre-test (O) to find out its initial state [19, 20]. Throughout the study, the sample group was given action (X) and the other groups were not given action. First, the two sample classes were given a pre-test in the form of essay questions containing indicators of students' mathematical representation translation abilities, then learning was carried out in 2 meetings where the experimental class used the concept sentence learning model based on multiethnic culture while the control class used a direct learning model. After learning was carried out, the sample class was given a post-test in the form of the same questions as the pre-test questions. The school where the research took place was at SMP Negeri 1 Singkawang class VIII.

The population in this study were all class VIII of SMP Negeri 1 Singkawang consisting of 5 classes totaling 160 people. Population is a generalization area which consists of: objects/subjects that have certain qualities and characteristics determined by researchers to be studied and then drawn conclusions [18]. The sampling technique in this study used the cluster random sampling technique. Cluster random sampling is sampling from a group or class and then individual samples are drawn from the selected class [21]. The class that became the sample in this study was class VIII A as the experimental class and class VIII B as the control class. Where previously all population classes were subjected to a homogeneity test to determine the sample to be selected.

The data collection technique used in this study was a measurement technique, namely by giving pre-test and post-test questions to measure the translation ability of students' mathematical representations and student learning completeness, and questionnaire sheets to measure students' global diversity characters. The data collection instrument used in this study was a written test in the form of essay questions which contained indicators of students' mathematical representation translation ability and questionnaire sheets for students' global diversity characters. The questionnaire distributed contained closed statements with four possible answers, namely Strongly Agree, Agree, Disagree, and Strongly Disagree.

The data analysis technique used in this study is quantitative analysis with statistics. After the research data has been collected from the results of data collection through tests and questionnaires, then the data is processed according to the following steps; (1) to see the completeness of student learning outcomes as seen from the results of the test student's mathematical representation translation ability after the implementation of the concept sentence learning model based on multiethnic culture, namely by using the 1 sample t test formula to calculate individual completeness, proportion test to calculate classical completeness. Students are declared to have completed learning individually if the grades obtained reach the KKM. The KKM score for mathematics at SMP Negeri 1 Singkawang is $\geq$70. In terms of the completeness of classical learning outcomes, a research class is said to be complete if the percentage achieved is $\geq$75% [22]; (2) to see which students' mathematical representation translation skills are better between classes that use the concept sentence learning model based on multi-ethnic culture and classes that use the direct learning model, namely by using the N-Gain formula. Based on the normality test and N Gain data homogeneity test, both data were normally distributed and homogeneous (can be seen in the research results). Then proceed with the independent t-test with the formulation of the hypothesis "Increasing the student's mathematical representation translation ability in the class using the concept sentence learning model based on multiethnic culture is better than increasing the student's mathematical representation translation ability using the direct learning model; (3) to find out the results of a questionnaire containing indicators of global diversity characters after the implementation of the concept sentence learning model based on multi-ethnic culture used a questionnaire sheet with a Likert scale, then from the results of the questionnaire calculated individual gains and the percentage of indicators.

3 Results and Discussion

The data obtained during data collection in the study were in the form of posttest processing results (data in the form of scores) from the experimental class, which applied the concept sentence learning model based on multi-ethnic culture, and the control class, which applied the direct learning model to students' mathematical representational translation abilities. As for the post-test questions given in the form of a test of the students' mathematical representational translation abilities, they consist of six questions that contain indicators, among others: translation of student representation from real script to visual (R-V), from visual to real script (V-R), from real script to symbol (R-S), from symbol to real script (S-R), from visual to symbol (V-S), and from symbol to visual (S-V), which works through the stages of representation translation: unpacking the source; preliminary coordination; constructing the target; and determining equivalence. Based on the calculation results, the average pretest and posttest values in the experimental and control classes increased, but for the experimental class, the average value was higher when compared to the average value of the control class. Recapitulation is presented in Table 1.

Table 1. Summary of Pretest and Posttest Values

	Control Class		Experiment Class	
	Pretest	Posttest	Pretest	Posttest
Total	856	1363	821	2361
Average	28.53	45.43	27.37	78.7
Many Students	30 Students		30 Students	

Based on Table 1, it can be seen that both the experimental class and the control class indicated that the posttest scores were higher when compared to the pretest scores. This condition indicates that in these two classes the students' mathematical representational translation abilities has increased.

3.1 Completeness of Students' Mathematical Representation Translation Ability Test Results

From the results of student tests, it was obtained that the average posttest score in the experimental class or the class that was given the treatment of the concept sentence learning model based on multiethnic culture was 78.7. While the results of the calculation of the individual completeness testing of experimental class students can be seen $t_{count} > t_{table}$, namely $3.542 > 1.603$ which is based on testing criteria meaning that H_0 is rejected and H_a is accepted, so it can be concluded that the average student in the experimental class achieves KKM, namely 70. Meanwhile, classical completeness is based on the results the students' posttest can be seen $Z_{count} > Z_{table}$, namely $1.732 > 156$ which based on the testing criteria means that H_0 is rejected and H_a is accepted, so it can be concluded that 75% of student scores have reached the KKM, namely 70.

Based on the results of the students' mastery learning, it was found that the students' mathematical representations translation ability in the experimental class achieved learning mastery individually and classically. This is because the stages of learning using the Concept sentence model based on multi-ethnic culture contribute to the learning process and students' understanding processes so that they can improve the students' mathematical representations translation ability, so that students can achieve completeness both individually and classically. It can be seen at the stage of presenting information where at this stage it is giving keywords to students according to the material presented, students are given concepts in the form of keywords that aim to help students develop ideas so they can think well. Then at the material delivery stage, students are given stimulation in the form of cultural forms such as lanterns, ketupat, betel nut and other cultural forms to introduce students to spatial shapes, then students are asked to tell briefly in their own language about these cultural forms and in the end students find an understanding of the initial concept of geometric shapes. Furthermore, when students are in discussion groups students are asked to make several sentences using keywords and also present them in pictorial and symbolic forms or vice versa. The results of Hasibuan's research study also mention that the concept sentence learning model is one of the learning models that can improve student learning outcomes in learning mathematics through the provision of keywords that can build student creativity [23]. Thus showing that the concept sentence learning model makes a difference to student learning outcomes.

3.2 Improving Students' Mathematical Representation Translation Ability Between Experiment Class and Control Class

There are three types of representation: visual, symbolic, and verbal (real script). So there are six types of translation that will be produced, with roles such as source representation and target representation. For example, V-S means that the questions are presented in visual form (pictures or tables), and then students are directed to use symbolic representations to solve problems. To see the process of changing the form from the source representation to the target representation, 4 stages of the translation process are used, namely: 1) unpacking the source; 2) preliminary coordination; 3) constructing the target; and 4) determining equivalence.

The students' mathematical representations translation ability is measured by administering test questions to students. The test items distributed contain six questions that include the students' mathematical representations translation ability from real script to visual (R-V), from visual to real script (V-R), from real script to symbol (R-S), from symbol to real script (S-R), from visual to symbol (V-S), and from symbol to visual (S-V). From the results of data collection during the study, data were obtained from the pretest and posttest results from the experimental class with the concept sentence model based on multiethnic culture and from the control class with the direct learning model on students' mathematical representations translation ability. Furthermore, based on the N-Gain calculation results, the N-Gain value recapitulation for each student in the experimental class is higher than the control class. The recapitulation of the N-Gain value for each student is presented in Table 2 below.

Table 2. Recapitulation of N-Gain Values for Each Student

Class	Number of students (N-Gain Score)			Amount	Average N-gain	Criteria
	Low	Medium	High			
Experiment	-	12	18	30	0.72	High
Control	17	10	3	30	0.25	Low

From Table 2, it can be seen that in the experimental class the average N-Gain is 0.75, which is in the high criteria, and in the control class the average N-Gain is 0.25, which is in the low criteria. To provide a more detailed description of the acquisition of the N-Gain value for each indicator of the students' mathematical representations translation ability, the following will show the results of calculating the N-Gain value for each indicator. The recapitulation of the N-Gain value for the indicator of the mathematical representations translation ability is presented in Table 3 below.

Table 3. Recapitulation of the N-Gain Value of Each Indicator of Student Mathematical Representation Translation Ability

Representational Translation	Control		N-Gain	Criteria	Experiment		N-Gain	Criteria
	Pretest	Posttest			Pretest	Posttest		
V-R	1.36	2.02	0.22	Low	1.08	3.71	0.81	High
R-V	0.87	2.3	0.42	Currently	1.14	3.41	0.72	High
S-R	1.25	2.3	0.34	Currently	1.2	3.86	0.80	High
R-S	1.34	2.15	0.27	Low	1.28	3.47	0.73	High
V-S	0.92	1.41	0.14	Low	1.25	3.27	0.66	Currently
S-V	0.95	1.31	0.11	Low	0.91	2.83	0.57	Currently
All Indicators	0.25			**Low**	0.715			**High**

From Table 3, it can be seen that the overall N-Gain value for the six indicators of mathematical representation translation ability in the experimental class has an average of 0.71 with a high criterion and the overall N-gain value for the six indicators of indicators of mathematical representation translation ability in the control class has an average of 0.25 with low criteria. From Table 3 it can also be seen that the experimental class experienced a higher increase than the control class in each indicator. Furthermore, to see significantly which improvement is better between classes using the concept sentence learning model and classes using the direct learning model, independent t-tests will be carried out. Before carrying out independent t-test, the normality test and homogeneity test were first carried out.

From the results of the Normality calculation of the N-Gain data for the experiment and control class, it is obtained that $\chi^2_{count} \leq \chi^2_{table}$, namely $3.89 \leq 11.070$. While the N-Gain data in the control class $\chi^2_{count} \leq \chi^2_{table}$, namely $7.41 \leq 11.070$, then H_0 is accepted and H_a is rejected. It can be concluded that the N-Gain data in the experiment class and the control class are normally distributed. The results of calculating the homogeneity of the N-gain value using the variance homogeneity test obtained $f_{count} \leq f_{table}$, namely $2.14 \leq 5.05$. Thus it can be concluded that the N-gain value of both the variances of the experimental and control groups is homogeneous. Based on the normality test and homogeneity test, it was found that the N-Gain data for the experimental class and the control class were normally distributed and had the same (homogeneous) variance. So to see which improvement is better between the experimental class and the control class, you can use the independent t-test. Then it is obtained that $t_{count} > t_{table}$, namely $14.21 > 1.672$. Thus H_0 is rejected and H_a is accepted with a significant level of 5% or 0.05 so that it can be concluded that the improvement in the students' mathematical representations translation ability in classes using the concept sentence learning model based on multiethnic culture is better than the students' mathematical representations translation ability in classes using direct learning models.

The difference in the increase in the students' mathematical representations translation ability was due to the differences caused by each treatment in the learning process. Increased students' mathematical representations translation ability were higher in the experimental class using the multi-ethnic culture-based concept sentence learning model, because the multi-ethnic culture-based concept sentence learning model was designed for students to provide opportunities for students to understand concepts using problems with how to connect the material being studied with the surrounding culture, so that a fun and meaningful learning process occurs. This is in line with Rohaeti's opinion that learning with culture can stimulate children to think more creatively to represent the problems given to them because they are directly related to children's daily lives [24]. In addition, the learning experience gained by students in each stage of the concept sentence learning model based on multi-ethnic culture emphasizes more on students making several sentences using keywords and also presenting them in pictorial and symbolic form or vice versa.

3.3 Results of the Global Diversity Character Questionnaire as a Profile of Pancasila Students

The multi-ethnic culture-based sentence concept learning model using local culture for student Learning experiences is also expected to strengthen the character of the Pancasila Student Profile, namely global diversity. In its application, students are divided into several groups consisting of various ethnicities, then given stimulation in the form of several local cultures to help them understand the material by asking them to present it in various forms and then using the presentation or representation to solve existing problems. Measurement of character with respect to global diversity is carried out by distributing character assessment instruments in the form of questionnaires to students. The questionnaires distributed contained closed statements with four answer choices (strongly agree, agree, disagree, and strongly disagree), and students only chose one answer out of the four choices. The number on the global diversity questionnaire port is 24 stations with reference to three indicators, namely: 1) knowing and buying culture; 2) intercultural communication in interacting with others; and 3) reflection on and responsibility for the diversity experience. The average result of calculating the global diversity character score given to 30 students is 85.28 in the very good category. The recapitulation of the results of the global diversity character assessment can be seen in the following Table 4 below.

Based on Table 4, it is known that the results of filling out the character questionnaire with global diversity after students were given a concept sentence learning model based on multi-ethnic culture were that around 63.33% of 30 students were in the "very good" category, around 30% were in the "good" category, and around 6.67% were in the "enough" category. To provide a more detailed picture of the score for each indicator of global diversity, the following will show the results of the questionnaire calculation for each indicator (Table 5).

Table 4. Recapitulation of Global Diversity Questionnaire

No	Interval	Criteria	Number of students	Percentage of the Number of Students
1	$82,25 \le P \le 100$	Very good	19	63.33%
2	$62,50 \le P < 81,25$	Good	9	30%
3	$43,75 \le P < 62,50$	Enough	2	6.67%
4	$25 \le P < 43,75$	Not good	0	0%
Amount			30	100%

Table 5. Recapitulation of Global Diversity Questionnaire Results for Each Indicator

No	Indicator	Number of Statements	Number of Student Responses				Total Score	Percentage	Criteria
			SS	S	TS	STS			
1	Indikator 1	8	135	99	6	0	849	88.44	Very Good
2	Indikator 2	8	107	125	8	0	819	85.31	Very Good
3	Indikator 3	8	101	106	33	0	788	82.08	Good
Amount		24	343	330	47	0	2456	**85.28**	**Very Good**
Average									

Overall, of the three indicators, the largest number of student answers was in the strongly agree option, namely 343 answers out of a total of 720 answers, or around 47.64%, with around 45.83% choosing to agree and 6.53% choosing to disagree. Based on the percentage gain, the indicator with the highest percentage is on the first indicator, and the lowest is on the third indicator.

In the first indicator, namely knowing and appreciating culture, and the second indicator, namely intercultural communication in interacting with others, a percentage of responses above 82.5% was obtained, which based on the criteria was in the "very good category. It is suspected that these results are obtained because the learning stages used correspond to each statement containing indicators of global diversity. For example, at the teacher's stage of delivering the material, students are given stimulation in the form of cultural forms such as lanterns, diamonds, betel nuts, and others, and then asked to tell briefly about these cultural forms. This learning helps students know and appreciate culture. Furthermore, when students are in discussion groups, they are asked to make several sentences using keywords and also present them in pictorial and symbolic form. At this stage, each student in the group communicates with each other, exchanges ideas, gives opinions, and makes agreements.

Furthermore, in the third indicator, namely reflection and responsibility for the diversity experience, the percentage of student responses was 82.08% in the "good" criteria. When students discuss in groups and during plenary discussions, each student is given responsibility by the teacher to explain cultural forms to his group friends, thereby helping one another in making presentations that are in accordance with the descriptions explained. Reflection and student responsibility are also trained in the final stage of learning when each group presents the results of the discussion in front of the class.

Based on this explanation, it can be concluded that the stages of the multi-ethnic culture-based concept sentence learning model that integrates local culture in Singkawang City can be used as an alternative learning method to form a profile of Pancasila students, especially characters with global diversity. The process of learning culture-based mathematics, which refers to three things, namely learning about culture, learning with culture, and learning through culture, that has been carried out is able to provide positive student responses based on the results of the global diversity questionnaire. Ethnomathematics-based geometry learning can convey mathematical concepts as well as instill personality in students as an effort to introduce and maintain national cultural identity with the times [25]. In addition, the results of Sulfayanti's research also state that through ethnomathematics, students obtain cultural education and character education through the introduction of local culture, which makes students appreciate their culture more and can practice the values contained therein, which will contribute to shaping the nation's character [26]. Thus, in the end, the application of learning that emphasizes character education based on local wisdom needs to be done to change the attitudes and behaviors of the younger generation so that, in the future, they are better prepared to face future challenges.

4 Conclusion

Based on the results of data analysis and discussion, it can be concluded that the multi-ethnic culture-based concept sentence learning model applied to class VIII junior high school building material learning can facilitate students' mathematical representation and translation skills. This can be seen in the achievement of the completeness of student learning outcomes (with KKM 70) both individually and collectively. In addition, when it was compared between the experimental class and the control class, it was concluded that the increase in the students' mathematical representation translation ability in the class using the concept sentence learning model based on multi-ethnic culture was better than the students' mathematical representation translation ability in the class using the direct learning model. The results of the global diversity character questionnaire calculation show an average percentage score of 85.28 in the very good category. So that it can be concluded that the application of the concept sentence learning model based on multi-ethnic culture by integrating local culture in learning mathematics (ethno-mathematics) by using the concepts of learning about culture, learning with culture, and learning through culture can be used as a solution for learning that supports the character profile of Pancasila students, one of which is the character of global diversity.

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Pawai Budaya as a Source of Peace Education in Singkawang City

Wasis Suprapto[1], Dodik Kariadi[1], Erdi Guna Utama[1], Zulfahita[1], Hairida[2], Aunurrahman[2], and Andi Mursidi[1](✉)

[1] STKIP Singkawang, Singkawang, Indonesia
andimursidi@hotmail.com
[2] Tanjungpura University, Pontianak, Indonesia

Abstract. This study aims to describe three things, namely the beginning of the parade activity, the process of implementing the parade, and exploring the meaning of the cultural parade. The cultural parade itself was carried out to coincide with the appearance of the solar eclipse phenomenon. This research was conducted in December 2019 in Singkawang City. The type of research used is phenomenological with qualitative methods. Data collection techniques are carried out through observation, interviews, and documentation. The results showed that (1) the cultural parade was initiated by the Ministry of Education in collaboration with the Ministry of Religion, and 17 ethnic groups in Singkawang City. (2) the implementation of cultural parade activities includes five activities, namely greetings from important figures in Singkawang, ethnic dance events, cultural parade activities, cultural attractions, and joint observations. (3) The urgency of the cultural parade is to foster a spirit of unity in diversity, and teach the younger generation to become agents who are actively involved in maintaining and preserving the values of peace in their social life.

Keywords: Cultural Parade · Eclipe Solar · Peace Education

1 Introduction

Bhineka Tunggal Ika become a historical milestone that accompanies the long journey of the birth of the Indonesian nation. History has recorded that long before Indonesia's independence, this spirit had become a unifying identity among the nation's children. This condition was strengthened by the Youth Pledge incident on October 28, 1928. The Youth Pledge event which later became the forerunner of people from all over the country to put aside all kinds of differences together. The Youth Pledge event emphasized the importance of "with one blood, nation and one language, namely Indonesia". These three mottoes are still often found during flag ceremonies or even internalized in subjects at school.

Enthusiasm *Bhineka Tunggal Ika* must be echoed in the social life of the Indonesian people. Currently, the Indonesian nation has indeed been released from the shackles of colonialism. However, various social problems that are now emerging are contrary to

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this spirit. Social conflicts such as anarchism, separatism, terrorism, brawls, ethnic and religious conflicts have become social problems that have colored the journey of 77 years of Indonesian independence. Ironically, various social problems actually occur among Indonesian citizens. President Soekarno at the 1963 Indonesian Independence Day had a will that "my struggle is lighter because it is against the colonialists while your struggle will be heavier because it is against your own nation" [1]. This testament seems to have come true if you look at the phenomenon of conflict in society.

Social conflicts in society are spread all over the country. Based on the analysis of various sources, the following types of conflict can be identified:

Table 1. Conflicts in Indonesia

No	Conflict Type	Location	Reason
1	Separatism	The Free Aceh Movement [2] The Free Papua Organization [3]	There are inequalities in various fields and a lack of attention from the central government
2	Religious Conflict	Poso [4] and Ambon [5]	There are misunderstandings, disputes occur, and lead to open conflict
3	Ethnic Conflict	Sambas [6] and Sampit [7]	There is a gap between immigrants and local residents
4	Anarchism	Jakarta [8]	There is a bad influence from the environment where you live

Source: Multiple Source Analysis

Referring to Table 1 above, it can be seen that there are at least four types of physical conflict in Indonesia. This conflict occurs due to various factors such as inequality, lack of attention, misunderstanding, and the influence of the surrounding environment. Uniquely the conflict didnot only involve all parties, including students.

An interesting series of conflicts to study. The existence of conflict is feared to threaten the unity and integrity of the nation. Conflicts that occur can approach the following characteristics of a failed state: (1) increased violence among adolescents, (2) use of bad language and words, (3) strong influence of peer groups in acts of violence, (4) increased self-destructive behavior such as drug use, alcohol and free sex, (5) the blurring of good and bad moral guidelines, (6) decreased work ethic, (7) lower respect for parents and teachers, (8) low sense of individual and citizen responsibility, (9) dishonesty is cultivated, and (10) there is mutual suspicion and hatred between people [9]. Referring to the ten indicators above, it can be seen that everything has happened in Indonesia. If these indicators are related to the conflict in Indonesia, there are at least numbers 1, 3, 5, 7 and 10. These five indicators are a dangerous alarm for the spirit of unity and oneness in Indonesia.

Social conflict in society is a shared responsibility. There are many things that can be done to minimize this problem, for example by prioritizing the local wisdom of a community. In practice, local wisdom has proven effective in uniting people from various backgrounds. This is reflected in tradition Kerapatan Kaum [10] in West Sumatera, *Beramai Baakuran* South Kalimantan [11] and *Satu Tungku Tiga Batu* in Fakfak [12]. In addition, local wisdom is also useful for reducing conflict. This can be seen from the tradition *Pill Pasanggiri* in Lampung, *Besaru* in West Kalimantan and *Pela Gandong* in Maluku [13].

In practice to strengthen the spirit *Bhineka Tunggal Ika* can be done through incidental activities. The manifestation of this activity was seen when the Solar Eclipse or in Indonesian called Gerhana Matahari Cincin. This phenomenon occurred at the end of December 2019. One of several areas, especially in West Kalimantan, which this phenomenon passed was in Singkawang City. The Solar Eclipse phenomenon in Singkawang has even been the longest compared to other areas such as Bengkayang, Sambas and Pontianak. The emergence of the Solar Eclipse phenomenon was taken seriously by the people of Singkawang City. This was proven through cultural parade activities which were attended by various walks of life.

Indirectly, the presence of the cultural parade in Singkawang is interesting to study. There are at least three main things that will be studied, (1) the beginning of the parade activities, the process of carrying out the parade, and exploring the meaning of the cultural parade. These three things are important to study, especially for areas that are multi-ethnic and have a track record of conflict, such as in Singkawang City.

2 Literature Review

The literature review examines three things, namely cultural parades, peace education, and the phenomenon of the annular solar eclipse. Basically, Indonesian people cannot be separated from cultural parade activities. The parade itself is usually carried out successively across generations. The main purpose of holding a cultural parade is to commemorate an important or historical event, such as when the phenomenon of the annular solar eclipse appeared. The results of a study from the Institute for Aeronautics and Space stated that an annular solar eclipse can only be witnessed again after 300 years in the same place [14]. In 2019, this phenomenon can only be enjoyed by regions in Indonesia. Specifically for the West Kalimantan region, it can only be seen in the following Mempawah, Singkawang, Sambas, Bengkayang, and Putussibau (Fig. 1).

For the people in Singkawang City, for example, the existence of the ring solar eclipse phenomenon has a special meaning. It is undeniable that the emergence of an annular solar eclipse will be followed by the emergence of myths in society. This is apparently not only happening in Indonesia but also in several other Asian countries. In Indonesia it is known that there is a large giant or buto trying to swallow the sun, in China there is a myth that there is an invisible dragon swallowing the sun, in Central Asia it is associated with the end of the war between the two Middle Eastern countries, in Japan there is a myth that poison has fallen into the water so wells and water are closed during eclipses, in India the people will immerse themselves in water up to their necks so that the sun can defend against dragon attacks [15].

Basically, socio-cultural phenomena that develop in society can be used as a source of learning peace education. This happens because peace education touches all types of activities, movements, efforts, and initiatives as part of a lifelong education process [16].

Fig. 1. The area through which an annular solar eclipse

One of the concrete manifestations is through cultural parade activities that are able to unite all levels of society from various socio-cultural backgrounds. This is in line with Toh's idea of all human rights for all people [17]. The Preamble to Charter of the United Nations also mentions that peace education is directed to the development of the human personality and strengthening of respect for human rights and fundamental freedoms.

Peace education has a noble purpose. UNESCO (1974) describes the five cultural values of peace, namely (1) containing human rights, democracy and tolerance, (2) fighting all forms of discrimination, (3) promoting democratic principles, (4) fighting poverty and development for a life that upholds dignity humans, (5) protecting and respecting the environment [18]. Mukhopadhyay (2005) explains the importance of three aspects, namely peacekeeping or maintaining peace, peace making or creating peace, peace building or building peace [19]. Sipayung (2008) explains the importance of cooperation, freedom, happiness, honesty, humility, love of appreciation, responsibility, simplicity, tolerance, and unity [20]. Sukendar (2011) sees the content of peace education teaching non-violence, love, compassion, trust, justice, cooperation for all human beings [21]. Seeing this presentation, it can be seen that peace education teaches about peace for all human beings.

3 Research Methods

This article is reviewed using a type of phenomenological research [22]. The main objective is to get an overview of the cultural parade activities that occur in Singkawang City, especially during the annular solar eclipse phenomenon. This research was carried out at the end of December 2019. Data collection techniques were carried out through observation, interviews, and documentation. Basically, the traditions that exist in the community are interesting things. Tradition and society are two elements that are related to one another. Tradition without society will not be presented or continued, on the contrary without tradition society will lose the identity of a thing. Therefore, cultural parade activities that develop in the community will be an interesting thing because there are important values that are taught across generations. This value is certainly expected to further strengthen the spirit of unity among diverse communities. The presence of the

Cultural Parade during the ring solar eclipse phenomenon is interesting to study from various aspects including peace education.

4 Results and Analysis

4.1 The Beginning of the Start of the Parade Activities

The cultural parade which took place at the end of December 2019 was able to run smoothly thanks to the collaboration of various parties. All elements of society contributed to the success of this event. The cultural parade was realized thanks to an initiation from the Ministry of Education in collaboration with the Ministry of Religion, ethnic associations, and the entire community of Singkawang City. The education office has an important role, especially in educating people's lives, both intellectually and socially. Intellectually, this cultural parade is necessary so that people are no longer bound by myths. So far, myths have sprung up because of the appearance of a solar eclipse. Though this phenomenon is part of the phenomenon of science.

Socially, the presence of the annular solar eclipse was welcomed by the community through cultural parade activities. All elements, starting from the Singkawang City Government, the Education Office, Ethnic Associations, Religious Associations, students, and the general public took part in the celebration of the parade. This is very natural because this momentum is the first time it has happened in Singkawang. Besides, it would take a very long time i.e. 300 years later to witness similar activity. The cultural parade was enlivened by a food bazaar and cultural attractions from each ethnic community in Singkawang. Uniquely each parade participant wears a traditional parade typical of their respective cultures.

On the other hand, the phenomenon of an annular solar eclipse is also an integral part of the religious context. Islam does not teach its followers to believe in myths. Islam through Rasulullah SAW has banned the myth about eclipses. The prohibition of the myth occurred because the people of the City of Medina at that time associated the appearance of an eclipse after the funeral of Ibrahim who was the son of the Prophet Muhammad on January 27 623 AD or towards the beginning of Zulkaidah in 10 Hijriah. The hadith narrated from Abu Dawud from Aisyah RA that Rasulullah SAW once said "The sun and moon do not eclipse because of someone's death nor because of their life. If you know it then pray to Allah Azza Wa jala, takbir, and give alms". This hadith teaches that when an eclipse occurs, Muslims are encouraged to recite dhikr, pray, and ask Allah for forgiveness. Worship that must be carried out when a solar eclipse occurs, namely the Eclipse Prayer, calling people to join in congregational prayers with the call *Al-Salatu Jami'ah*, remembrance, prayer, istighfar, alms, freeing slaves, and preaching [23]. Some of these worships are carried out in order to get closer to Allah so that all kinds of disasters are kept away.

In its implementation, the cultural parade activities also involved ethnic groups. Based on the results of the study it is known that there are at least 17 ethnic groups in Singkawang covers Majelis Adat Budaya Tionghoa (MABT), Majelis Adat Budaya Melayu (MABM), Dewan Adat Dayak (DAD), Ikatan Keluarga Madura (Ikama), Paguyuban Jawa, Paguyuban Bali, Ikatan Keluarga Maluku (IKM), Paguyuban Aceh, Ikatan Keluarga Sumatera Barat (IKSB), Simpay Seuweu Siwi Siliwangi, Kerukunan

Keluarga Banjar, Kerukunan Keluarga Kawanua Maesa (Manado), Kerukunan Keluarga Sulawesi Selatan (KKSS), Ikatan Keluarga Besar Sriwijaya (IKABES), Persatuan Keluarga Besar Batak Singkawang (PKBS), Flobamora (NTT), dan Ikatan Keluarga Besar Kepulauan Riau. The 17 ethnic groups mingle with each other, especially when there are cultural performances such as when the annular solar eclipse occurs. The main goal is to strengthen inter-ethnic integration in Singkawang.

4.2 Cultural Parade Process

The cultural parade was carried out through six stages. *First,* the welcome from the Mayor of Singkawang, Tjhai Chui Mie. On that occasion, Tjhai Chui Mie emphasized the importance of taking advantage of every moment to foster a spirit of tolerance among Singkawang residents. Tolerance is again echoed so that people can live together as one without division. The spirit of unity was also reaffirmed by the Singkawang Police Chief so that all parade participants could appreciate differences without demeaning them because being different is beautiful. Speeches were also given by the Head of the West Kalimantan Province Space Aviation Institute. On that occasion, he emphasized that the people of Singkawang city should become smart individuals who don't easily believe in myths.

Second, the activity is enlivened by a special dance program performed by a dance studio in Singkawang. This activity was carried out to provide entertainment for invited guests and all the spectators who attended. On that occasion, the dance studio showed mesmerizing attractions. The dances that are presented do not only come from the area of origin of Singkawang but other regions in Indonesia. This is deliberately done to foster love for the Indonesian nation.

Third, the declaration of peace from 17 ethnic groups in Singkawang City. This activity was represented by a representative of an ethnic group and was followed by representatives from other associations. The activity begins with regional greetings such as *Aga Kareba* from Kerukunan Keluarga Sulawesi Selatan (KKSS), then answered *Aga Madeceng*. *Ape kabar* from Majelis Adat Budaya Melayu (MABM), then answered fine. *Hip Hip* from Kerukunan Keluarga Kawanua Maesa (Manado), then answered Hura. *Horas* from Persatuan Keluarga Besar Batak Singkawang (PKBS), then answered *Horas, Horas, Horas* three times. *Sampurasun* from Simpay Seuweu Siwi Siliwangi then answered *Rampes*. *Pripun Kabare* from Paguyuban Jawa, then answered *Sae.* On that occasion the declaration represented by the KKSS declared "The Unitary State of the Republic of Indonesia is Dead, United We are Whole, Divided We Collapse, Singkawang is Safe" as follows (Fig. 2):

Fig. 2. Declaration of Peace

Fourth, cultural parade activities carried out on foot around Singkawang City. This activity was attended by parade participants and spectators. On that occasion the researchers captured a unique moment where the participants wore their respective traditional clothes. At that time it was seen that there were male students wearing black shirts and pants and wearing *Udeng* or headbands identical to the Madurese ethnicity. The male student next to him who wears a light blue shirt complete with *Tajak* or a hat is identical to the Malay ethnicity. Female students who wear all red clothes are identical to the Dayak ethnicity as shown in the following picture (Fig. 3):

Fig. 3. Parade Participants

Fifth, the activity committee has prepared a stage that will be used for art performances from 17 ethnic groups in Singkawang City. This stage is prepared especially for students. Based on the results of the analysis, it is known that there are four different ethnic groups taking part in one of the stages. The four associations include Ikatan Keluarga Besar Riau, Kerukunan Keluarga Banjar, Ikatan Keluarga Sumatera Barat, dan juga Simpay Seuweu Siwi Siliwangi (Fig. 4):

Fig. 4. Ethnic Association Performance

Sixth, joint observation of all participants attending the cultural parade. This observation is carried out by wearing special glasses to avoid radiation. This is done to avoid the participants from eye pain due to solar eclipse radiation.

4.3 Urgensi Pawai Budaya

West Kalimantan Province is a strategic area to study the true meaning of peace education. The research results of Petebang [24], Zasco [25], and Kristianus [26] conclude that West Kalimantan has a high level of vulnerability to conflict. Data from the United Nations Support Facility for Indonesia Recovery (UNSFIR, 2004) [27] divides the following conflict categories:

Table 2. Kategori Konflik Sosial di Kalimantan Barat

No	Conflict Category	Conflict Frequency	Number Killed	Number of Wounded	Ruined House	Destroyed Public Buildings
1	Natural resources	6	0	0	0	8
2	*Ethno Communal* (Madura vs Dayak)	19	1098	441	2724	6
3	*Ethno Communal* (Madura vs Melayu)	28	453	109	969	6
4	Between state apparatus	2	5	15	0	1
5	Political Parties	5		8	0	2
6	Fights between residents and villages	7	1	10	0	0
7	State and society	9	6	43	0	9

Sumber: UNSFIR

Referring to Table 2 above, it can be seen that Ethno-Communal based conflicts often occur in West Kalimantan. UNSFIR data shows that conflicts that often occur involving Madurese and Malay ethnicities occur 28 times. The conflict resulted in 453 people died and 109 people were injured. The same thing also happened between Madurese and Dayak ethnicities which happened 19 times. The conflict resulted in 1098 deaths and 144 injuries. In addition, conflict also occurred between ethnic Dayak and Chinese in 1967 [6]. In 2008, there was conflict between ethnic Malays and Chinese in Singkawang City [26]. Uniquely, the four major ethnic groups that have been involved in the conflict both live in Singkawang City.

Singkawang on its journey was able to become a home for all ethnicities in Indonesia. Although several ethnic groups have been involved in open conflict, currently they are able to live side by side with one another. The assimilation that occurred in Singkawang even received national recognition. A survey conducted by Setara Institute in 2019 [28] and in 2021 [29]. These results can be an indicator that the people of Singkawang City are able to live assimilated within the framework of diversity.

The cultural parade activity to commemorate the solar eclipse phenomenon is interesting to study from the context hypothesis theory. The theory coined by Gordon Allport emerged in 1954 when the United States was experiencing inter-ethnic conflict [30]. Through the contact theory, Gordon Allport tries to reduce conflicts that arise between ethnic groups by making contact. Contact is needed especially to minimize prejudice, stereotypes, and the like between parties who have been involved in a conflict [31]. The thing that can be done to make this happen is to allow the members of each group to interact with each other. There are various forms of interaction, including the use of cultural performances.

Culture that lives and develops in society can be used as a medium of communication. Traditions can be used to foster brotherhood and solidarity among citizens [15]. Referring to some of these opinions, it can be seen that tradition can be used to strengthen brotherhood between communities. Such cultural presence *Pill Pesenggiri, Beramai Baakuran, Pekasiwia, Pela, dan Satu Tungku Tiga Batu* proven to be able to strengthen social relations between communities. A similar situation can also be seen from the existence of a cultural parade in Singkawang City.

5 Conclusion

Cultural parade activities in Singkawang City are interesting to study further. This phenomenon can actually be realized by the collaboration of various parties, both the Ministry of Education in collaboration with the Ministry of Religion, and 17 ethnic groups in Singkawang City. In addition, there are also other social elements involved in it. The cultural parade was lively. The activity was carried out through five activities, namely greetings from important figures in Singkawang, ethnic dance events, cultural parade activities, cultural attractions, and joint observations. The existence of a parade culture can actually be used to foster a spirit of unity in diversity, and forbids the younger generation from becoming agents who are actively involved in maintaining and preserving the values of peace in their social life.

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Educational Assessment Design for Computer Programming Module to Create Awareness on Sustainability Development Goals Among Information Technology Undergraduate Students

Mohamad Firdaus Che Abdul Rani(✉) and Vinothini Kasinathan

School of Computing, Asia Pacific University of Technology and Innovation, Kuala Lumpur, Malaysia
firdaus@apu.edu.my

Abstract. By 2030, the Sustainable Development Goals (SDGs) hope to have eradicated poverty and inequality, protected the environment, and ensured everyone's wellbeing, justice, and prosperity. The SDGs Report 2022 suggests that public knowledge of the SDGs and the 2030 Agenda is inadequate, especially at the community level. The educational assessment is one method that can be employed to raise awareness of the SDGs. Educators and organizations involved with education are divided as to whether the current assessment processes promote lifelong learning in students and whether assessment procedures are the most effective way to enhance learning and prepare students for the real world. To construct effective educational assessment plans in Malaysia, educators in higher education must have a complete understanding of learning outcomes as specified by the Malaysia Qualification Framework 2.0 (MQF 2.0). Students can apply their knowledge and abilities to ill-defined scenarios like those experienced in real life when adopting a comprehensive assessment strategy. This article is proposing an educational assessment design for Computer Programming module to create awareness on SDGs among Information technology undergraduate students.

Keywords: Sustainable Development Goals (SDGs) · Higher Education · Educational Assessment · Computer Programming Module

1 Introduction

The United Nations defines sustainable development as "progress that meets present requirements without sacrificing future generations". For development to be deemed sustainable, the capacity of future generations to satisfy their own needs must not be jeopardized (World Commission on Environment and Development, 1987). In September 2015, 17 SDGs connected to 169 objectives were presented as the determined 2030 Sustainable Development Agenda. Despite the number of actions undertaken at all levels, community-level knowledge of the SDGs and the 2030 Agenda remains low, according

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to the most recent Sustainable Development Goals (SDGs) Report (2022). Although higher education is not directly mentioned in the SDGs, attaining the SDGs by 2030 would require the engagement of all segments of society. The SDG 4 Target identifies Education for Sustainable Development (ESD) as an educational strategy that educates students with the essential knowledge, skills, and attitudes to achieve sustainability. Despite the fact that numerous universities have adopted ESD pedagogies, and many have declared sustainability-related educational goals for their program (Barker-Ruchti & Purdy 2021; Cebrián Bernat 2019; Strachan et al. 2019; Trad 2019; Wilhelm et al. 2019), little is known about the quality, curricular content, and efficacy of university offerings in sustainability education.

In 2007, with the establishment of the Malaysian Qualification Framework (MQF) and its implementation was enforced in 2011, the Outcome-Based Education (OBE) system was introduced across all levels of education in Malaysia's higher education institutions. The MQA Council Meeting in December 2017 gave its approval to the new version, MQF 2.0 (Malaysian Qualification Agency 2017). Every Malaysian university uses OBE to reach a predetermined set of results focused on what students can do and what they are unable to do, rather than on what students know or do not know. Because of this, it is essential for educators to have a comprehensive understanding of learning outcomes as directed by the MQF 2.0 to design appropriate educational assessment plans. This is because educational assessment represents a crucial component in both teaching and learning (Akimov & Malin 2020; Johnston & Webber 2003; Rima & Rodriguez 2022; Tosuncuoglu 2018). Assessment outcomes are crucial for a variety of stakeholders, including students, educators, institutions, and employers; furthermore, assessment outcomes must correspond to the learning outcomes that are intended for the module.

It is essential for educators to focus a significant amount of attention on assessment strategies that make a positive contribution to the entire learning experience of their students. Educators and organizations whose primary focus is education have engaged in a substantial amount of discourse on the question of evaluating the enrolled students at institutes of higher education. They debate whether the current assessment practices encourage lifelong learning in students and whether assessment procedures are the most effective way to enhance learning and prepare students for the real world (Murdoch-Eaton & Whittle 2012; Pinto & Reshma 2021; "Redesigning Malaysia's Higher Education System" 2018). Students can apply their abilities and knowledge to uncertain, real-world-like situations when a comprehensive assessment plan is implemented. Therefore, the assessment could be one of the mechanisms by which the SDGs are communicated. The purpose of this study is to look into the role of educational assessment in raising Malaysian higher education students' understanding of the SDGs and aims to answer the following questions: (i) What are the current educational assessment methodologies utilized in Malaysian Higher Education?; (ii) Which type of educational assessment is appropriate for growing SDG awareness among Malaysian Higher Education students?

2 Literature Review

2.1 The Sustainable Development Goals (SDGs)

The SDGs, which have been ratified by the United Nations, aim to foster international collaboration to build a more sustainable and balanced global community. The previous agenda's eight goals, known as the Millennium Development Goals (MDGs), were established in 2000 with the goal of eliminating extreme poverty and hunger, increasing access to quality education for all, promoting gender equality and women's empowerment, and launching a global development effort by 2015 (Gabay 2015; Müller 2021). In order to strengthen the Global Partnership for Sustainable Development, the new plan increased the number of targets to 17. The SDGs are more global in scope, whereas the MDGs are primarily concerned with developing countries (Palmer 2015; United Nations 2015).

2.2 Higher Education and SDGs

Higher education institutions can demonstrate their influence, provide students with the SDG-related education they seek, form new collaborations, expand their revenue streams, and establish themselves as a credible, world-conscious institution by becoming involved with the SDGs. Several SDGs specifically mention education and research, and higher education institutions are critical to achieving these goals. However, because higher education institutions can help with both the SDG framework and each individual SDG, their contribution to the SDGs is likely to be far greater (Australia/Pacific SDSN 2017). Because of their broad mandate of knowledge generation and delivery, higher education institutions have historically been key leaders in global, regional, and local invention, economic progress, and community well-being. As a result, higher education is critical to achieving the SDGs and will benefit greatly from interacting with them (Aarts et al. 2020). Higher education institutions have a special responsibility to educate future generations of educated professionals and leaders who will advance social and economic progress. Furthermore, universities are critical because of the research they conduct and the new information and innovations they produce, which aid in the resolution of global problems and the formation of sound public policy. Through community engagement and collaboration with a variety of stakeholders, including the governmental and corporate sectors, as well as civil society, institutions can have an impact at the local, national, and international levels.

2.3 Educational Assessment in Higher Education

The goal of educational assessment is to provide a systematic basis for drawing conclusions about the extent to which students have learned and grown. The educational assessment is intended to be used as a tool to assist in the identification of learning gaps among students and the types of remedial steps, if any, that should be taken to bridge such learning gaps (Ibarra-Sáiz et al. 2020). Students are required to perform these actions to continue or advance their studies. As a result, students have more opportunities to showcase their talents and more control over how their abilities are evaluated, allowing for the assessment of a broader range of professional and subject-specific competencies. Furthermore, this allows for the assessment of a broader set of competencies. Assessment is used in higher education to assess not only what a student knows and can do, but also how their knowledge and abilities affect the institution as a whole ("Handbook on Measurement, Assessment, and Evaluation in Higher Education" 2017; O'Leary et al. 2020). Institutions collect data from various sources to gain a better understanding of students' learning processes and to identify repeating patterns of strengths and weaknesses among various groups of people. The outcomes are extremely valuable to the institution because they advise and direct appropriate educational planning, decision-making, and resource allocation. In a nutshell, assessment determines whether a higher education institution's educational model is truly making a difference in the student's life.

Type of Educational Assessment in Higher Education

Various approaches can be taken throughout the assessment process in higher education. For a variety of reasons, it is necessary to use the various assessment methods available both during and after the learning process. Most of the research on teaching and learning focuses on two distinct methods of evaluating student work: formative assessment and summative assessment (Basera 2019; Lau 2016; Mannion 2022; Yüksel & Gündüz 2017).

Summative Assessment

The summative assessment occurs near the end of the educational programme. The primary goal of this assessment is to generate a metric that "sums up" the learning that has occurred among the students (Knight 2002). The summative assessment has a broad scope, with the primary focus being on the outcomes of the learning process. Although summative assessments can provide information about patterns of student success, they do so without providing students with the opportunity to reflect on and demonstrate change in areas identified as needing improvement. Furthermore, it does not allow educators to change their method of instruction while students are still being taught and educated. Even though summative assessment is beneficial, it does not allow students to demonstrate their achievement in areas where they have room for improvement (Darabi Bazvand & Rasooli 2022; Iannone & Simpson 2017). Students will complete summative assessments at the end of the course, such as exams or papers that cover a significant amount of course content.

Formative Assessment

Formative assessment tracks the development of student learning over time. The primary goal is to assess student development to improve learning while it is taking place (Šteh & Šarić 2020; Yorke 2003). The interpretation of students' performance through formative assessment, followed by the sharing of the results with the students, allows educators to assist students in gaining a better understanding of both their strong and weak points, as well as in considering how they can continue to improve throughout their education (Šteh & Šarić 2020). A variety of methods can be used to assess students' understanding and knowledge. Whether they are a young child in elementary school or a higher education student working their way through an undergraduate programme, they are all aware that schoolwork, tests, and quizzes are an unavoidable part of the educational experience. These are not meant to be assessed in any way, as are all formative assessments. Instead, they are designed to be simple and to provide a basic understanding of the students' level of comprehension (Basera 2019; vaz Oliveira et al. 2016).

Issues and Challenges for Assessment in Higher Education
Educational assessment is widely regarded as the most important setting for student-teacher interaction. Students can now conduct their own studies to a much greater extent than they could previously, when they relied heavily on lectures and tutorials to gain access to the information contained in the learning materials. Assessment in higher education raises several issues for educators working in the field. Singer-Freeman & Robinson (2021) identified four major challenges in higher education assessment. The study's top issues indicate that the assessment sector has progressed beyond performing assessments to demonstrate compliance and is now ready to embrace the use of assessments for improvement in its entirety. One of the difficulties in performing assessment, particularly formative assessment, according to Arif et al. (2019), is the level of preparation and mastery of the topics being revised by students. In a society where educational institutions rarely investigate the feasibility of developing multiple forms of assessment for a wide range of student types and abilities, Ali (2018) emphasized the importance of special needs education and lifelong learning. Sambell et al. (2019) identified eight key current challenges and discussed potential solutions for educators. One of the difficulties is determining how to make assessments more authentic and meaningful for students. It is possible to conclude that the concerns and challenges associated with assessment in higher education may differ depending on a variety of factors and characteristics, such as the level of study and the courses taken.

3 Discussion

Educational assessment can help raise awareness of the SDGs in Malaysia. Higher education educational assessment is typically done in a variety of ways and is a continuous process. Defining SDGs literacy in learning outcomes is not a priority here because educators can relate the SDGs to any component or activity related to assessment for any module and level in a higher education institution, which is what we will do as we evaluate the role of assessment in developing SDGs awareness. By incorporating SDGs into educational assessment, educators can better define their students' abilities and foster the development of future sustainability champions.

Students majoring in computer science and information technology are often required to take "Introduction to Computer Programming" module during their first academic year (Sobral 2021). Computer programming is one of the essential skills for undergraduate students majoring in Computing and Information Technology, according to the Second Edition of the Malaysian Qualification Agency's (MQA) Program Standards 2015, as well as the Association for Computing Machinery's (ACM) and Institute of Electrical and Electronics Engineers' (IEEE) Computing Curricula 2020. One of the common learning outcomes for "Introduction to Computer Programming" module is, at the end of the semester, students should be able to "Construct a programmable solution to a given scenario using relevant problem-solving approaches and programming ideas". The summative assessments for this module often included a lab test, an assessment based on a project, and a final exam, whereas the formative assessment was a quiz. Except for project-based assessment, it is neither appropriate nor practical to include a question with the SDGs as its focus in lab tests, final exams, or quizzes that are regularly used to evaluate students' coding proficiency (Thangaraj 2022).

Project-based assessments allow students to put their higher order thinking skills to the test (Eliyasni et al. 2019). The ability to see how knowledge in one area relates to real-world scenario applications in another is one advantage of project-based assessments. For a long time, educators relied on project-based assessment to evaluate students' programming abilities (Thangaraj 2022). By having students' complete assignments that culminate in a project-based assessment, educators can assess students' capacity for originality, diversity, and authenticity with their coursework and acquired experience. The criteria for the project-based assessment can be as specific or as broad as the educator desires. This provides educators with the opportunity to select appropriate SDGs scenarios and use them as the theme for the project-based assessment question. Using SDG3 "Good Health and Well-being" as a starting point, an educator could create a few scenarios involving healthy lifestyles and the promotion of well-being for people of all ages and provide some samples to motivate students to devise a suitable response using the programming concept they learn in class. While briefing students on the assessment, the educator may want to emphasize the importance of the SDGs, why the younger generation needs to be aware of the goals, and how they can help to achieve the goals.

Portfolio-based assessment is an evaluation method that has gained popularity in recent years. According to Lam (2020), portfolio-based assessment is based on the systematic collection of learner work that represents competencies, exemplary work, or the learner's developmental progress. In addition to examples of their work, most portfolios include reflective statements prepared by learners. Portfolios are assessed for evidence of learner achievement with respect to established learning outcomes and standards. According to a study conducted at the Universitas Pendidikan Ganesha in Indonesia, the use of computer-based portfolio assessment in an Integral Calculus course improved students' self-regulated learning (Mahayukti et al. 2018). The study employed a pretest-posttest control group design and found that there was an improvement in students' self-regulated learning after following the course with computer-based portfolio assessment. Portfolio-based assessment is a valuable tool for evaluating student learning and progress. By incorporating reflective statements and a variety of learner work, this type of assessment provides a more comprehensive view of student achievement.

Table 1 illustrates the rubric that can be utilized for evaluating the comprehension and awareness of students regarding SDGs and their incorporation into the domain of computer programming.

This rubric allows for the evaluation of students' comprehension and integration of sustainability development goals within the realm of computer programming. It serves as a tool for providing feedback and guiding their learning progress.

Integrating SDGs into educational assessment methods can play a critical role in raising awareness of sustainability issues among higher education students in Malaysia. While traditional assessment methods such as quizzes and exams may not be appropriate for incorporating SDGs, project-based and portfolio-based assessments can provide opportunities to address real-world sustainability challenges. However, educators must

Table 1. Rubric for evaluating student comprehension of SDGs in computer programming.

Criteria	Poor	Fair	Good	Excellent
Understanding of SDGs	Little or no understanding of the concept of SDGs, or confusion about their goals and objectives	Basic understanding of the SDGs and their relevance to sustainable development, but limited knowledge of specific goals and targets	Solid understanding of the SDGs and their goals and targets, and able to provide examples of how they relate to sustainable development	Comprehensive understanding of the SDGs, including their goals, targets, and indicators, and able to articulate their importance and relevance to sustainable development
Understanding of Computer Programming	Little or no understanding of computer programming concepts and terminology, or confusion about how programming can be used to promote sustainability	Basic understanding of computer programming concepts and terminology, but limited knowledge of how programming can be used to address sustainability challenges	Solid understanding of programming concepts and terminology, and able to provide examples of how programming can be used to address sustainability challenges	Comprehensive understanding of programming concepts and terminology, and able to articulate the specific ways in which programming can be used to address sustainability challenges
Integration of SDGs and Computer Programming	Little or no understanding of how the SDGs can be integrated into computer programming, or difficulty in articulating specific examples	Basic understanding of how the SDGs can be integrated into computer programming, but limited knowledge of specific techniques and tools	Solid understanding of how the SDGs can be integrated into computer programming, and able to provide examples of specific techniques and tools	Comprehensive understanding of how the SDGs can be integrated into computer programming, including a deep knowledge of specific techniques and tools, and able to articulate how they can be applied to real-world sustainability challenges

(*continued*)

Table 1. (*continued*)

Criteria	Poor	Fair	Good	Excellent
Communication Skills	Poorly written or unclear responses that do not effectively convey the student's understanding of the subject matter	Responses that are generally clear and understandable, but may contain errors or lack detail	Well-written responses that effectively convey the student's understanding of the subject matter, and provide sufficient detail and examples	Exceptionally well-written responses that demonstrate a mastery of the subject matter, and provide clear, concise, and detailed explanations with appropriate examples

be prepared to advocate for the SDGs both inside and outside of the classroom to truly make a meaningful impact on student awareness and action. Additionally, while incorporating SDGs into assessments is a step in the right direction, it is important to recognize that this alone is not sufficient in achieving sustainability goals. A holistic approach that includes changes in curriculum, teaching methodologies, and institutional policies is necessary to truly foster a culture of sustainability in higher education. By embracing sustainability in all aspects of education, we can prepare a new generation of informed and empowered individuals who are capable of creating a more sustainable future for us all.

4 Summary

The SDG 4 Target recognizes ESD as an educational strategy. Through the implementation of this strategy, students are equipped with the information, skills, and mindsets required to make progress toward achieving sustainability. Even though many educational institutions have adopted ESD pedagogies, little is known about the effectiveness, quality, and subject matter of educational programmes focusing on sustainability. This paper has discussed the strategies that can be used to raise SDG awareness is educational assessment. It is critical for educators to devote a significant portion of their attention to the development of assessment techniques capable of making a positive contribution to their students' overall educational experience. When a comprehensive assessment plan is implemented, students can apply their skills and knowledge to uncertain scenarios that are like those they would face in the real world. According to the SDGs Report 2022, there is little grassroots understanding of the SDGs and the 2030 Agenda. Assessment can be used by educators to raise students' awareness of the SDGs by tying assessment questions or activities to the SDGs. Summative and formative assessments are both appropriate for increasing SDG knowledge; however, before using either type of assessment, educators must first be prepared to advocate for the SDGs both in and out of the classroom. Finally, diversifying assessment techniques and methods at higher education institutions can increase community knowledge of the SDGs.

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Learning Technologies

A Self-diagnosis Medical Chatbot for H5N1 Virus

Vinothini Kasinathan[1(✉)], Aida Mustapha[2], Ooi Zhen Wei[1], and Tham Hoong Ching[1]

[1] Faculty of Computing, Engineering and Technology, Asia Pacific University of Technology and Innovation, Technology Part Malaysia, Bukit Jalil, 57000 Kuala Lumpur, Malaysia
vinothini@apu.edu.my

[2] Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, 86400 Panchor, Johor, Malaysia

Abstract. Chatbots are everywhere these days. This paper presents a chatbot, Hans, that is designed for dealing with the public during a H5N1 pandemic. Hans provides a natural way of educating the public on health safety measures with its conversational ability. Users are able to perform self-assessment for H5N1 infection and receive suggestions on preventive actions from the virus spread. Hans is developed based on the Verbot tool with C# programming platform. User Acceptance Test is carried out via an online questionnaire distributed among 30 respondents. The results revealed favorable feedback from the users on the roles and capacity of Hans in providing information and diagnosis on H5N1. Hans is hoped to assist the frontliners in terms of improving service times, reducing workload, and saving costs in manning the medical team.

Keywords: Conversational Agents · Chatbot · H5N1 Virus

1 Introduction

Influenza A virus of subtype H5N1 (A/H5N1) or commonly known as the "bird flu" is a subtype of the influenza A virus that can cause illness in human and many other animal species. This virus originated from bird and it can be transmitted to human via air. H5N1 virus started from poultry in southern China and was transported by wild migratory birds to Qinghai Lake in west China [5]. The virus was then spread out from the Southeast Asia region into Europe, the Mediterranean and Africa through the rest of 2005 and 2006 [12]. The virus continued to spread in Africa, west and northwards in Europe and through the Middle East and South Asian subcontinent in 2006 and 2007.

Although the outbreak ended in 2007 [3], this virus still exists worldwide with occasional spike in certain countries. Public awareness is crucially important as the infection rate and the lethal rate is high. The most ideal approach to avoid getting H5N1 virus is to get influenza antibody consistently. Because H5N1 infections develop continually, the World Health Organization (WHO) advised that individuals are ought to get inoculated not long before the flu season starts for the best inclusion, although getting immunized any time during flu season is also able to prevent influenza contamination [14].

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https://doi.org/10.1007/978-3-031-34754-2_11

H5N1 is the principal pandemic in history where innovation and web-based media are being utilized to guard the public through massive information dissemination. Lack of information can be unsafe to individual physical and emotional wellness as it leads to helpless recognition of general wellbeing measures. Empowering the public with pandemic information and risks is the best way to control the pandemic.

One of the recent information dissemination innovations is the chatbot or conversational agent. Chatbots have recently been deployed in various industries such as e-commerce [11] and even in the on-going pandemic, the Coronavirus or Covid-19 [4]. A chatbot is a natural way of educating the public on health safety measures to contain the pandemic due to its natural conversational ability. A chatbot is able to suggest preventive actions to protect the public from the virus as prevention is better than cure. The public will also be able to diagnose themselves if they encounter any of medical symptoms that potentially relate to H5N1. A chatbot will enable the public to detect the disease immediately and get treatment from the nearest health institution.

As part of an intervention effort in addressing the H5N1 pandemic issues, this paper proposes a chatbot based on an expert system architecture that is able to communicate with the general public in natural language, which is English. The objective of the chatbot is two-fold. The first is to serve as a knowledge portal that offer answers on general information about the virus, similar to question and answer list in a Frequently Asked Question (FAQ) section of a website. Basic knowledge such as the symptoms and available medication should be made available through this chatbot as the first barrier of entry of a medical consultation so as to alleviate the burden among the medical personnel in attending questions during critical pandemic times.

Secondly, the chatbot is able is to offer an expert system service that can guide the public to perform self-assessment when they encounter symptoms that possibly caused by the virus before admitting themselves for further treatment. This role is similar to a triage system at the emergency room in a medical facility. Since the main users are the general public, self-assessment should not be too technical and should be able to be performed at home. This means when a patient is aware of the suspected symptoms, he or she can verify the information through the chatbot as soon as possible, without having to wait for face-to-face consultation.

Expert systems have been widely used in the medical field to provide a decision-making support in the form of diagnosis or prognosis [3] such as in kidney disease [1] or ear disease [2]. An expert system is used to help identifying the disease that affects the whether the kidney or the ear through identifying the symptoms based on a list of symptoms given by a particular system. A common data collection method from the users is through multiple questions and users will need to answer the questions by choosing the answer options (YES/NO or TRUE/FALSE). The expert system then examined the answer and calculated the outcome of the prediction at the end of the process. When the user sends the first symptom through the symptoms user interface, the symptoms checker interfaces with the inference engine to send initial suggestion to the inference engine, which then generates possible groups of symptoms based on some set of rules, back to the user.

In [6], the system uses the user dialogue which is represented as a linear design which proceeds from the extraction of symptoms to the mapping of symptoms where the matching symptoms is then distinguished and the patient is then diagnosed if the disease is considered as a minor or major. If the disease is major the patient will be referred to the correct doctor with the details taken from the database. Chatbots add values to the expert system through its conversational ability. Recent chatbot dealing with Covid-19 used the logic of Artificial Intelligence Markup Language (AIML) to survey the current client ailments by picking up suggestive catch-phrases. The chatbot then assess the seriousness of the infection through input from a predefined survey. At the same time, if the user neglects to recognize exact answers, the bot will neglect to give the right reaction. After the assessment of a user's condition, the chatbot gives a conspicuous reaction as either conventional content or text recovered from the information base reaction [4].

Medical institutions across the globe are redefining patient engagement laws in leveraging the power of conversational AI and chatbot solutions, in line with research in raising awareness on Dengue virus [8] and medical centers [9]. To support these movement, the objective of this paper is to develop a chatbot prototype with conventional abilities to spread awareness and self-assessment among users with regards to H5N1 virus. The remaining of this paper will continue with prototype implementation of the H5N1 chatbot in Sect. 2, followed by its evaluation in Sect. 3. Finally Sect. 4 will conclude the paper.

2 Materials and Methods

This paper proposes a chatbot called Hans for dealing with the public during a H5N1 pandemic outbreak. Hans is developed using the tool Verbot, which offers a combination of Artificial Intelligence and Natural Language Processing capabilities to create an engaging virtual personality to perform a particular task. The coding platform for Hans is C# under Windows 7.

2.1 Knowledge Base

Figure 1 shows the sematic networks for Hans's knowledge base. The information are sourced from online public sources. Next, Fig. 2 shows the one of the rules in the knowledge base.

2.2 Prototype

Upon starting, Hans will first ask for user's name for future screens. The chatbot will also greet the user based on the day. Some algorithm is used to determine the time for the user initiate. As example, the screenshot time is at 10am, so the chatbot will greet the user "good morning". This interaction is shown in Fig. 3.

In this screen, user will be presented with options: Intro, spread, symptom, cure, prevention and FAQ and diagnosis. The user will have to enter any one of these to proceed. There will be a message to teach user to ask the chatbot to repeat the answer that given by it previously. If the user presses Intro, the screen will present general introduction about the influenza virus. If the user wishes to know more related information, they could choose the rest of the items such as the origin and the outbreak. If the user chooses

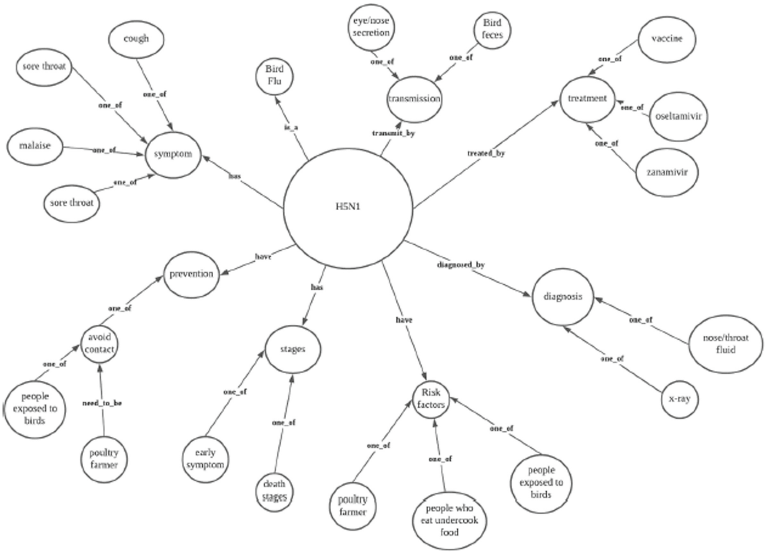

Fig. 1. Sematic network for Hans

Rule Name: 3. Symptom
Input Text: 3
Input Text: Symptom
Input Text: 3. Symptom
Output Text: The symptoms of H5N1 infection may include fever and malaise, cough, sore throat, and muscle aches.

Below are other information that I know:
1. Rare early symptom
2. Phase 2 symptom
3. Death
4. Diagnosis method
0. Main Menu
Rule Name: Rare early symptom
Input Text: 1
Input Text: Rare early symptom
Output Text: Other early symptoms may include abdominal pain, chest pain and diarrhoea.
Rule Name: back
Input Text: *
Output Text: <send 3. Symptom>
Rule Name: Phase 2 symptom
Input Text: 2
Input Text: Phase 2 symptom
Output Text: The infection may progress quickly to severe respiratory illness (for example, difficulty breathing or shortness of breath, pneumonia, Acute Respiratory Distress Syndrome) and neurologic changes (altered mental status or seizures)
Rule Name: back
Input Text: *
Output Text: <send 3. Symptom>

Fig. 2. Rules for the keyword "Symptom" in the knowledge base

to know about the outbreak, Hans will offer the full report of the updated lethality rate. An expert of conversation with Hans is also provided.

HANS: Dear Ali, H5N1 is type of influenza virus that causes a highly infections, severe respiratory disease in birds called the Avian influenza or "bird flu".
HANS: Human cases of H5N1 Avian influenza occur occasionally, but it is difficult to transmit the infection from person to person.
HANS: When people do become infected, the mortality rate is about 60%.
HANS: There are more things that I know.
HANS: 1. Origin

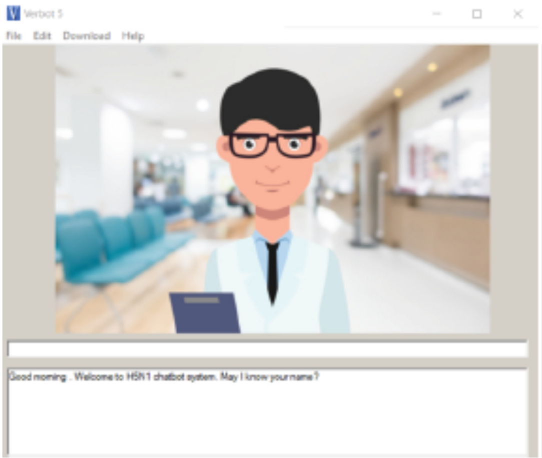

Fig. 3. Faces of Hans

HANS: 2. Outbreak
ALI: 2
HANS: Globally, from January 2003 to 4 February 2021, there ere 862 cases of human infection with Avian influenza A (H5N1) virus reported from 17 countries.
HANS: Do you want to see the full report or lethality rate?
ALI: I want to see the full report.

In the conversation, user asked for the full report, therefore Hans will display a Wikipedia entry of the global spread of H5N1 so the user can check out the accurate numbers in the page as shown in Fig. 4. The ability to extract new information real time is important rather than storing them statis in the knowledge base. This can guarantee the dynamic of Hans knowledge base.

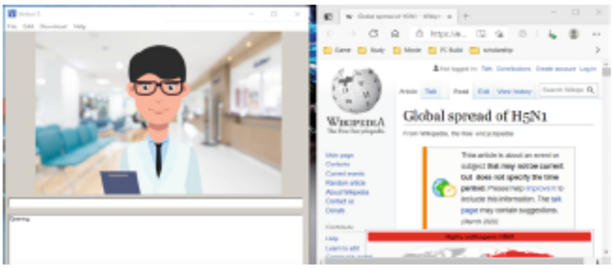

Fig. 4. Specific output from input initialization

Back in the menu, choosing FAQ bring the user to this screen where user is given more selections to answer the FAQs. The user will be first asked if they have fever as the very common symptoms of flu is high temperature. If the user is below 38c then they are most likely have not caught the flu. The other evident symptoms will be cough, headache, sore throat and runny nose that can be used as dip stick for flu virus too, if the user have it then system will decide if the user is likely to have caught the flu. Just to be extra sure, Hans will also ask if the user have been to countries with H5N1 outbreaks as people are more likely to catch it when they were in those areas. Therefore, it will be better to check up regardless.

To help users to perform self-assessment for H5N1, Hans asks series of probing questions as follows.

HANS: What is your current body temperature?
HANS: Do you have cough, headache, sore throat or runny nose these few days?
HANS: Do you travel to any H5N1 pandemic area for the past 1 week?

Then, based on the answers by the users, Hans provides sample responses as follows.

HANS: Dear Ali, H5N1 is a type influenza virus that causes a highly infectious, severe respiratory disease in birds called the Avian influenza or "bird flu".
HANS: Human cases of H5N1 Avian influenza occur occasionally, but it is difficult to transmit the infection from person to person.
HANS: I'm not sure whether you get infected by H5N1, but you better go for a medical checkup as you just came back from the infected areas.
HANS: Cheers! You're clear from H5N1 symptoms and you're healthy.
HANS: You probably get infected with H5N1 please immediately go to the nearest hospital or call 999 for immediate medical assistance.

Hans also provides quiz to the users. Finally, if the user input the character that is unidentified the by the chatbot, Hans will inform them and recommend them to go to the main menu. Then, user will greet goodbye when they input "Goodbye" to exit. The application will be closed once user hit enter button again.

3 Result and Discussion

The prototype of medical chatbot for H5N1, Hans, was evaluated via User Acceptance Testing (UAT). UAT, also known as beta or end-user testing, is part of Software Development Lifecyle [13]. It is defined as testing a software or mobile application prototype by the user or client to determine whether it can be accepted or not.

To test out the user acceptance, an online questionnaire was used as a method of getting feedback from 30 respondents to appreciate the response towards the developed chatbot. The system was given to 30 respondents to use and asked them to answer five (5) questions in the User Acceptance Form based on their experience of the chatbot system. The statements are as follows:

- Hans chatbot help me to know more about H5N1 virus.
- The interaction with Hans is very attractive and smoothly.
- Hans gives sufficient information about H5N1 virus.
- The answer style given by Hans is close to human reply.
- With the help of Hans, I don't need to look for doctor for further advice.

The first question which was sent out asking the users how much Hans Chatbot knows information about H5N1 virus. The results are show in Fig. 5. The first statement was used to determine the output given by the Hans chatbot was helpful for user to know more about H5N1 virus. Most of the respondents agreed to this statement, which both 46.7% of respondents "Agree" and "Very Agree". However, 6.6% of respondents feel neutral about the information which Hans provide. For this kind of problem, some respondents may feel the information provided by the Hans chatbot is insufficient and outdate. For example, Hans chatbot cannot update the latest information about H5N1 virus. Lastly, the chatbot should be improved by giving more lates and usefulness information about H5N1 for users have a better experience.

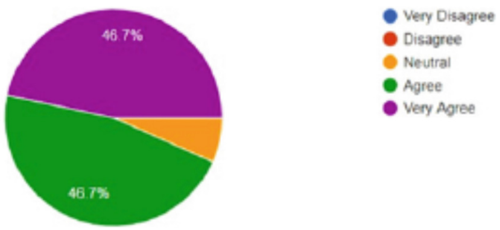

Fig. 5. Hans chatbot help me to know about H5N1 virus

The second statement asked whether the interaction with Hans is very attractive and smoothly. The results are shown in Fig. 6. The interaction with Hans chatbots is included the avatar and the chatbot application pictures background. For the avatar, the team adopted the design from a mobile game called Genshin Impact. We believe that by introducing an anime character will attract the user to user more with the system. The avatar will have animation based on the pronunciation of the word and it will smile to the user in some cases.

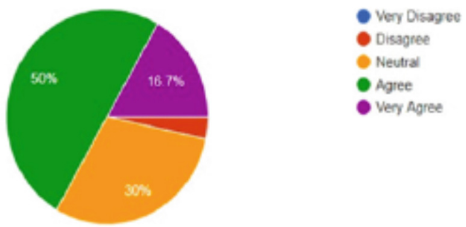

Fig. 6. The interaction with Hans is very attractive and smoothly

The output of the chatbot also is designed as closed as a normal human reply. According to the responses, half of the respondents "agree" and 16.7% if the respondents "very agree" the statements. This result showed most of the respondents feel attractive with the interaction of Hans chatbot. However, 30% if respondents "neutral" and 3.3% if respondents disagreed about the interaction with Hans. As a result, the chatbot is not perfect and it still need to some improvement. For example, more animation and effects could be added to the avatar instead of just moving its mouth while talking.

The third statement questioned if Hans knows all about H5N1 virus. The results as in Fig. 7. The statement "Hans knows all about the H5N1 virus" was used to determine whether the Hans Chatbot required an adequate knowledge-based about the H5N1 virus. The graph shown that 88% of respondents "agree" and "very agree" that Hans has equipped sufficient information about H5N1. However, it got 16.7% of respondents feel "neutral" of the information that Hands provide. It means systems still need some improvement about the detail of data and update latest information. For example, the outbreak of the virus can be explained more by the chatbot before redirect user to the webpage. Next, all answers from the chatbot need to be added with more detailed information. This information can be set as optional to the user to decide to see or not. More scientific knowledge can be also added into the chatbot which as some scientific term or explanation to improve the professionalism of the chatbot.

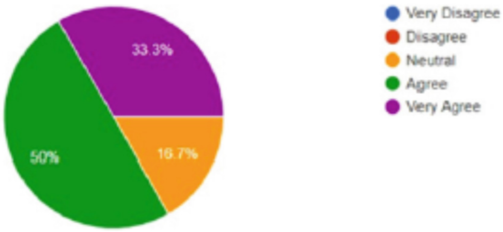

Fig. 7. Hans gives sufficient information about H5N1 virus

The fourth statement asked if the answer style given by Hans is close to real human reply. The results are shown in Fig. 8. This statement is designed to determine the chatbot system whether it has a regular communication ability like human being. As the graph shows, most of the respondents accepted the ways of Hans speaks, with 63% "agree" and 13.3% "very agree". It proved that users are having nice communicate experience between users and Hans chatbot. Nevertheless, 23.3% respondents feel "neutral". Therefore, programmer needed upgrade the humanization of Hans's reply style can be more realistic. Additional conversations like "Are you okay", "I am waiting for your reply" can be introduced in the future. More emotional expression can also be added such as wow, sad or angry.

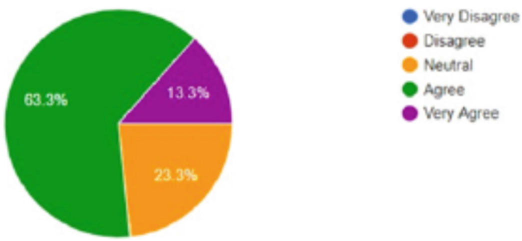

Fig. 8. The answer style given y Hans is close to human reply

The final statement states an opinion that with the help of Hans, users do not need to look for doctor for further advice. The results are shown in Fig. 9. In this statement, it requires to determine does the users are necessary to look for doctor for further diagnosis advice. From the user acceptance testing results, there are polarization response between agree or disagree, it is only 50% of respondents accepted about this statement which only 33.3% "agree" and 16.7% "very agree". Moreover, there are 26.7% "neutral", 20% "disagree" and 3.3% "very disagree". That makes a total of 50% respondents.

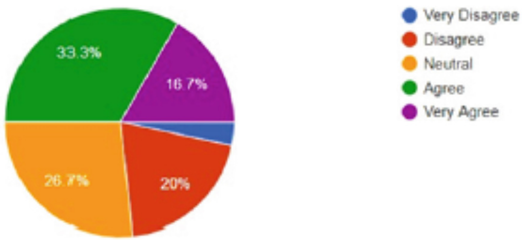

Fig. 9. With the help of Hans, I don't need to look for doctor for further advice

From the results, the responses are mixed and it can concluded that medical officers ae needed to complete the diagnosis. The team accept the response as t the end human is the most accurate and suitable field to get the most accurate information and get the correct diagnosis result.

4 Conclusions

This paper presented a chatbot prototype for H5N1 diagnosis and prognosis called Hans. Hans is aimed to assist the general public when it comes to getting to know the influenza virus (H5N1) better. Evaluation conducted revealed few issues to be addressed in the beta version. Based on the user feedback, the interaction with users had more to be desired. As for now, the user keys in the number to trigger a response. In the future, Hans is aimed to implement trigger keywords and also utilize Machine Learning (ML) methods such as clustering or Natural Language Processing (NLP) methods such as Named Entity Recognition (NER) to identify similar keywords to the assigned trigger keywords.

Users also requested for more symptoms so that users can have more chance to stumble on and find out if they can catch the virus. Finally, Hans is character avatar and voice pack need to be improved to make the system more attractive and relevant to local community. Future enhancement may also include other languages as in [7]. Healthcare and health-tech chatbots are on the rise to improve patient experience, assist medical personnels to improve health care systems and revealing valuable insights. Overall, the proposed chatbot solution for assisting the public during pandemic times is hoped to improve the service rate in terms of responsiveness, reduce the workload among medical assistants and medical officers during the outbreak, save costs as compared to hiring more medical staffs as the information dissemination front liners.

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Science to Life: User Experience in Children's Science Book with Augmented Reality (AR)

Vinothini Kasinathan[1](✉), Aida Mustapha[2], Noor Hanifah Husain[1], Aida Zamnah[1], and Rizawati Rohizan[1]

[1] Faculty of Computing, Engineering, and Technology, Asia Pacific University of Technology and Innovation, Technology Park Malaysia, 57000 Kuala Lumpur, Malaysia
vinothini@apu.edu.my

[2] Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, 84600 Panchor, Johor, Malaysia

Abstract. This paper proposes an interactive Science book called Science to Life that is supported by Augmented Reality (AR), based on Malaysian Science textbooks from Year 1 to Year 6. The AR application is developed using Unity 3D with the support of the Vuforia engine. The evaluation showed favorable feedback from the users on the roles and capacity of Science to Life in educating young students on the Science subject. This AR book is hoped to spark interest among primary school students to learn and master the Science subject.

Keywords: Augmented Reality · Science · Education

1 Introduction

In recent years, technologies such as Augmented Reality (AR) and Virtual Reality (VR) have been significantly improved for vivid user experience through a screen. These technologies can be used for many educational platforms in order to help students to learn any subjects that require interaction with real objects safely in their own environment. AR technology is capable of educating children through visualization of the subjects that they are learning. AR is often regarded as one of the most promising technologies currently available. Following the smartphone revolution, everyone now owns a mobile device, and all of these mobile devices often include a CPU, GPS, a display, a camera, a microphone, and other components that make AR possible (see https://www.onirix.com/).

The way AR works is that it understands the surrounding of the real world by interpreting the Computer Vision from the device camera and displays its digital content on the screen where it assimilates its content with the real-life environment. Computer Vision is a technology that understands real-world environments, it recognizes any objects (semantics) that are already in position (geometry) where it scans the linked mark that has already been rendered to display digital content through the screen in AR. This is called a marker-based AR where it needs some kind of mark or code to recognize the function of displaying the AR.

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The way AR display digital content is that it needs specific objects to be recognized, once the technology recognizes a certain object, it then starts to render the digital content onto the camera which displays it on the screen of a device. For example, the most popular use of AR is in social media platforms such as Instagram, Snapchat, Tiktok, and more. These ‘filters’ recognizes the facial feature through the user’s camera that triggers to display of the rendered AR on the device’s screen, this allows users to visualize any subject of either logical or non-logical content in the real world. Another example of AR is markerless AR which requires understanding the 3D space in the real-world environment, which triggers to display of the content as if it is in the real world. Figure 1 shows examples of some AR applications.

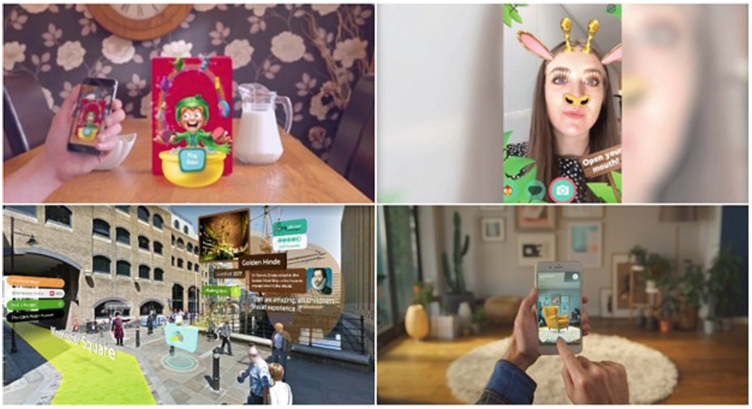

Fig. 1. Examples of AR applications.

Since AR has widely spread around the world, the use of AR has increased, and more people are demanding AR for their daily life. Many AR application has developed over the years, and creating a new idea of using AR is nearly impossible since there are millions of ideas that relate to AR has already been patented [5]. Augmented Reality has been used across many subjects such as scenery [3], autism [4], epidemiology [1], and anxiety [2]. Science is one specific subject that would benefit from the use of AR in visualizing real-life body parts such as organs and bones, animals, planets, and more. By using AR, the 3D models that are usually presented in a classroom or laboratory setting can be made available to students at their own convenience. AR is best at this type of subject as it allows students to interact with the objects in a full rotation.

As such, this paper proposes an interactive Science book called ‘Science to Life’ that is supported by Augmented Reality. Two applications that are comparable to the augmented reality book project under study include Arpedia and Augmented Classroom. Arpedia provides a variety of education and culture services in three different ways targeting the entire age spectrum from children to adults, including not only children reading and learning services but also the publication of books in various genres. Their idea is to deliver a book that has AR features (https://www.arpediabook.com/. Comparing Arpedia to this project, Science to life specifies the subject of knowledge which helps students to learn efficiently. Whereas Arpedia provides a wide range of subjects for the student to learn from.

Another similar system is called Augmented Classroom. This is a browser-based technology that allows students to learn about plants and animals while also exploring the globe. Students may engage in a range of activities, learn about the curriculum, and test their understanding of topics such as geography, meteorology, geometry, and space. Students may also interact and create with students from all around the world using Augmented Classroom (https://augmented-classroom.com/). Compared to Science to Life, the Augmented Classroom system needs an Internet connection to be accessed.

Table 1 compares similar augmented reality-based systems with Science to Life. Although Arpedia and Augmented Classroom provides various types of subjects for children, both systems require Internet connection to access the content. Science to Life on the other hand, is a standalone mobile apps that does not requires the Internet. Another convenience of Science to Life is that learning only requires a physical book and an application that can be installed on a smartphone. By this comparison, Science to Life hoped to encourage children to learn on the go and increase their knowledge over time.

Table 1. Comparison between the similar and proposed system.

Science to Life	Arpedia	Classroom
Education tracking	Yes	No
Internet connection	Not Required	Required
Games and quizzes	Yes	No
Platform	Apps, book	Apps, book, flashcard Browser
Type of AR	Marker-based	Markerless
Subject provided	Science	General

2 Materials and Methods

This paper reports the design and development of a children's Science book that is equipped with Augmented Reality (AR) technology. The application for this project was made in Unity 3D and with the support of the Vuforia engine, and the book was designed in Adobe InDesign. From gathering information from Malaysian Science textbooks from Year 1 to Year 6, resources from freepik.com, and 3D models from sketchfab.com. Using Vuforia Engine in Unity, the AR technology can be implemented in the application with imported assets such as Vuforia AR camera and image target. And in order for AR to work, several image targets have been implemented in the unity project to ensure the system works perfectly when scanning the visuals from the book.

This project consists of a book that has been designed based on the information and knowledge gathered from the Science textbook, websites, and YouTube Science

Tutorial videos. This science book includes visuals and elements of science such as animals, microorganisms, dinosaurs, and more. There are sections where the users can revise their knowledge of science.

2.1 Design

This project requires researching detailed information and resources to design, model, develop, prototype, test and implement the proposed Augmented Reality book for Science to Life as shown in Fig. 2.

Fig. 2. Project plan flowchart.

The whole design of this book is to reflect the children expectation of how a book should be, the design of the book consists of many graphics, colors, patterns, and images. This allows the children to identify and visualize the elements in the book, and also makes it easy for the children to understand Science.

2.2 Prototype

There are 2 main features that have been included in this project, the main feature is as mentioned the Augmented Reality (AR) technology feature. The AR technology is bound to the printed Science book that consists of texts, visuals, and graphics. Figure 3 shows the Science to Life book along with the mobile application and finally the augmented reality feature in action.

3 Evaluation

For this project, conducting an interview and distributing questionnaires is the most suitable type of research method. This allows us to understand the perspective and opinions of other individuals about this application, this method also will determine

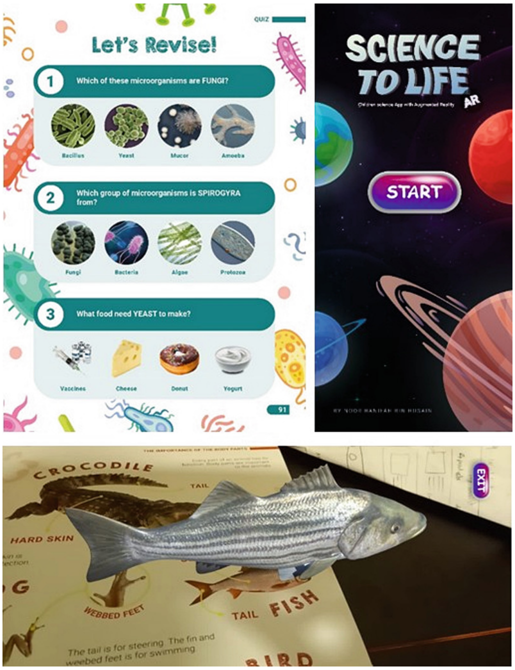

Fig. 3. From book to apps to AR in action.

whether this project would be beneficial for the targeted audience. For the interview, a set of questions related to the project and AR will be asked to the targeted audience which are children from age 6–12, primary school teachers, and also parents who have children ages 6–12. The sample of demographic questions is as follows:

– What is your age group? (18–21/22–25/26–29/30+)
– What is your gender? (Male/Female)
– Do you have children? (Yes/No)
– What is your occupation? (Student/Part-time/Employed/Unemployed/Other)

The interview will also include questions that related to children's education and their opinion about the education system in the future. The sample of interview questions are as follows:

– What do you think about the children's education system right now?
– How long do your child/students spend time with their smartphones daily?
– Is a smartphone a good platform for children's education?
– What is your opinion on Augmented reality for children's education?
– Do you think Augmented reality can improve the children's education system?
– What do you think about this proposed 'Science to life' project that aims to improve children's education by implementing AR?
– Do you think this application would be beneficial in the future?

- What are the other suggestions that could improve this project?

Another evaluation method is the questionnaire, this method would be conducted by distributing a survey via Google forms. This survey determines others' perspectives and opinions upon developing this application, which allows us to understand the scope and the objective for this project. The sample of the questionnaire is as follows:

- What is your operating system? (Android/IOS/Other:)
- How often do you use a smartphone? (Rarely – 1 – 2 – 3 – 4 – 5 – Frequently)
- What do you use smartphones for? (Social media/Entertainment/Education/Business/Productivity/Other)
- How familiar are you with Augmented Reality (AR) technology? (Totally unfamiliar – 1 – 2 – 3 – 4 – 5 – Very familiar)
- Does your current smartphone support AR technology? (Yes/No/Maybe)
- Have you used an Augmented reality (AR) app before? (Yes/No)
- If yes, which application have you used for AR?
- Do you think smartphones can be used for education for children? (Yes/No)
- If no, what is your opinion on why education for children through smartphone is not necessary.
- Which do you think is suitable for children education in this era? (Books/Smartphones/Laptop/Computer)
- Does graphic and animation attract children? (Yes/No)
- Do you think children prefer 2D or 3D graphics? (2D graphics/3D graphics)
- Do you think AR technology can be implemented in children education? (Yes/No)
- If no, why do you think AR technology can't improve the education system for children?
- Do you think AR technology can make learning more interesting for children? (Yes/No)
- Do you think children would be interested in this concept of Augmented reality (AR) education? (Yes/No)
- If yes, why do you think AR technology benefits children education?
- In your opinion, what other features need to be added to this system?

After compiling the questions, it is now time to distribute and interview the selected individuals to gather the data for the research of this project. Surveys will be distributed online where it is easy to gather and get people's opinions in a short period of time. By using Google Forms, it is easier to summarize the survey by using the pie chart and graph that have already been implemented in the tool. The interview would be conducted via online video call and also face-to-face.

The findings in Fig. 4 show that most of the participants are in the age group of 22–25. This question doesn't really affect the project since the target audiences of parents and teachers can be aged above 30.

Figure 5 shows the main purpose use of smartphones among children. From the graph findings, it is understandable that most participants use smartphones for social media, entertainment, and education, which is the main usage of this system.

Figure 6 shows the findings for a question that asks whether children can use smartphones for education. From the findings, 92.7% of participants think that smartphone can be used for children's education while 7.3% disagrees.

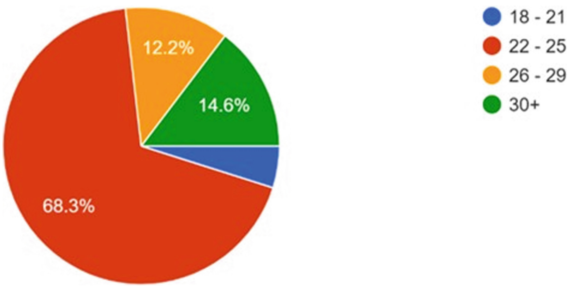

Fig. 4. Age demographic.

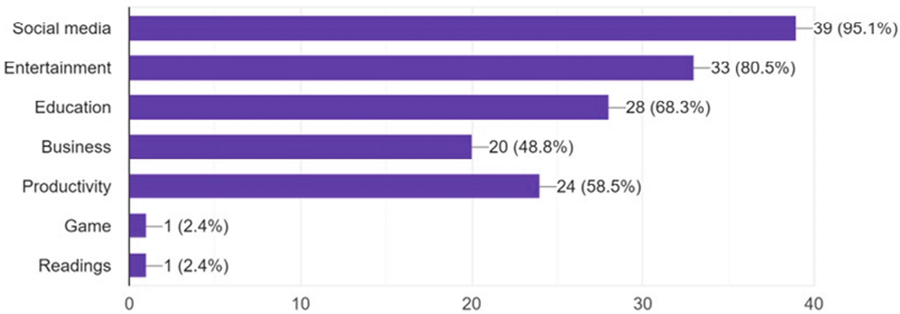

Fig. 5. Purpose of using smartphones.

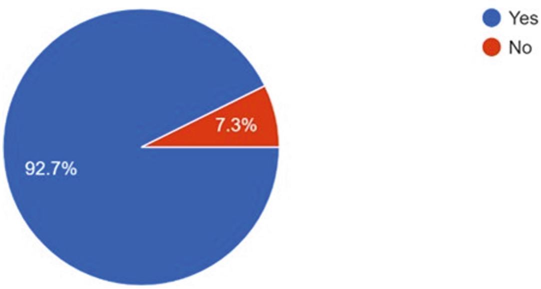

Fig. 6. Do you think smartphones can be used for educating children?

Finally, the findings in Fig. 7 show that all respondents agreed that the application is very useful for children.

It is hoped to provide primary school students to further enhance their learning experience at their own pace and comfort.

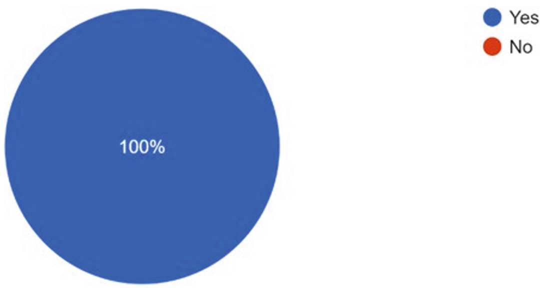

Fig. 7. Does this application useful for children?

4 Conclusion

This paper proposed the use of Augmented Reality (AR) technology in Science education via a physical book called Science to Life. This is a traditional textbook that covers the subject for children between the age of 6 to 12. In addition, this book also contains illustrations that can be scanned with the AR camera from the accompanying mobile application. The AR camera is used to scan a mark or a code from a children's Science book and activate the AR content. This capability allows children to understand the actions of the scanned subject via sound, animations, movements, and interaction. Overall, one main challenge for completing this project is to model the 3D science elements for the AR application, because visualizations need accuracy in both aspects of animation and appearances.

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An Interoperable License Management Component for Educational Content

The-Anh Nguyen[1](✉), Christopher Krauss[1], Truong-Sinh An[1], Boris Heithecker[2], Patrick Neiss[3], and Frank Ziegler[3]

[1] Fraunhofer Institute for Open Communication Systems FOKUS, Kaiserin-Augusta-Allee 31, 10589 Berlin, Germany
{the-anh.nguyen,christopher.krauss, truong-sinh.an}@fokus.fraunhofer.de

[2] Landesinitiative n-21: Schulen in Niedersachsen online e.V., Schiffgraben 27, 30159 Hannover, Germany
heithecker@n-21.de

[3] Verband Bildungsmedien e. V., Kurfürstenstraße 49, 60486 Frankfurt am Main, Germany
{neiss,ziegler}@bildungslogin.de

Abstract. So far, it is the exception - at least in Germany - that digital school content from publishers is presented in the learning platforms used by schools. On the one hand, because contents are usually only available in proprietary formats. On the other hand, because the necessary license information and assignments to user IDs cannot be mapped.

This paper presents an interoperable license management component that aims to bridge the gap between educational content providers and learners' learning platforms, thus enabling seamless access to different educational content. The proposed solution enables different proprietary license definitions to be mapped to a standardized exchange format while allowing learners to access content from different providers' target systems. The novel approach integrates known partial solutions, models an authorization mechanism, and provides a management interface for easy visualization and modeling of rights of use for digital content.

The license management component is intended to meet the needs from media providers, real schools, realized on the example of the German state of Lower Saxony, as well as their students and must be as interoperable and flexible as possible for reusability. The uninterrupted perception by users of the publisher's content integrated in this way for the first time in a school learning platform still must be proven by user tests. The work to be done next includes large-scale evaluations, assessment of the practicality of the management interface, and possible integration of payment processes. Overall, this work demonstrates a prototype of a license management component that adequately addresses the challenges of interoperability in education.

Keywords: Open Digital Rights Language (ODRL) · OIDC · Educational Ecosystems · Interoperability

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1 Introduction

The use of licensed digital educational media from different sources is complicated by media disruptions and a variety of registration procedures and user accounts. In addition, the processes of obtaining licenses and assigning and managing user rights for users by the respective institution are often time-consuming and involve a great deal of manual effort.

Using a middleware for license management as a link, the diverse systems and applications can be integrated and used in a simple and legally secure manner. As a technical link in interoperable IT architectures, this middleware enables data to be exchanged between users, applications, registration servers, content providers and license providers via standardized interfaces. In addition to efficient management of usage rights, this enables the seamless and uncomplicated use of digital educational media.

Education providers want to offer their digitally content to licensees in an online format. Licensees are usually school representatives who have purchased the licenses in advance on an online marketplace so that their students can consume this content. The problem is that the school representatives or learning resource managers (hereafter LRMs) have their own authentication service, e.g., used for their learning management systems (LMS), for their users, which must be adapted to the specific conditions of the online platforms of the respective content providers, so that it is presented to the students in their learning management system. These learning management systems are usually tightly interlocked with the product access of a school's authentication service on the one hand and the content provider on the other. Furthermore, there are metadata providers that can either be operated independently or are available as part of the content provider and provide information regarding the presentation in the learning management systems. Besides, the authorizations resulting from the individual license agreements of the online marketplaces must be assigned either to individual users or to groups and functionally visualized in a management UI, which only the LRM has access to. In this constellation, the number of product accesses to stand-alone solutions that an LRM uses and must distribute to their users is linear with the number of educational providers defined in the purchased license agreements, which requires that a solution be created that allows school institutions to access any number of content providers via the respective authentication service and learning system using assigned licenses. The problem that students are often tied to their own ecosystem and can only access a select range of learning content through product access has resulted in past projects such as the Fraunhofer Common Learning Middleware[1] (CLM) that allows product access to external systems using specified standards through a single-entry point. There are also industry products such as the German Bildungslogin[2], which has recognized the problem and is attempting to provide a digital Media shelf of enhanced E-books in conjunction with the major textbook publishers Westermann, Klett, Cornelsen and participating schools, so that learners can authenticate via Single Sign-On (SSO) to access the bundled content provided by the participating publishers.

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[1] https://www.fokus.fraunhofer.de/de/fame/projekte/clm.

[2] https://info.bildungslogin.de/.

The paper answers the technical question of how, in times of digitization, on the one hand, educational providers can make their licensable digital content available to educational institutions or private consumers and, on the other hand, how users can gain authorized access to a variety of digital offerings without disrupting their user experience.

This paper is structured as follows: First, in the next chapter Related Works, all related concepts and ideas are named that are relevant to the license management component (LMC) and analyzed for their application in the work. Then, the architecture and the technical framework conditions are named under which the LMC is applied. In the chapter Application the generic application is put under test. Finally, it is analyzed to what extent the formulated goals were reached, a look into the future is ventured and a summary of the present work is made.

2 Related Work

This chapter discusses related work and different approaches and discusses the concepts that are mentioned in the literature or that are used practically. These works are instrumental in the design of the license management component and are analyzed with respect to the application. The authors outline the common methods used to effectively secure content in the education domain. The importance of modeling rights in the digital space is addressed by explaining Rights Expression Languages (REL), explaining the need for techniques that facilitate product access to digital content in the educational space to ensure a seamless user experience, while analyzing these concepts for applicability to the solution presented. In the context of related work, this paper is to be seen as a complementary solution that takes the various concepts, adapts them for its own purposes, and synthesizes them into something new.

2.1 Bildungslogin

Bildungslogin is an industry-driven solution that aims to simplify access and distribution for learners and teachers [3]. It is associated with the three large German publishers Westermann, Klett, Cornelsen and other small participating publishers and offers a product that allows students and teachers to access licensed products in application, called Bildungslogin, which is embedded in school platforms or IDAM Systems.

2.2 Open Educational Resources and Repositories

Open Educational Resources (OERs) are free to use and can be integrated into learning management systems. These educational resources can come in any size and can be referred to as learning objects, as they can be used in reusable units in different contexts. These OERs are made available in content repositories usually based on interoperable standards, such as SCORM or Common Cartridge or can also be accessed through LTI. The author Santos-Hermosa [5] has analyzed in his paper the current state of OER content repositories and addresses the question of what practices would need to be undertaken to ensure that an increase in the interconnectivity of these repositories follows so that OERs can be recycled in education. In terms of this paper, OER repositories are an interoperable solution so that learning management systems are empowered to provide their users with a wide range of learning materials, from different content repositories. One problem is that at this stage OERs do not cover the commercial benefit of content providers, as OERs must be in creative commons format, so they do not sufficiently cover the use case of licensing agreements. Furthermore, it is not possible to regulate permissions for individual users or groups and thus to allocate content.

2.3 Rights Expression Language

When it comes to defining the rights of digital content across systems and thereby ensuring that easy consumption is possible for authorized parties, Rights Expression Languages need to be named. The industrial need for interoperability between different systems in the context of rights to digital content has gained importance. Furthermore, rights are not static but dynamic and depend on the utility of the content, license term and other factors. Since the description of licenses on digital content can become complex, standardization efforts have been made for this reason, resulting in several specifications. A major goal of these specifications is to model intellectual claims and make them machine-readable. Many such RELs exist such as ccREL[3], XrML[4], MPEG-21 Part 5[5], with Open Digital Rights Language[6] (ODRL) being given more importance due to market penetration, good documentation, and industry acceptance. In the context of this paper, significant value could be gained from using ODRL to define a user's or group's right to access and consume a piece of digital content.

2.4 SSO

Single Sign On (SSO) is to be named when it comes to interoperability between different services. It means that a user is granted access to different systems or applications with the help of a fixed pair of credentials. Consequently, users no longer must remember multiple passwords, which benefits security because users are more often inclined to reuse the same credentials for other applications [1]. It also provides greater usability and allows users to have a seamless login process. SSO is often used in the education sector, where many online services are accessible via company/school email. A common authorization framework to allow SSO is OAuth2. SAML and Open ID Connect (OIDC) can be used for complementary authentication. SAML 2.0 is based on an XML-SAML format and used in enterprise applications, while OIDC, which is more lightweight and uses JSON Web Tokens, is based on the protocol of OAuth2. Both standards do not differ in the login process, but in the underlying implementation. Because it has greater developer appeal thanks to its simpler implementation [2], this work focusses on OIDC.

3 https://www.w3.org/Submission/ccREL/.
4 http://www.xrml.org/.
5 https://www.mpeg.org/standards/MPEG-21/5/.
6 https://www.w3.org/TR/odrl-model/.

2.5 SchulConneX

The SchulConneX specification, developed by Fraunhofer FOKUS on behalf and together with the Landesinitiative n-21, a state initiative of the German State of Lower Saxony, describes a data model and interfaces of a central identity provider for school purposes considering common standards and technologies, such as Open ID Connect. The SchulConneX standard is narrowly adapted to K-12 education in Germany.

The specification supports two fundamentally different use cases: First, use as a login and context data provisioning service for users of educational services (e.g., LMSs), and second, as a system that allows school information systems (SIS) – managing data of those users – to synchronize data across applications. Access to all endpoints of the REST APIs of the login service are secured by a central authentication and authorization server. Access to the endpoints is possible only with a valid access token issued by this server.

2.6 Learning Interoperability Standards

The need to make learning units modular and usable for different learning management systems brought forth standards that aim at simplifying access to these materials in the core task. Learning Tools Interoperability[7] is a specification developed by 1EdTech[8], which addresses the security demands and the changing nature of the Web and propagates a seamless integration of different learning contents to learning management systems. The counterpart to this is CMI5[9] which was developed by Advanced Distributed Learning[10] (ADL) and is more oriented towards learning analytics but deals with the integration of different systems in a different use case. Both solutions can be understood as SSO solutions that allow access to different systems via one login.

2.7 Common Learning Middleware

The Common Learning Middleware (CLM), developed by Fraunhofer FOKUS, is a background service that acts as a mediator between different educational ecosystems. It offers various standardized interfaces that enable educational ecosystems to be networked [4]. To achieve that, the CLM leverages various open specifications and learning technologies such as LTI, cmi5 or IEE LOM to achieve data/workflow standardization. Thus, educational ecosystems do not have to agree with each other on a common interchange format to allow content playback for each other's platforms, but each can access CLM interfaces that rely on a set of interoperable data interchange formats. Thus, there are two entities that play a role: consumers and providers. The middleware understands a consumer as an application like an LMS or learning experience platform that can come with their own user base or use the CLM's user management. They can access the providers' learning content through the CLM interfaces, while product access is verified for each user. Providers, as the name suggests, offer their digital learning content to the

[7] https://www.imsglobal.org/activity/learning-tools-interoperability.
[8] https://www.1edtech.org/.
[9] https://aicc.github.io/CMI-5_Spec_Current/.
[10] https://adlnet.gov/.

CLM and, thus, to various consumers. The learning content can then be assigned to individual users or groups via interfaces. In this way, the CLM provides a firm link between educational ecosystems. The basic requirement is that both providers and consumers conform to the standard of the CLM, which in turn itself relies on industry-approved specifications such as LTI, making connectivity almost seamless. The biggest advantage of this constellation is that the different ecosystems do not have to adapt to each other so that users of the other platform can obtain the content. The disadvantage is that they all must adapt to the CLM, which consequently forces standardization at the specified interfaces. Thus, for the first time, it has been possible to offer an interoperable solution with respect to the presentation of digital educational content for different learning platforms, even if the educational providers are responsible for different authorization solutions (LTI, CMI5) to verify the authorization. Furthermore, compared to other solutions, an N-N relationship is now at least theoretically possible, with the first node representing the consumers and the user base of the consumers of the CLM, and the second node being the content providers and the platforms of the content providers. However, this requires interaction with the education providers who freely provide their content to the CLM. Since the use case of commercial benefit or modeling interoperable licenses is not addressed by the CLM, the license management component can be seen as supplement solution. CLM can accordingly be understood as an SSO solution, where logging in at a single-entry point causes access to many other content providers.

2.8 Implications for the License Management Component

As mentioned above, there are solutions that have identified and solved the sub-problems (rights mapping to digital content via Rights Expression Language, modular consumption of digital content via content repositories/learning interoperability standards, and management and enrollment of digital content and enrollment to digital content), but these solutions do not address the aggregate problem of legal-commercial consumption on cross-platform content by education providers based on interoperable standards. This is where the presented solution tries to differentiate itself and to design a custom-fit solution that on the one hand allows education providers to delegate rights verification and rights assignment (license assignment) and on the other hand enables education consumers to allow their users a legally media-break-free consumption on educational content.

3 Architecture

The license management component (LMC) is intended to enable users to consume the contents of education providers in a legally secure manner, while at the same time meeting the needs of education providers. The LMC is designed to model the certain rights of use to their content. It mediates data between education providers, learning management systems and their users. Consequently, these systems must comply with the standard of the LMC. The solution presented here attempts to achieve this by modeling compatibility with the third-party systems involved based on interoperable exchange formats.

The following stakeholders are relevant, who would mainly benefit from the license management component:

- **Content provider:** This system makes licensed offerings online and is careful not to validate the rights of use per tenant through proprietary means, but to delegate this to the license management component.
- **Learning Resource Managers (LRMs):** They manage the permissions of learners or groups of learners to access media content via license assignments,
- **Learners**: They are provided with a media catalog of licensed content via group-bound or user-bound licenses. That offering must be media-break-free.

The systems involved, which in another constellation would communicate with each other without the LMC, are highlighted in color in Fig. 1, while the components of the license management component are gray. The external systems were addressed in the problem definition in the introduction and are specified in more detail here with the interaction of the license management component:

- **The Management UI (MGMT-UI)**: is needed to regulate the assignment of rights of a content to a user or group.
- **License Management API**: REST interfaces available to learning management systems to make user-specific queries or for the MGMT-UI.
- **Authentication Services (AS)**: Authentication Services (AS) control the login process or the product access to the learning management system (client system) or to the MGMT-UI. It is an indispensable criterion that the AS support the OIDC workflow. In this project, the AS is based on the SchulConneX specification. Furthermore, if the LMC is to be able to assign rights to users, it is necessary that information regarding the learners and their group memberships can be queried by the license management component.
- **Learning management systems; Management Systems (LMS; also client systems)**: This system is the learners' entry point where user-specific licensed content is displayed.
- **Content-metadata provider**: This system provides information regarding the presentation in the learning system, such as thumbnail, title of the digital content language, etc.
- **Online Marketplace System (OMS)**: This system is used to download the purchased licenses acquired independently of the license management component or to acquire new licenses.

License imports can be performed by communication with license management system or by initiation of license vendors. It will also enable an institution's organizational structure to be synchronized with the LMC. The bundled management functionalities are exclusively available to LRMs, via an MGMT UI. This includes the mapping of existing users from different identity providers, as well as the representation of the hierarchical structure of the organizational units at runtime of a license assignment of a user. Based on the import of the data, the LRM should be able to perform license assignments so that the license-related question can be answered per user. To achieve this, the component provides REST interfaces so that applications such as learning management systems can make digital learning content available to users. The invocation of digital content by

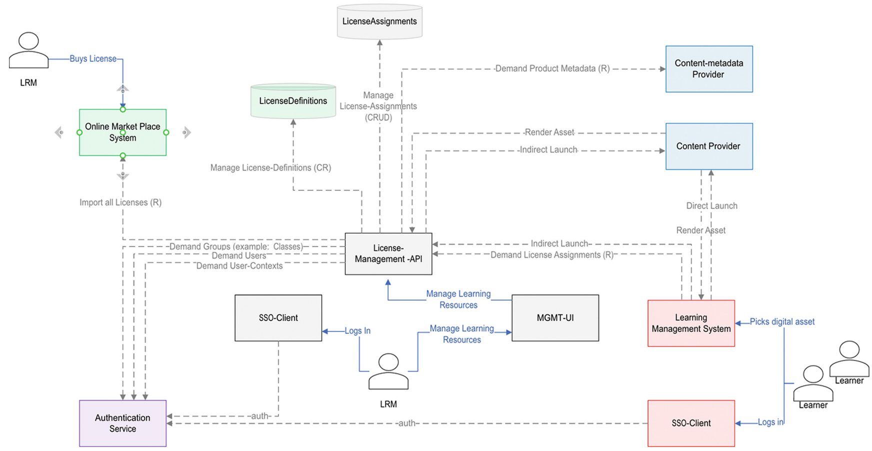

Fig. 1. Architecture

a user leads to the corresponding verification of the appropriate license for the user at the interface of the license management component. The call can be denied if an LRM has not activated the required license for the individual users. For this reason, from an education consumer perspective, the requirement is for education providers to be able to either articulate their need for licenses to initiate a new licensing phase or make an adjustment to the existing license agreement. The learningmanagement systems should be able to make a standardized call against a content provider-based license query per user so that the content can be presented to the user. Any interaction with any of the external source systems requires that an OIDC-compliant workflow has been initiated beforehand.

The class diagram shown in Fig. 2 gives an overview of the data models that will be relevant in the implementation.

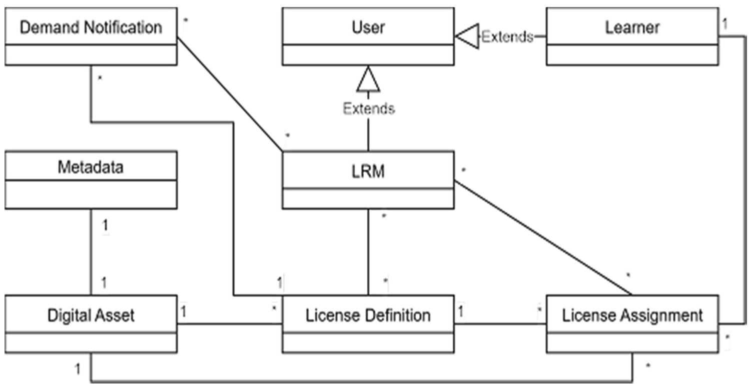

Fig. 2. Class Diagram

A license definition is associated with multiple license assignments. These assignments reference a digital asset that has metadata, where an assignment always belongs to a user and learners can access their own assignments or the learning LRMs can access all assignments. Demand notifications can exist for license definitions, which can be accessed by the LRMs.

3.1 License Definitions and License Assignments

As a first step, license agreements originating from the OMS must be imported into the license management component. These license agreements reflect the right of licensees in which form one or more digital contents may be used. These are usually persisted in a proprietary interchange format, which is why they are mapped internally to the ODRL data format. The exchange format must also indicate where meta information about the digital content can be obtained (metadata provider). Furthermore, license assignments can be made based on these agreements, which answer the technical licensing questions on a user-specific basis.

In general, there are many types of licenses depending on the licensor, while the table below presents three manifestations supported by the license management component and tries to cover most use cases in practice, while future work could build on the existing types to model edge cases.

Table 1. License Types

License Type	Description
Group license	This license can be assigned to on group. All users in the group thereby receive a personal license to access the digital content. A constraint such as that users have a certain role at the time of assignment as well as at the time of launch can be defined
Single license	From this license, only one license assignment can be made to a specific user. Unlike the other licenses, a constraint like a role can be specified here. A constraint such as that users have a certain role at the time of assignment as well as at the time of launch can be defined
Volume License	This license provides the possibility to make the number of license assignments to persons defined in the license definition. A constraint such as that users have a certain role at the time of assignment as well as at the time of launch can be defined

OMSs must allow an export to ODRL up front or a mapping to an ODRL format before the import into the LCM. If the license management component is to be able to define a user's permissions to a digital learning content, it is first necessary to discuss what attributes must exist when bilaterally exchanging or uploading the license definition.

First, the issuer of the license must be named. Since the LRM often wants to assign a contingent of licenses to a school or group, the number of licenses must be included in the license definition. Since educational content usually has a time limit on when the content may be activated, a period of activation should be named. Furthermore, it must be clearly identified to which educational content the license definition refers to, since the client system can use this to query the metadata for the digital assets from the license management component. Since the license definitions differ in their characteristics, it is also important to know what type of license it is (see Table 1) and for which role a license assignment is possible.

If this data is available and mapped to ODRL, the LRM can make a license assignment to the defined content for specific users or groups via the MGMT-UI.

This assignment results in an ODRL compliant representation, as shown in Table 2. The parent definition is referenced by the attribute "inheritfrom". Furthermore, the user-specific permissions are stored in the "permissions" array. Compared to other proprietary representations, ODRL provides the ability to better represent relationships. In the example, the framework conditions (parent element) are set out under which user-specific content may be consumed. This assignment from the license regulates, when a selected content is requested, whether the user is authorized to consume the content.

Table 2. ODRL License Assignment

```
{
    "uid":"cc564c05-c4d7-46e8-b7d3-f42faede7ae5",
    "createdAt":"2023-01-08T13:58:26.443Z",
    "updatedAt":"2023-01-08T13:58:26.443Z",
    "type":"http://www.w3.org/ns/odrl/2/Ticket",
    "inheritfrom":"https://{hostname:port}/
     licenseDefinitions/1393b8d8-9627-4097-98f6-9d213913b044",
    "assigner":"provider_02",
    "assignee":"8b815e91-b241-4dc1-994f-affee2200637",
    "permission":[
        {
            "action":"http://www.w3.org/ns/odrl/2/use",
            "target":"https://metadaprovider/product_04",
      "constraint":[
                {
                    "name":"http://www.w3.org/ns/odrl/2/event",
                    "operator":"http://www.w3.org/ns/odrl/2/eq",
                    "rightoperand":"deactivated"
                }
            ]
        }
    ]
  }
```

3.2 Metadata Mapping

Information regarding the presentation of content in the learning system is provided by the metadata provider. Assuming that this is a separate system from the content provider, it is necessary to define the way in which the metadata must be presented. Internally, a representation of IEEE LOM is chosen. IEEE LOM[11] provides a standardized and

[11] https://standards.ieee.org/ieee/1484.12.1/7699/.

flexible approach to describing learning objects and educational resources, which can improve search and discovery, enhance interoperability, enable personalized learning, support quality assurance, and increase efficiency in education and training.

3.3 Demand Notification

Since licenses are typically limited to a certain period, it is at the discretion of the LRMs to publicly communicate their need for licenses to publishers. The assumption here is that publishers/account providers can sign up with the licensing component via a registration mechanism like a newsletter to receive messages of a demand from LRMs. This is simply modeling the process of initiating a new license phase, not the process of entering into a license agreement by having content providers agree or deny the request. The specified details of the license agreement must happen outside the business logic of the license management component. While it is possible to embed this process here, the licensing component sees itself primarily as a broker or aggregator of data rather than an entity to enter contracts. Here, mapping this process would entail many legal implications that will not be further named in the context of this paper.

3.4 Digital Content Launch

To present the content via the license management component to the client systems for their users, two approaches can be adopted, whereby the advantages and disadvantages are named below - **Direct Launch** and **Indirect Launch.**

Direct launch means that LMC communicate directly with the content provider if the necessary meta information is available. This requires that after a user logs in to the client system, the license assignments and the associated metadata can be requested by the license management component. For each license assignment, the metadata of digital content exists, where features such as the launch URL and the credentials are included. With this information, the client system can make a call against the content provider to present the content to the calling user. A major disadvantage of this approach is that the client systems are forced to implement the specific authorization mechanisms of the content provider to present the content to learners. In addition, content providers are reluctant to have increased circulation of the same credentials for their digital assets, as the chance of compression is increased.

The **indirect launch** describes the process in which there is no direct communication between the content provider and the learning system, but instead the license management component is the single source of truth. All launch requests are made against the LMC, which in turn makes a launch request to the respective content provider. If the launch request is successful, an HTML page is sent as a response, which contains an iframe that displays the digital content. This has many advantages: e.g., the credentials are only made known to the license management component, and the client systems do not need to implement a content provider specific standard. Client systems only need to adhere to the licensing component's standard, thus providing users with a seamless educational journey. This approach of modeling the launch mechanism is preferred because it is easier to implement and is more sustainable in the overall view of the whole ecosystem.

4 Application

There are projects where the problem of licenses and content calls is addressed and where the promise of the license management component to be a generic and custom-fit solution can be put to the test. One of these projects is Control & Connect[12] (hereafter C&C). The project is sponsored by the German Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung – BMBF). In the project, the Association of Textbook Publishers Germany (VBMS), which jointly provides a content repository of enhanced E-Books, and the Landesinititative n-21 of the state of Lower Saxony[13], which provides an LMS and login services for the states' schools to access digital learning content, face each other on the other side. Fraunhofer FOKUS develops the license management component as middleware.

In this project, one instance of each of the relevant systems exists. They are relevant in the architecture and are connected to the license management component, so that the license management component builds the link between these systems. The systems communicate through automated synchronization with the license management component or through interactions of the LRM in the MGMT UI. To access the MGMT UI, the authentication via the OIDC workflow is required. Thereby it is necessary that in the authorization context the AS provides the role in the attributes, the license management component interprets the role and translates it to an internal role model. After successful authentication, the interface is displayed as shown in Fig. 3. The interface is divided into four quadrants, where the external systems are involved in some cases.

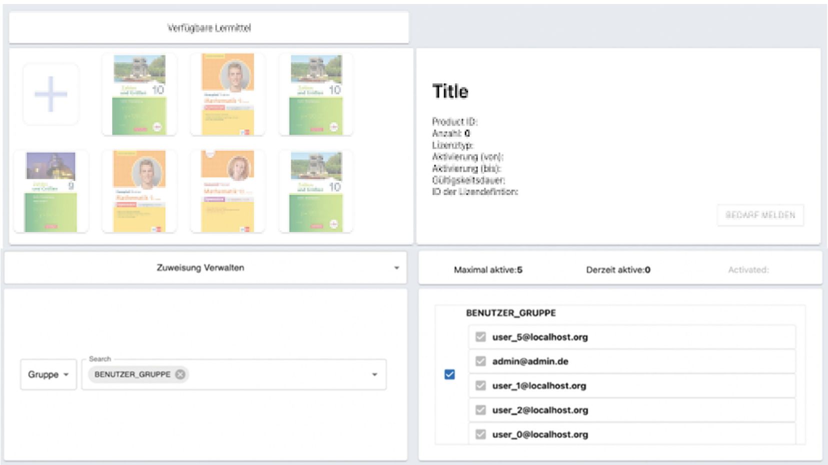

Fig. 3. Interface

[12] Control & Connect Project: Sponsored byBMBF; Funding Number 16INBI002C; Duration: October 2022 to September 2023.

[13] In 2022, more than 800,000 students attended general education schools in Lower Saxony.

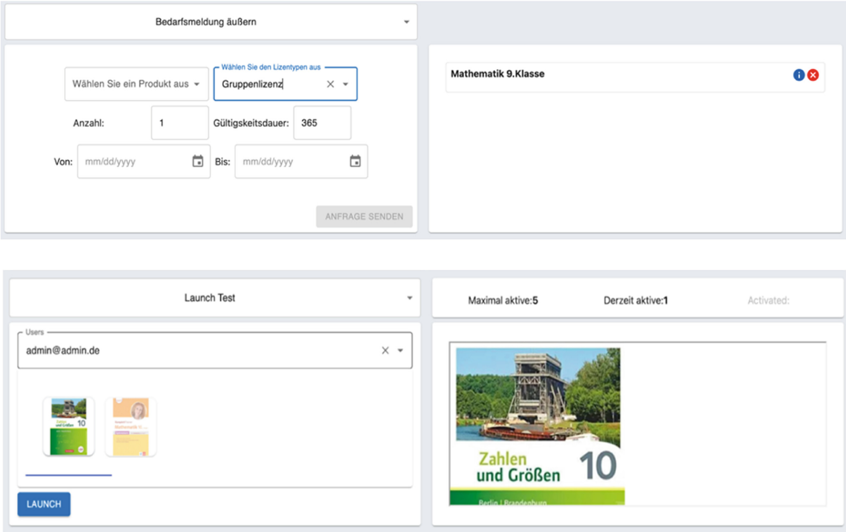

Fig. 4. Fourth Quadrant: Expressing a need/Launch test

The first quadrant displays the license definitions that must be imported by the LRM beforehand. Through the Plus button, an import of license definitions is possible, whereby the license definitions of the OMS were not played out in the desired ODRL format. Furthermore, the OMS offered to query all previously purchased licenses via a download ID. This circumstance was mapped in the license management component by querying the OMS after entering the download ID in the MGMT UI to get the license definitions of the proprietary format. These are then translated and the ODRL representation is persisted. Since in the license's information concerning the metadata provider is noted, this can be addressed also, to affect the representation. Also, the metadata provider did not support the desired data format IEEE LOM, but a proprietary format, why again a transformation was necessary, this time to IEEE LOM. However, this representation is not persisted, but queried on demand for each license.

The second quadrant conditions that an available license is selected in the first quadrant. These prepare the product information of the referenced digital content in textual form, also originating as the IEEE LOM representation.

The third quadrant is variable depending on a selector and influences the representation of the fourth quadrant just as shown in Fig. 4:

- **Manage assignment**: Once this setting is selected, it is possible to filter between users or groups, which are displayed in quadrant four. For this, it was necessary that the AS provides necessary information about the people of a school and the contexts. It is important which group the persons belong to and which role they have, because based on these conditions' assignments can be made. The license management component does not ask for the data until the LRM authenticates with the AS to address privacy concerns.

- **Expressing a need**: Education providers can submit a demand to license a desired product. This requires that necessary information be provided via form fields. The selection of possible licensing products is limited by the available supply of metadata providers.
- **Launch Test**: To simulate an LMS that displays the assigned licenses specifically for a selected user, a launch test was integrated. It can be queried for each user to initiate the digital content launch. This query checks the framework under which consumption is possible. It checks with the license management component whether a user-assigned license exists for the requestor at the time of the query. Here, the LRM calls out in the name of the selected user.

5 Conclusion

The use of interoperable standards at the interfaces of the relevant, external systems allows for a sustainable solution that meets the needs of school institutions, education providers and consuming students. The paper has presented a solution that meets the requirement of acting as a mediator between the existing systems. Furthermore, defining the external systems and their role in relation to the presented solution allows for more flexibility and collaboration in the educational space, as they do not have to maintain proprietary dependencies on each other, but only a dependency on the LMC. In addition, this makes it easy to exchange subsystems, which is difficult or impossible based on proprietary exchange formats. Unlike related works that have correctly identified and solved the sub-problems, the presented solution stands out in novelty in that it integrates the sub-solutions, additionally models an authorization mechanism based on them and offers them in an MGMT UI.

The LMC is applied in a real project context in Lower Saxony where it must meet the requirement of interoperability and flexibility by writing mappers for the external systems that translate the proprietary formats to standards expected in the license management component.

The need for a seamless educational journey is met by the LMC and at least theoretically demonstrated by the integration of the Launcher. However, it remains to be seen whether the users perceive this fact as such from the learning management systems of the LMC. This cannot be proven based on measurement results, since no measurements could be taken in the context of the present work yet. To this end, a large-scale study is planned in the summer for all participating schools in Lower Saxony that access their central authentication service.

Based on this preliminary work, the license management component can be analyzed against various metrics in the future. LRMs have yet to test the MGMT UI for practicality, so feedback would be needed there.

In conclusion, it can be said that the project was already successful in its objectives and that the license management component was able to meet the interoperability requirements. However, the LMC still has to prove its usability in practice in the planned field tests.

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The Effectiveness of Integrated Online Problem-Based Learning (iON-PBL) Physics Module on Pre-university Students' Motivation and Problem-Solving Skills

Elnetthra Folly Eldy[1], Fauziah Sulaiman[2(✉)], Mohd. Zaki Ishak[3], Lorna Uden[4], and Jo-Ann Netto-Shek[5]

[1] Preparatory Centre for Science and Technology, Universiti Malaysia Sabah, Jalan UMS, Kota Kinabalu, 88400 Sabah, Malaysia
elnetthra@ums.edu.my

[2] Faculty of Science and Natural Resources, Universiti Malaysia Sabah, Jalan UMS, Kota Kinabalu, 88400 Sabah, Malaysia
fauziahs@ums.edu.my

[3] Faculty of Psychology and Education, Universiti Malaysia Sabah, Jalan UMS, Kota Kinabalu, 88400 Sabah, Malaysia
movolk@ums.edu.my

[4] Faculty of Computing and Digital Technologies, Staffordshire University, Stoke-on-Trent ST4 2DF, UK
l.uden@staffs.ac.uk

[5] English Language and Literature, National Institute of Education, Nanyang Technology University, Singapore, Singapore
joann.shek@nie.edu.sg

Abstract. Dropping number of enrolments in physics is the primary motivation of this study. Students' view of physics as a difficult subject contributed to this scenario, and problem-solving skills and motivation directly influenced them. Physical practice proved that problem-based learning (PBL) improves students' motivation and problem-solving skills. Hence, main objective of this study is to investigate the impact of the integrated online problem-based learning (iON-PBL) module of physics on students' motivation and problem-solving skills in learning physics. Quasi-experimental research approach was used with a pre-test, post-test, and delayed post-test control group design. The target population comprises of 166 students, 88 females and 28 males, amongst pre-university students of the Preparatory Centre for Science and Technology (PPST), Universiti Malaysia Sabah. Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich & Groot and Problem-Solving Inventory (PSI) by Heppner & Petersen were adopted as the instruments to measure students' motivation and problem-solving skills towards learning physics after intervention with the iON-PBL module of physics. Data collected was analysed using SPSS, with paired sample t-test to test the research questions and hypotheses raised at an alpha level of 0.05. Study shows significant difference in students' motivation towards learning physics, i.e., intrinsic value, and cognitive strategy use components. Similar results in problem-solving

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skills, i.e., students' personal control, where this component shows significant difference favour to the experimental group. Some suggestions on how to implement iON-PBL effectively are also highlighted.

Keywords: iON-PBL · Online Problem-based Learning · Physics · Motivation · Problem-Solving Skills · Pre-university

1 Introduction

Many studies show concern about the dropping popularity and number of physics enrolment amongst students at school and university levels [1–3]. When compared to other science-related disciplines from secondary school to university, physics is typically less attractive to students because it is regarded as the most difficult area of learning within the field of science [4]. Ornek et al., [5] identified from their survey on what makes physics difficult is factors such as *physics is very difficult subject, physics is very abstract, too much material to learn, too much theory, too many formulas*, and *too many laws and rules.* But the interesting factors found was the lack of real-life applications and problem solving especially conceptual related is amongst the factors stated by students [5].

Therefore, to address the issue, researchers integrated learning physics with different approach of learning such as project-based learning (PjBL) [6], collaborative learning [7], and problem-based learning [8] to make teaching and learning interesting and meaningful. These approaches have been proved by various study able to contribute on students' motivation [9], and also problem-solving skills on learning physics [10].

Particularly, problem-based learning (PBL) has a long history of being practiced notably in medical education since introduced at McMaster University in 1960s. Since then, PBL widely adopted in other fields such as STEM, languages, and arts. Though PBL is implemented with different approaches, strategies, and tools according to the background of the field, it is normally exercised face-to-face. Hence, important elements such as discussion, reading, and presentation are held in class in person. Integrating PBL online however, is rarely being done for various reasons such as students adaptation [11], technical and pedagogical readiness [12].

Hence, the aim of this paper is to study the impact of a developed Integrated Online Problem-Based Learning (iON-PBL) Module of Physics on pre-university students' motivation and problem-solving skills in learning physics. Unfortunately, misconceptions frequently occur when learning physics and lead to students' negative attitudes toward learning physics. This is recognized contributed to weakening students' motivation towards learning physics [13] and problem-solving skills [14]. Moreover, it is challenging to rectify the misconception using conventional educational techniques [15].

Hence, this motivates the researcher to answer enquiries that lead to the research question of this study as lists:

RQ1: Does the use of the iON-PBL module of physics effectively affect students' motivation towards learning physics?

RQ2: Does the use of the iON-PBL module of physics effectively impact students' problem-solving skills?

Furthermore, the main objective of this study is to study pre-university students' motivation and problem-solving skills towards learning physic after being intervened with the developed iON-PBL module of physics. Accordingly, the hypothesis of this study is as lists:

H_{01}: There are no significant difference between the pre-test, post-test, and delayed post-test on the mean score on pre-university students' motivation towards learning physics following iON-PBL module of physics.
H_{02}: There are no significant difference between the pre-test, post-test, and delayed post-test on the mean score on pre-university students' problem-solving skills in learning physics following iON-PBL module of physics.

2 Literature Review

Students' motivation driven by extrinsic and intrinsic factors is essential for students in physics. Intrinsic motivation is the desire to perform a task for their own sake because they find it fun and challenging, and extrinsic motivation is related to self-rewards [16, 17]. These two motivations can have different effects on students in the learning process—intrinsic motivation results in high-quality learning and creativity. Still, educators cannot always rely on it because not all the tasks that need to be performed by the students are interesting and enjoyable [17]. Extrinsic motivation has a limited effect and reduces students' motivation to do similar tasks in the future, but it can also boost intrinsic motivation [16]. One way to motivate students to learn physics is by making the activity exciting and achieving the outcome that becomes important [18]. Recent studies show that students are motivated to study physics using modern information technology, computers, the internet, and mobile phones [19]. Other than that, different teaching and learning approaches could boost students' motivation in learning physics., i.e., via project-based learning [20], inquiry-based learning [21], game-based learning [22].

From another perspective, problem-solving skills influence students' essential skill when learning physics [23] and are even more relevant to daily life [24]. The ability of students to develop and exercise problem-solving skills will reflect on their learning achievement and respond to the challenges of the 21st century. However, ineffective problem-solving skills when learning physics are typically encountered and decrease students' interest [20, 25]. Students commonly need help understanding the core of the assigned problem; they like to memorise when learning physics, which contributed to the failure to exercise this skill [20]. Istiyono et al., [23] in their study highlighted the importance of students ability to analyse and evaluate given problem will make problem-solving skills works.

Undoubtedly, problem-solving skills also influence students' motivation to learn physics. However, findings such as those by Argaw et al. [24] show no dormant students' motivation when their study integrated problem-based learning (PBL) in learning physics. However, there is a significant increase in students' problem-solving skills.

Various studies also show the direct positive impacts of PBL on students' problem-solving skills and learning motivation. Hasrawati et al. [26], for instance, show how PBL improved students' problem-solving skills and motivation by applying the PBL model to learn mathematics.

A long history of PBL in science education indicates mixed results towards students' motivation and problem-solving skills. Problem-based learning is the interplay between stimulus and response and a relationship between two learning orientations and environments. The environment gives students input in the form of learning issues and assistance. The brain's nervous system works to successfully interpret that help so that the problems they face can be studied, appraised, analysed, and sought solutions effectively. According to studies summarised by Argaw et al.[24], students learn more effectively when collaborating with classmates to solve open-ended, complex, and challenging problems rather than sitting passively in lectures. Accordingly, the PBL approach offered constructivist active learning activities such as students centred learning, ill-structured real-life problems, and teamwork. Hence, it is suitable to practice in this study.

3 Development of Module and Implementation of Online Problem-Based Learning

The module of this study was developed using ADDIE instructional design. ADDIE is an acronym and consists of five (5) essential steps, i.e., analysis, design, development, implementation, and evaluation.

i. Analysis

In this most important stage, four important instruction to facilitate designer on the developing effective module was highlighted; needs assessment (i.e., analysis of the learner, analysis of the instructional goals, problem identification, task analysis, and developing learning objectives [27, 28].

ii. Design

Three aspects of this step were highlighted: designing assessments, choosing the course format, and developing the instructional technique [27].

iii. Development

This stage was depending on the first two phases. Creating factual sample for instruction design, developing the materials of this course, and run through the conduction of the design is the steps Aldoobie [27] outlined in this stage.

iv. Implementation

This stage is where the plan transformed into action. Components such as instructors training, students' preparation and learning environment was the key point at this stage.

v. Evaluation

The procedure of evaluating the module's suitability is the last step. Aldoobie [27] highlighted evaluation such as one to one formative evaluation, small evaluation group, formative evaluation, and summative evaluation in this final stage of ADDIE model.

Online problem-based learning (PBL) in this study is described as PBL practices occupied with the use of network information, communication technology, and available electronic devices. With this, all steps of PBL from introducing students to the problem to reflections were fully held online. The PBL process applied in this study was similar to steps introduced in McMaster health science curricula, i.e., introducing the problem, students reviewing the scenario, sharing information, exploring of problem, gathering information, application of new knowledge, and reflection.

4 Research Methods

4.1 Instruments

The main objective of this study is to observe the impact of the iON-PBL module of physics on students' motivation and problem-solving skills towards learning physics. For this study, the Motivated Strategies for Learning Questionnaire (MSLQ) by Pintrich & Groot [29] consists of thirty (30) items was adopted and clustered into four themes:-self-efficacy (SE), intrinsic value (IV), cognitive strategy use (CSU), and self-regulation (SR). Meanwhile, the Problem-Solving Inventory (PSI) by Heppner & Petersen [30] was adopted consisting of thirty-two (32) items of PSI categorised into three themes:-problem-solving confidence (PSC), approach-avoidance style (AAS), and personal control (PC). Both dependent variables will be measured before, after and six weeks after the intervention of the iON-PBL Module of Physics.

A pilot test was conducted to evaluate the reliability of both instruments before being administered to the study participants. As a result, it is found that Cronbach's Alpha of the analysis from Statistical Package for Social Science (SPSS) V28 are 0.905 and 0.756 for MSLQ and PSI, respectively and based on ranges of values summarised by Taber [31], this value is sufficient, satisfactory, and acceptable to use. Subsequently, this instrument was sent to expertise for content validity.

Since this study was conducted during COVID-19, Google Forms was used for the data-gathering process. Besides the fact that Google Forms is easy to operate and free to use, this app is quick to complete and easy for participants to respond to [32]. Furthermore, considering that the participants of this study are at their homes with varying internet capacities, Google Forms is a suitable medium as it is also mobile-friendly.

4.2 Data Collection and Analysis

A pre-test, post-test, and delayed post-test design of quasi experimental with control group method was used in this study. The summary of implementation of the module and collection of data shows in Fig. 1. The delayed post-test in this study is essential

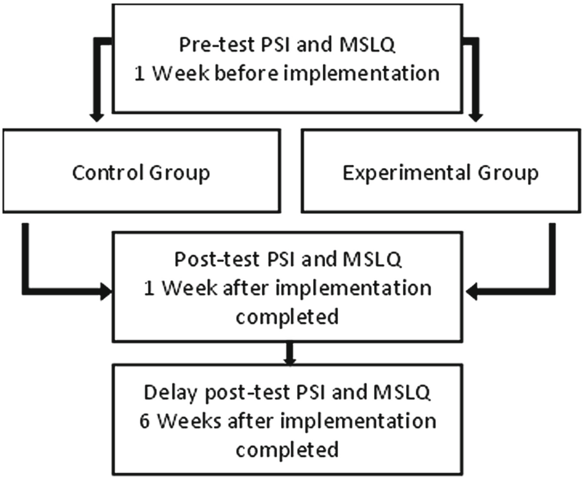

Fig. 1. The Flow Chart of The Study's Dependent Variable Administration

to measure the retention of students' motivation and problem-solving skills on learning physics after intervened with the module.

The paired sample t-test was conducted to analyse all gathered data using the latest version of SPSS (Version 28) to compare two related or repeated variables. In addition, the Paired sample *t*-test was conducted to determine if there was any significant difference in students' motivation and problem-solving skills towards learning physics before and after the intervention of the iON-PBL Module of Physics between both groups, i.e., Experimental Group and Control Group.

5 Data Findings

5.1 Background and Demographic of Participants

Participants of this study were pre-university students at Preparatory Centre for Science and Technology, Universiti Malaysia Sabah Session 2021/2022. The study participant enrolled on a one-year Foundation in Science Program which compulsory to sit for science subjects, i.e., physics, biology, chemistry, and mathematics.

Table 1 shows the distribution of gender of students both for control and experimental group. The sample size of this study covered 147 students, 108 females, and 39 males. For experimental group, a total of N = 116, consists of female (N = 88, 75.9%) and male (N = 28, 24.1%) was participated. Meanwhile, for control group a total of N = 31, consists of female (N = 20, 65.5%) and male (N = 11, 35.5%) students was participated.

5.2 iON-PBL on Students' Motivation on Learning Physics

Students' motivation was measured with adopted version of MSLQ with four theme, Self-Efficacy (SE), Intrinsic Value (IV), Cognitive Strategy Use (CSU), Self-Regulation

Table 1. Distribution of Students Gender

Group		Frequency (N)	Percentage (%)
Experimental (EG)	Female	88	75.9
	Male	28	24.1
	Total	116	100
Control (CG)	Female	20	65.5
	Male	11	35.5
	Total	31	100

(SR) after intervention with the module. Table 2 shows the results of paired sample *t*-test for both groups. Results shows a significance difference in retention on students' motivation to learn physics for experimental group, with score of sig. 2 tailed $p \leq 0.05$ on post-motivation to delayed-motivation, MD = 0.24, SD = 0.67, $t = 0.38$, $p < 0.01$. However, no significance found on pre-motivation to post-motivation for experimental group and both for control group. As the absolute p-values were smaller than critical references, the null hypothesis H_{01} is rejected.

Table 2. Paired Sample *t*-Test of Students' Motivation

Paired Sample *t*-Test					
	MD	SD	*t*	df	Sig.(2-tailed)
Experimental Group					
Pre-Post	−0.05	0.52	−1.06	115	0.29
Post–Post Delayed	0.24	0.67	0.38	115	* < 0.01
Control Group					
Pre-Post	0.07	0.49	0.75	30	0.46
Post-Post Delayed	0.09	0.61	0.78	30	0.44

* Sig. (2-tailed), $p \leq 0.05$, MD = Mean Difference

Table 3 shows the results of paired sample *t*-test on specific components of students' motivation. Results shows there are retention on two of the motivation components for experimental group, i.e., intrinsic value (IV) and cognitive strategy use (CSU). The score of sig. 2 tailed on post IV to delay post IV, MD = 0.20, SD = 0.77, $t = 2.83$, $p = 0.005$, and on post CSU use to delay post CSU, MD = 0.31, SD = 0.76, $t = 4.41$, $p < 0.001$. However, no significance difference on pre-test to post-test of both components. Furthermore, no significance difference found on other components (i.e., SE, SR) for experimental group and all components for control groups.

Table 3. Paired Sample *t*-Test for Specific Components of Students' Motivation

Components	Test	Paired Sample *t*-Test				
		MD	SD	*t*	df	Sig.(2-tailed)
Experimental Group						
SE	Pre-Post	−0.03	0.88	−0.41	115	0.686
	Post- Post Delayed	0.12	1.06	1.23	115	0.223
IV	Pre-Post	−0.02	0.63	−0.35	115	0.0.728
	Post-Post Delayed	0.20	0.77	2.83	115	*0.005
CSU	Pre-Post	−0.06	0.65	−0.95	115	0.344
	Post- Post Delayed	0.31	0.76	4.41	115	* < 0.001
SR	Pre-Post	−0.09	0.53	−1.88	115	0.063
	Post-Post Delayed	0.05	0.71	0.80	115	0.426
Control Group						
SE	Pre-Post	0.02	0.71	0.14	30	0.886
	Post-Post Delayed	0.08	1.04	0.42	30	0.678
IV	Pre-Post	0.23	0.71	1.78	30	0.086
	Post-Post Delayed	0.02	0.76	0.12	30	0.907
CSU	Pre-Post	0.21	0.56	2.03	30	0.051
	Post-Post Delayed	0.10	0.62	0.90	30	0.374
SR	Pre-Post	−0.23	0.65	−1.98	30	0.057
	Post-Post Delayed	0.15	0.75	1.13	30	0.267

Self-Efficacy (SE), Intrinsic Value (IV), Cognitive Strategy Use (CSU), Self-Regulation (SR)
* Sig. (2-tailed), $p \leq 0.05$, MD = Mean Difference

5.3 iON-PBL on Students' Problem-Solving Skills

Students' problem-solving skills was measured with adopted version of PSI with three themes, i.e., Problem-Solving Confidence (PSC), Approach Avoidance Style (AAS), and Personal Control (PC) after intervened with the module. Table 4 shows the results of paired sample t-test of students' problem-solving skills for both groups. Results shows a significance difference on students' problem-solving skills after intervention for experimental group, with score on pre-test to post-test of MD = −0.05, SD = 0.28, $t = -2.05$, $p = 0.04$. However, no significance found on retention score for experimental group and control group. As the absolute p-values were smaller than critical references, the null hypothesis H_{02} is rejected.

Table 5 shows the results of paired sample t-test on specific components of students' problem-solving skills. Results shows there is significant difference on students' personal control (PC) after the intervention as score on pre-PC to post PC, MD = −0.19, SD = 1.01, $t = -2.03$, $p = 0.04$. Significant difference on students' retention on PC also as score on post PC to delay post PC, MD = 0.22, SD = 1.04, $t = 2.27$, $p = 0.02$. However,

Table 4. Paired Sample *t*-Test of Students' Problem-Solving Skills

Paired Sample *t*-Test					
	MD	SD	*t*	df	Sig.(2-tailed)
Experimental Group					
Pre-Post	−0.05	0.28	−2.05	115	*0.04
Post- Post Delayed	0.01	0.27	0.55	115	0.58
Control Group					
Pre-Post	−0.12	0.35	−1.92	30	0.06
Post- Post Delayed	0.05	0.19	1.55	30	0.13

* Sig. (2-tailed), $p \leq 0.05$, MD = Mean Difference

no significance difference on pre-test to post-test of both components. Furthermore, no significance difference found on other components (i.e., PSC, AAS) for experimental group and all components for control groups.

Table 5. Paired Sample *t*-Test for Specific Components of Students' Problem-Solving Skills

Components	Test	Paired Sample *t*-Test				
		MD	SD	*t*	df	Sig.(2-tailed)
Experimental Group						
PSC	Pre-Post	−0.04	0.32	−1.25	115	0.21
	Post- Post Delayed	−0.03	0.31	−0.97	115	0.34
AAS	Pre-Post	−0.02	0.31	−0.72	115	0.47
	Post- Post Delayed	−0.02	0.25	−0.91	115	0.36
PC	Pre-Post	−0.19	1.01	−2.03	115	*0.04
	Post- Post Delayed	0.22	1.04	2.27	115	*0.02
Control Group						
PSC	Pre-Post	−0.16	0.46	−1.92	30	0.06
	Post- Post Delayed	0.06	0.24	1.29	30	0.21
AAS	Pre-Post	−0.12	0.41	−1.55	30	0.13
	Post- Post Delayed	0.03	0.27	0.70	30	0.49
PC	Pre-Post	−0.09	0.78	−0.60	30	0.55
	Post- Post Delayed	0.07	0.41	0.88	30	0.39

Problem-Solving Confidence (PSC), Approach Avoidance Style (AAS), Personal Control (PC)
* Sig. (2-tailed), $p \leq 0.05$, MD = Mean Difference

6 Discussions and Conclusion

Intrinsic goal orientation refers to students' perception of why the student is engaging in a learning task, whether students' general goals or the course as a whole [29]. With this significance shows from the findings, it shows students agree they are more participating in their learning after the intervention of the iON-PBL physics module for reasons such as challenge, curiosity, and mastery. This is a positive sign of students' perception towards learning physics, which instead of avoiding solving physics problems, they make an effort to reach the end of it. Learning approach, i.e., PB), contributed large influences on it which in line with finding by Mohamad Hanefar et al. [33].

Meanwhile, cognitive strategy use (CSU) is a component of self-regulated learning strategies in MSLQ. This describes students' learning strategies, such as reciting or naming items from a list. This strategy is best used for simple tasks and activation of information in working memory rather than acquiring new information [34, 35]. This study's key finding demonstrates how common it is for students to learn by memorising, and this is a norm practised [36]. The benefit of using this approach for learning physics is that it will aid them in memorising the fundamental ideas and concepts. The risky part, though, is that they will frequently fail because they are probably unable to interpret the problem the way they memorise it, or more is needed to solve most problems [37].

On the other hand, the significant difference in students' problem-solving skills signifies that after engaging with the iON-PBL, students from experimental group evaluated themselves as more robust problem solvers and were satisfied with their problem-solving abilities. This is mainly due to the behaviour of this learning approach itself, as students work with real-life problems [33] and encourage them to develop their flexible knowledge (i.e., gain new knowledge, relate the problem with what they already know) [36].

Personal control component in PSI questionnaire described students' ability to control their attitudes towards learning growth. Kourmousi et al. [38] summarise the importance of self-control and its positive impact on problem-solving skills and problem-solving ability becomes positive, not impulsive, not avoid but approach problems with strategy, and confident. Hence, the significant difference in this study shows that students recognised their ability to control their learning after online PBL. Furthermore, flexibility is a key component in the successful implementation of any online learning [39], and this trait offered in the iON-PBL contributed much to students' ability to control their learning.

In emergency situation such as during COVID-19, online learning is an ideal alternative to make sure curricular is still running. Though, limitations such as readiness or technology infrastructure amongst students and teachers are often discussed, online PBL is a useful alternative strategy that can be used in distance learning. Nonetheless, it should be remembered that only particular sections of online courses should use PBL [40].

This study has developed an integrated Online Problem-based Learning (iON-PBL) Module of Physics with ADDIE instructional design. This usage of this module during COVID-19 impacted students' motivation towards learning physics on intrinsic value and cognitive strategy use components. A similar output shows that the student's problem-solving skills, in general, were also improved in the personal control component. It indicates that the iON-PBL physics module has improved students' motivation and problem-solving skills on its components respectively. Therefore, this study can be a guideline for educators and lecturers to effectively teach physics, especially to boost students' motivation and develop problem-solving skills.

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A Curriculum Framework for Introducing Hackathons in Engineering Studies

Saša Brdnik, Jozsef Györkös(✉), Saša Kuhar, and Muhamed Turkanović

Faculty of Electrical Engineering and Computer Science, University of Maribor, Koroška cesta 46, 2000 Maribor, Slovenia
{sasa.brdnik,jozsef.gyorkos,sasa.kuhar,muhamed.turkanovic}@um.si

Abstract. The idea and benefits of introducing hackathons in higher education courses are frequently addressed topics in discussions on active learning. This form of pedagogical approach is manifestly accepted from the students' and educators' points of view. To accelerate the endorsement rate of needed curriculum adaptations, this paper proposes a framework for introducing hackathons in an engineering higher education set-up as a means of active learning. The proposed approach was validated in one Masters' level academic course over four academic years with 14–42 students per year in three different scenarios; online, hybrid and face-to-face. Empirical data supporting the successful implementation of hackathons is presented, including event satisfaction surveys for students and mentors and a university-wide survey of course satisfaction. Along with stakeholders generally involved in educational hackathons; students, educators and industry representatives; we recognise two additional parties of interest - the university's business incubator and the knowledge and technology transfer office. Recognised benefits, case studies, and lessons learned that complement the existing literature and the environment of further proof of concept are presented.

Keywords: Hackathon · Active learning · Higher education · Framework · Case study · Curriculum · European universities

1 Introduction

Contemporary engineering education programs are required to offer their students a comprehensive set of knowledge as well as formal and informal skills. One of the most crucial skills engineering students have to obtain is coordinating numerous competencies to reach the goal and to solve the problem [15]. One of the learning approaches complementing traditional classroom learning is a hackathon. A hackathon can be described [12] as a highly engaging, continuous event centred around a key theme where participants in small groups create working software prototypes in a set amount of time, usually within one to three days. Key recognised characteristics of hackathons are a reflection on knowledge, work within a team, focus on the implementation, and an outcome evaluation [16]. Hackathons utilise active learning, a learning strategy describing anything

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involving students doing things and thinking about the things they are doing [1]. Previous research on hackathons has observed multiple benefits to its participants, such as solving industry-based problems, teamwork, cooperated learning, building industry-focused skills, as well as practical and informal learning [13,14,16]. The introduction of hackathons into the engineering curriculum fits the recognised competencies that are important for engineering practice. From the sixteen engineering competencies identified by the comprehensive literature review [15], at least twelve are directly addressed with hackathons (apply knowledge [13], apply skill [13], communicate effectively [13,16], coordinate efforts [16], take the initiative [16], gather information [16], think creatively [10], solve problems [10,13,21], design solutions [10], make decisions [21], take responsibility [16,21], and expand skills [13,21]).

Related work reported lessons learned in a decade of organising code camps and hackathons for engineering students, where Porras et al. [16] proposed detailed taxonomy for hackathon events and guidelines for using each in the graduate program. The positive view on hackathons from educators' perspective was recently reported by Mehta et al. [13], where 162 engineering educators who have participated in a hackathon perceived it as beneficial for students. Along with the mentioned benefits, the hackathon's role in students' professional development was also recognised in this study. An application of the hackathon method in a project-oriented undergraduate Computer Science and Informatics course on the Internet of Things was presented in [10]. The authors describe a 24-h marathon where students used aspects of challenge-based learning and design thinking to ideate their projects. Authors have limited their methodology to project-oriented courses and have not seen hackathons as a feasible learning approach in theoretical courses. Čović et al. [21] used the term hackathon-based learning and analysed the competencies developed through this method emphasising its positive impact on the recognised gap between the education system and the labour market.

Multiple stakeholders can be identified in hackathons in the educational setting [16,21]. *Students* are the main stakeholders in this learning method and should benefit the most from the development of new skills and competencies mentioned above. For *universities*, hackathons represent a new approach to competence and skill evaluation in a more realistic setting while offering a method for the project-oriented organisation of a course. Universities also benefit from increased stakeholder collaboration, whether with industry or surrounding society in the case of society-focused themes. For *industry representatives*, hackathons pose a unique opportunity to connect with prospective future employees while providing them with multiple new ideas on the presented challenges. *Society and citizens* are also recognised as stakeholders, though their role in engineering hackathons is usually less insight. Society benefits from innovative solutions presented at hackathons, visibility of new technologies and youth citizen participation. Additionally, we also recognise the role of University's business incubators, and Knowledge and Technology Transfer Offices (KTTO). In our case these were the Venture Factory and our University's KTTO. Their benefit is mostly the promotion of their services, as they get in touch with prospective users while also offering students guidelines and business advice for further developing solutions on their own.

The benefits of hackathon use in an educational setting in engineering studies have been addressed in the existing body of literature. However, its successful introduction into the curriculum has not been reported in the form of an organised, ready-to-implement framework, which would allow an easier and faster introduction of this learning form into the curriculum. We specifically acknowledge and promote that during the curriculum and before the hackathon, students need to familiarise themselves with several concepts to participate in a hackathon in a meaningful manner. This paper aims to answer the main research question: ***How to improve learning outcomes by successfully introducing a hackathon to the engineering curriculum***.

1.1 Originality

The paper proposes a curriculum framework for supporting innovation processes in the engineering curriculum by introducing hackathons. Furthermore, it defines pre-hackathon concepts students should be familiarised with, as well as a post-hackathon event introducing students to opportunities for venture capital. The methods used in the proposed framework are presented in Sect. 2, the proposed framework is presented in Sect. 3, and the results are summarised in Sect. 4. The results and future work are discussed in Sect. 5.

2 Methods and Materials

The focus object of this study is the course Service Science and Innovations (hereinafter SSI), offered in the winter semester of the second year of the Informatics and Technologies of Communication Masters program at the Faculty of Electrical Engineering and Computer Science, University of Maribor. The course scope is 6 ETCS, and its main objective for the students is to obtain knowledge about the processes needed to support innovation culture, design, delivery and governance, as well as to get familiar with the field of IT-based service development, deployment and management. Design thinking (hereinafter DT) is one of the main concepts students learn in this course before the hackathon. DT is a human-centred approach to problem-solving based on placing the users as the source of insight into problem-solving and solution-forming. To improve the projects and solutions, students become familiar with DT, and its five steps (empathise, define, ideate, prototype and test) [6] before they engage in hackathons. The grade students obtain consists of lab work, a completed project, and two midterm examinations. The number of enrolled students has ranged between 14 and 42 in the last four years (N = 4, M = 21.3, SD = 12.0).

Four hackathons have been held in four consecutive academic years, from 2019/2020 to 2022/2023, as part of the SSI curriculum (Table 1). The hackathons varied each year, with two organised by academia (SSI teaching staff), one by a company and one by a University business incubator. The challenges and technologies also varied, with different stakeholders proposing them each year. Mentors in all four years were from academia, industry and business incubators, although the number of people from each category differed.

Table 1. Comparison of hackathons in the SSI course

Year	Length	Challenge	Organised by	Form	Stakeholders	Participants	Ref.
2020	28 h	Advanced learning and paperless business	Industry	Face-to-face	Post of Slovenia, University	Students, companies, start-ups	[17]
2021	34 h	Innovation and business opportunity	Academia	Online	BearingPoint// Beyond, University, KTTO, University business incubator	SSI Students	[3]
2022	34 h	Innovative IT or IS solutions and approaches	Academia	Hybrid	Beyond by BearingPoint, Databox, University, KTTO, University business incubator	SSI Students	[4]
2023	48 h	New solutions in finance, insurance and investment	Business incubator	Face-to-face	Zavarovalnica Sava insurance company, Ljubljana Stock Exchange, European Space Agency, University, University business incubator	Students, entrepreneurs, engineers, designers, researchers, policymakers, financial professionals, and others	[19]

The first hackathon to be included in the SSI curriculum was in January 2020, when students participated in a hackathon organised by the Post of Slovenia. The challenge was to develop a content on-demand solution, tackling UX, gamification, gender equality, paperless business, and blockchain technologies. Participants were students from high schools and faculties, individual entrepreneurs and teams from companies or start-ups. Mentors were representatives from companies, two foreign universities, a research institute, and a University business incubator. SSI teachers were not among the official mentors but were available to SSI students during the hackathon. Thirteen students in three teams participated in the 28-h-long hackathon. First place was tied between three groups, including the SSI students' team.

In 2021 the Covid-19 pandemic initiated a widespread lockdown, causing the entire study process to be held online. Consequently, the hackathon was organised online, fully by the SSI teaching staff. The challenge was provided by the BearingPoint//Beyond company, which was beforehand collaborating with the faculty. The challenge was entitled Innovation and business opportunity. Students had to develop innovative and competitive solutions integrating technologies such as 5G, the internet of things, web services, and the Infonova Digital Business Platform - a solution for orchestrating services by BearingPoint//Beyond. Twenty mentors cooperating in the hackathon were mostly from academia (teaching staff of various disciplines), three were from BearingPoint//Beyond, one from the KTTO, one from a University business incubator and one from an independent business. Altogether, twenty mentors cooperated in the hackathon. Coupons for food delivery services for students and mentors, as well as prizes for the three best solutions, were provided by the company involved. Microsoft Teams platform was used for communication and video conferencing, and a shared Microsoft Excel spreadsheet was used for scheduling meetings among teams and mentors. In the spreadsheet, fifteen-minute slots were available for teams to make an appointment with mentors. After the team selected a time slot and a mentor, two teaching assistants scheduled the meeting in Microsoft Teams, inviting the team members and the mentor. Such an organisation ensured that no meetings were overseen in the spreadsheet as all parties received notification fifteen minutes before the meeting. Forty-two students in twelve teams participated in the 2021 hackathon, which lasted 34 h.

The third hackathon, happening in January 2022, was also organised by SSI teaching staff, but this time, it was a hybrid form. Students and the majority of mentors were meeting face-to-face, whereas some of the mentors were, for a limited time, available online. Again, the Excel spreadsheet and Microsoft Teams were used for organising the meetings. Two companies provided the challenges - Beyond by BearingPoint (the same company as in 2021 but renamed) and Databox. The challenge was to create an innovative IT or IS solution or approach using artificial intelligence, blockchain, 5G and internet of things technologies. Students had to choose to work with either Infonova Digital Business Platform (Beyond by BearingPoint) or Business Analytics Platform by Databox, intended for connecting, analysing, and visualising data. Both companies provided mentors (two from Beyond by BearingPoint and four from Databox) whereas the majority were from the faculty, two from a University business incubator, and one from the KTTO. Again, the two collaborating companies provided prizes and food delivery coupons. Seven teams with twenty-seven students altogether competed in this 34-h-long hackathon.

In the 2022/2023 academic year, the students participated in the 4th Cassini Hackathon, happening in November 2022. Organised by European Commission, it took place simultaneously in ten European countries. In Slovenia, Venture Factory, the university's business incubator, was the local organiser. The competitors had to develop new financial, insurance and investment solutions that utilise data from European space technology programs and contribute to Europe's sustainability and green goals. Participation was open for students, entrepreneurs, engineers, designers, researchers, policymakers, financial professionals, and others. Three teams formed with fifteen SSI students participated in the hackathon that lasted for 48 h. Altogether, eleven solutions were presented in the hackathon, whereas SSI students won in two of three challenges: Enabling green and sustainable investments and Advancing global financial intelligence.

3 Framework

The proposed framework consists of three stages; *pre-hackathon activities* focused on equipping students with the knowledge needed for successful innovation, the *main event*, and *post-hackathon event* focused on familiarising students with the possibilities of venture capital for the innovations. The relevant course content and pedagogical approaches used in the proposed framework are presented in Fig. 1. Prerequisites to the hackathon are familiarisation with DT, innovation process and innovative thinking, techniques for increased creativity (Koinonia, morphological analysis, exquisite corpse, lotus flower, brainstorming, SCAMPER, etc.), understanding of intellectual property (including models and patents and the process of obtaining one) and technology readiness level. The curriculum is based on core literature on service science and solution engineering [2,11,20]. Before the hackathon, students can learn the aforementioned concepts while working on ideas non-related to the hackathon. Separate challenges are used for the learning stage to provide students with widely accepted directions. Examples of challenges used for learning are 17 sustainable development goals of the United Nations. Before the hackathon is confirmed with faculty and other stakeholders, student consent needs to be collected for participation in this pedagogical form, especially due to the scheduling changes.

After the hackathon, students should be advised of the possibilities of obtaining funding for their current and future innovations. Classic pedagogical approaches (lectures, lab activities) may be used to master the basics of the aforementioned concepts, though invited lectures of domain experts are also encouraged.

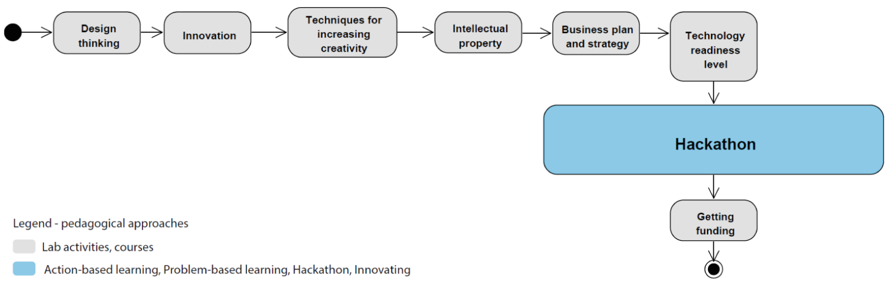

Fig. 1. Relevant course content and pedagogical approaches

A description of categorised activities directly connected to the hackathon is presented in Table 2. The framework is applicable for an internal hackathon organisation at faculty (marked with $*$ in the table) or for joining the external event organised by another stakeholder. Five activity categories are recognised; collaboration with other stakeholders, activities related to the hackathon challenge, scheduling, activities linked with the competition aspect of the event and general organisation activities, gathered in the internal execution category.

Table 2. Categorized activities of the proposed framework

Category	Activities
Collaboration	1. Create an informational website or information packet. ∗ 2. Find sponsors for the prize pool and media sponsors. ∗ 3. Find mentors (internal mentors from the university, external mentors from other stakeholders) 4. Get access to the challenge-related technology if needed. 5. Agree on intellectual property between included parties. ∗ 6. Define prize pool and prize storage. ∗ 7. Find invited lecturers for pitch training and the final lecture. ∗
Challenge	1.1 Define and confirm an original challenge with all included industry partners, ∗ or 1.2 Find an existing hackathon aligned with the course and students' abilities
Scheduling	1. Students: organise students' timetable changes, and take other courses into account 2. Faculty: find a suitable space available for the event period, and change the teaching staff schedules. ∗ 3. Mentors: check mentor availability, plan 15-min slots for meetings with mentors, and synchronise availability in real-time at the event. ∗
Competition	1. Define groups 2. Present the challenge and intellectual property rules and share access to any available datasets or test environments. ∗ 3. Define the assessment criteria 4. Present mini-games with small rewards to encourage competitiveness and keep the students motivated. ∗ 5. Assess the projects while students attend invited lecture. ∗ 6. Organise the closing ceremony and results announcement. ∗
Internal execution	Before the event 1. Organise food and snacks during the event. ∗ 2. Organise welcoming and closing ceremony, end-of-the-day overview and possible invited guests; find a moderator. ∗ 3. Provide working space for teams and quiet space for meetings, prepare the tool for organising meetings and plan the reminders. ∗ 4. Organise media coverage, photographer. ∗ 5. Prepare a background presentation to be displayed at all times with the timetable and current activity. ∗ After the event 1. Evaluate the event, prepare and send surveys for students and mentors 2. Review the detailed grades and share them transparently with students 3. Prepare a report and share it with all involved parties 4. Publish a report of the event and promote it on university media outlets

∗ Activities relevant only to the organisation of the internal hackathon are marked with this symbol.

4 Results

4.1 Empirical Findings

The University of Maribor conducts an annual student survey on satisfaction and perceived workload, in which all students who have successfully completed the course participate. This subject's average student satisfaction rating has been steadily increasing since the hackathon was introduced in the course curriculum in 2019/2020. Average grades of the course lecturers and assistants have improved between 4% and 11% in the last three years [18]. Perceived workload slightly decreased over four academic years from 2018/2019 (the year before the hackathon was introduced) until 2021/2022 (the last year of the available student survey). The perceived workload is measured as the percentage of agreement with three statements: insufficient, adequate and too much workload. As shown in Fig. 2, students perceive the workload to be mostly adequate, with agreement ranging from 90% to 98%. There has been a slight decrease in adequacy in recent years, but answers are deviating in both directions, towards insufficient and too much workload. Additionally, this university-wide survey on course and educator satisfaction shows the SSI course reached a higher-than-average grade of 1.51 (on a scale of -2 to 2), compared to the mean for the whole study programme satisfaction grade of 1.27, which was observed in the last academic year (2021/22).

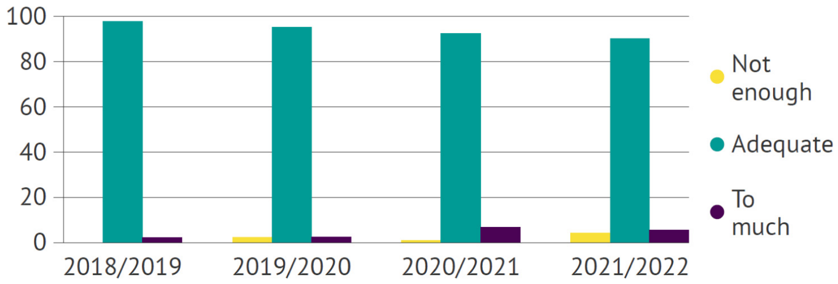

Fig. 2. Percentage of agreement regarding the workload in SSI course

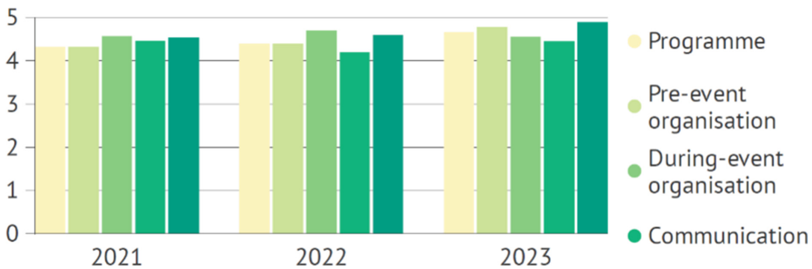

Fig. 3. Rating of hackathons in the last three years

In the last three years of the hackathon, a short survey was distributed to students after the event. They were asked to rate the hackathons in five categories: programme (introduction, conclusion, presentation guidelines), pre-event organisation (website, sponsors, prizes, lunches), during-event organisation (selecting time slots and scheduling meetings), communication (dissemination of information by the organisers), mentors (areas of expertise, advice). A Likert scale was used, ranging from 0 - unsatisfactory to 5 - excellent. At the end of the survey, an open question on impressions, wishes, criticisms and suggestions was also included. In 2021, 28 out of 42 students enrolled in the SSI course completed the survey; in 2022, 10 out of 27 students, and in 2023, 9 out of 15 students. Figure 3 shows high rates in all years, on average above 4.4. A slight increase occurred in 2023, especially regarding the expertise of the mentors.

Answers to open questions provided additional insights. In 2021, three students found the online hackathon exhausting, especially as it took place in the last weeks of the semester when seminars and projects from other courses also had to be submitted. Five students wished that the platform had been better presented before the hackathon so that they would have had enough time to work on their ideas. Seven students recognised the high level of organisation, especially in the difficult Covid-19 lockdown: *"Great organisation of the event given the difficult conditions. The responsiveness and flexibility of the mentors/organisers were also excellent."*. Three students also expressed their gratitude for being able to participate in a hackathon and acknowledging gained knowledge and skills: *"A very great idea, and thank you for enabling us to get such a hands-on experience in the course's practical work and our studies in general!"*. One student reported that their team had connection issues, and another expressed the grading had not been transparent enough.

In 2022, four students stated that the hackathon was a great experience *"There was excellent networking and presenting topics that I find very important, besides just designing and producing ideas."*. Again, two students highlighted the lack of transparency in the assessment, and one student mentioned the less convenient timing - at the end of the semester. Altogether, five students found the hackathon to be a great experience.

Two positive and one negative answers were received with the 2023 survey. One student expressed that the workload could have been more evenly distributed during the semester, as the hackathon took place a month in the semester. As a result, the theoretical part had to be worked on in the first month, resulting in a higher workload at the beginning and a lower workload at the end of the semester. Otherwise, two students were positive about it, stating: *"This is the next stage of knowledge acquisition in our generation. Better than sitting down with a book and reading the same sentence until you memorise it"*.

In 2022, a similar survey was distributed among mentors, where the average received grade was 4.9. All open-question answers were positive, one stating: *"The participants were highly motivated and enthusiastic in developing their ideas. It would make much sense to expand the event and allow other teams of talented idea developers to participate"*. Industry participants also mentioned the event helped them to recruit students.

4.2 Benefits for Stakeholders and Lessons Learned

Iterations of SSI hackathons revealed numerous lessons learned. Firstly, we recognise the importance of the collaboration of various companies (e.g., Post Slovenia, BearingPoint, Databox); secondly collaboration with KTTO; thirdly, the collaboration with the university's business incubator over the years. The importance of innovation and learning the process of innovating to improve the outcome of the projects is also highlighted. Lastly, we recognise the importance of knowledge transfer between industry and academia. The summary of the five main lessons learned with benefits for each stakeholder type is presented in Table 3.

Table 3. Recognized benefits for the stakeholders through lessons learned

	Students	University	Industry/KTTO/ Accelerator
Collaboration with the university's KTTO	Learn to protect and commercialise their expertise, technologies and ideas	Transfer knowledge and technologies to economic and social environment	Promotion of innovation activities, expanding the university's innovation ecosystem
Collaboration with regional university's business incubator	Get familiar with the start-up opening process, meet business mentors	Teach entrepreneurship	Connect with the prospective users of their services, and publicity
Collaboration with industry	Insight into the industry, solve real-world problems, improved skills, reference for future job search	Student skill evaluation in a more realistic setting, collaborate with the industry on future projects	New ideas, possible solutions for their challenges, recruit students, making sure graduates have the skills they need, generate long-term projects, network with other companies, publicity
Learning through innovation and learning the process of innovation	Innovation experience, knowing steps of protecting their ideas, new skills	Innovative and teaching for quality graduate careers	New ideas, possible innovative solutions for their challenges
Knowledge transfer industry-academia	Courses get more aligned with industry needs	Recognize industry needs, better prepare graduates for the job market, further collaboration	Possible further collaboration with university

5 Discussion

Related work [10,14,21] emphasises the need for higher education curriculum to include hackathons as methods of teaching creative thinking, decision-making skills, problem-solving, solution development, teamwork, use and expansion of skill and innovation. With the recent confirmation of hackathons as a pedagogical tool in the eyes of educators [13], we believe the method is ready for wider adoption. This paper aims to offer support for introducing hackathons as a pedagogy tool. The proposed framework will hopefully shorten the time before this form of learning becomes widely included in engineering higher education while also improving the quality of organised events with provided lessons learned. Additionally, by including the university's knowledge and technology transfer office and business incubator, students are presented with options for further developing their ideas in the existing innovation and knowledge ecosystem. The main limitation of the proposed framework is its evaluation of limited sample size; a hackathon was introduced in one course in the selected study program with master students who have had an abundance of prior technical knowledge obtained from their previous studies. The same approach might not be feasible for other types of hackathons or when students have limited technical knowledge.

5.1 Future Work

In this section, the future works are presented through the proof of concept within an attainable testbed - the ATHENA alliance - one of the European Universities. The European Universities initiative supports higher education institutions to make a substantial leap in quality, performance, attractiveness, and international competitiveness. The universities across different EU Member States are working together not just in the field of education but increasingly involving research and innovative potential. The vision of the European Education Area (EEA), enhanced by the strong policy decision, "are foreseen as setting standards for the transformation of higher education institutions across the EEA and the European Research Area (ERA), also making lifelong learning and talent circulation a reality" [5]. Within the ERAMUS+ programme, 44 alliances are funded [9]. Similar activities to hackathons are already integral parts of ATHENA: Praxis & Blended Intensive Programmes. Praxis - the European Centre for Project/Internship Excellence [7], is a network of companies, research labs, and higher education institutions offering internships and advertising planned projects. On the Praxis platform, students can seek internships, apply for projects and work in international teams to solve challenges. Although challenges are not addressed in hackathons, similarities can be drawn - students cooperate with industry, non-profit or academic stakeholders and try to find solutions to their problems.

Blended Intensive Programmes (BIP) [8] combine physical and virtual mobility, with part of the programme taking place online and the other part on-site. Students undertake lectures on a relevant topic, then take on a challenge on the same topic and solve it in transnational and transdisciplinary groups. Closely to the concept of hackathons, the students address a relevant topic in a short period of time, present their ideas and gain new experiences through group work.

In conclusion, implementing the concept within the ATHENA testbed and integrating it with lessons learned from related approaches like Praxis and BIP should provide an international and multidisciplinary environment so that these cooperation models can be reusable role models also implementing the micro-credentials and cross-border industry involvement.

6 Conclusion

Authors frequently identify hackathon as a learning method in engineering studies. However, the approach has not yet seized all its potential. This paper aimed to answer the main research question, "How to improve learning outcomes by successfully introducing a hackathon to the engineering curriculum". This work aimed to expedite the inclusion of hackathons in the engineering curriculum in the form of a standardised pedagogical approach. To achieve this, a framework of activities organised by five main categories, collaboration, challenge, scheduling, competition, and internal execution, was proposed for the educators. The presented approach is based on the organisation of four consecutive hackathons organised as a part of the master's level course in the observed Informatics and communication technologies study program. These events were organised as educational hackathons by following the proposed framework. Three performance formats, online, hybrid and face-to-face, were used over the years. Two of the four events were internal faculty hackathons, and two were externally organised events. Success was confirmed with annual student surveys, where the course achieved very high assessment grades. Additionally, after-event surveys, including mentors and students, showed highly positive results. Students expressed their satisfaction as *"This is the next stage of knowledge acquisition in our generation."*, while mentors affirmed the successful event implementation with statements such as *"The participants were highly motivated and enthusiastic in developing their ideas."*.

The presented framework is not focused only on the event itself but also defines crucial topics students should be familiarized with before attending the hackathon event. This includes the concepts of design thinking, innovation, intellectual property, basics of business planning and strategy, and technology readiness level. Recognized pre-hackathon activities represent an imperative addition to the existing body of literature. Furthermore, for wider use, the post-hackathon event promoting entrepreneurship and innovation should enrich the event itself. This gives students the opportunity to get familiarized with the potential for venture investments, as well as available calls for funding at the university and from various regional, national, and EU sources. An essential extension of the existing approach to hackathons should be the recognition of the role university business incubators and knowledge transfer offices can play. Both stakeholders are strongly involved in innovation and the entrepreneurial ecosystem. The recognized benefits of the proposed framework were listed for all stakeholders. As a future work, the proof of concept is planned within one of the European university alliances.

In conclusion, students have gained and reinforced essential competencies for engineering practice. They obtained hands-on experiences with an improvement in soft skills, with an emphasis on coordinating efforts, communicating effectively, thinking creatively, solving problems and designing solutions.

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Learning Methodologies and Models

CIRC Model Based on Audiovisual Local Wisdom on Ability to Write Malay Pantun

Gunta Wirawan[1](✉), Eti Sunarsih[1], Susan Neni Triani[1], Sri Mulyani[1], Heru Susanto[1], Chairil Effendy[2], and Andi Mursidi[1]

[1] Sekalah Tinggi Keguruan dan Ilmu Pendidikan (STKIP), Singkawang, Indonesia
gwirawan91@gmail.com
[2] FKIP Universitas Tanjungpura, Pontianak, Indonesia
chairileffendy@fkip.untan.ac.id

Abstract. One of the factors causing the low ability of students in writing literature is because learning is centered on the teacher (teacher center) and not focused on students (student center). Generally, teachers use conventional methods and models so that it affects the low learning achievement of students. The purpose of this paper is to describe the effect of the Cooperative Integrated Reading Composition (CIRC) model based on audiovisual local cultural wisdom on the ability to write Sambas Malay pantun for students of Indonesian Language and Literature Education. By using audiovisual media, it is hoped that it can arouse students' imagination in expressing their expressions in pantun. Learning in general follows standard steps from the CIRC model, by providing innovations complemented by audiovisual media so that learning is easier and more enjoyable. This research is a quantitative research with experimental method. The data source was 24 first semester students of the Indonesian Language Education Study Program at STKIP Singkawang who were formed into 6 heterogeneous groups and assigned to compose 3 pantun for each group. The results showed that writing pantun in groups using the audiovisual-based CIRC model provided more motivation and creativity for students so that the pantun created were maximally successful.

Keywords: CIRC · audiovisual · local cultural wisdom · Malay pantun

1 Introduction

The learning process requires a variety of strategies so that students are interested in participating in learning so as to create an easy and fun learning atmosphere. The existence of effectiveness in a lesson is important in order to achieve the quality of the abilities and knowledge of students as expected. Learning is said to be successful if students are able to understand what is conveyed by the teacher as indicated by satisfactory learning outcomes. Therefore, it is necessary to design the learning process in educational units to be held interactively, inspiring, fun, challenging, motivating students to participate actively and provide sufficient space for initiative, creativity and independence in accordance with the talents, interests and physical and psychological development of students.

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Cooperative Learning methods have various models, one of which is Cooperative Integrated Reading and Composition (CIRC). Cooperative learning is a collaborative learning model that heterogeneously groups students consisting of four to six people to achieve success in learning together. Each group is given the opportunity for discussion activities. Cooperative learning provides facilities and opportunities for students to work together optimally in a group to achieve common goals.

The Cooperative Integrated Reading and Composition (CIRC) model in learning to write aims to design, implement, and evaluate a writing process approach in writing and language arts lessons that will take advantage of the presence of classmates. In the Cooperative Integrated Reading and Composition (CIRC) model, students plan, revise, and edit their essays in close collaboration with their teammates (Slavin, 2010: 204).

One of the factors causing the low ability of students in writing, especially literature, is because most of the teachers use conventional methods and models that seem monotonous and boring. This kind of learning model allegedly does not give students enthusiasm for learning because it does not involve them totally. Learning is centered on the teacher (teacher center) and not focused on students (student center) so that it affects the low learning achievement of students. This is in line with the research conducted by Hadiwinarto and Novianti (2015: 118) that there are some aspects that can affect the low learning results of students. The aspects that affect the students' learning success can be categorized into internal and external aspects. One of the internal aspects is the condition of the student. The external factor is the instrumental input, namely: educators, facilities, and learning process aspects. One of the learning process aspects is the learning method implemented by the teacher. The good learning model has to involve students actively by considering the cognitive, affective, and psychomotor aspects. During the implementation of the learning model, teachers play a great role in designing a fun, attractive learning strategy so students can get motivated to make achievements and comprehend the lessons well.

One of the oral literature that is still maintained by the community is pantun. For the Malay community, pantun does not only function as a subtle delivery of values and advice, but also as a means of communication and a medium for storing customs, preserving oral literature, increasing imagination, creativity and thinking power, and forming the character of students.

The previous research, among others, was made by L.C. Rosa Dewi, IB. Putrayasa, I.A. Md Darmayanti, with the title "Application of the Cooperative Integrated Reading and Composition (CIRC) Model to Improve Reading Comprehension of Discussion Texts in Grade VIII.4 Students of Junior High School 2 Singaraja Published in the Journal of Ganesha University of Education, Department of Indonesian Language and Literature Education, Vol: 6 No: 1 of 2017. This research is a classroom action research. The subject of this study was an Indonesian language teacher and students of class VIII.4 at Singaraja 2 Junior High School. Data collection methods used are observation, tests, questionnaires, and interviews. Data were analyzed using quantitative and qualitative data analysis techniques. The results showed that (1) there was an increase in teacher and student activity in reading comprehension of discussion texts in applying the CIRC learning model. The results obtained also increased; (2) the average score of the pre-action students was 68. In cycle I, the score increased to 78.95, and in cycle II to 82.5;

and (3) responses related to interests, talents, attitudes, student motivation, and goals also increased from cycle I to cycle II, namely from 44.07 to 47.11. The researcher suggests that the results of this study can be applied by Indonesian language teachers to improve students' reading comprehension skills of discussion texts.

In addition, research conducted by Nyoman Alit Budiani entitled Application of the CIRC (Cooperative Integrated Reading and Composition) Learning Model to Improve Civic Education Learning Outcomes was published in the journal of Education Action Research Vol. 3 No.3 2019. The results of the study show that the application of the CIRC (Cooperative Integrated Reading And Composition) learning model can effectively improve PPKn learning outcomes for class X MIA 2 semester II students at SMAN 1 Denpasar in the 2018/2019 academic year. This is shown from the mean in cycle I of 73.19 with classical completeness of 77.78%. While the mean in cycle II was 86.25 with classical completeness of 91.67%.

The purpose of this study was to describe the application of the cooperative integrated reading composition (CIRC) model based on audiovisual local cultural wisdom to the ability to write Sambas Malay pantun in Indonesian Language Education students.

2 Research Methods

This research is a quantitative research with experimental method. Sugiyono (2016: 107) says that the experimental research method can be interpreted as a research method used to seek the effect of treatment on others under controlled conditions.

The form of experimental research used is the One-Shot Case Study. The formula used (Sugiyono, 2016: 112) is as follows:

$$\boxed{X\ O}$$

X = the treatment given (variable independen)
O = observation (variabel dependen)

The One-Shot Case Study experimental model can be read as follows:

There is a group given treatment, and then the results are observed (the treatment is the independent variable, and the results are the dependent variable). so it does not require an experimental class or a control class.

The data sources in this study were 24 semester 1 students of the Indonesian Language Education Study Program at STKIP Singkawang, consisting of 5 men and 19 women. The implementation of the learning model is carried out in class 1A of the Indonesian Language and Literature Education Study Program. Students were formed into 6 heterogeneous groups and assigned to compose 3 pantun for each group. Thus, the number of pantun resulting from the implementation of the CIRC model is 18 pantun. However, what is written in this article is the result of 6 pantun, each group showing 1 pantun.

3 Results and Discussion

3.1 Learning Model

The learning model is a pattern that is used as a guide in planning learning in groups or tutorials. Joyce and Weill (in Huda 2014: 73) state that teaching models are plans or patterns used to shape curriculum, design instructional materials, and guide the teaching process in classrooms or in different settings.

The selection of the learning model must consider several things, namely (1) learning objectives, (2) the nature of the subject matter, (3) the availability of facilities, (4) the conditions of the students, (5) the available time allocation. Thus, the function of the learning model is as a guide for teachers in carrying out learning. The choice of learning model is strongly influenced by the nature and material to be taught, the goals to be achieved in learning, and the ability level of students.

3.2 Cooperative Learning

Gupta dan Jyoti Ahuja (2014: 1) say that cooperative learning (CL) as one of the means of active learning might serve as an appropriate and promising strategy helping to increase learning effectiveness and providing students with the skills of collaborating, cooperating, sharing and socializing. Cooperative learning may be defined as any classroom learning situation in which students of all levels of performance work together in structured groups toward a shared or common goal.

Cooperative learning is a form of learning in which students learn and work collaboratively in small groups whose members consist of four to six people with heterogeneous group structures (Rusman, 2014: 202). Each group is given the opportunity for discussion activities. This interaction activity will provide students with a form of synergy that benefits all members. The teacher schedules time for groups to evaluate the process of group work and the results of their collaboration so that they can work more effectively next. Cooperative learning accommodates how students can work together in groups, group goals are common goals. Cooperative situations are part of students to achieve group goals, students must feel that they will achieve goals, then other students in the group have togetherness, meaning that each group member must be cooperative with fellow group members.

According to Hamdani (2011: 31) the characteristics of cooperative learning, namely) a) each member has a role, (b) there is a direct interaction relationship between students, (c) each group member is responsible for how he learns and also his group mates, (d) the teacher helps develop group interpersonal skills, and (e) the teacher only interacts with the group when necessary.

3.3 Cooperative Integrated Reading and Composition (CIRC) Model

Varışoğlu (2016: 1169) quotes Slavin's opinion, saying that the technique of Cooperative Integrated Reading and Composition (CIRC), one of cooperative learning methods basically applied to develop reading and writing skills, is one of the techniques used in language teaching. The purpose of this technique is not only to find solutions to the problems experienced in traditional teaching of reading and writing skills but also to develop these skills.

According to Sharan (2009: 36) all CIRC development plans are focused on using cooperative learning as a vehicle that can be used to introduce exercises in reading and writing into routine classroom exercises, and to embed cooperative learning within the structure of elementary school reading and writing programs.. Durukan (2011: 103) that Cooperative integrated reading and composition (CIRC) technique, one of the learning techniques based on cooperation, is designed to develop reading, writing and other language skills in the upper grades of primary education. The CIRC technique presents a structure that increases not only opportunities for direct teaching in reading and writing but also the applicability of composition writing techniques.

CIRC is a cooperative method that introduces the latest practical curriculum training techniques for teaching reading. Cooperative Integrated Reading and Composition (CIRC) is a comprehensive program for teaching reading and writing/language arts. It has three principle elements: story-related activities, direct instruction in reading comprehension, and integrated language arts/writing. Program developers include Robert Slavin, Robert Stevens, Nancy Madden, and Anna Marie Farnish (Darmayanti, 2014: 115; Huda, 2014: 221–222; Ilham, 2016: 122).

The cooperative integrated reading and composition technique (CIRC) is one of the learning techniques based on cooperation, designed to develop reading, writing and other language skills in the upper grades of primary education. The CIRC technique presents a structure that increases not only opportunities for direct teaching in reading and writing but also the applicability of composition writing techniques.

3.4 Steps of the Cooperative Integrated Reading and Composition (CIRC) Model

In order for learning to be carried out using the CIRC model to be measurable and systematic, it must follow the steps that are in accordance with the rules of using the model. According to Stevens (in Huda, 2014: 222) the steps for the Cooperative Integrated Reading and Composition model are as follows.

a. The teacher forms groups, each consisting of 4 students.
b. The teacher gives discourse according to the topic of learning.
c. Students work together to read to each other and find the main idea then provide responses to the discourse written on sheets of paper.
d. Students present or read out the results of group discussions.
e. The teacher provides reinforcement.
f. Teachers and students together make conclusions.

This learning model is good for use when the teacher wants students to explore or understand more in detail and in detail what the material being taught is.

According to Varışoğlu (2016: 1171) that the application phases of the CIRC technique were as follows:

1. Determining the instructional goals and measurement tools: In this phase, the knowledge and skills to be acquired by the students with the help of the CIRC technique were determined.

2. Forming the groups: The duties were shared by the students in a way to increase their attachment to one another.
3. Organization of the classroom for group work: The classroom was organized in a way to facilitate intergroup and intragroup interaction and communication.
4. Informing the students about the goals, the measurement tools and the achievement criteria: At the beginning of the process, the students were informed about the goals and outcomes in relation to comprehension of a text with the CIRC technique. Parallel to the activities carried out regarding the text, quizzes were given. According to the results of these quizzes, the most successful group was declared.
5. Determining the subject-related materials to be used by the students and informing them about their use: The material to be used by each student was provided by the researcher. When considered necessary, a presentation related to the subject was made to provide background information.
6. Starting and maintaining the in-group study process: The steps taken in the application process of the CIRC technique to be used for reading comprehension and writing activities in teaching.

3.5 CIRC Audiovisual as Supporting Media for the CIRC Model

Audiovisual media has many advantages which are very supportive and able to arouse the feelings and thoughts of the audience. The use of audiovisual media in learning to write pantun is expected to motivate and help students create ideas and develop these ideas and ideas into a literary work. Thus, it is assumed that audiovisual media is very effectively applied in learning to write pantun. According to Sudjana (2009: 3) that the use of learning media in the learning process is highly recommended to enhance or improve the quality of learning. This is based on the results of research conducted on the use of media with the conclusion that at the process stage and student learning outcomes using the media show significant differences without using the media.

Arsyad (2014: 6) states that educational media has the notion of aids in the learning process both inside and outside the classroom. In education, media is used as a teacher's tool in conveying learning both inside and outside the classroom. Sanaky (2013: 4) states that learning media are educational tools or tools that can be used as intermediaries in the learning process to enhance effectiveness and efficiency in achieving teaching goals. This opinion states that the media as an intermediary for learning from teachers to students so that students can easily achieve teaching goals effectively and efficiently. Learning media is considered important because using the media will make it easier for students to understand the material because with the help of the media it can equate the perceptions of students who are different from one another, concretize abstract concepts, are able to present large and dangerous objects in learning, and can shows a particular process that is too fast or slow in its work. Thus the existence of a media becomes very important in every lesson.

3.6 Sambas Malay Pantun as Oral Literature Containing Local Cultural Wisdom Values

Oral literature is the beauty of Malay art. In oral literature, various cultural treasures are stored which are a reflection of the supporting community. Therefore, oral literature is a part of the oral tradition. Oral literature developed among the people by using language as the main medium. In general, oral literature was born in regional languages (Neldawati, 2015: 69).

The people of West Kalimantan still live in a primary oral tradition. In relation to oral literature, various kinds of oral literary texts are still found in society (Effendy, 2006: 65). According to Ong (in Effendy, 2006: 63) what is meant by primary oral tradition is that almost the entire process of transferring and instilling socio-cultural values, knowledge systems, values, norms, laws that occur in society takes place orally from generation to generation. Asmoro (2005: 367) says that oral literature is passed down from the older generation to the next generation. The same thing was also said by Indiarti (2017: 27) that oral literature is passed down orally from one generation to the younger generation.

According to Taum (2011: 65–68), materials for oral tradition can be in the form of non-verbal traditions (traditions characterized by material and non-material characteristics). Thus, pantun is included in the verbal tradition. Oral tradition is also known as folklore. Danandjaya (2007: 22) says that part of folklore can be in the form of folk language, traditional expressions, riddles (traditional questions), pantun, poetry, folk prose stories, such as myths, legends and fairy tales, folk songs, folk theater, folk games., beliefs, fine arts, folk music and gestures.

Malay society has a very high oral literature. One of the oral traditions that is still preserved and passed down from generation to generation is the culture of chanting. According to Maulina (2012: 109) pantun is pure folk poetry originating from the local linguistic intelligence of the genius of the Indonesian nation itself. Pantun is one of the oral traditions that is still maintained and used by the community in their events and activities. Thus, pantun is part of the culture of the Indonesian nation which grows and develops in the midst of a society that is recognized as common property and is preserved as the pride and characteristics of the community that owns it. Likewise with the Sambas Malay community in West Kalimantan, the culture of chanting is very familiar and has become the daily life of the people. Almost all events and activities are usually accompanied by pantun, especially at events such as engagements, weddings, religious events, and so on.

Demonstration of language skills among the Malay people, which are full of subtle tastes, usually use pantun (Effendy, in Effendy, 2014: 129). According to Musa (2012: 164) that the Malay people are indeed reliable, wise and agile, because they have a strong and noble heart. With pantun, this allegorical form of literature, the Malays show communication that is not straightforward. Effendy (20014: 129) says that the politeness phenomenon of language can be seen in the formulas in the pantun verses. Likewise with the pantun that exist in the Sambas Malay community of West Kalimantan. Pantun that lives in the midst of Malay society contains, (1) courtesy in the form of wisdom, (2) courtesy in the form of generosity, (3) courtesy in the form of appreciation, (4) courtesy in the form of humility, (5) courtesy courtesy in the form of agreement and agreement, and (6) courtesy in the form of sympathy.

Pantun usually consists of four lines (or four lines if written), each line consisting of 8–12 syllables, pantun at the end with the pattern a-b-a-b and a-a-a-a (no a-a-b-b, or a-b-b-a). Pantun was originally an oral literature but now there are also written pantun (Maulina, 2012: 109). The first two lines are the cover, and the last two are the contents.

According to Sutan Takdir Alisjahbana (Maulina, 2012: 110) the function of sampiran is primarily to prepare pantun and rhythms to make it easier for listeners to understand the contents of the pantun. This is understandable because pantun is oral literature.

The Malay community looks up to noble character, courtesy, gentleness (Abdullah, 2009: 45). The characteristics of the Malay community are polite in behavior and language. This politeness can be seen in conveying intentions or advice in the social life of the community through the media of pantun because with pantun advice is conveyed without offending or injuring the feelings of the person being advised or those who hear it. Thus, it can be said that pantun has a function and position in the midst of the life of the speakers as entertainment and a means of communication. Mohd Taib Osman (in Abdullah, 2009: 44) considers pantun, apart from being a means of communication in its social context, is a cultural artifact.

Malay literature, both written and spoken, with its various genres was created for the noble purposes of cultivating religiosity, teaching to be honest, tolerant, disciplined, hard working, creative, independent, democratic, curiosity, national spirit, love for the motherland, respect achievement, friendly or communicative, peace-loving, fond of reading, caring for the environment, social care or responsibility, all of which start with the formation of personality and character (Effendy, 2014: 128). These positive values are a reflection of human behavior in relation to God Almighty, oneself, fellow human beings, the environment and nationality which are embodied in thoughts, attitudes, feelings, words and actions based on religious norms, laws, ordinances. Manners, culture, and customs.

Pantun has long been rooted in Indonesian society, especially Malays. Therefore, pantun is one of the classic literature in the archipelago. By studying and popularizing pantun, there are many benefits that can be taken. Kosasih (2013: 228–229) says that the benefits of learning classical literature are (1) literature gives pleasure, joy, and enjoyment, (2) works of classical literature must arouse students' curiosity, curiosity about something, be it with respect to characters, background, and other elements, (3) literature can provide strange experiences that seem to be experienced by students themselves, (4) literature can develop students' insights into human behavior with character, (5) literature can present and introduce universality experience to students, for example the values of courage, piety, chivalry, loyalty, friendship, patience, honesty, and others, (6) literature is the main source for the transmission and dissemination of literary heritage from one generation to the next.

Pantun functions as a guide. Effendy (2004: 7) argues that according to Malay elders, demonstrating Malay teachings are all advice, trust, role models, and advice that lead humans to the straight path and are blessed by Allah, whose blessings save humans in life in this world and in life. in the afterlife. Demonstrations of Malay are expressions related to all aspects of life and various noble teachings of Malay. Thus, the function of pantun is:

(1) As a means of maintaining language, pantun acts as a guardian of the function of words and the ability to maintain the flow of thought. Pantun trains someone to think about the meaning of words before speaking.

(2) Socially, pantun has a social function. Pantun shows a person's speed in thinking and playing with words. However, in general the social role of pantun is as a means of reinforcing the delivery of messages.
(3) Pantun can be used as a communication tool, to infuse advice or sermons, or even to carry out social criticism, without hurting anyone's feelings. Pantun is not only used as a means of entertainment, jokes, satire, to vent feelings of longing for revenge, but what is more interesting is its role as a medium in conveying teachings (Maulina, 2012: 110).

In addition, if you examine the role and function of pantun in society, it can be said that pantun is very effective as a medium for forming national character. Hidayatullah (2010: 13) states that character is a quality or mental or moral strength, character or character of an individual which is a special personality that drives and drives, and differentiates it from other individuals.

3.7 Implementation of Audiovisual-Based CIRC Model of Local Cultural Wisdom to Improve Ability to Write Sambas Malay Pantun

Learning writing skills has various forms, one of which is poetry writing skills. Learning to write pantun has an important role in directing students to be able to express their feelings and emotions.

The activity of writing pantun is essentially related to someone's experience which is poured into writing that tries to arouse feelings so that the reader can understand what the writer feels. Writing activity is not an ability that can be mastered by itself, but with various processes that must be mastered, both elements of language and elements of content in developing writing skills. One of the materials in Indonesian language lessons that are within the scope of writing skills is literature.

Observing the fact that learning to write pantun does not meet expectations, it is necessary to make effective efforts to teach pantun writing. In this case, a technique is needed that can help students overcome problems in writing pantun, one of the techniques that is assumed to help students create a literary work, especially creating pantun, is through audiovisual media. Audiovisual as a medium that makes it easier for students to develop ideas in the form of pantun because there are movements and visualization (sound) of an object so that students only have to formulate the object through diction until a pantun is created.

Several previous studies have stated the success of the CIRC learning model in an effort to improve students' writing skills. Thus the accompanying impact of the CIRC model innovation development is assumed to be successful.

The steps of the audiovisual-based CIRC learning model are not much different from the cooperative method learning steps in general. However, in this study the CIRC learning model was developed using audiovisual media in which each group formed was given audiovisual enrichment about local cultural wisdom so that it helps students (students) imagine to express it in writing in the form of pantun.

The following are the steps for the CIRC learning model based on audiovisual media.

a. Students form groups, each consisting of 4 people.
b. Students play audiovisuals for each group whose facilities have been prepared (can be in the form of an Android cellphone that can search the internet). However, if it is not possible, the lecturer can play it in front of the class.
c. Students work together to express and find main ideas and then provide responses to the audiovisual show.
d. Students make responses to the contents of audiovisual media shows
e. Students write pantun according to the theme of the audiovisual media broadcast. The trick is that 2 students each make a sampiran, and the other two, each make the contents of the pantun.
f. Students present or read their work
g. The lecturer provides feedback or reinforcement

Based on the results of research on semester 1 students of the Indonesian Language and Literature Education Study Program, it can be said that writing pantun in groups using the audiovisual-based CIRC model of local wisdom is very good. This is evidenced by the results of creative and imaginative pantun writing. As quoted below:

Sambas Malay Pantun	Translate
Bangun pagi makan kue bingke Datang ummak bawa aek kopi Makan besaprah sedap rasenye Dapat mengikat tali silaturrahmi	Get up early to eat bingke cake Mother came with coffee It's delicious to eat Can bind brotherhood
(Group 1: Ika Prawiandani, Oktaviani, O'om Abdul Rahman, Putri Indah Lestari)	

Sambas Malay Pantun	Translate
Pergi ke pasar beli beras Usah lupak beli piring Mun kite urang Sambas Lestarikan budaya ngamping	Go to the market to buy rice Don't forget to buy plates If we are Sambas people Preserve the ngamping culture
(Group 2: Della Rahayushita, Henny W, Fadira Yuniandita, Rizqi Ihsan Maulana)	

Sambas Malay Pantun	Translate
Bubur pedas dibarek kecambah Lebih nyaman agek dibarek teri Paling nyaman makan besaprah Karne menambah silaturrahmi	Bubur Pedas sprinkled with sprouts Better if you add anchovies Most delicious to eat besaprah Because of brotherhood
(Group 3: Alvin Fernando, Mahmudah, Farida, Ichi Afriani)	

Sambas Malay Pantun	Translate
Ke rumah tetangga kite maing Usah lupak bawak makanan Numbok padi kite ngamping Bentuk syukur kite kepade Tuhan	Visit the neighbor's house don't forget to bring food pound rice for ngamping Our form of gratitude to God
(Group 4: Aulia Noventi, Deyne Tiara, Kasensia Meicy, Salwah el Wasitah)	

Sambas Malay Pantun	Translate
Dari mane maok berlabuh Dari Japang ke Bandar Cine Jangan kite tinggalkan besaprah Karene warisan budaya kite	Where do you want to land From Japan to Bandar China Let's not leave besarah Because of our cultural heritage
(Group 5: Yordy, El-Roy Setiawan, Wiwik, Muliana)	

Sambas Malay Pantun	Translate
Sungguh sedap ketupat besantan Sambil disantap duduk besaprah Bebalas pantun kite lestarikan Budaye Melayu menjage marwah	The ketupat with coconut cream While eating, sit up besaprah In return we preserve pantun Malay culture maintains customs
(Group 6: Melly, Lora Amalia, Yulia Arsela, Denisa Putri Andini)	

Moving on from the explanation above, it can be said that learning to write pantun for Indonesian Language Education students using the CIRC model based on audiovisual media can be improved. This is as stated by Zainuddin (2015: 18) in his research using the CIRC model, that Therefore, it can be concluded that the Cooperative Integrated Reading and Composition (CIRC) technique significantly affects the students' descriptive text reading achievement compared to the classical method (CM).

4 Conclusion

1. Cooperative Learning learning methods have a variety of methods, one of which is the Cooperative Integrated Reading Composition (CIRC). Cooperative integrated reading and composition learning is integrated learning between reading and writing. In this study each student is responsible for group assignments. Each group member issues ideas to each other to understand a concept and complete the task, so that the same understanding and learning experience is formed.
2. Audiovisual media is a supporting medium in implementing the CIRC learning model so that it makes it easier for students to learn to write pantun.
3. Writing pantun in groups using the audiovisual-based CIRC model provides more motivation and creativity for students so that the pantun created are maximally successful.
4. This research can be a reference for other researchers, especially research that uses the CIRC learning model, or the theme of oral literature, especially pantun.

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The Students' Perspective on Assessment Pattern Catalog for a Distant Education

Tina Beranič(✉), Luka Pavlič, Lucija Brezočnik, and Marjan Heričko

Faculty of Electrical Engineering and Computer Science, University of Maribor, Koroška cesta 46, 2000 Maribor, Slovenia

{tina.beranic,luka.pavlic,lucija.brezocnik,marjan.hericko}@um.si

Abstract. Systematically developed and validated assessment pattern catalogs can improve the knowledge assessment process within the pedagogical process significantly. Relying upon and implementing proven best practices, especially in new and challenging situations, could result in many positive aspects for teachers and students. Based on the identified gap, we developed an assessment pattern catalog for a distant education, combining proven and validated best practices emerging from practical experiences. Although the validation of the catalog by the teachers and teaching assistants provided many intriguing aspects, studying the students' perspectives on defined patterns represents an important research path. This paper presents the preliminary results of the ongoing research looking into students' views on the assessment catalog. The presented results were based on the answers of 51 participantswho were involved actively in many remote assessments. Therefore, they experienced the practical use of the formed patterns. In the paper we present their views on the patterns' popularity - ranking the patterns based on their importance for successful and effective remote knowledge assessment. The students' ratings are also compared to the sequences made by the educators. An overlap in popularity is detected in some patterns, while the ratings of others differ. Nevertheless, the variations are understandable and explainable, based on different points of view.

Keywords: knowledge assessment · best practices · distance learning · online learning · students' satisfaction · popularity

1 Introduction

Systematically collected and validated educational best practices can contribute significantly to the improvement of the teaching process. Existing practices can offer a hand when coping with new or existing, but still unaddressed, challenges. One of the recent challenges educators have had to cope with is challenges connected to distant education. The events within recent years moved some of the previously established and well-defined processes to the online environment. Although it seemed like a temporary solution, in some cases, distant education remains part of the study process. Therefore, challenges connected to distant learning still need to be considered and addressed correctly.

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One of the essential parts of the educational process is knowledge assessment. Especially when implemented in remote environments, it requires additional attention and precautionary measures. Using previously proven best practices can result in many positive outputs, including improvement in students' satisfaction and motivation. In our previous work (Pavlič et al. 2022), we presented a novel catalog of assessment patterns for distant education. The catalog was designed based on practical experiences at the Institute of Informatics, which is part of the Faculty of Electrical Engineering and Computer Science, University of Maribor. The initial set of patterns that were identified by the teaching staff was aggregated and refined using a systematic approach. The included patterns were later validated by educators, who researched their attitudes towards the formed practices.

Although educators introduce the assessment patterns, students, as actively involved participants, can offer us an important point of view on the designed catalog. Therefore, our research continued in the direction of studying the students' perspectives on the assessment pattern catalog for distant education. This paper presents the preliminary results of two generations of students who were involved in the distant knowledge assessment actively. The presented results are focused on the following topics. The first research question (*RQ1*) studied the students' perspectives on:

Which patterns are most crucial for successful and effective remote knowledge assessment?

The second research question (*RQ2*) looked for possible overlaps of top-rated patterns between students and educators:

Is there an overlap between the top-rated patterns chosen by students, teachers, and teaching assistants?

The rest of the paper is organized as follows. In the following section, we highlight the related work in the field of assessment patterns, including its validation. Section 3 presents the distant assessment patterns catalog briefly, presenting the categories and patterns description template. In continuation, Sect. 4 presents the results of an implemented study researching the students' perspectives on the defined catalog. The results emphasize the top-rated patterns, which are then compared to the ratings made by the educators. The paper is concluded in Sect. 5, summarizing the answers to the formed research questions and laying the foundation for future work.

2 Related Work

Koppe, et al. (2017) stated that "educational patterns provide teachers with examples of educational designs and a language for creating new educational designs". Only a few pedagogical patterns catalogs were detected in an implemented SLR (Pavlič et al. 2022), namely, Pedagogical Patterns by Teaching Activities and Pedagogical Values (Bennedsen and Eriksen 2006), Pattern Language for Hybrid Education (Koppe et al. 2017), Patterns (Online document storage) (EduPLoP) and Open Repository for Online Learning System Patterns (Open Pattern Repository for Online Learning Systems). Although the identified catalogs combine a variety of pedagogical patterns, a significant gap was detected when looking for knowledge assessment pedagogical patterns. Still, some assessment patterns could be found (Koppe et al. 2020a, b; Bergin et al. 2016;

Warburton et al. 2016; Seoane Pardo and García-Penalvo 2014), together with different studies addressing the assessment within a COVID-19 pandemic (Oliveira et al. 2021; Rodrigues et al. 2022; Can and Bardakci 2022). However, none of the mentioned examples or patterns were cataloged systematically or consistently. We believe that our previous work (Pavlič et al. 2022) filled the identified gap.

An essential part of pattern catalog development is its validation. Different stakeholders must validate the patterns to confirm their appropriateness, define possible limits or restrictions, and, on the other hand, the suitability of use. A systematic approach for pattern validation was not detected within related work. Our catalog (Pavlič et al. 2022) was validated by multiple educators, i.e., teachers and teaching assistants. We also looked beyond distant education, researching the aspects of classroom applicability (Heričko et al. 2022). In addition, the presented paper presents another validation focused on students' perceptions of the identified patterns within the formed catalog.

3 The Distant Assessment Patterns Catalog

The catalog of assessment patterns for distant education was developed in 2020 and 2021. The catalog's development was done by implementing sequential systematically defined steps: (1) Collecting the preliminary recurring practices, (2) Preliminary Cataloging, (3) Cataloging, and (4) Validation. The details of each step are presented in the paper by Pavlič et al. (2022).

The catalog depicted in Fig. 1 includes 47 assessment patterns divided into six categories. In addition to two unclassified assessment patterns and three anti-patterns, the patterns are divided into the following categories:

- Patterns for the **assessment conceptual design**;
- Patterns for **defining questions, answers and schedules**;
- **Execution and grading** patterns;
- **Communication** patterns.

The first category combines the patterns aimed at developing and organizing knowledge assessment within study courses. Patterns like *Pentathlon* (The final grade is composed of multiple assignments.) and *Continuous Testing* (Integration of remote assessment into lectures as a tool for teaching.), are just two of the defined patterns for assessment conceptual design. Patterns used for defining questions, answers and assessment schedules are joined within the second category. They are intended for selecting the tasks and defining the schedule of the knowledge assessment adequately. The representatives of the patterns are, for example, *Colleague Veto* (Eliminate or correct questions in case of doubts or concerns of a colleague.) and *Theme Variants* (Preparation of different online assignments‘ variants for the same assessment type).

The catalog also offers a group of patterns that can be applied within the execution of knowledge assessment and grading of the students' outputs. Among others, applying the mentioned patterns can contribute to a more objective and consistent grading process. The representatives are pattern *Bonus Points* (Introduce bonus points to engage students better in an online setting.) and pattern *Personal Defence* (Students' oral defence). The fourth group unites the communication patterns. They enable educators to improve knowledge assessment with well-defined communication approaches. The catalog proposes using the patterns *Game Rules* (Explanation of assessment rules at the first lecture or before the assessment.) and *Time Reminder* (A reminder about the time remaining during the assessment).

(1) ASSESSMENT CONCEPTUAL DESIGN	(2) DEFINING QUESTIONS, ANSWERS, AND SCHEDULE	(3) EXECUTION AND GRADING	(4) COMMUNICATION
Open Book	**Content Validators**	Timebox	Appetizer
Stagewise Approach	Expert Validator	Randomized Order	Game Rules
Pentathlon	Statistical Validator	Results With Delay	Time Reminder
Continuous Testing	Hidden Validator	Identity Guarantee	To-Do List
Expert-Level	Colleague Veto	Accessibility Adjustments	**Separate Channel**
Innovator alias Open Spectrum	**Time Validators**	Objective Assessor alias Score Calibrator	Emergency Call alias 911
Student Achievement Portfolio	Mathematical Validator	Criteria List	Member Channel
Colleague Bloom	Professional Multiplier	Eurosong	Academic Integrity Appeal
	Val. with a Try	Bonus Points	Proactive Teacher
	Dress Rehearsal	Third Shift	Firewall
	Example Questions	Number Draw	Student Proxy
	Questions Donor	Impro League	
	Theme Variants alias Alternate BOM	Self-Assessment	
		Personal Defense	

ANTI-PATTERNS	OTHER
24/7 alias Permanent Availability	Safe Exam Browser
Full-Time Job	Big Brother
Certification Centre	

Fig. 1. The assessment pattern catalog

The designed catalog also includes detailed pattern documentation within uniform descriptions. Therefore, all the included patterns are described in detail in the same manner, allowing stakeholders to gain all the available information. Table 1 presents a template used to describe all the included patterns.

4 Patterns' Popularity Rating

The designed catalog combines 47 patterns. It is not expected that all patterns will be used at once, or that one will use each pattern. One of the steps within the catalog's creation was also the validation. Participating stakeholders answered multiple questions

Table 1. Template for unified pattern description

Pattern Name (Category)
Challenge solved by the pattern
The main idea of the solution
Applicability/Context
Participants, participation and environment
Implementation steps
Possible variations
Advantages
Disadvantages and threats
Known uses
Related patterns
Do not use with
Specific resources/tools required for implementation

regarding each pattern. Among others, we asked them to pick their top 5 patterns that are, in their opinion, vital for successful and effective remote knowledge assessment. Within the analysis, each pattern was assigned points according to the provided rating. Therefore, the patterns could get:

- 5 points ranked as the most important;
- 4 points second;
- 3 points third;
- 2 points fourth;
- 1 point listed fifth;
- 0 points all other patterns.

The final score of each pattern is the sum of the gathered points given by the participants. In the continuation, we present the results of our ongoing research, studying the students' perspectives, followed by a subsection identifying and explaining the overlap between the students and educators.

4.1 Students' Perspectives

Students' perspectives regarding each pattern can give us important feedback for improving, adjusting, or even adding new patterns to the catalog. In the presented research 51 students participated, and all of them were involved actively in remote knowledge assessment during the COVID-19 pandemic. At the time of the study participation, they were enrolled in the 1st year of a master's degree study programme focused on informatics.

Hereinafter, we present the preliminary results of our study,in which we researched students' opinions and views of the assessment patterns. This paper focuses on patterns of popularity rating, which was done using the methodology described at the beginning of Sect. 4. Based on the performed analysis, the top-rated assessment patterns for distant education are presented in Fig. 2. The Figure depicts all 47 patterns, ordered in declining popularity, together with the gathered points. As can be seen, the *top 5* patterns that are most crucial for successful and effective remote knowledge assessment, according to the students, are:

1. *Open Book* (All assets are allowed during an online assessment.)
2. *Pentathlon* (The final grade is composed of multiple assignments.)
3. *Bonus Points* (Introduce bonus points to engage students better in an online setting.)
4. *Objective Assessor* (Eliminate questions that turn out to be problematic.)
5. *Example Questions*
6. (Provide online question examples.)

The analysis was also done by the defined categories. The *top 3* patterns in each category are:

- Patterns for the assessment's conceptual design (*Open Book*, *Penthathlon*, *Continuous Testing*)
- Patterns for defining questions, answers and schedules (*Example Questions*, *Expert Validator*, *Statistical Validator*)
- Execution and grading patterns (*Bonus Points*, *Objective Assessor*, *Accessibility Adjustments*)
- Communication patterns (*Appetizer*, *Game Rules*, *Time Reminder*)

It can be observed that, in the general top 5 list, two patterns are the patterns for assessment conceptual design, two from the list of patterns used within execution and grading, and one pattern from the category of patterns for defining questions, answers and schedules.

4.2 Comparison Between the Students' and Educators' Perspectives

The educators' perspectives of the most popular patterns were already presented in detail in our previous papers (Pavlič et al. 2022; Heričko et al. 2022). The ratings were gathered for the whole population of educators and separately for teachers and teaching assistants. In the paper by Heričko et al. (2022) we also presented a list of the top 3 patterns for each of the catalog's categories.

Figure 3 depicts the rating comparison between students and educators. The first list presents the students' ratings, while the remaining three present the educators' perspectives. Namely, the second list depicts teachers' perspectives, the third teaching assistants' perspectives, and the fourth list rated patterns for the joined population of educators.

It can be seen that some of the patterns are rated high regardless of the participants' population. For example, the pattern *Pentathlon* is ranked 2nd among students and 1st among educators. Highly rated is also the pattern *Open Book*. Students rated the pattern as the most crucial for successful and effective remote knowledge assessment. It is reasonable that the students encourage the idea of having all the assets available within the knowledge assessment. The pattern *Open Book* is also highly rated by the teachers, but not as high among teaching assistants. However, this pattern is an excellent example illustrating the need for pattern matching. For example, if we decide on an *Open Book* it

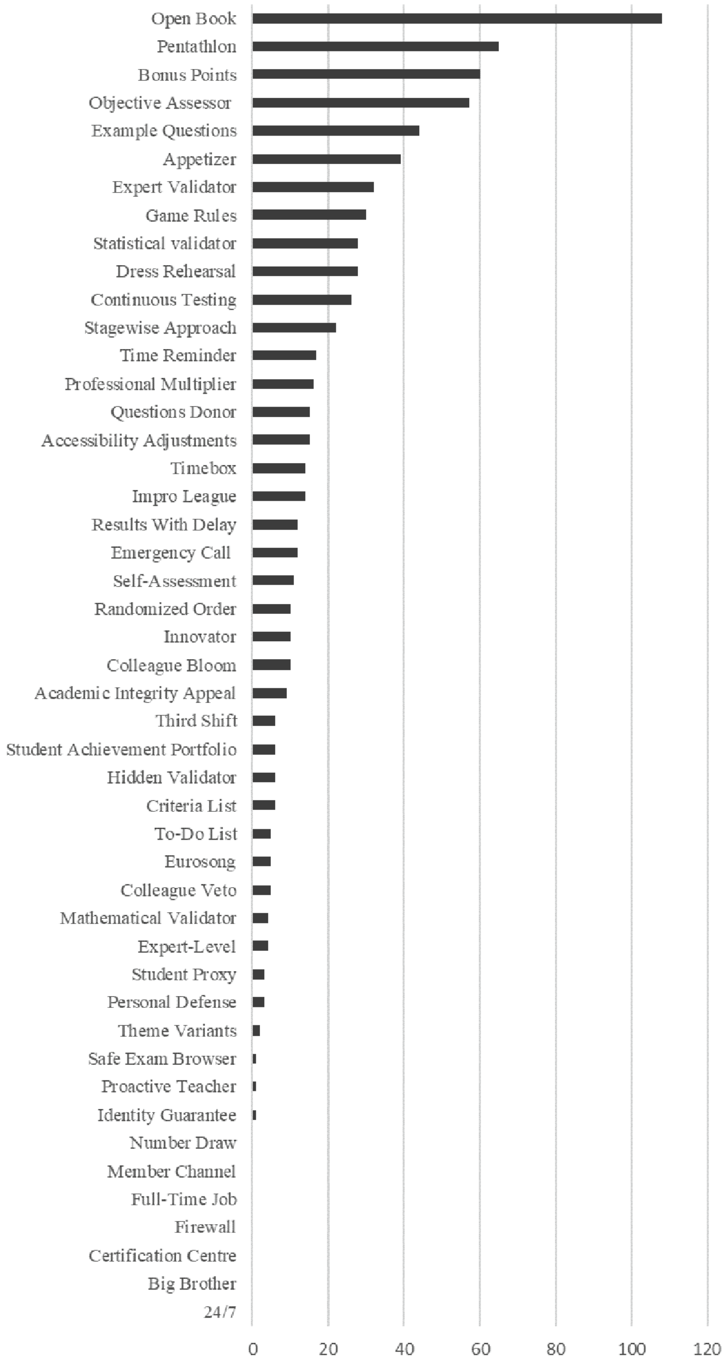

Fig. 2. Top rated patterns among students

Students	Teachers	Teaching assistants	Educators
Open Book	Pentathlon	Pentathlon	Pentathlon
Pentathlon	Timebox	Personal Defense	Personal Defense
Bonus Points	Open Book	Randomized Order	Timebox
Objective Assessor	Theme Variants	Game Rules	Randomized Order
Example Questions	Randomized Order	Colleague Veto	Open Book
Appetizer	Continuous Testing	Timebox	Theme Variants
Expert Validator	Personal Defense	Innovator	Continuous Testing
Game Rules	Bonus Points	Professional Multiplier	Game Rules
Statistical validator	Professional Multiplier	Stagewise Approach	Professional Multiplier
Dress Rehearsal	Big Brother	Expert Validator	Colleague Veto
Continuous Testing	Hidden Validator	Criteria List	Bonus Points
Stagewise Approach	Questions Donor	Dress Rehearsal	Innovator
Time Reminder	Identity Guarantee	Continuous Testing	Expert Validator
Professional Multiplier	Game Rules	Theme Variants	Criteria List
Questions Donor	Expert Validator	Bonus Points	Stagewise Approach
Accessibility Adjustments	Number Draw	Academic Integrity Appeal	Dress Rehearsal
Timebox	Expert-Level	Expert-Level	Expert-Level
Impro League	Proactive Teacher	Emergency Call	Questions Donor
Results With Delay	Criteria List	Open Book	Emergency Call
Emergency Call	Colleague Veto	Student Achievement Portfolio	Student Achievement Portfolio
Self-Assessment	Results With Delay	To-Do List	Results With Delay
Innovator	Innovator	Statistical validator	Academic Integrity Appeal
Colleague Bloom	Emergency Call	Results With Delay	Proactive Teacher
Randomized Order	Student Achievement Portfolio	Time Reminder	Identity Guarantee
Academic Integrity Appeal	Firewall	Questions Donor	To-Do List
Student Achievement Portfolio	Appetizer	Student Proxy	Statistical validator
Hidden Validator	Example Questions	Proactive Teacher	Big Brother
Criteria List	Impro League	Objective Assessor	Hidden Validator
Third Shift	24/7	Appetizer	Time Reminder
Colleague Veto	Academic Integrity Appeal	Accessibility Adjustments	Student Proxy
Eurosong	Certification Centre	Third Shift	Appetizer
To-Do List	Time Reminder	Identity Guarantee	Number Draw
Expert-Level	Stagewise Approach	Member Channel	Objective Assessor
Mathematical Validator	Member Channel	Mathematical Validator	Accessibility Adjustments
Personal Defense	To-Do List	24/7	Third Shift
Student Proxy	Mathematical Validator	Certification Centre	Member Channel
Theme Variants	Student Proxy	Eurosong	Mathematical Validator
Identity Guarantee	Eurosong	Full-Time Job	Firewall
Proactive Teacher	Full-Time Job	Firewall	Example Questions
Safe Exam Browser	Objective Assessor	Colleague Bloom	Impro League
Number Draw	Colleague Bloom	Example Questions	24/7
Member Channel	Accessibility Adjustments	Self-Assessment	Certification Centre
Firewall	Self-Assessment	Safe Exam Browser	Eurosong
24/7	Statistical validator	Impro League	Full-Time Job
Full-Time Job	Dress Rehearsal	Big Brother	Colleague Bloom
Certification Centre	Third Shift	Hidden Validator	Self-Assessment
Big Brother	Safe Exam Browser	Number Draw	Safe Exam Browser

Fig. 3. The rating comparison between students, teachers, teaching assistants and joint educators

has to be combined with a *Timebox* pattern in order to implement an efficient knowledge assessment. In addition, if we want to use a Timebox pattern properly, the time needed for the assessment has to be fixed based on systematic validation. Therefore, *Mathematical Validator* or *Professional Multiplier* could be used.

On the other hand, two of the patterns, *Objective Assessor* and *Example Questions,* that are rated 4th and 5th by cruciality by the students, are ranked much lower by educators. This is understandable, since the patterns are very student oriented. While the *Objective Assessor* eliminates the problematic questions, the *Example Questions* provide the students with the possibility for exam preparation.

From a different angle, the comparison is also interesting and understandable. While educators value *Personal Defense*, the pattern is not highly rated by the students. It is he same with the pattern *Timebox*. The educators are aware that, without a time limit, knowledge assessment within remote environments could bring certain challenges. The students, of course, prefer to avoid the time pressure.

5 Conclusions

The paper presents a preliminary insight into the research studying students' perspectives on the developed assessment pattern catalog for distant education. The catalog was developed based on practical experiences gained during the COVID-19 pandemic. Practical examples that proved successful were combined with a systematic approach into an assessment pattern catalog. The catalog was developed following a few sequential steps, wherein the last step presented the validation of the catalog.

In the paper we presented a part of the validation and opinion study, gathering students' perspectives. The participating students were involved actively in the remote knowledge assessment, in which they experienced several of the categorized patterns in the real environment. The research population included 51 students. According to their answers, the top 5 assessment patterns crucial for successful and effective remote knowledge assessment are *Open Book*, *Penthathlon*, *Bonus Points*, *Objective Assessor,* and *Example Questions*. The gathered students' ratings were also compared to the ratings made by teachers and teaching assistants. While an overlap could be detected for *Penthathlon* and *Open Book*, the ratings differed for the patterns *Objective Assessor* and *Example Questions*. This was predictable, since the perspective of pattern assessment was different.

Our study will be continued, considering the presented research depicts only preliminary results. We will also explore different aspects of pattern use, namely, grading objectivity, consistency, students' satisfaction and motivation, and others. We will also look deeper into the differences between educators and students. We also plan to develop our catalog further, by providing a web page with all the patterns and corresponding uniform descriptions available in different languages.

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A Study on Requirements for High School Teachers in Japan Based on the Regional Factors

Kenji Kido(✉) and Masakazu Takahashi

Graduate School of Sciences and Technology for Innovation, Yamaguchi University, 2-16-1 Tokiwadai, Ube, Yamaguchi 755-8611, Japan
b002wcv@yamaguchi-u.ac.jp

Abstract. This paper discusses what is necessary for someone to be called a teacher in a technical high school based on the responses to the questionnaire survey conducted among the parents. From the result of the survey, it was confirmed that what parents consider necessary for a teacher are: First, "easy to understand lessons," second, "teaching license," and third, "equal attention to students." We also confirmed that what they think is necessary for teachers varies from area to area.

Keywords: Teacher · Industrial Education · Specialized High School · Educational Skills · Parents · Questionnaire Survey

1 Introduction

In Japan, the goal of high school industrial education is "the development of qualities and skills necessary for professionals who will contribute to the healthy and sustainable development of the community and society through manufacturing.

Various measures have been implemented to achieve the above objective. Teachers also play an essential role. However, their busy schedules are a social phenomenon. Even if it is limited to vocational colleges, teachers are busy in a wide range of areas, including teaching, practical training, life guidance, and club activities, and various factors affect the busyness of teachers. Therefore, it is difficult to determine the factors and the solution.

As a result, teachers' busyness is a significant obstacle to achieving the above goals. Therefore, it is necessary to understand teachers' current situation and problems and develop measures for improvement. The target group of teachers is limited to high schools in this paper. To determine the needs of teachers, a questionnaire is conducted to parents in this paper. The results of this survey will be discussed.

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The paper is organized as follows. Section 2 presents the status of vocational high schools and their problems. Section 3 reviews the status of vocational high schools and existing studies about teachers. Section 4 discusses the educational leadership required of teachers based on the parent questionnaire results and the parents' responses. Furthermore, finally, in Sect. 5, a summary of the paper and future work are discussed.

2 Backgrounds

This section provides an overview of technical high schools' current status and issues. To this end, the Japanese schooling system is described and compared with schooling systems in other countries. This paper will compare the schooling system with that of the United States.

Figure 1 is a schematic diagram of the Japanese school system chart presented by the Ministry of Education, Culture, Sports, Science and Technology. In this figure, the regular school system, correspondence courses, major courses, and schools for the disabled are omitted. Figure 2 is a schematic diagram of the school system chart in the United States.

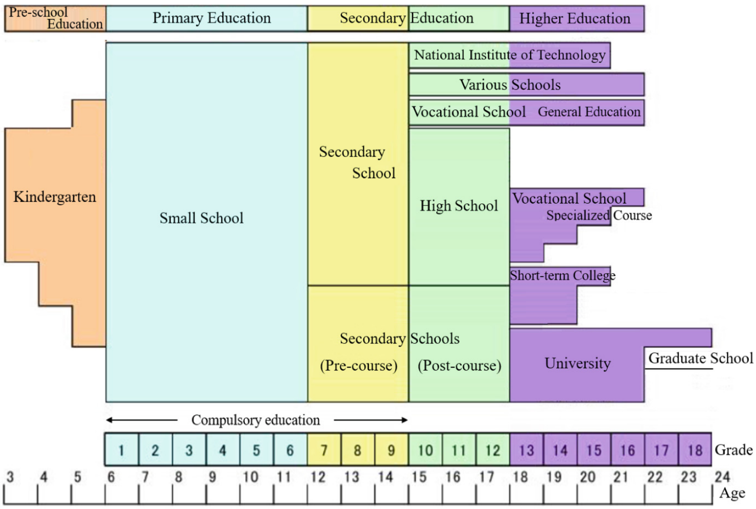

Fig. 1. Japanese School System Chart (Outline)

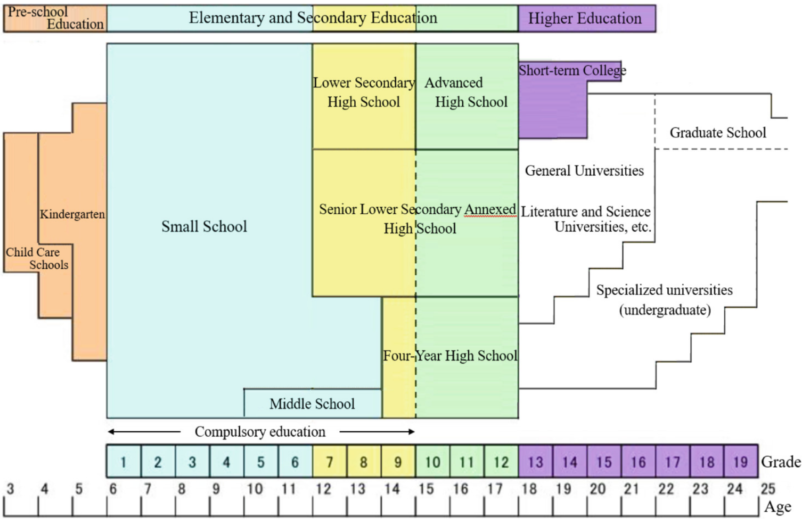

Fig. 2. School System Chart in the U.S.A. (Outline)

The Japanese school education system can be roughly divided into elementary education (6 years), secondary education (3 years + 3 years), and higher education (4 years + 2 years + 3 years). The high school serves the latter stage of secondary education. High schools can be roughly classified into two categories by the content of study: regular high schools and specialized high schools.

Regular high schools focus on "regular subjects," such as Japanese, Mathematics, English, Science, and Social studies. Specialized high schools are schools other than regular high schools in the sense that students study specialized knowledge and skills in fields such as Industry, Commerce, Agriculture, and Fisheries.

The typical length of study in Specialized high schools is three years. Class hours are divided roughly 50–50 between general studies courses and specialized courses. In technical high schools, study time for technical subjects is about half that of regular subjects. However, students can learn knowledge and skills in each specialized field that are not available in regular high schools.

Let us take an example of a student who wishes to study a specialized field of industrial studies. In Japan, when students want to study a specialized field of industry in high school, they go on to a technical high school. In contrast, in the U.S., education up to high school is compulsory, and students go on to a high school determined by their place of residence. They then select industrial classes of their interest at that high school.

Both Japan and the U.S. have the same system in which students must earn credits determined for each class in order to graduate from high school. However, in Japan, the class system is emphasized along with the credit system. Generally, if a student fails to take credits for compulsory subjects in a given school year, the same school year is repeated the next year. Then, you must earn all the credits required for that grade again. On the other hand, American students only need to earn the credits they have not yet earned.

Teachers' duties at a regular high school begin with morning make-up classes, then their assigned classes, and continue through after-school make-up classes. In between, teachers respond to questions from students and provide guidance. Homeroom teachers also have morning and evening homerooms, career counselling, processing of class grades, home visits for daily life guidance, and responding to complaints and consultations from parents of students.

In addition to the teaching duties of a regular high school, students at a vocational high school must also prepare for practical training for each specialized department and supervise the laboratory reports submitted by the students. In addition, teachers also supervise students who conduct research after school in the subject research course, in which research is conducted throughout the year. Futhermore, they must also supervise club activities after school. As described above, there are a great many tasks that must be performed in school education today. Each of them is important and cannot be omitted.

Most industries have work hours and finish work after hours. Teachers also have work hours. However, many teachers stay involved with students past their working hours to support and guide students in doing well in their studies and club activities. While non-teaching positions are generally entitled to overtime pay, teachers are not.

The fact that teachers' workload in education is laborious has become well-known to the public through recent news reports [1]. As a result, the number of applicants for teacher employment examinations continues to decline due to the negative image of the teaching profession. Figure 3 shows the number of examinees, recruits, and competition rate for the high school teacher recruitment examination in FY2022. The number of examinees is at an all-time low [2].

Fig. 3. Changes in the number of examinees, the number of recruits, and the competition rate (recruitment rate) in the high school teacher recruitment examination.

Through his practical experience as a teacher, the author believes that one of the reasons why teachers are so busy is that the workload of teachers is too large for the number of teachers required by law. Therefore, based on this current situation, we aim to reduce the workload of the faculty members.

First, we will identify the priorities of the necessity of the faculty members' work. Then, the faculty members should perform the essential work. For less necessary work, it will be necessary to devise ways to make it possible for staff members who do not have a teaching license to perform these tasks. Students, faculty members, and parents are involved in school education. The investigation of students and faculty members is left to other studies. In this paper, a questionnaire survey for parents is conducted and discussed.

3 Related Work

This section reviews existing research related to the current situation and issues in specialized high schools and the abilities required of teachers and confirms the novelty of this study.

Kido et al. have conducted a questionnaire survey on the ideal image of a teacher among students who graduated from a school with a new type of coronavirus infection and who could not attend sufficient classes. As a result, they derived that students considered teachers who conduct easy-to-understand courses to be excellent teachers despite the coronavirus infection [3]. Yamamoto et al. have surveyed in-service teachers on the theme of "images of teachers that leave a lasting impression. As a result, they found that the ideal teacher is kind and accepting of students but also has a strict attitude rather than a teacher who teaches and guides students in learning, such as teaching skills [4].

Tsuji has presented four perspectives for improving "teacher ability" to students who want to become teachers: "teaching ability," "ability to prepare teaching plans," "ability to transmit and pass on knowledge," and "peer power" [5]. Suzuki et al. have proposed a teaching method that considers the qualities necessary for industrial high school teachers in the industrial education method of university teaching courses [6].

Oba et al. have conducted a questionnaire survey of teachers in Japan and Canada to clarify their perceptions and behaviours toward innovation. As a result, they derived that in Japan, the influence of senior and fellow teachers is significant and that these learning relationships are linked to improving teachers' qualifications [7]. Hara has examined the attitudes and enthusiasm of students who aspire to become teachers based on the questionnaire survey results. As a result, he could confirm what students were thinking and feeling anxious about in their teaching careers [8].

Watanabe has analyzed the vacancies and overcrowding of high school industrial science teachers based on the special measures in the Education Personnel Law and the status of teacher recruitment examinations in each prefecture. As a result, it was confirmed that each municipality systematically limits the number of teachers it hires regarding vacancies [9]. Ono has examined the necessary elements for technical high school teachers based on his experience in the career guidance section and indicated the following four items: (1) enthusiasm, (2) ability to give easy-to-understand explanations, (3) a great deal of knowledge and advanced skills, and (4) a person of integrity [10].

Kodama has clarified the discrepancy between the "ideal image of a teacher" as answered by students aiming to enter the teaching profession and the "desired image of a teacher" as indicated by the Ministry of Education, Culture, Sports, Science and Technology and local governments that employ teachers [11]. Nakagawa has summarized his 38 years of teaching experience at elementary, junior high, and senior high schools and pointed out the necessity for high school teachers to receive training and study in classroom practice to consider the formation of teacher competence [12].

Yufu has pointed out the situation and issues facing junior high and high school teachers during the reform period of the teacher licensing system and indicated the system's ideal future state [13]. Kaneko has problematized the issue of the increasing number of non-regular teachers as a problem in terms of teachers' career development, as well as from the perspective of the peculiarities of educational labour [14].

Yamada has pointed out that there is little evidence for the decline in teacher quality based on teacher misconduct statistics. He also clarified the evaluation of the training system and work environment by teachers and examined the possibility that educational policy decreases the attractiveness of teachers, which in turn leads to a decline in their qualifications [15]. Tamaoki et al. have surveyed the job satisfaction of elementary, junior high, and high school teachers. As a result, they found that teachers' enthusiasm for "for education" and "for children" kept them in the teaching position, and as a result, the more experienced they became, the less motivated they became [16].

Ito has summarized the qualities and abilities required of high school industrial science teachers and described how to organize curricula to foster these qualities and skills [17]. Yamane et al. have conducted a questionnaire survey of the four competencies set by the Okayama Prefectural Board of Education for students in the Faculty of Education to examine the abilities and attitudes required of teachers. As a result, it was confirmed that the ratings of "the ability to communicate with children" and "the ability to notice changes in children" were high in all school types, and the rating of "giving easy-to-understand classes" was also increased in junior high and high schools [18].

Nakai et al. have surveyed junior high school students to examine their trust in teachers and its determinants. As a result, it was revealed that there were three levels of interpretation in the students' trust scale toward their teachers: "security," "distrust," and "legitimacy" [19]. Shinnyo et al. have examined differences in teachers' willingness to engage in educational activities and practices by age group of teachers. The results showed that teachers' motivation to engage in educational activities declined with age. In addition, it was confirmed that educational practice dropped between the ages of 30 and 35 but gradually increased with increasing age after that [20].

Tagami et al. have classified and overviewed the factors influencing teacher stress into three categories: occupational peculiarities, individual characteristics, and environmental peculiarities, and indicated the need for research to clarify the processes causing teacher stress reactions and research on cooperation with local communities and school-related organizations [21]. Koyama et al. have surveyed teachers four times about their self-education ability. They summarized the items commonly possessed by teachers with high self-education ability as "student grasp," "visionary orientation," "spiritual fulfillment," "acceptance of others," "group cooperation," and "self-reflective ability" [22].

Kikuchi has analyzed the ideal teacher image using data collected using the Interpersonal Value Scale and the Personal Value Scale. The results showed that students' outstanding teacher images changed during their developmental stages [23].

In an overview of previous studies, there were numerous studies on the current state of the educational field and teachers' qualifications and academic abilities. On the other hand, there were no studies on the evaluation by students and parents, who are the beneficiaries of education.

4 Survey Design and Analytics

This section presents the survey details and the results of the responses. Based on the previous research survey results in Sect. 3, a questionnaire survey was conducted to identify the elements required of teachers at technical high schools from the parent's perspective.

A marketing research firm was surveyed for three days from October 5, 2022 [24]. The survey was sent to 39,207 respondents and received responses from 414 respondents. The response rate was 1.10%. Table 1 shows an overview of the survey.

The response rate of 1.10% seems too small. However, the Ministry of Health, Labor and Welfare indicate that the marriage rate in Japan in 2020 will be 4.3%. Then, the condition that "the child is currently a student at or within three years of graduating from a vocational high school" is added to the above figure. Therefore, a value of approximately 1% is considered reasonable.

The target population for this survey was parents whose children were currently in the first year of high school through the third year after graduation from a vocational high school. We thought that parents would not forget their feelings as parents for about three years after their children graduated.

It is necessary to confirm the thoughts of students and teachers. However, in this paper, we decided to conduct a questionnaire survey of parents, which has not been shown previously. In the questionnaire, parents are asked to answer each of the following items regarding their level of need for high school teachers (excluding administrative staff).

Table 1. Survey Outline

Survey Term	October 5–7, 2022
Target Respondents	Parents of professional high school students (include within 3 years after graduation)
Residence Area	Japan, Nationwide
Survey Method	Web questionnaire, email response request
Respondents (a)	39,207
Valid Respondents (b)	414
Response Rate (b)/(a)	1.10%

The questionnaire asked respondents to answer the following ten things: (1) passion for education, (2) life guidance, (3) teaching license (proof of having studied education),

(4) fairness, (5) knowledge of specialized subjects, (6) career realization, (7) easy-to-understand teaching, (8) cooperation with colleagues, (9) qualifications in specialized fields, and (10) dialogue with students.

The choices were on a 7-point scale: 1 necessary, two necessary, three somewhat necessary, four undecideds, five instead not required, six not necessary, and seven not necessary. The survey items were narrowed down from the author's 38 years of teaching experience while referring to survey topics from previous studies.

The survey was conducted by requesting questionnaires from members throughout Japan via the Internet. The survey was conducted by requesting questionnaires from members nationwide via the Internet, and those who fulfilled the conditions were asked to respond to the main question.

The number of respondents for this survey was set at 400. Therefore, the survey request will be closed when the number of responses exceeds 400. Due to the time lag between the end of the survey request and the transmission of response results, the final number of respondents was 414.

Figure 4 shows the results of all the responses for each item. The following are characteristic findings from the response results.

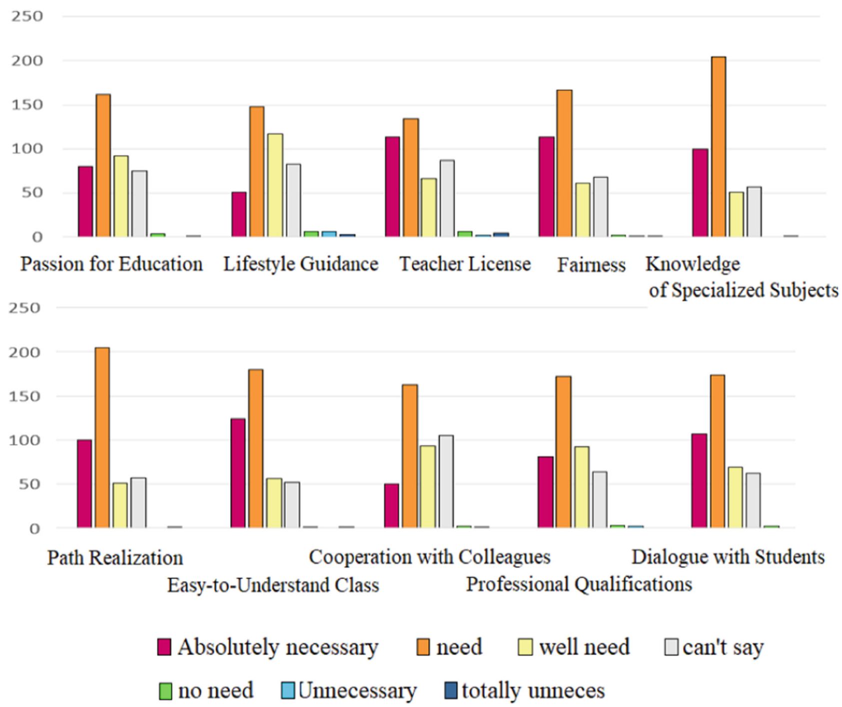

Fig. 4. Questionnaire Response Results

1) The top three items considered necessary are "easy-to-understand lessons," "teaching license," and "fairness."

2) "Life guidance" and "Collaboration with colleagues" received the least number of "necessary" responses.
3) "Easy-to-understand classes," "Knowledge of specialized subjects," "Teaching license," and "Fairness" was selected "Necessary" by about twice as many parents as those who selected "Somewhat necessary.
4) "Collaboration with colleagues" was selected most frequently by parents who answered, "somewhat or strongly."
5) The least number of parents answered "necessary" for "life guidance" and "cooperativeness with colleagues," and about twice as many parents answered "somewhat necessary.

The results indicate that parents, first and foremost, expect teachers to conduct classes that are easy to understand. In addition, parents want teachers who treat students fairly. Parents positively consider "easy-to-understand classes," "knowledge of specialized subjects," "teaching license," and "fairness" to be necessary. This is especially true for "easy-to-understand classes. However, it can be confirmed that many parents answered undecided or had negative opinions about "teaching licenses.

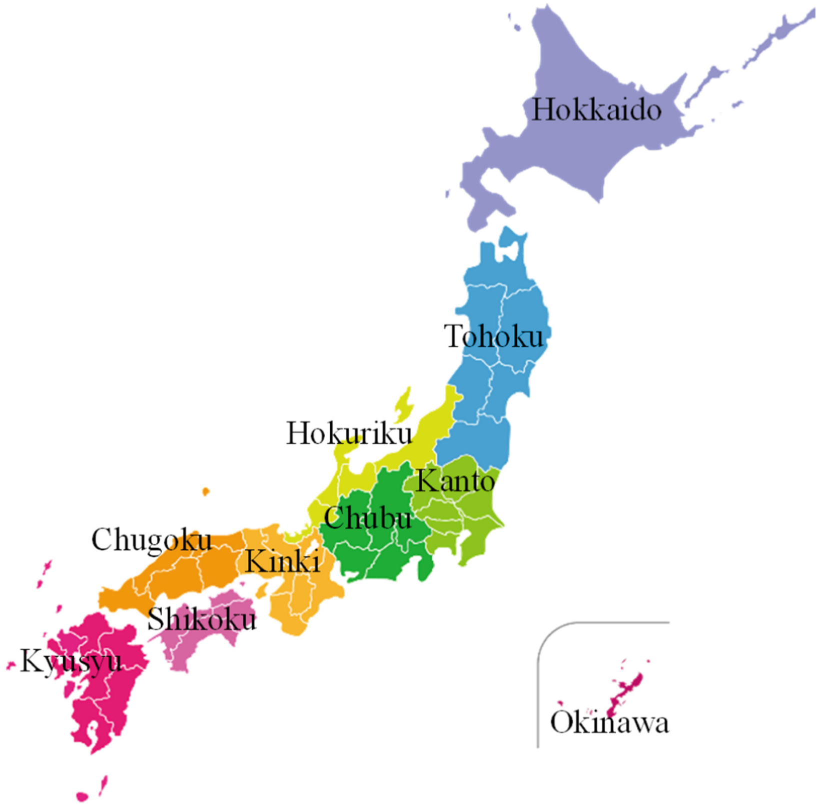

Fig. 5. Regional distribution map in Japan

Parents do not consider "collaboration with colleagues" to be essential. In contrast, "life guidance" and "cooperativeness with colleagues" were confirmed to be negatively considered necessary. In particular, the negative attitude toward "life guidance" is conspicuous, and we can confirm that it is quite low in necessity.

These findings allow us to derive the items that teachers must prioritize even when busy. The priority is to prepare for teaching in a way that is easy for students to understand. The second is training to enhance the expertise of each teacher.

The relationship between the response results and the region of residence of the parents will be analyzed using a significance difference test. The significance level is 5%. The likelihood ratio test is used in the analysis.

Based on the survey results, we examine regional differences in what parents think is necessary for teachers. For this survey, we divided Japan into ten regions. The survey was commissioned by a private research firm. The research firm used the Internet to randomly request surveys from members nationwide who were registered as respondents. Among those who responded, those members who met the criteria to be eligible for this survey were asked to respond to the survey. Figure 5 shows Japan by region. The Okinawa region was not included in this study because there were no respondents in this survey.

Nine regions were included in this survey. Most items showed no significant differences between regions at the 5% level of significance. However, there were some items for which it could not be asserted that there were no significant differences among regions. Tables 2 and 3 show the items for which we cannot assert that there are no significant differences in responses among the regions. Findings from Tables 2 and 3 are as follows.

1) In all regions, there are items for which significant differences can be confirmed with other regions. This result confirms that there are differences in what parents want from teachers in each region.
2) In certain regions, there are many cases where the items for which significant differences can be confirmed are the same as in other regions. For example, in the Hokkaido region, there is a significant difference in "cooperativeness" between the Tohoku region, Hokuriku region, Shikoku region and Kyushu region.
3) In each region, there are often different items for which significant differences can be confirmed between each region and the other regions. For example, the Hokkaido region significantly differs in cooperativeness from many other regions. However, in fairness, the Hokuriku region is significantly different from the other regions in career guidance, and the Chugoku region is significantly different from the other regions. This result confirms the existence of region-specific ideas about teachers.
4) There is a large difference in the number of items with significant differences among the regions. Kanto region and Hokuriku region have seven items significantly different from other regions. However, in the Chubu region, there is only one item that is significantly different from other regions. This result confirms that the strength of the idea peculiar to a region also differs significantly from region to region.

The parents' responses in this study suggest that they assume that teachers conduct classes and interact with students as homeroom teachers. These tasks can only be done by teachers who have a teaching license. Other types of jobs can be performed without a teaching license, such as training assistants. Practical assistants cannot perform either of these duties. Parents consider all non-clerical personnel working in schools to be teachers. In reality, some of them cannot perform the duties of a teacher in a vocational high school.

The discrepancy between the parent's perception of the school organization and the actual situation is inconvenient from the viewpoint of cooperating with the parents in providing school education. Therefore, we believe that it is necessary to make efforts to equalize the workload of teachers and training assistants, who are viewed by parents as teachers. In addition, it is essential to average the workload of teachers and staff throughout the school.

My specific suggestions are as follows. Currently, training assistants cannot, in principle, teach classes, be in charge of classes, or lead students on their own. Therefore, the training assistants should be able to perform these duties. The conditions for this would be to have at least a certain number of years of experience as a training assistant, and to take education-related classes at an educational institution and obtain a certain number of credits. We believe that these improvements will reduce the workload of teachers in a short period of time.

Table 2. Significant Difference Between Regions (1)

Region Name	Hokkaido	Tohoku	Kanto	Hokuriku
Hokkaido	―――	Cooperativeness Specialty Qualifications		Cooperativeness
Tohoku	Cooperativeness Specialty Qualifications	―――		
Kanto			―――	Expertise Path Realization Dialogue with Students
Hokuriku	Cooperativeness		Expertise Path Realization Dialogue with Students	―――
Chubu				
Kinki				Path Realization Dialogue with Students
Chugoku		Cooperativeness Fairness	Fairness	Path Realization
Shikoku	Cooperativeness		Cooperativeness	
Kyusyu	Cooperativeness	Dialogue with Students	Passion Dialogue with Students	

Table 3. Significant Difference Between Regions (2)

Region Name	Chubu	Kinki	Chugoku	Shikoku	Kyusyu
Hokkaido				Cooperativeness	Cooperativeness
Tohoku			Cooperativeness Fairness		Dialogue with Students
Kanto			Fairness	Cooperativeness	Passion Dialogue with Students
Hokuriku		Path Realization Dialogue with Students	Path Realization		
Chubu	———		Fairness		
Kinki		———			
Chugoku	Fairness		———		
Shikoku				———	Teacher License
Kyusyu				Teacher License	———

5 Concluding Remarks

In this paper, against the backdrop of an educational environment that places an excessive workload on teachers, a questionnaire survey of parents was conducted to identify items that should be prioritized by the educational field. The main findings we were able to obtain as a result are as follows. (1) Parents strongly demand "easy-to-understand classes" and "fair treatment. (2) Only a small number of parents strongly feel the need for "life guidance. (3) Parents' views on education differ depending on the region in which they live, and the strength of their views and opinions about teachers differ.

The issues are as follows: (1) This survey was conducted only among parents. Therefore, the views of students and teachers were not included. (2) It is necessary to investigate the causes of regional differences in parents' views on education. (3) When analyzing the results of the questionnaire survey of parents in future research, it is necessary to take into consideration the fact that parents' views on school education differ from region to region.

A school organization is an organization in which teachers and staff from various positions work together to support the growth of students. It is essential for teachers and staff working in schools to confirm the image of teachers and staff that parents seek. On top of that, we believe it is also necessary for each of them to engage with students to the best of their abilities. This is because all faculty and staff working in schools are working toward the same goal of "supporting students' growth.

In the future, we will continue to work on resolving the above issues and to identify problems faced by the educational field in order to derive various measures to improve the educational capabilities of specialized high schools.

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A Smart Pedagogical Framework Facilitated by Web Technologies for ICT Students' Motivation

Vasiliki Karampa(✉) and Foteini Paraskeva(✉)

Department of Digital Systems, University of Piraeus, Karaoli Dimitriou St. 80, 185 34 Piraeus, Greece
{bkarampa,fparaske}@unipi.gr

Abstract. In Smart Learning Environments (SLEs), Smart Pedagogy (SmP) provides teachers and students with methods, strategies, and techniques to integrate and effectively leverage cutting-edge technology in the teaching and learning process for optimal learning. International research disposes several studies, which highlight the motivational dimension of the teaching and learning process, enhanced by technology. However, there is still a lack of smart conceptual frameworks, based on motivational learning design which present how web technologies are employed, as well as practical evidence from interventions. To this end, the present study attempts to orchestrate a conceptual framework aligned with the principles of SmP, based on a motivational design process. It proposes a smart pedagogical framework, designed in accordance with Project Based Learning (PjBL), the ARCS-V (Attention, Relevance, Confidence, Satisfaction and Volition) motivational model and SmP principles, enhanced by Web technologies. To better understand how these technologies facilitate SmP and influence students' motivation, an e-course was developed and delivered to twenty-nine ICT students during an academic course. The results of a quantitative data analysis highlighted a positive impact on their motivation and practical evidence on designing smart pedagogical frameworks.

Keywords: Smart Pedagogy (SmP) · ARCS-V Model · Project Based Learning (PjBL) · Web technologies · Smart Learning Environments (SLEs)

1 Introduction

As the world gets increasingly digitalized, Technology-Enhanced Learning Environments (TELE) have become known as Smart Learning Environments (SLEs), where Smart Pedagogy (SmP) is the driving force behind implementing cutting-edge technology by educators and learners [3]. In these learning environments, technology by definition enhances learning and makes it more enjoyable for learners, ensuring that the next generation acquires the knowledge and cultivates the skills to develop sustainable solutions [2]. However, this can only be achieved by integrating technology into the teaching/learning process in a pedagogical way. In addition, it is important

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to determine which one of the five dimensions (knowledge, inclusivity, sustainability, rights and responsibilities, motivation) of the teaching and learning process, technology can positively affect, and what are the perspectives of this dimension [3]. Considering that motivation influences learners' performance and future achievements, it should be brought to the fore, anticipating that technology might create additional incentives [11].

Several researchers i.e. [20, 24] in the field of smart learning state that an SLE should be motivating and engaging, because of its educational affordances. For instance, when the learning environment provides formative and immediate feedback [6], opportunities for collaboration and social interaction [4], as well as the learning process is tailored to learners' personal interests, needs, learning styles etc., motivation could be fostered [24]. However, the breadth of forms that these learning environments can take, which depends on the learning settings, the type of technology they incorporate and the pedagogical approaches they utilize, leave plenty of room for further research. In addition, it is necessary to design motivational frameworks on the basis of SmP, so that when evaluated they can provide empirical data and good practices as guidelines to the design and development of SLEs. In particular, when these frameworks utilize web technologies in forms of web tools, they can be easily leveraged and reused by any educator without specialized technical knowledge and effort [17].

To this end, this paper attempts to employ a smart pedagogical conceptual framework enhanced by web technologies and to investigate the impact of these technologies on ICT students' motivation. More specifically, it utilizes the Project Based Learning (PjBL) teaching model [5] and a set of strategies proposed by the ARCS-V motivational model for learning design [7, 19], through the lens of a systematic motivational design process [12, 15], in order to orchestrate an e-learning solution aligned with SmP principles. This solution was implemented with the form of an e-course, delivered to ICT students during an academic semester, providing empirical data for further research. The rest of the paper is structured as follows: Sect. 2 contains the theoretical background. Section 3 refers to the Method. Finally, Sect. 4 presents the conclusion.

2 Theoretical Background

2.1 Smart Pedagogy (SmP) in Smart Learning Environments (SLEs)

Digitalization is now a global phenomenon to every sector of humanity, transforming all aspects of society. The educational sector could not remain unaffected, as emerging technologies have successfully transformed traditional learning settings into new, innovative, and digital. As the web evolved from read-only version 1.0 to symbiotic/intelligent version 4.0, followed by trends to emotive version 5.0, Technology-Enhanced Learning Environments (TELE) underwent a transformation from e-learning environments to mobile, ubiquitous, and finally smart [1]. Nowadays, Smart Learning Environments (SLEs) can provide access to a wide range of content and resources, be context-aware (real-time, in the real world), provide real-time, adaptive, and personalized learning by utilizing ubiquitous computing systems, aligned with learner needs to enhance learning [5]. An SLE could perform three core functions that provide features of smartness. Firstly, it is possible for an SLE to sense, namely collect data from the context, the physical environment and the participants during teaching and learning activities. Secondly, collected data could be analyzed by data analysis techniques to make decisions about teaching and learning. Therefore, the third function of an SLE is to react, thus, provide customized recommendations for optimal interventions [21]. However, the word "smart" can be used not only to describe the learning environments focused on the incorporated technologies (hardware/software), but also to employ pedagogical approaches that are not aligned with traditional learning theories [21].

This direction has been emphasized by the concept of Smart Pedagogy (SmP) in SLEs, or TELEs in general. It identifies the type of pedagogical activities needed to ensure not only that technology and technological solutions are incorporated into the learning process, but that they also lead to greater learning outcomes or better access to knowledge [3]. SmP ensures that technology is used in the learning environment in a pedagogical manner, providing teaching methods, strategies and techniques that are innovative and meet the demands of the 21st century and therefore enhance learning through technology. Uskov et al. [23] defined SmP as "…a set of instructor's teaching strategies, activities and judgements to a) understand the student/student profile (background, goals, skills, competencies and capabilities), and b) provide optimal learning processes and environments with corresponding smartness features to help students to achieve their goals" (p2). Additionally, these authors recommended the following six features of smartness (or else Levels of Smartness, LoS): 1. Adaptation, 2. Sensing (Awareness), 3. Inferring (Logical Reasoning), 4. Self-learning, 5. Anticipation and 6. Self-organization. Obviously, this classification is detailed regarding the three abovementioned core functions of an SLE, could be included to them and be incorporated into SmP as follows: The function of "sense" includes the level of Sensing (awareness) namely, all pedagogical approaches that utilize technology in order to be used as toolkits for data collection and experimentation as part of the teaching/learning process [8, 9]. The function of "analyze" comprises the level of Inferring (Logical Reasoning) which in turn encompasses all the conditions of processing and producing information, evidence, and rules. From a pedagogical perspective it could refer to all methods used as to provide students data visualization and feedback about their performance [8, 9]. Finally, the function of "react" embraces the levels of anticipation, adaptation, self-learning, and self-organization [8, 9]. The concept of anticipation refers to all the opportunities for predicting and managing different learning situations appropriately. More specifically, it could refer to pedagogical approaches that provide learners opportunities to predict their future outcomes. Adaptation could include pedagogical approaches that allow students to quickly adapt (individually/collaboratively) to the learning process mainly by stimulating their motives [8, 9]. The term self-learning could encompass all pedagogical approaches that help students learn individually, in groups or through social interaction [8, 9]. Finally, self-organization could contain strategies that provide students self-organization within groups or learning communities [8, 9]. Moreover, Zhu et al. [24] proposed a four-tier architecture of SmP aiming at learners' competences enhancement. By engaging students in a variety of tasks according to their learning preferences, "Class-Based Differentiated Instruction", the first layer, enables students to cultivate basic knowledge and core skills. "Group-based collaborative learning", the second layer, entails engaging students in collaborative tasks to enhance their comprehensive abilities. The third layer of "Individual-based personalized learning", refers to strategies that should enhance students' personalized expertise, namely, students' pace of learning, the selected method, and the tools according to their interests and needs. Finally, at the fourth layer of "Mass-based generative learning", strategies should enhance students' collective intelligence. It means that students are active participants in constructing relevant content and have acquired metacognitive abilities [8].

2.2 The Motivational Dimension of Teaching/Learning Process Based on ARCS-V Model

In 1987, John Keller [10] introduced the ARCS model, a systematic approach for designing motivational instructions. It stands for Attention, Relevance, Confidence and Satisfaction, the four important conditions in the learning process that can enhance and sustain learners' motivation. As motivation is inadequate to explain human behavior without the role of volition, he revised the model by adding a fifth category of Volition, expanded to ARCS-V [14, 16]. Three basic subcategories/factors comprise each category, which are accomplished by a set of motivational strategies [7, 19]. Attention, the first category, is associated with the capture of curiosity and the maintenance of interest. It includes the factors of Perceptual Arousal (A1), Inquiry Arousal (A2) and Variability (A3). Attention is achieved when surprise, doubt, distrust is cultivated by using humor, active participation, variety of audiovisual media such as graphics, animations, and videos, content presentation, and teaching methods, as well. The second category of Relevance consists of Goal Orientation (R1), Motive Matching (R2) and Familiarity (R3). Creating relevance involves conceptualizing and implementing strategies that connect content and didactics to student goals, outcomes, and learning styles. Relevance can also be explained by values, affiliation, power, competence, and flow [6]. As a third category, confidence refers to learners' expectancy for success, the belief in their abilities and efforts for the accomplishment of their tasks. It is divided to the factors of Learning Requirements (C1), Success Opportunities (C2) and Personal Control (C3), which mean that learners should monitor and manage their learning, as well receive positive experiences to succeed in their assignments. In order to sustain motivated and continue learning, learners should be satisfied. Therefore, the fourth category of Satisfaction refers to learners' expectation for their effort and performance and is analyzed to Self Reinforcement (S1), Extrinsic Rewards (S2) and Equity (S3), as well. This means that positive rewards and recognition should be provided by reinforcing both intrinsic and extrinsic motivation. Finally, the additional category of Volition is associated with the concept of self-regulation. Volition first analyzed by Keller [14] into the factors of Strong Intentions (V1), Action Initiation (V2) and Self-Regulation (V3). However, Nakajima et al. [18] after research and discussion with Keller, proposed a similar classification of Implementation Intention (V1), Appropriate Self-control (V2) and Self-monitoring (V3). That means that learners should be assisted to use self-regulatory strategies, in order to come up with obstacles and distractions and become more goal-directed [6]. These components of ARCS provide a basis of a ten-step systematic design process for the development of motivational courses/e-courses tailored to learners' preferences [11, 12, 15, 16].

3 Method

3.1 Research Questions

As part of the broader context of the authors' research into smart pedagogical conceptual frameworks, two research questions have been identified, as the most critical for bringing motivation to the fore:

RQ1: *Does the design of a conceptual framework aligned with smart pedagogical principles have a statistically significant impact on ICT students' motivation?*

In particular, based upon: *Attention* (**RQ1.1.**), *Relevance* (**RQ1.2.**), *Confidence* (**RQ1.3.**), *Satisfaction* (**RQ1.4.**) and *Volition* (**RQ1.5.**).

RQ2: *Which web technologies integrated into an e-course, developed according to smart pedagogical principles have impact on ICT students' motivation?*

In particular, with respect to: *Attention* (**RQ2.1.**), *Relevance* (**RQ2.2.**), *Confidence* (**RQ2.3.**), *Satisfaction* (**RQ2.4.**) and *Volition* (**RQ2.5.**)

To give answers to the previous research questions in this paper, the design-based research methodology is utilized and described in the next paragraph.

3.2 Design-Based Research Methodology

Since this study concerns both the design and the research of technology-enhanced learning environments (TELEs) such as e-courses, the design-based research methodology is demonstrated as a very suitable and validated methodology for this purpose [22]. Consequently, the current study is aligned with the three stages of a mini-cycle of Design-based research methodology (Fig. 1).

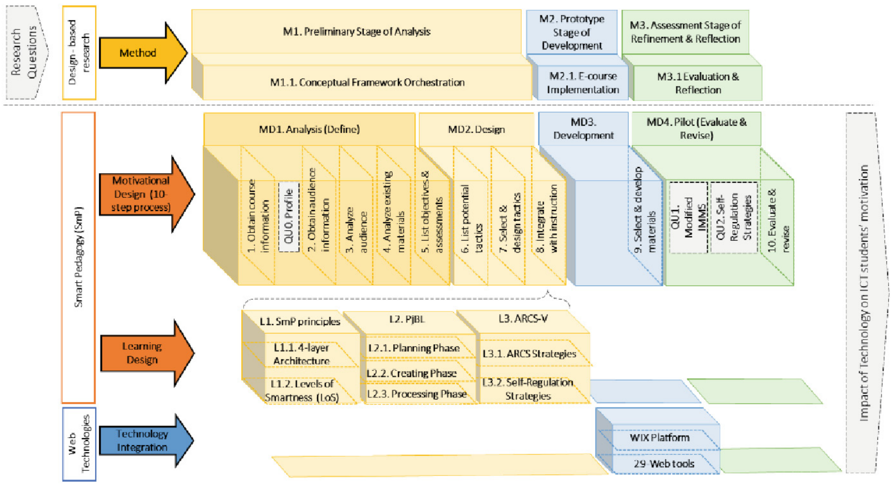

Fig. 1. The research framework of the current study – A mini-cycle of Design-based research

At the preliminary stage of the analysis (M1), a conceptual framework was orchestrated (M1.1), following the phases of Analysis (MD1) and Design (MD2), which constitute the first eight steps of a systematic 10-step motivational design process [11]. MD1 and MD2 were conducted in alignment with SmP (principles and concepts for learning design) tailored to learners' recorded preferences. At the second prototype stage of development (M2), an e-course was implemented (M2.1), by selecting and developing the materials (learning content, resources, and tools). At the third assessment stage of refinement and reflection (M3), the constructed e-course was delivered to learners for evaluation (M3.1).

Analysis Stage: Conceptual Framework Orchestration (M1 – M1.1). To orchestrate the conceptual framework, authors followed the phases of Analysis (MD1) and Design (MD2), namely the first eight steps of the motivational design process, while they took into account the following components of SmP: a) learners' profile; b) the learning design with the PjBL teaching model [5], including strategies stem from ARCS-V model [7, 19]; and c) the Levels of Smartness (LoS) [23], corresponding to the four-layer architecture of SmP [24].

Analysis (MD1): The instruction was intended for ICT students in a university department and concerned teaching and learning approaches applied in e-learning settings. Therefore, as potential future ICT teachers, ICT students should mainly be able to apply pedagogical concepts to design, develop, implement, and evaluate the educational process in computer-supported collaborative learning (CSCL) environments. Moreover, they should be capable of adapting and orchestrating pedagogical methodologies to digital tools and environments (Step 1). A questionnaire (QU0) was then given with the form of an interview and the recorded answers were analyzed (Step 2–3). With respect to the cognitive subject, results revealed basic knowledge of ICT concepts as well as some basic knowledge of pedagogical concepts. In terms of developing skills and competencies, learners emphasized collaboration and communication skills as dominant 21st century skills. They certainly emphasized the pedagogical competence, i.e., being able to apply smart pedagogical methodologies to develop and manage respective digital learning environments. In addition, they highlighted the importance of clarity in learning design (goals, determined learning modules and units, interaction, estimated duration, resources and tools, forms, and criteria of assessment). Accordingly, the usability, the functionality, and the accessibility of digital learning environment, as well as the opportunities for collaboration, communication, scaffolding, and feedback were considered essential. Finally, they focused on their personal short-term and long-term goals. Their short-term goals included the successful completion of the e-course, the acknowledgement of alternative modes of learning, flexibility in thinking, and personal development, while their long-term goals included their future involvement in the e-learning discipline, the e-course design, and the pedagogical digital content development. Next step (Step 4) encompassed the analysis of existing material, namely the emerged positive features, the problems or deficiencies, and the related issues.

Design (MD2): Steps 5–8 dealt with the design. According to Han and Bhattacharya [5], three phases take place when Project-based Learning (PjBL) is applied to the instruction (Table 1, Table 2, Table 3) and are diffused by a set of principles (PjBL features). The first

Table 1. Learning Design aligned with PjBL (Planning Phase), Motivational Strategies of the ARCS-V model and Smart Pedagogical Principles

PjBL Model		Procedure	4-layer SmP	LoS	PjBL features	Motivational Strategies (STR) based on ARCS-V model
1. Planning Phase	1.1. Overall Climate	P1. Study and follow the instructions.	Layer 1 Layer 3	Sensing, Adaptation, Self-learning, Self-organization	Analytical Content, Time Management, Student-centered (Voice and Choice)	**STR1.** Clearly define and present the course design and the process **(C1, V1)**. **STR2.** Describe the value of the knowledge/skills provided in the present and future **(C1)**. **STR3.** Help learners write down their personal goals, a timeline, and a plan to meet them by providing them relative tools **(V1)**.
		P2. Structure your physical learning environment and explore the digital.				**STR4.** Embed a virtual assistant to guide learners configure their environment without distractions **(V2)**. **STR5.** Hide elements and set passwords for curiosity arousal **(A1)**. **STR6.** Provide learners the ability to control their study rate by using navigation utilities (menus, submenus, previous-next buttons etc.) **(C3)**.
		P3. Make your presence known in the learning community.				**STR7.** Introduce the emotional element by guiding learners to customize their profiles, create avatars, and introduce themselves in the community **(A1)**.
		P4. Create Groups and Assign Roles.				**STR8.** Shift interaction between peers instead of learner-educator **(A3)**. **STR9.** Provide opportunities for collaboration and personal responsibility **(R2)**.
	1.2. Inquiry	P5. Study the supporting material.	Layer 1 Layer 2, Layer 3	Adaptation, Self-learning, Anticipation	Analytical Content, Student-centered (Voice and Choice), Authentic Tasks, Time Management, Innovative Assessment	**STR10.** Use humor and attractive content that provokes surprise or doubt **(A1).** **STR11.** Provide various audiovisual media for content delivery **(A1, A3).** **STR12.** Use examples and concepts that are directly related to learners' experiences and values **(R1).** **STR13**. Provide learners opportunities to select methods and tools for their activities **(R2).** **STR14.** Divide the general purpose into clear objectives in each educational unit or activity **(C1).** **STR15**. Highlight previous knowledge that help students achieve their goals **(C1).** **STR16.** Use educational games for relax and practice of new knowledge **(S1).** **STR17.** Provide opportunities for taking notes, memorization, and organization of information **(V1).**
		P6. Investigate specific tasks according to the assigned role.				**STR18.** Set problem-solving activities **(A2).** **STR19.** Provide scaffol**ding (C2).** **STR20.** Provide external resources for seeking information **(V2).** **STR21.** Provide opportunities for seeking assistance from peers/educator **(V2).**

phase of "Planning" consists of two subphases. The first subphase of "Overall Climate", should ensure all the presuppositions for collaboration through the development of a such learning environment. The second subphase of "Inquiry" includes the selection of themes and topics (students' voice and choice), as well as the sharing of the resources, the study, and the investigation.

The second phase of "Creating" includes three subphases. "Analyzing Data", is the first subphase where collected data are analyzed. "Collaboration" is the second subphase. It includes all necessary procedures for collaboration and communication in order to find out a solution. Additionally, "Developing Thoughts" refer to the third subphase, which is focused on the construction of the artifacts, the assembly, and the construction of the final project.

Table 2. Learning Design aligned with PjBL (Creating Phase), Motivational Strategies of the ARCS-V model and Smart Pedagogical Principles

PjBL Model		Procedure	4-layer SmP		LoS	PjBL features	Motivational Strategies (STR) based on ARCS-V model
2. Creating Phase	2.1. Analyzing Data	P7. Analyze data	**Layer 2, Layer 3**		Adaptation, Self-learning, Self-Organization	Student-centered (Voice and Choice), Authentic Tasks, Collaboration, Multiple ways of Expression	**STR22.** Provide opportunities for reviewing personal notes, learning material and graded work **(V2)**. **STR23.** Stimulate students to share knowledge with peers who have gaps **(S1)**.
	2.2. Collaboration	P8. Communicate and collaborate to select solution		**Layer 4**			**STR13.** Provide learners opportunities to select methods and tools for their activities **(R2)**. **STR24.** Define peer-to-peer interaction for consolidation of confidence feelings **(C2)**. **STR8.** Provide opportunities for collaboration and personal responsibility **(R2)**. **STR9.** Provide opportunities for seeking assistance from peers/educator **(V2)**.
	2.3. Developing Thoughts	P9. Create and assemble artifacts for the project					

The third phase of "Processing" includes two subphases. The first subphase of "Presenting Knowledge" refers to project sharing to the learning community and further diffusion to the society. The second subphase of "Reflection" deals with reflection and follow up. Learners reflect on their and other groups' work and suggest improvements. All tables (Table 1, Table 2, Table 3) present the learning design aligned with PjBL, selected motivational strategies (ARCS-V) and smart pedagogical principles.

Table 3. Learning Design aligned with PjBL (Processing Phase), Motivational Strategies of the ARCS-V model and Smart Pedagogical Principles

PjBL Model		Procedure	4-layer SmP	LoS	PjBL features	Motivational Strategies (STR) based on ARCS-V model
3. Processing Phase	3.1. Presenting Knowledge	P10. Share the project	Layer 4	Adaptation, Self-learning, Inferring	Innovative Assessment	**STR23.** Stimulate students to share knowledge with peers who have gaps **(S1)**. **STR25.** Stimulate students to share their projects in order to acquire acknowledgement from peers **(S1)**.
	3.2. Reflection	P11. Self-Assessment				**STR26.** Provide high marks and positive feedback for boosting good performance **(S1)**. **STR27.** Use quizzes and other relative self-assessment methods **(S2)**. **STR28.** Provide external fees (e.g., badges, points through leaderboards, certificates) **(S2)**. **STR29.** Provide learners opportunities for evaluation of the quality or progress of their work through portfolios **(V2)**.
		P12. Peer-to-peer assessment				**STR30.** Provide predetermined criteria for all (assessment rubrics) **(S3)**.

Development Stage: E-course Implementation (M2 – M2.1, MD3). In order to implement the e-course (Step 9), a website was created according to the learning design. Due to the ease of building websites via drag-and-drop procedures, the free edition, and the number of utilities available to administrators and end users, the WIX platform was chosen over others. The teaching units were matched with the websites, and additional information (structure, goals etc.) was included on other pages. WIX was also customized by setting or installing additional functionalities. Meanwhile, twenty-nine Web tools (Storyjumper, Puzzlemaker, Thinglink, Learningapps, Genially, Google Slides, Canva, Pixton, Padlet, Wordwall, Jigsawplanet, ArtSteps, My Heritage, Google Arts and Culture, zappAR, PowToon, Lino, Kahoot, Google Sheets, Twiddla, Google Docs, Renderforest, Quizizz, Google Forms, WordArt, Poll Everywhere, Voki, Notely, Keepthescore) were embedded through HTML iframes, or hyperlinks to facilitate the pedagogical concepts.

Assessment Stage: Evaluation and Reflection (M3 – M3.1, MD4). To evaluate Motivation, two improvised questionnaires were exploited (Step 10). The first (QU1) was based on the well-known IMMS (Instructional Materials Motivation Survey) tool, which was designed to measure students' motivational reactions to self-directed instructional materials [13]. It includes 36 questions, to measure students' Attention (12 questions), Relevance (9 questions), Confidence (9 questions) and Satisfaction (6 questions) in self-regulated educational environments. The second (QU2) was based on Self-Regulation learning strategies and measured the parameter of Volition (15 questions). The responses have been utilized the psychometric 5-point Likert scale (1 – Strongly disagree to 5 – Strongly agree). Statistical tests (one sample t-test) were conducted in IBM SPSS (version 27.0.1) for each parameter as follows: **Attention** (mean = 3,985632, Std. Dev. =

Table 4. Facilitating SmP (Motivational Strategies) by Web Technologies Integration

Motivational Strategies by ARCS-V	WIX Customization/ Web Technologies	Motivational Strategies by ARCS-V	WIX Customization/ Web Technologies
STR1, STR2, STR14, STR15	Pdf viewer applet and video applets (Youtube, Vimeo etc.).	**STR16, STR27**	Genially, LearningApps, Wordwall, Quizizz, Kahoot, Jigsawpuzzle
STR20	WIX embedded URLs	**STR18, STR24**	Google Docs, Google Slides
STR6	(WIX menus, submenus, previous-next buttons, additional webpages quickly accessed etc.)	**STR19, STR21, STR23, STR24, STR26**	WIX chat applet (chat in groups), WIX forum applet (ratings), Voki, WIX members applet
STR5	WIX password protected webpages	**STR29**	WIX forum applet, Padlet
STR8, STR9, STR25	Padlet, Lino, Google Sheets, Twiddla, Google Docs, Google Forms, WIX chat applet	**STR26, STR28**	KeeptheScore, Polleverywhere, Genially, WIX forum ratings
STR7	Pixton, WIX forum applet, WIX members applet	**STR10**	Pixton, Wordwall, Genially, zappAR,
STR4	Voki	**STR30**	Google Forms
STR3, STR17, STR22	Notely	**STR11, STR12, STR13**	All the 29 Web Tools and WIX customization

3,985632), **Relevance** (mean = 4,1456, Std. Dev. = 0,45436), **Confidence** (mean = 3,8238, Std. Dev. = 0,50702), **Satisfaction** (mean = 4,1839, Std. Dev. = 0,540695), **Volition** (mean = 3,7609, Std. Dev. = 0,38443) and **Motivation** (mean = 3,9425, Std. Dev. = 0,37181). The table below (Table 5) presents the p-values of the t-tests with test value = 3, which is the mean value of 5-scale.

Table 5. Statistical Tests for Motivation (One sample t-test)

One Sample t-test						
				Test Value = 3	95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Attention	12,067	28	,000	,98563	,8183	1,1530
Relevance	13,578	28	,000	1,14559	,9728	1,3184
Confidence	8,749	28	,000	,82375	,6309	1,0166
Satisfaction	11,791	28	,000	1,18391	,9782	1,3896
Volition	10,659	28	,000	,76092	,6147	,9071
Motivation	**13,651**	**28**	**,000**	**,94253**	**,8011**	**1,0840**

All the mean values are greater than the test value 3. Satisfaction has the highest mean value of all the variables, followed by Relevance. Therefore, most participants scored these two motivational conditions very positively (4 or 5). In other words, following the motivational design process and the smart pedagogical principles, the e-course was related to their learning preferences and provided a high level of satisfaction. It is evident from the t-test that all p-values indicate a statistically significant impact on all motivational variables, thus answering the RQ1 and its sub questions (RQ1.1–RQ1.5).

To answer the second research question (RQ2), and the sub questions (RQ2.1–RQ2.5), all the aforementioned tables (Table 1, Table 2, Table 3, Table 4) were combined. Attention was accomplished by STR5, STR7, STR8, STR10 and STR11, through integrating gamification elements such as avatars created by Pixton and content unlocking (hidden passwords for protected webpages). On the other hand, all web tools provided variability in content and offered opportunities for study and research. Strategies related to Relevance were STR9, STR12 and STR13. For each one of the web tools, a short manual was provided, as well as examples of how it could be used in teaching practice. Specifically, Padlet, Lino, Twiddla, and Google tools (Sheets, Slides and Docs) were suggested for real-time peer-to-peer interaction and collaboration in groups. Regarding Confidence, STR1, STR2, STR6, STR14, STR15, STR19 and STR24 were the selected strategies. Menus and submenus were set for quick navigation through learning units, where the design and the process as well as additional learning information was clearly defined. Moreover, previous knowledge was described by incorporating introductory reflective activities. Important web tools were considered Voki and Notely. With Voki, a digital assistant guided learners to the learning environment, while Notely offered a digital personal notepad. These two web tools contributed to the achievement of Volition, which was dealt with the strategies STR1, STR3, STR4, STR17, STR20, STR21, STR22 and STR29. At the same time, a lot of embeded URLs, drove learners to look up for further information. In terms of Satisfaction, the utilized strategies were STR16, STR23, STR25, STR26, STR27, STR28 and STR30. Genially, LearningApps, Wordwall, Quizz, Kahoot, Jigsawpuzzle, offer various attractive game-type activities for relaxing and testing the new knowledge. Genially also offers various certification templates, while Keepthescore provides customizable leaderboards. Participants communicated mainly through WIX chat and forums. Additionally, forum and Padlet were customized as individuals' and groups' portfolios for posting and rating their work. Finally, Poll Everything and Google Forms were appropriate for creating polls and rubrics for peer-to-peer assessment.

4 Conclusion

From the positive findings, the smart pedagogical framework facilitated by web technologies seems to boost ICT students' motivation. The provided web tools succeeded in deploying a TELE, implemented by following a motivational design process, and a learning design aligned with SmP principles. Empirical data document the theoretical background (high mean values of motivation, particularly for **Relevance - 4,1456**, and **Satisfaction - 4,1839**, confirmed by statistical tests). On the other hand the provided tables (Table 1, Table 2, Table 3, Table 4) offer practical guidelines for well-designed TELEs, namely SLEs driven by SmP. Research methodology is validated on-going with experiments performed in the past or planned for the future. Research limitations, however, motivate authors to conduct further study and refine their work.

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Educ-AI-ted – Investigating Educators' Perspectives Concerning the Use of AI in University Teaching and Learning

Rebecca Tritscher, Johanna Röck, and Stephan Schlögl(✉)

MCI - The Entrepreneurial School, Innsbruck, Austria
stephan.schloegl@mci.edu
https://www.mci.edu

Abstract. Artificial Intelligence (AI) is currently been embedded into various tools and devices supporting many of our daily activities and routines. Thence, it is not surprising that AI-driven applications are increasingly also found in the education sector. Such an integration, which is often referred to as AIEd, not only offers great new opportunities for learners, but may also trigger significant challenges for education providers. The work discussed in this paper aims to bring some light to this problem space by offering teachers' perspectives on the topic. We report on a Delphi study with $n = 17$ university teachers, focusing on their experiences, their doubts and their future wishes concerning the use of AI in teaching and learning settings. Results from three rounds of questioning indicate that educators are generally open to the idea of integrating AI components into their pedagogical concepts, even if in specific application scenarios, such as student assessment, opposing perspectives exist. Results furthermore show that corresponding tool training and better (technical) support is required in order successfully manage this significant change our education landscape is currently undergoing.

Keywords: AIEd · Delphi Study · Education Technology & Tools

1 Introduction

In recent years, we have seen a constantly increasing uptake of Artificial Intelligence (AI) technologies and tools, both in private as well as in professional settings. Whereas during the first decade of the new millennium, AI progress was mainly driven by the implementation of autonomous planning, scheduling and spam fighting applications (cf. [1]), it seems that ever since the introduction of Apple's Siri[1] in 2011, a significant part of AI innovation has been focusing on the development of ever more sophisticated personal assistants, aimed at simplifying our daily lives. These developments have seen their latest peak in November

[1] Online: https://www.apple.com/de/siri/. [accessed: January 23th 2023].

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https://doi.org/10.1007/978-3-031-34754-2_20

2022 when OpenAI introduced the *ChatGPT* chatbot system[2] powered by its newest GPT language model. Promising to offer comprehensive answers to many types of questions (from concrete programming tasks to open-ended, essay-like questions on contemporary politics), *ChatGPT* quickly became students' best friend and educators' worst enemy. And while this may only be the spearhead of the significant changes we are currently experiencing in our use of modern technology, it clearly points to an imminent need for education providers to increase their engagement with the different types of available AI tools and applications, and embrace those benefits that they may provide to educators and learners alike. The work presented in this paper aims to set a first respective step in this direction by focusing on teachers' experiences and perceptions regarding the use of AI in education. In this, we particularly investigate the current use of Intelligent Tutoring System (ITS) (e.g. [2,5,26]), chatbots (e.g., [30,37,38]) and automatic grading systems (e.g., [29,35,36]), in order to provide some first-hand insights as to the opportunities but also the challenges these tools may bring to the 'education table'.

2 Artificial Intelligence in Education

The multi/interdisciplinary nature of AI makes it applicable to various fields of application, all of them facing their very distinct benefits and limitations (cf. [16,28,33,36]). In education, respective tools, which are often referred to as AIEd, usually take on a supporting role [11], helping to reduce administrative tasks, so that educators may be able to devote more time to their actual teaching activities [10]. This administrative function of AI spans over all phases of the teaching process, from preparation to follow-ups [11]. AIEd tools may furthermore be used to predict the likelihood of drop-outs [14], as well as the general performance of students, so that institutions and teachers may be able to intervene early on [4]. Building upon this, they might be used to identify optimal learning paths or even help create individual course curricula [11]. Furthermore, they can enhance the learning experience, e.g., through intelligent agent mentors.

Aiming to classify the characteristics of AI in education, Ouyang & Jiao [31] define three application paradigms: (1) the **AI directed** paradigm, where the learner is considered a receiver of the AI system; (2) the **AI supported** paradigm, where the learner is considered a contributor; and (3) the **AI empowered** paradigm, where the focus is put on learning process interventions and analyses. Baker & Smith [4], on the other hand, rather focus on selected user groups. According to them, **learner-facing AIEd** concentrates on individual students, **teacher-facing AIEd** supports teachers, and **system-facing AIEd** deals with AI data processing and its use across organisations.

Finally, Zawacki-Richter et al. [38] categorize the application fields of AIEd into: (1) **profiling and prediction**, (2) **Intelligent Tutoring System (ITS)**, (3) **assessment and evaluation**, and (4) **adaptive systems and personalization**. Profiling and prediction tools use machine learning to create learner

[2] Online: https://openai.com/blog/chatgpt/. [accessed: January 23$^{\text{th}}$ 2023].

profiles and success estimates and thus allow for the development of personalized learning paths and the optimization of admission decisions [17,38]. ITS, on the other hand, focus on teacher support in that they help deliver content and provide feedback to students (cf. [9,12,22,23,38]). Consequently, the focus here lies on Human-AI collaboration in order to help foster the relationship between educators and learners and in doing so enhance the overall teaching experience [23]. Hwang et al. [23] discuss four roles of AIEd in this context: (1) AIEd as an intelligent tutor to support learners in the learning process, (2) AIEd as an intelligent tutee to motivate learners to fulfil the role of an advisor and thus better understand complex contents and topics, (3) AIEd as an intelligent learning tool or partner to analyse and evaluate learner data and then visualise the information obtained through maps, and (4) AIEd as an advisor in policy making by reviewing the educational environment so that trends and issues can be understood and acted upon in a timely manner [23]. With respect to assessment and evaluation, AI tools are used for automated assessments [3,29,35,36], for feedback generation [21] and to evaluate teacher and learner understandings. Finally, as for the use of AI in adaptive systems and personalization, teachers should find support at the pedagogical level. Machine learning supported personalization [8,25], for example, allows for the visualisation of individual learning paths via e-learning systems [8]. Using methods such as data augmentation [8], individual learner assessments can be automated an individual learning paths be created. A personalized teaching and feedback process [11] may furthermore provide insights into learners' motivation and learning performance and consequently help adapt to learners' different personalities.

While the above clearly points to some significant benefits AI may bring to the education field, the penetration of respective tools in the sector is still rather low. To this end, one may argue that an increase in tool uptake is strongly linked to the willingness of educators to engage in AI-supported teaching settings. Hence, our goal was to understand to what extent teachers of different disciplines at university level are aware of and potentially use AI tools, and what they would need in order to progressively adopt these solutions as part of their pedagogical concepts. Consequently, our analysis was guided by the following research question:

What are university teachers' perceptions concerning the use of AI tools in education?

3 Methodology

In order to address the above outlined research question, we chose a Delphi study approach. The method, which was initially developed by Dalkey & Helmer [13], focuses on multiple rounds of systematic questioning. During the first round, participants are usually confronted with a number of open-ended, essay-like questions, aiming to collect insights on personal experiences, perceptions and opinions [6]. All responses are then summarized, structured, and rewritten in the form of concrete statements to be used during the second round of questioning. Here, participants are asked to rate their agreement with these statements on a 5-point Likert scale [20]. Finally, during the last round, participants are given the average Likert scale ratings for all statements and asked to once more review their own choices. A Delphi study usually lasts for several months, with sufficient time available in between rounds (usually a week or more). Trough this type of repeated and controlled feedback, where participants are continuously asked to review and potentially change their answers, researchers aim to trigger deeper reflections; the final goal of it being to reach either consensus [32] or reveal clear disagreement [34]. Heiko [18] furthermore states that participant opinions that remain stable over several rounds may be considered a sign of validity in Delphi studies, whereas the method's inherent repetitiveness makes results more robust. And although the strength of the method comes from an exchange of and reflection upon opinions, participants are never introduced to each other, which maintains their anonymity [18].

3.1 Sampling Procedure

Although there is no clear definition as to how many participants are required for a Delphi study to yield expressive results, Skulmoski et al. [34] recommend a homogeneous sample of approx. 10 to 15 domain experts. In our case, this meant to focus on people with a certain level of pedagogical competence and teaching experiences. Thus, we determined that our participants should posses substantial experience with respect to the preparation of course content and respective materials as well as the assessment and evaluation of student performances. Using this sample frame, we reached out to a total of 37 professors, lecturers and PhD students. From those, we were able to recruit 17, all of whom completed all three rounds of our study. At the time of the study, they taught at different universities and business schools in Austria and Germany. For nine of them, this was their main occupation, whereas three were still engaged in their doctoral studies and the remaining five had their full-time employment in the private sector. Unfortunately, the sample showed a significant gender imbalance containing only two female participants, which we see as a clear limitation that needs to be tackled in future investigations. As for the sample's age distribution, we managed to include representatives from a broad spectrum of age classes. That is, six experts were between 25 and 34, six between 35 and 44, two between 45 and 54, and three between 55 and 64 years old at the time of the study.

3.2 Initial Question Development

We used the SPSS method [19] to define the question set for our first Delphi round. That is, we went through the following four steps in order to assure a valid starting point for our investigations: (1) collect a broad set of potential questions, (2) evaluate each question based on whether it fits the experts' prior knowledge and determine if it is sufficiently open so as to yield rich responses,

(3) sort all selected questions according to their topic, (4) create categories for each of the generated topics. This process led to a final questionnaire that consisted of three parts. The first part contained an introduction to the study and the field of AIEd. The second part contained open-ended questions focusing on participants' experiences with AI in education. Those were sub-divided in (1) questions about the individual educational process, (2) questions about the used technologies and AI supported systems, (3) questions about the experiences and difficulties with respective technologies and AI supported systems, and (4) questions concerning requirements and expectations when it comes to future AI tool usage and support by institutions. Finally, the third part of the questionnaire focused on participants' background and demographics.

3.3 Data Collection and Processing

Data collection and processing followed three phases, which were repeated three times (i.e., for each round of the Delphi study): (1) preparation of the Delphi round, (2) collection of the data, (3) evaluation of the collected data. In total, the entire investigation lasted approx. two months. During its first iteration (i.e., in round one of the Delphi study), participants were asked to complete the above described questionnaire (cf. Sect. 3.2) and additionally given the opportunity to comment freely on all aspect they thought were missing [24].

From this, we formed a set of concrete statements, which were then used in the second iteration (i.e., the second round of the Delphi study). Respective statements were categorized in (1) difficulties with AI, (2) institutional requirements, (3) AI tool requirements, and (4) fields of application. Next, participants were asked to rate their level of agreement with these statements on a Likert scale ranging from 1 = "do not agree at all" to 5 = "fully agree". In addition, they were given the opportunity to clarify and/or justify their answers via an open text field [34]. We applied measures of central tendency to describe these Likert scale responses. In addition, we used the SD to calculate the level of consensus among participants. We decided to assume clear consensus for statements where $SD < 1$, moderate consensus where $SD = 1 - 1.4$ and disagreement where $SD > 1.4$. Finally, the third iteration (i.e., round three of the Delphi study) reiterated the statements of round two. In addition, participants received the mean statement ratings from round two as well as their own ratings, so that round three was mainly focusing on the question whether a participant would change his/her own previous rating after having seen the mean ratings of the others. Also in this third iteration it was possible to leave a comment after each block of statements so as to justify and/or explain one's rating [20].

4 Results

Results show that our participants use a variety of different tools to prepare and/or conduct their teaching and evaluate learners' performances. Respective applications may be categorized into (1) communication tools (i.e., different email systems), (2) learning management tools (e.g., *Moodle*[3], *Sakai*[4], etc.), (3) questioning tools (e.g, *TCExam*[5], *Mentimeter*[6]), (4) teamwork tools (e.g., *Mural*[7], *Miro*[8]), (5) different types of text processing tools (*Microsoft Office*, LaTeX), literature research and management tools (i.e., various citation programs and *Google Scholar*), and (6) more specific programs such as graphic and programming tools.

Particularly asked about AI-based tools, nine of the 17 participants stated to have already employed them in academic work and teaching settings. Named examples included language tools such as *DeepL*[9] and *Google Translate*[10] for translation or *Grammarly*[11] to correct grammar mistakes in essay-like texts. Furthermore, *Research Rabbit*[12] is often used to deepen literature work, and tools such as *turnitin*[13] and *PlagScan*[14] to check for potential plagiarism in student papers. Finally, with computer science students, *GitHub Copilot*[15] has been found to offer helpful support in the creation and evaluation of programming tasks. Despite of this awareness for some relevant AI tools in education, it still seemed rather difficult for educators to distinguish between more traditional IT tools and those tools which embed at least some sort of AI.

4.1 Perceptions on Difficulties with AI in Education

Although just over 50% of our study participants had previously been in touch with AI-based tools and applications in education, the overall perception concerning the use of these tools has been generally positive. Three of them, for example, explicitly stated that AI-supported tools make (scientific) work easier. Another one highlighted that the gain and consequent transfer of knowledge is significantly supported through AI and that respective technologies would help in the translation and formulation of academic texts. Yet, we also encountered negative perceptions. Two experts, for example, remarked that AI generated results are often erroneous and thus may be misinterpreted for which significant rework is required. To this end, a number of difficulties were mentioned that lecturers may face when using AI tools (e.g. minority bias). Also, the aspect of fake authorship has been addressed, in that the individual work of students may be questioned, whenever they have access to automatic text production systems

[3] Online: https://moodle.org/. [accessed: January 30th 2023].
[4] Online: https://www.sakailms.org/. [accessed: January 30th 2023].
[5] Online: https://tcexam.org/. [accessed: January 30th 2023].
[6] Online: https://www.mentimeter.com/. [accessed: January 30th 2023].
[7] Online: https://www.mural.co/. [accessed: January 30th 2023].
[8] Online: https://miro.com/. [accessed: January 30th 2023].
[9] Online: https://www.deepl.com/translator. [accessed: January 30th 2023].
[10] Online: https://translate.google.com/. [accessed: January 30th 2023].
[11] Online: https://www.grammarly.com/. [accessed: January 30th 2023].
[12] Online: https://www.researchrabbit.ai/. [accessed: January 30th 2023].
[13] Online: https://www.turnitin.com/. [accessed: January 30th 2023].
[14] Online: https://www.plagscan.com/en/. [accessed: January 30th 2023].
[15] Online: https://github.com/features/copilot. [accessed: January 30th 2023].

(note: our study was conducted before OpenAI released its *ChatGPT* platform). Another negative aspect of AI was found in its need for data processing, which may at times infringe on privacy laws and regulations. And, it was also outlined that although AI tools may be able to support teaching and evaluation activities, they should not replace face-to-face communication in class. Yet, there was no agreement ($SD > 1.4$) on whether the use of AI tools in academic settings should require clearer and more rigorous institutional regulations. All mean ratings and *SDs* of participants' agreement with statements related to difficulties with AI, as well as how some of their opinions changed between rounds two and three of questioning, are depicted in Table 1, which can be found towards the end of this article.

4.2 Perceptions on Institutional Requirements

As for relevant institutional requirements, participants requested more help, training and support (17 out of 20 statements). That is, institutions should offer respective workshops on possible AI use cases in learning and teaching, dedicated tool training courses and joint testings, and they would need to provide technical support when it comes to the integration and monitoring of AI solutions. Consequently, there should be clear standards as to the use of AIEd, accessible by both teachers and learners. Such may require financial resources, not only to support staff training but also to more deeply integrate AI capabilities into universities' existing IT landscapes. Other mean ratings and *SDs* of participants' agreement with statements related to institutional requirements, as well as how some of their opinions changed between rounds two and three of questioning, are depicted in Table 2, which can be found towards the end of this article.

4.3 Perceptions on AI Tool Requirements

While institutional requirements are of a more governing nature, tool requirements are directed at solution providers. To this end, almost all demanded aspects concern the usability of AI applications. That is, participants would want for those tools to be simple and intuitive to use. No major configuration effort should be required of users in order to get started. In other words, the tool should help save time instead of causing more work. At a later stage, however, individual configuration should be possible. Tools should feature automatic data collection and training, but at the same time offer possibilities to delete and correct data entities and learned behaviour if needed. All mean ratings and *SDs* of participants' perceptions on AI tool requirements are depicted in Table 3, which can be found towards the end of this article.

4.4 Perceptions on Fields of Application for AI in Education

Currently, it seems that the most disputed area of application for AI in education concerns learner assessment (mentioned by nine of our 17 participants). This

Table 1. Agreement rates and respective *SD* for rounds two (i.e., R2) and three (i.e., R3) of our Delphi study with $n = 17$ teaching professionals questioned on the use of AI in education. Likert scale running from 1 = "do not agree at all" to 5 = "fully agree".

Difficulties with AI	*Mean*		*SD*	
	R3	*R2*	*R3*	*R2*
The results of an AI should be questioned.	4.56	4.56	0.63	0.63
The results of an AI need further correction.	4.35	4.35	0.79	0.79
Educators trust an AI.	3.38	3.38	0.96	0.96
AI use in education raises concerns.	2.87	2.93	0.99	1.03
An AI is flawed.	2.79	2.79	0.58	0.58
AI use leads to frustration.	2.29	2.29	0.99	0.99
AI use requires a lot of prior knowledge and competencies.	3.88	4.06	1.27	1.25
AI technology receives too much trust.	3.31	3.31	1.08	1.08
Individual students' performance needs to be questioned when using AI.	3.31	3.31	1.14	1.35
There are data concerns when consciously working with AI.	2.71	2.65	1.10	1.11
Educators lack conviction to use AI.	2.71	2.76	1.21	1.30
An AI can critically reflect.	1.94	2.12	1.14	1.32

includes both the evaluation and grading of multiple-choice exams as well as the analysis of open-ended, essay-type questions. To this end, one of our participants stated that, although teachers may still need to verify AI results, automatic grading would help increase transparency. This was countered by another participant who believes, that only humans would be able to produce fair exam grades and respective feedback. Finally, a combination of both views was articulated by a third participant proposing to use AI only for the creation and assessment of completely standardized online exams or for plagiarism checks.

Another valid area of use in education was found with administrative and organisational tasks. Particularly, the use of chatbots was named as advantageous (explicitly mentioned by four participants), as they can help answer administrative questions and provide online support.

Finally, participants pointed to the use of AI to directly support learning tasks. Here it was thought, that AI can help explore learning content – dig deeper, find additional information about topics of interest, and classify these additional insights in a learner-centered way.

Except for the rather controversial discussion on the use of AI for learner assessment (a discussion, which today may reach a totally different result, due to the introduction of *ChatGPT*) participants found moderate to clear consensus on the above named areas of AI application. Participants' respective mean ratings and *SDs* are depicted in Table 4, which can be found towards the end of this article. One fact they all agreed on, however, is that AI will and should change

Table 2. Agreement rates and respective SD for rounds two (i.e., R2) and three (i.e., R3) of our Delphi study with $n = 17$ teaching professionals questioned on the use of AI in education. Likert scale running from 1 = "do not agree at all" to 5 = "fully agree".

Institutional Requirements	*Mean*		*SD*	
	R3	*R2*	*R3*	*R2*
There is a need for AI workshops and training.	4.53	4.53	0.62	0.62
There is a need for a clear overview of AI tools.	4.65	4.65	0.49	0.49
There is a need for technical support.	4.65	4.65	0.79	0.79
Freedom of teaching needs to remain.	4.94	4.94	0.24	0.24
Tools should be tested with educators.	4.69	4.69	0.48	0.48
Financial support is needed.	4.31	4.31	0.48	0.48
A proactive approach in using AI tools is needed.	3.80	3.80	0.86	0.86
Exchange of experience with others is needed.	4.41	4.41	0.62	0.62
Freedom to choose the tool is required.	4.41	4.41	0.94	0.94
Integration into existing systems is required.	4.47	4.47	0.72	0.72
A reflective and critical approach is needed.	4.47	4.47	0.87	0.87
Trust of the institution to use the tool is required.	4.25	4.19	0.68	0.83
Trust towards the department which is promoting the tool is required.	4.07	4.07	0.92	1.07
Technical requirements need to be secured for using AI.	4.44	4.44	0.73	0.73
Standards should be provided.	4.12	4.06	0.89	1.03
No surveillance should happen through AI.	4.47	4.47	0.87	0.87
It needs a shift in thinking towards the usage of AI tools and performance appraisal.	3.63	3.63	0.98	1.09
There needs to be a list of limitations for the tool.	4.18	4.12	1.09	1.27
The initial effort when using the tool should be low.	3.06	3.12	1.29	1.41
Tools should be used outside the institution.	2.88	3.06	1.41	1.48

the future education sector and that this change needs to be accompanied by respective (technical) training and support for educators.

5 Discussion

Our analysis has shown many concordant but also some rather diverse viewpoints on the use of AI technology in education. It was also shown, that the comprehension for what may be considered an AI tool and what should be classified as a traditional computer program (sans 'intelligent' behaviour) is not always given. Consequently, AI tool use among our study participants is currently limited and sometimes happens even unconsciously. Training in what AI is and how it could

Table 3. Agreement rates and respective *SD* for rounds two (i.e., R2) and three (i.e., R3) of our Delphi study with $n = 17$ teaching professionals questioned on the use of AI in education. Likert scale running from 1 = "do not agree at all" to 5 = "fully agree".

AI Tool Requirements	*Mean*		*SD*	
	R3	*R2*	*R3*	*R2*
The usage of AI makes sense.	4.65	4.65	0.49	0.49
There is a need for compliance towards data correction.	4.76	4.76	0.75	0.75
There is a need for reliability.	4.59	4.59	0.71	0.71
There is a need for correctness.	4.65	4.65	0.61	0.61
There is a need for traceability.	4.53	4.53	0.80	0.80
Time should be saved when using AI tools.	4.41	4.41	0.71	0.71
AI tools should be easy to use.	4.12	4.12	0.99	0.99
It should be possible to calculate and analyze quantitative data.	4.35	4.35	0.79	0.79
The AI tool should react individually on results.	4.38	4.38	0.81	0.81
The AI tool should adapt to individually work processes.	4.41	4.41	0.62	0.62
Setting individual criteria is needed.	4.35	4.35	0.61	0.61
AI tools should collect data on its own.	3.76	3.82	0.90	1.01
AI tools should delete wrong data sets.	4.13	4.13	0.96	0.96
AI tools should respect the "right to be forgotten".	4.43	4.43	0.94	0.94
There is a need for reproducibility.	4.47	4.47	0.87	0.87
A certification of AI tools is needed.	3.63	3.63	1.20	1.31

support the education sector would remedy this situation and should thus be given high priority in the strategic development plans of education providers.

Recapitulating our participants' wishes, the ideal (future) AIEd tool works correctly and reliably, following a traceable decision space that is compliant with the institution's rules and regulations. Given such a prerequisite, participants confirm previous work in that such a tool may then be used for both administrative tasks [11,30,38] as well as in student learning and assessment tasks [11,30,37,38], focusing particularly on the personalization of learning content [27] and the support of writing tasks and other analytical procedures that aim at the reflection of information and the generation of insights. Yet, while respective tools may certainly support in-class as well as distance learning [9], they should not replace the human component in the learners' space, as this will easily generate resistance and dispute among the educating faculty. Rather, it is advised to focus on awareness raising and inclusion, highlighting the benefits AI-Human-Co-teaching might bring to the education sector [5,7,15,39].

Table 4. Agreement rates and respective SD for rounds two (i.e., R2) and three (i.e., R3) of our Delphi study with $n = 17$ teaching professionals questioned on the use of AI in education. Likert scale running from 1 = "do not agree at all" to 5 = "fully agree".

Fields of Application	*Mean*		*SD*	
	R3	*R2*	*R3*	*R2*
AI tools are used for plagiarism checks.	4.88	4.88	0.33	0.33
AI tools are used for administrative questions.	4.12	3.82	0.50	1.01
AI tools are used to pre classify students' knowledge	3.88	3.59	0.89	1.06
AI tools offer personalized learning content.	4.00	3.75	0.73	1.06
AI tools are used to search for scientific articles	4.24	4.24	0.66	0.66
Texts are analysed using AI tools.	4.06	4.06	0.77	0.77
AI tools recognize formal error and structures.	4.29	4.29	0.69	0.69
AI tools facilitate scientific work.	3.81	3.71	0.83	1.10
AI tools transcribe automatically.	4.24	4.24	0.75	0.75
AI tools recognize which statistics to use for which dataset.	3.65	3.65	0.93	0.93
AI tools automatically create exercises.	3.47	3.47	0.87	0.87
AI tools are not used.	1.33	1.33	0.71	0.71
Chatbots are choosen for mock exams.	3.75	3.56	1.06	1.15
AI tools analyze personalized learning paths.	3.50	3.38	1.03	1.20
Avatars are used for support.	3.63	3.50	1.29	1.32
There is a need to evaluate forums.	3.35	3.41	1.25	1.18
Exams are created with an AI.	2.94	2.71	1.37	1.45
AI is used to analyze qualitative content.	3.41	3.41	1.09	1.18
AI is used to create course material.	2.88	2.71	1.39	1.45
AI is used for exam evaluations.	3.59	3.53	1.41	1.37

6 Conclusion and Future Outlook

It is save to say that AI will increasingly enter and consequently shape the future of education. The release of *ChatGPT* was probably only the first spark that was needed to trigger a more holistic discussion on how the roles of teachers and students may need to change in the future. To this end, the results of our study clearly emphasize the need for better, more educator-centered AI tools as well as respective training, so as to fight negative attitudes and mistrust. We see this as an important problem space that requires multi-disciplinary input. Thus, future work should not only focus on improving AI algorithms, but also investigate how these tools can be integrated into pedagogical concepts, so that AIEd may eventually move from its 'shadowing existence' to the forefront of modern education.

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The Planning and Practice of Online Philosophy Courses: An Example from the Introduction to Philosophy in Liberal Studies Program at Fu Jen Catholic University

Din-Yuang Huang(✉)

Holistic Education Center, Graduate Institute of Educational Leadership and Development, Fu-Jen Catholic University, New Taipei City, Taiwan, R. O. C.
060967@mail.fju.edu.tw

Abstract. In light of technological advances and the impact of the epidemic, distance learning has become a common mode of teaching in modern times. In 2020–2021, the Office of Academic Affairs of Catholic Fu Jen University in Taiwan began planning a freshman summer online course for freshmen who have applied for admission to take the course during July and August. In 2020–2021, the researcher cooperated with the Faculty Development & Instructional Resources Center to redesign the curriculum, starting from the design and writing of lesson plans, to convert the course from a physical course to an online course, and to record the teaching video in the same year. The program had already be available for online registration in June 2021 for freshmen who had applied to school, and the actual online course had be conducted in July and August. The second year of the online course was conducted in 2022 and had be continued in 2023 in the same way. The purpose of this research paper is to illustrate how the researcher, as the teacher, conducts the course from planning to implementation.

Keywords: Online Course · Liberal Course · Introduction to Philosophy

1 Introduction

In light of technological advances and the impact of the epidemic, online learning has become a common mode of teaching in modern times. In 2020–2021, the Office of Academic Affairs of Catholic Fu-Jen University in Taiwan began to plan a freshman summer online course for freshmen who had applied for admission to take the course in July and August. In 2020, the course be reorganized and recreated in accordance with the school's policy, and in 2021, the online course started to run until now. The purpose of this research paper is to illustrate how the researcher, as a teacher, conducts the curriculum from planning to implementation. In the following, we will discuss some aspects of this process based on the actual teaching strategies used in the course, in particular, how to design activities to lead the students' discussions, how to let the students implement the content in their lives, and how to discuss and suggest the future of the course.

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2 Target Audience and Course Nature Analysis

The Freshman Year Program is designed for students who have applied for college admission in their senior year of high school in Taiwan. These students will have a window of about 3–4 months before they apply to Fu-Jen University in May and before they start college in September: this time is not only for graduation, but also for part-time work and study. If we can arrange for students to start taking university courses earlier during this time window - whether they are liberal education courses or basic courses such as statistics or calculus - it will not only allow students to start bridging the college curriculum gradually, but also give them more flexibility in applying their time after entering university.

In response to the needs of the elective students, the university plans to incorporate the Introduction to Philosophy offered by the Center for Holistic Education at Fu-Jen University into the freshman prerequisite courses. The course "Introduction to Philosophy" plays a fundamental role as a liberal education course [10], but there are different opinions on how to conduct this course. Wang [10] leads students to enter the field of philosophy through different modules in the course, such as discuss hot topics and "doing philosophy". His fruitful work has been produced in a variety of ways, including writing reports, making videos, acting in dramas, producing game software, producing animations, and producing picture books. Yu and Pang [12] used PBL teaching method to lead class discussions in small groups. Yu also introduced online teaching as a platform for the Introduction to Philosophy course, which includes online learning activities, class progress and lecture notes for students to download, a discussion group forum, an online chat room, online assignment submission, and online learning assessment and statistics on the "Fu-Jen University Basic Philosophy Learning Website".

When planning an introductory philosophy course, the researcher, in principle, follows the content of the introductory philosophy textbooks in the broad area of planning. As an introductory course, the question of what to choose as the content belongs to the field of educational sociology on the one hand: "What should we teach? as a question." [11] On the other hand, introductory philosophy has its own traditional lineage of content presentation and the areas that must be introduced: this can be seen in the writings on introductory philosophy, see Table 1 below.

It is impossible to put all fields in one course or work on course which introduce to philosophy, but comparing different courses or works we can still get the result of overlapping fields. The above comparison of the main fields of philosophical introductory works allows us to note that while different fields of philosophical introductory works have their own main orientation, they also contain different philosophical fields (political philosophy for the more classical considerations, and applied philosophy for the more lifelike or applied ones, with a focus on sexual power or environmental ethics). The content of our courses has been adjusted from physical to online, and the consideration of the content of the courses and writings has been adjusted according to the tradition.

Table 1. Areas of philosophy discussed in different writings

BooK	Smith	Cleave el.td	Rayne	Soloman & Higgins
Introduction	●	●	●	●
About History	●	△	●	●
Human	●	●	●	●
Logic	●		●	●
Epistemology	●	●	△	●
Metaphysics	●	△	△	●
Ethics	●	●	●	●
Others	●	●	●	●

* The above table was compiled from Smith [8], Cleave team [5], Payne [7], Soloman & Higgins [9].
** ●: A special chapter is devoted to this topic
△: There is no dedicated chapter, but related concepts are mentioned in the text or interspersed in some chapters.

3 How to Adjust Course Content and Delivery Through the Assistance of the Faculty Development and Instructional Resource Center

Many studies have noted the importance of helping instructors prepare for online courses as they transition. For example, Hoffmann et. ld. [6] noted early on that with the increase in online courses, it is important to help teachers prepare themselves for this innovative approach to teaching. This preparation is geared toward learning to use online tools, collaborating with online course design teams, and supporting school administrative teams to deliver courses that meet higher education standards.

Although this course was formerly known as Introduction to Philosophy in the liberal studies program and has been offered since 2013, the change from a physical course to an online course required adjustments and preparations. The original physical course structure was designed with the following components:

1) Introduction to the Course.
2) Four introductory modules on logic, theory of knowledge, metaphysics, and ethics.
3) Group Reports.
4) Two examinations.

The move from physical to online has required the instructor to re-engineer and re-adjust the course content. First, some of the physical sessions of the course itself, while possible in the classroom, could not be delivered online (e.g., in the ethics module, the practical manipulation of Game Theory illustrates the sources of morality). In addition, some of the group activities that were originally intended to be conducted in teams, such as the group work in the unit of philosophy of religion, where the group was assigned to analyze the bronze statues of saints on campus to illustrate the distinction between the sacred and the secular, had to be modified to fit the course content. In order to adjust the course content, the center assigned teachers and teaching assistants with online learning experience to discuss and make appropriate adjustments to the course proposal with the teachers from September to October 2020. After October, we assigned a team to assist the teacher to record the course video and create the teaching PowerPoint after the teaching plan was finalized. As a result of this adjustment, the course content was adjusted as follows:

1) Reorganization of the module planning: The reorganized curriculum consists of 14 online lessons, in order of six main directions: logical thinking, theory of knowledge, metaphysics, ethics, theory of justice, and semiotics, in order to meet the practical needs.
2) Re-plan the content of each lesson. In principle, each lesson is designed for 5–6 units, plus time for homework or discussion. Considering that online courses are not easy to interact during lectures, the principle of the course design is 15 min per unit, adding life experiences relevant to students as examples, adding special units on the life of philosophers, and integrating homework design, mainly related to students' life experiences.
3) Designing discussion sessions: Philosophy courses emphasize the discussion process. In the practical course, questions can be designed to guide students' discussion step by step according to the course PowerPoint. In a physical course, the instructor can also walk into the groups to participate in the discussion and thus conduct the class operation. In an online course, however, it is not easy for the instructor to do this with a class of 65 students unless the class is taught in a synchronous group setting. In order to maintain corresponding discussions even when the course is not synchronous, the instructor uses the discussion function of the course platform to design questions and ask for comments and feedback from students. The instructor also gives comments and interacts with the students during the grading process. In addition, the instructor will set up a live online discussion room at regular intervals to invite students to join the discussion and give their opinions.

Since the audience of this course is the admitted freshmen, the center has arranged for the production of an introductory promotional video on Youtube to help promote the course.

4 Teaching Strategies in the Actual Teaching Process

In accordance with the above-mentioned adjustments to the course strategy and the needs of the online course, the actual teaching strategy of the course is adjusted as follows:

1) Focus on designing activities and leading discussions. In order to help students participate in the discussions, the instructor had setting specific topics for discussion and feedback after the course has been moved to online delivery. The instructor and teaching assistants would also provide appropriate feedback and discussion when possible. The teaching web Tron Class system would be used as the discussion platform to convert the discussion in the physical classroom into an online exchange of ideas.

2) Design course activities that allow students to put into practice what they have learned in their lives. As an introductory course, the main task of Introduction to Philosophy is to introduce students to different areas of philosophy within a prescribed cycle. According to the planning of Fu-Jen University's whole-person education program, Introduction to Philosophy is an elective course in the field of humanities and arts, so it is easy to give people a feeling that it is not easy to practice this course. Therefore, the course is designed with activities that are integrated with life so that students can deepen their understanding of philosophical theories through life practices.
3) Coursework requirements for attribution. A common problem in online courses is that students do not clearly indicate the source of the citation or cite it inappropriately. In order to avoid disputes over plagiarism, students are required to cite the content in APA format, in addition to being reminded at the beginning of the course and during the course that failure to cite sources is considered plagiarism. Students who are judged to have plagiarized will not receive a grade for the assignment, but will be allowed to resubmit it at the end of the course.

5 Post-course Satisfaction Analysis

A questionnaire survey was conducted for students who took the course before and after the course in 2021 and 2022. The following is a statistical description based on the statistical results only.

5.1 Statistics on the Number of Respondents

The statistics of the number of students taking courses and the number of respondents in the pre and post-tests for both years are shown in Table 2.

Table 2. Course Selection and Response Count

Year	Number of Students	Fill in the number of answers	
		Pre-test	Post-test
2021	68	64	67
2022	32	30	20

The pre-test asks about motivation and willingness to take courses, and the post-test asks about satisfaction with courses and willingness to receive credits. We noted that the decline in the number of students taking courses in 2022 is related to the problem of the decreasing number of students in higher education in Taiwan. The decrease in the number of students taking the post-test is also related to the decrease in the percentage of students completing the course and the ability to receive credit. Fu-Jen University has its own plan for the liberal studies program, and some departments have excluded courses. For example, this course is excluded from the Department of Philosophy and the Department of Chinese Language and Literature, but five students from these two departments took it in 2022. They had not completed the course or post-test.

5.2 Motivation of Course Selection

See Table 3 for an analysis of the motivation of course selection for both years:

Table 3. Motivation Analysis of Course Selection. The number in front of the table is the number of people, and the percentage at the back

Reason for choosing a course	2021	2022
Personal intresting	54/84.4%	29/96.7%
Professional Needs	8/12.5%	5/16.7%
Come to us by name (teacher or course)	4/6.2%	2/6.7%
Credit Requirements	41/64.1%	13/43.3%
Non-Voluntary Enrollment	0/0%	0/0%
Learning Incentives	24/37.5%	7/23.3%
Other reasons	2/3.1%	1/3.3%

Since there is no single motivation for selecting a course, this answer is a multiple choice. As we can see from the table above, each respondent chose a course for approximately two reasons. We noted that "Personal Interest" and "Credit Requirements" were always the two strongest reasons for choosing courses. In addition, in both years, a certain percentage of students chose courses for "learning incentive" reasons. No students enrolled involuntarily, and for those who chose "other reasons", we are unable to know at this time because no explanation was given.

5.3 How About the Feel After the Course

A post-test questionnaire was administered in the last module and the last week of the course to understand students' satisfaction and acceptance of the course. In 2021, 97% of the 67 students who responded were either very satisfied or satisfied with the course (41 very satisfied and 25 satisfied). The problem with the 2022 data is that in addition to the inaccuracy of the data due to the low number of respondents, students entering their first year of college in 2022 experienced two epidemics in the two years from 2020–2022 that resulted in This is due to the fact that they may have rejected the online course due to the two epidemics they experienced from 2020–2022. This can be seen from one student's response: although all responses were very satisfactory or satisfactory, the student still "wished there were more physical teaching courses".

5.4 Crediting the Will

In both years, all 67 respondents indicated their willingness to take the credit in 2021 and 21 out of 22 respondents in 2022. The only student who elected not to receive credit for 2022 was an incoming philosophy student who was unable to receive credit.

5.5 Qualitative Discussion Content

In addition to the quantitative statistics, students also gave considerable feedback. Discounting personal praise for the teacher (e.g., "The teacher is funny", "The teacher is an amazing person, easy to close", or "The teacher is cute and I like it"), many of the responses are listed here as the basis for analysis. We set two types of questions for the questionnaire discussion: one question was about feedback on the course, and the other question was about suggestions for the course. According to the results of the questionnaire, the students' feedback on the course was very rich, but their suggestions for the course were relatively few.

We first list the sections of feedback on the course:

1) The teaching video is concise and clear.
2) The video briefly introduces many philosophical theories and provides easy-to-understand examples in some of the more difficult and boring parts.
3) Not only did we learn philosophy itself, but we also stimulated me to think about the things around me in my life, so I learned to think in a new way.
4) The course started with a little bit of psychology and why we had to pay tuition and so on. I came to the class because I saw that the teacher was very interesting, and I hope to double major in my sophomore year, so I hope that now I can pass this freshman year without being too tired. Thank you to the teachers and the team for being so attentive to the production and the teachers for being so interesting and lively.
5) I think all of them are superb, but I think the teachers are the reason why I can have so much fun and benefit so much. I think the teacher is very good at teaching, he is very humorous and interesting, and he will explain many new concepts in an easy-to-understand way, and he often has some very funny incidents or says a lot of super funny things to make people laugh. The teacher is also very willing to communicate with us and let us ask a lot of questions that we do not understand, and we like the process of listening to stories and then thinking together! Thank you very much, although every time I write my homework, I feel a sense of accomplishment after I have organized a set of logical theories, not only do I feel enriched in the process of thinking, but my thinking has become more and more organized and systematic. Thinking makes me happy!
6) Don't have to worry about the usual grades because there are a lot of homework to finish.
7) Even if I was too busy and accidentally submitted the assignment late, the teacher was kind enough to let me make it up from FB.
8) My favorite unit is the fallacy unit, which can be applied in real life.
9) Through the course, I could learn more about philosophy and think more about many things. I am glad to have met the teacher. It's a pity that I didn't get to take the class, but I feel that I am a good teacher and friend. I think it's scary that there is a discussion platform, but I don't dare to click on it every time.
10) The video is of good quality, with a very clear picture and a good sense of image. The teacher's explanation was lively, with real-life examples to help me understand more and connect the knowledge to life situations. The course arrangement of interviewing

different religions was interesting and allowed me to learn more about different perspectives, which was very interesting.

We noticed that the students were more concerned about the curriculum and its relevance to their lives (practical or not). In the past, philosophy was often considered difficult to understand, or difficult to comprehend because it included too many systematic theories. Through students' feedback, we noticed that if the online course is properly planned, complex philosophical theories can be made accessible and easy to understand. In addition, if the philosophical theories are directly related to the students' lives through the design of the assignments, the students' understanding of the theories can be strengthened.

Since the students participating in 2021 and 2022 are from Gen Z, they are familiar with the online course, so they pay more attention to the quality of the video (and even the sound effect). In addition to the school's basic system, the students were also helped by the use of different social software. For example, the researcher used Facebook as a contact system in both years, and students were able to connect directly with teachers through Facebook. Using the right system helped the course run more smoothly.

The following are some of the representative suggestions from the students on the course:

1) The system will also think that the course is only halfway through if I ignorance some paragraphs.
2) I wish there were more physical classes. I think if there was a class each week where the whole class was online and discussed the week's content together, it would help stimulate more debate.
3) Although I have the flexibility to adjust the class time, sometimes the schedule may need to be adjusted again to fit the class due to sudden changes.
4) I am a bit shy about discussing problems with the teacher.
5) There are a few modules in the back that do not have subtitles. I wish they were all captioned.
6) I would like to have some hints or suggested directions to help us catch the direction more quickly.

In terms of the recommendations, the main problems were the following: system settings, the presence or absence of subtitles, and the payment of assignments. The main problem of the system is that although the TronClass system used by the school has already met the actual needs, the system is prone to misjudgment of the student viewing ratio due to the system settings. The presence or absence of subtitles is related to the work schedule of the curriculum production team. The assignments are related to students' personal habits and subjective judgment. In terms of assignment setting, while students expected more resources (e.g., PowerPoint and handouts in advance, or clearer directions for the assignments), some students felt that the assignments were appropriately scaled to help them think for themselves.

Although the online course gave students more freedom and flexibility, we noticed in the feedback we received that students were still expecting more from the physical course. Although the Introduction to Philosophy online course was designed with online discussion assignments and a separate online interactive classroom, some students did express their fear of joining. This situation is similar to that of non-course online social media, where participation or non-participation is entirely up to the individual. In the researcher's own subjective experience, only about 15% of the students in the class participated in online discussions in two years. From this perspective, although most students are familiar with online courses after the epidemic, physical courses still have their irreplaceable advantages.

6 Discussion and Suggestions for Future Development

Based on the above development process and research, the directions and issues that can be further studied and discussed in the future are as follows.

1) Introduction to the theoretical basis: We note that in the field of educational sociology there is a theoretical discussion on the part of curriculum and knowledge transfer: we can also examine the Introduction to Philosophy online course through theory. For example, in the future, we can use the theory of educational sociologist Basil Bernstein [1–4] to illustrate this course, if possible. In addition, we can think about the content of the Introduction to Philosophy course by looking at the way and content of knowledge transfer in sociology of education.
2) Motivation Analysis: In addition to knowledge transfer, we can also consider the motivation and practicality of the Introduction to Philosophy course. Why do Taiwanese students choose Introduction to Philosophy courses when they take them? Is it because of the graduation requirement? Or do they have a genuine interest in philosophy courses? Can this course meet the spirit of pragmatism and even achieve the practice of secondary school? These are all questions that can be studied further.
3) Problems with the assessment mechanism: Due to the online classroom, the assessment mechanism has become relatively complicated. According to the course plan, the learning outcomes are a combination of four total scores: the online viewing score, the homework score, and two online quizzes. Is this a reasonable mechanism? Are students comfortable with this learning process? Or is there a more appropriate way? These are all worthy of further study.
4) Further analysis and comparison: First, is there a difference in the data when comparing this course with other pre-first-year courses? Secondly, if this course is compared with the results of the online course on Introduction to Philosophy offered by the researcher in the university's Department of Advanced Studies using the same course content, will there be different data results? In addition, this conference paper was published in July 2023 at the same time as the 2023 online course, so the results of the 2023 course responses should be included in the future analysis. Finally, the qualitative feedback provided by some of the students on the questionnaire can also be used as evidence in the data analysis to understand students' thinking and reactions to the course before and after their selection.
5) In addition to the above discussion, how the course can be adjusted internally through feedback and suggestions is also a direction that can be discussed in the future. The Introduction to Philosophy online course was designed in 2020, but as the feedback and suggestions listed in the previous section, students still have their own expectations and ideas about the course. The instructor and the team can adjust the course

content through the feedback collected from students, and this process involves the recording process and preparation of the course content after the changes are made. How to achieve this goal, however, requires separate study and discussion.

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Learning Technologies Performance

Best-of-Breed: Service-Oriented Integration of Artificial Intelligence in Interoperable Educational Ecosystems

Christopher Krauss[1(✉)], Alexander Streicher[2], Eva Poxleitner[3], Daniela Altun[4], Joanna Mueller[2], Truong-Sinh An[1], and Christoph Mueller[1]

[1] Fraunhofer Institute for Open Communication Systems FOKUS, Kaiserin-Augusta-Allee 31, 10589 Berlin, Germany
{christopher.krauss,truong-sinh.an, christoph.mueller}@fokus.fraunhofer.de

[2] Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB, Fraunhoferstraße 1, 76131 Karlsruhe, Germany
{alexander.streicher,joanna.mueller}@iosb.fraunhofer.de

[3] Fraunhofer Academy, Hansastraße 27c, 80686 Munich, Germany
eva.poxleitner@zv.fraunhofer.de

[4] Fraunhofer Institute for Communication, Information Processing and Ergonomics FKIE, Fraunhoferstraße 20, 53343 Wachtberg, Germany
daniela.altun@fkie.fraunhofer.de

Abstract. Artificial Intelligence (AI) offers great potential for optimizing learning processes, teaching methods, learning content, or organizational procedures. However, the success of AI components in educational environments is by no means guaranteed and depends on several conditions in their respective learning settings. In this article, we analyze requirements that are often addressed prior to introducing AI features. We address organizational, methodological, didactical, content-related, and technical challenges. The research question of this work is how AI features can best be incorporated into modern educational system landscapes to create sustainable system architectures that are accepted and perceived as added value by users. Thereby, the article discusses two approaches to software architecture: Best-of-Suite (for monolithic architectures) and Best-of-Breed (for service-oriented architectures). Monolithic systems offer a wide range of functions, can be offered by a single provider but can become difficult to manage and create dependencies. Specialized and service-oriented systems, in turn, consist of modular functions handled by specialized services, are more flexible and scalable, and can be integrated with a wide range of tools and services, but require more effort to set up and manage. We explain why the Best-of-Breed strategy is a sensible approach to the use of AI components, how this can be implemented sustainably with the help of a middleware component, and we report on the user experiences from a field test. While in this work we evaluate the implemented system with a cybersecurity training as an on-the-job course, the middleware has been successfully used in other educational contexts, as well.

Keywords: Artificial Intelligence · Best-of-Breed · Learning Analytics · Didactic · Interoperability · Middleware · Best Practice

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1 Introduction

Artificial Intelligence (AI) not only shows tremendous potential in general but also in particular for increasing efficiency and effectiveness in learning environments [1]. The technological progress in the last few decades enabled the use of AI methods in a broad range of use cases from automatic signal processing to personalized recommendation systems. This progress also resulted in steadily improving accuracy and speed. The following text created by ChatGPT exemplifies the performance of modern AI-based systems, for it succeeds in describing the purposes of AI in educational settings:

"There are many ways that artificial intelligence (AI) can be used in educational environments to enhance teaching and learning. some examples include:

- *Personalized learning: AI can be used to create personalized learning experiences for students by adapting to their individual needs and abilities.*
- *Tutoring and feedback: AI can be used to provide one-on-one tutoring and feedback to students in real-time, helping them to better understand concepts and improve their skills.*
- *Content creation: AI can be used to create customized learning materials and resources for students, such as personalized study plans and interactive educational games.*
- *Grading and assessment: AI can be used to grade assignments and assess student performance, freeing up teachers to focus on other tasks.*
- *Student support: AI can be used to provide support to students outside of class, such as answering questions and providing guidance on assignments.*
- *Overall, AI has the potential to greatly enhance the education experience by providing personalized and interactive learning opportunities for students."*[1]

Reviews like the one from Guan et al. [2] identify similar themes in the scientific community. They examined over 400 articles in major educational journals from 2000 to 2019. Notable trends they found are learning analytics and user modeling for individual adaptive learning and aided teaching systems for grading and evaluation [2].

Conclusions and decisions can be made automatically by an AI, e.g., in recommender systems or in adaptive educational systems by generation of learning paths or dynamic difficulty adjustments of exercise difficulty levels [1]. Alternatively, the learners and teachers themselves interpret the results, typically by looking at pre-processed data visualizations in dashboards [3]. These visualizations can provide an overview by displaying relevant data as the average completion time per task and even indicate learning progress, weaknesses or learning needs. Additionally, AI approaches such as chatbots (recently the topic ChatGPT received a very high attention) used as virtual learning assistants may also lead to increased user satisfaction and, thus, promote higher user motivation and better learning outcomes.

Generally, AI systems are complex and research intensive, hence the integration and re-use of existing components is preferred over new developments. However, the integration in existing system environments poses organizational and technical challenges,

[1] This text was generated automatically by the AI-based Chatbot "ChatGPT" on the question "How can Artificial Intelligence be used in educational environments?"; https://chat.openai.com/chat (on January 5, 2023; ChatGPT Dec 15 Version. Free Research Preview).

for instance varying and changing public technical interfaces. The research question of this work is how AI features can best be incorporated into modern educational system landscapes to create sustainable system architectures that are accepted and perceived as added value by users.

The contribution of this work is a model for a middleware-based, AI-integrating software architecture and its application and evaluation in a public field test. The model has evolved over time from integrating various standard software in heterogeneous system landscapes. It formulates a so-called Best-of-Breed approach which describes the combination of well-tested, high-quality (AI) systems in a standardized manner for effective use in applications.

This article is organized as follows. Section 2 describes some of the most important data categories in educational systems and which are also central to our approach and to AI-based systems. Section 3 discusses the theoretical foundations for AI-supported educational systems, and we address requirements on organizational, methodological, didactical, content-related, and technical levels. Section 4 introduces the methodology and Sect. 5 pleads for the Best-of-Breed strategy instead of Best-of-Suite. Section 6 describes a modular, service-oriented environment based on an educational middleware that orchestrates external AI services.

2 Foundations on Data in Educational Ecosystems

Data is the foundation that every AI-supported functionality relies on. Without loss of generality, data used by educational institutions can typically be divided into identity and profile data, activity data, institution data, content metadata, communication data, and application-specific data. These categories are explained in the following.

2.1 Identity and Profile Data

Users authenticate themselves as principals by means of their identity information stored within identity provider systems. Single sign-on describes a mechanism in which users must authenticate themselves only once for multiple software platforms. Irrespective of the authentication mechanism, personal data is usually collected and managed for an identity, e.g., name, birthday and place, address or contact data. Dynamic data that make up the personal educational biography, such as educational stages already completed or knowledge, skills or competencies acquired, are usually stored in user profiles.

2.2 Activity Data

Traditionally, activity data is understood as learning behavior data but can also include self-assessments, defined learning goals, or answers in exams. Typical formats for such learning records are Experience API (xAPI) or CALIPER which have their origin in general activity streams (e.g., W3C Activity Stream). Since profile data also results significantly from the activities of the users within the education stations, the boundary to activity data is fluent. Processed activity data can be stored as learning information in the user profile (e.g., competency level).

2.3 Institutional Data

Data that is typically generated or primarily processed by an institution. This includes administrative data, such as enrollments in classes or courses or assignments to instructors, rights, and roles of individual users for access to certain content, e.g., via the W3C's Open Digital Rights Language (ODRL). Exam questions or certificates and evidence are also usually created by or on behalf of the educational institution and subsequently made available to learners. Applications, enrollments, or learner files are usually managed by the educational institutions but are created almost exclusively through the actions of the individuals involved.

2.4 Content Metadata

Content metadata describe learning objects, their characteristics, creation and editing history, technical requirements, rights, educational characteristics, and pedagogical information, e.g., in the IEEE LOM format. It is also important to indicate the relation to other content. For example, learning objects can be nested within each other, linked to further objects, or combined to form entire courses. These courses should also be well described to make them easily locatable. The content metadata should be created at the smallest possible level of knowledge transfer and assessment. This metadata is aggregated for the combinations of new learning objects or complete courses.

2.5 Application Specific Data and Preferences

Such data is platform- or application-specific and does not belong to one of the previous categories. Obviously, each application produces its own data, typically proprietary. Here we focus on interoperable data accessible to and processable by other platforms either via an API or via export functions. Examples for application-specific data are individual preferences such as options of the personal start page, the font sizes, theming, design of an avatar, etc. Further data can be communication data between users, i.e., social interactions or chatbot inputs.

3 Literature Review on Challenges and Requirements for AI-Supported Educational Systems

While designing any AI-supported educational ecosystem developers face interdisciplinary challenges that impact the success and acceptance of AI to a great degree [4]. These challenges occur irrespective of the AI-functionalities and must be addressed before implementation. In the following, we highlight some of these aspects, ranging from organizational challenges (e.g., roles or regulations), to methodological (e.g., evaluation), didactical (e.g., course design), technical (e.g., interoperability) or aspects regarding content (e.g., digitalization and metadata).

3.1 Organizational Aspects

The introduction of artificial intelligence in educational environments requires the involvement of different stakeholders [1]. Above all, the responsible organizations must ensure that the application of AI is in accordance with applicable laws (in the EU, e.g., GDPR, data processing contracts), all regulatory requirements are met (e.g., naming of responsible persons, such as data owners, anonymization) and that IT and data security concepts are state-of-the-art. In this context, Flanagan and Ogata [5] discussed the increasing need for data and privacy protection throughout the entire AI workflow. Renz and Meinel [6] addressed the requirement to use pseudonymization for the GDPR-compliant collection of xAPI learning records and argue for the use of an appropriate middleware. An organization must additionally ensure that the role holders have sufficient resources, even after the initial launch of AI [3]. And for the general AI acceptance it is important to train the instructors and raise awareness for any AI particularities beforehand [3].

3.2 Methodological Aspects

Most AI applications in learning environments aim at optimizing learning by making it more effective (e.g., goal-oriented recommendations, learning path adaptations) or more efficient (e.g., less redundant, less already-known content). In the context of learning recommender systems, for instance, *efficiency* describes the quality of a learning path to achieve a personal (learning) goal. In a small-scale course setting, higher efficiency can save efforts and time to reach the course goal. *Effectiveness* directly affects the results achieved, e.g., a better mark in the exam or longer lasting knowledge [7]. Thus, the purpose of an AI function is essential for design choices, development of an appropriate methodology and selecting an optimal evaluation framework [8]. The user's interface, its usability and the user experience (UX) are integral for an AI-supported system to ensure user acceptance of the system [9].

3.3 Didactical Aspects

When organizers know how humans accomplish a certain task, such as analyzing learning groups at the beginning of a course or recommending appropriate learning materials, they can then consider having an AI component take on that task. We strongly believe that following a didactical concept instead of blindly replacing all classroom sessions would not only improve the learners' and teachers' overall acceptance of a system, but also result in better learning outcomes. The AI-based analysis provides additional information for creating and improving didactical concepts. As many AI applications are aimed at automating didactic activities [10], e.g., selection of learning material, it is necessary to decide on a robust didactic concept as a foundation [11]. As such, the didactic concept should be evaluated as thoroughly as the analytics' functionalities themselves.

3.4 Content Aspects

When well-structured data on learning content and usage is available, learning analytics can offer additional, clearly visible value for many users. However, it is not enough to just describe the content. Learning analytics (LA) is digital and hence, content must be available in a digital and compelling format, ideally following an established standard. For interoperability purposes, we encourage the use of standards, such as IEEE Learning Object Metadata (LOM) or IMS Common Cartridge (CC) - ideally also IMS Content Packaging (CP) and IMS Question & Test Interoperability (QTI). The required metadata for AI functionalities depends on the respective application's purpose and overall didactic concept. From our experience, the implementation and maintenance of metadata standards for one's own content involves a great deal of effort, which, in the best-case scenario, is automated or already realized during the creation of individual content.

3.5 Technical Aspects

Finally, a successful implementation and integration of LA into corporate learning environments – especially in environments of multi-institutions with distributed services – requires the use of widely accepted interoperability standards [3]. To address typical technical challenges such as IT security and network limitations (e.g., CORS) while still adhering to given data-privacy and data-protection regulations, we identified and implemented multiple core technologies and protocols which adhere to established specifications. Notable standards include the learning record specifications xAPI and CALIPER, which can be persisted in distributed Learning Record Stores [12] or user-controlled Data Wallets [13], LTI (Learning Tools Interoperability) or cmi5 (computer managed instruction, 5th attempt) launch specifications, as well as standards for the exchange of content metadata, such as CC, LOM or Question and Test Interoperability specification (QTI). However, not every service in a complex educational ecosystem follows the same standard and many direct links between individual adaptive services are difficult to maintain. Therefore, a middleware architecture for service orchestration is often recommended [14]. This middleware can either be standards-agnostic and allow communicating services to agree on a particular form of communication, or act as a standards-translator, e.g., between LTI and cmi5 [15]. A specific challenge arises, however, when decentralized storage or replication of learning record data becomes necessary. We observed a standard corporate requirement: multiple as well as decentralized Learning Record Store (LRS) instances. Each subsidiary can have its own data handling constraints, resulting in the need for individual stores. This motivates LRS replication strategies, control of the data flow, and operating dashboards under customer sovereignty.

4 Methodology for Developing an Interoperable AI-Supported Educational Infrastructure

This article focuses on the development of an AI-supported educational infrastructure in the context of the interdisciplinary research project TripleAdapt[2], funded by the German Federal Ministry of Education and Research (BMBF) as part of the INVITE program. TripleAdapt develops cross-platform digital learning opportunities by interconnecting learning platforms from different institutions as well as AI-supported teaching and learning options.

[2] TripleAdapt Project: Sponsored by BMBF; Funding Number 21INVI1306; Duration: May 2021 to April 2024; See: https://www.fokus.fraunhofer.de/en/fame/projects/tripleadapt.

TripleAdapt uses the concept of an adaptive triplet to expand the digital learning environment in such a way that employees can be supported in real challenges in their work processes. The learning concepts emerge from the analysis and modeling of process data based on developed competence profiles, which are anonymously matched with actual competence profiles. In this way, actual learning needs can be identified, which transparent and comprehensible systems recommend differentiated learning content. The result of the implementation should be a perceptible increase in learning success, considering various aspects such as workload in variant-rich production.

The project focuses on a total of nine use cases in the three categories: Networking platforms, platform-related innovations, and AI-supported teaching/learning offerings. The networking use case on cybersecurity, for example, envisions public testing of a networked online educational landscape on IT security with a focus on cryptography and hacking. For example, a portal shall serve as a central entry point for retrieving digital media from an ILIAS LMS, from a company's proprietary learning management system, and from learning platform for further professional training. The difficulty levels of the offered exercises shall adapt to the users and micro certificates shall be issued at the end via blockchain-based technology.

To combine these independent functions into a common offering without interruption for the users, a suitable infrastructure solution must be designed that also makes it simple to add further functions. For this purpose, possible monolithic and service-oriented solution approaches and interoperability standards have been analyzed. The most suitable approach in the authors' view, a middleware-based solution, was deployed and tested in a large-scale field test. In a first field trial, users were asked to evaluate their experience in using the services after attending a cybersecurity course whose content and AI functions were distributed across different platforms.

5 Considerations for a Sustainable System Architecture

Monolithic systems offer a wide range of functions and can be managed by a single provider. They are relatively easy to use and can offer a high-quality experience for users in small systems. However, they can become difficult to manage as they become more complex and need to be integrated interconnected with other services. They also create dependencies and can be less flexible and futureproof compared to specialized and service-oriented systems. Specialized and service-oriented systems, on the other hand, consist of modular functions handled by specialized services. They are more flexible and scalable and can be integrated with a wide range of tools and services. However, they require more effort to set up and manage, and may not offer the same level of user experience as monolithic systems. This section discusses monolithic systems and service-oriented architectures (SOA), classified as Best-of-Suite (for monolithic) and Best-of-Breed (for SOA).

5.1 Monolithic Systems – Best-of-Suite

Learning Management Systems (LMSs) such as Moodle have become very popular and thus widespread in recent years[3]. Over time, numerous professional communities have been involved in expanding these systems for various use cases and functions. In addition to these open-source communities, there are also various, mostly closed-source LMS solutions that address the needs of paying users as comprehensively as possible.

Best-of-Suite (BoS) describes systems consisting of functionality and infrastructure from one source or provider. The biggest advantage and at the same time the biggest disadvantage of the BoS approach is that the developer or software architect is responsible for all parts of the system. In systems with a small scope, this promotes well-coordinated, high-quality services and great experience for the users. However, the more extensive the functions become, and the more existing services need to be integrated, the more difficult it becomes for a single institution to manage the various aspects. Whether intended or not, complex systems also cause dependencies (to 3rd party plugins as well as to the rights holder) to increase over time, often creating so-called lock-in effects. These effects are particularly apparent, for example, when individual modules of an overall system must be accessed separately so they can be reused in other independent systems. Vice versa, it can be a big challenge to integrate data, identities, or content from external sources into the existing system. In these cases, the developer must add functions and data flows to extend software modules of the monolithic LMS with often only limited software documentation available. Especially when numerous existing systems (i.e., identity providers, authoring tools, or already established processes) must be integrated or connected to the LMS, the effort needed to build necessary interfaces and to translate between various, often proprietary, data and exchange formats quickly becomes unmanageable, especially for larger institutions with growing user-bases and expanding course-portfolios. On top of that, monolithic systems tend to be less futureproof compared to their alternatives. While they might satisfy immediate needs and pain points, relying on monolithic systems often leads to incompatibilities or other problems in the future. In most of these cases, this means considerable effort for the developer to implement workarounds or to reimplement specific modules, in the worst case this could even mean a replacement of the entire system.

5.2 Specialized and Service-Oriented Systems – Best-of-Breed

Complex interconnected artificial intelligence systems are likely to exceed the maintenance capabilities of one organization. Relying on a one-fits-all solution would not be sustainable, since the number of additional functions and modifications would make it very difficult to maintain and expand monolithic systems. For this reason, service-oriented architectures (SOA) increase in popularity. A key aspect of SOA is that each modular function is handled by a specialized service. In this architecture approach, services can also either be integrated as flexible Software-as-a-Service (SaaS) solutions (e.g., cloud-based), or hosted entirely or in part on premise, usually when deeper integration with existing services and architectures is needed. This results in a shift towards

[3] See: European LMS Market Report: https://eliterate.us/new-release-european-lms-market-report/.

a Best-of-Breed (BoB) approach which describes the strategy to utilize the best possible component to take care of a specific problem. Compared to monolithic systems, SOAs tend to be more complex during the initial setup phase. However, the modular nature of the SOA approach allows several developer teams from different organizations to work on different parts of the overall system in parallel. The entire system, as well as parts of it, can be better operated and maintained, or quickly replaced if necessary. This leads to parallelizable, scalable systems. However, for the corresponding services to offer users transitions that are as seamless and imperceptible as possible (e.g., users want to open the next appropriate content, the video conference, or the associated forum with just one click), the services must exchange information efficiently. To achieve this, all services involved must agree on a common understanding of the exchange mechanisms, data formats and semantics. For this reason, it is highly advisable to use established interoperability standards when opting for the SOA approach.

5.3 Interoperability Standards

BoB architectures and their services need to have compatible interfaces and protocols to communicate with each other. Several specialized standards and specifications from different initiatives and consortia exist for this purpose. Global initiatives that push the creation of new interoperability standards are prevalent in the learning community. Internationally established are the initiatives ADL (Advanced Distributed Learning; e.g., SCORM or xAPI) or the 1EdTech Consortium (formerly "IMS Global Learning Consortium"; e.g., LTI, Common Cartridge or LOM). Many learning platforms support formats from those initiatives.

ADL's Sharable Content Object Reference Model (SCORM) was for a long time the most suitable and thus most widely used format for managing, linking and representing learning content. The monolithic character of SCORM has proven to be too inflexible for modern service-oriented educational technologies. The following strategies have been considered more promising for building sustainable educational ecosystems:

- Standardized content launch approaches to enable uniform access to learning materials and services: 1EdTech Learning Tools Interoperability (LTI), ADL cmi5 (Computer Managed Instruction, 5th attempt; part of the ADL xAPI specification).
- Well-structured definitions of learning records: ADL xAPI, 1EdTech CALIPER.
- Persistence of well-structured metadata: Common Cartridge, Content Packaging, and QTI from 1EdTech and IEEE LOM.

There is usually not only one de facto standard for each application area, but several alternatives (e.g., xAPI and CALIPER, or LTI and cmi5). A dossier by Reichow et al. [16] provides a good overview of the most important standards and recommendations for implementing digital professional development platforms. While it is focused on the field of vocational training, it also shows great applicability beyond this. In 2021, the authors of this article analyzed the 53 most popular LMSs and found wide disparities in support for certain interoperability standards. While 72% of the LMSs supported the outdated SCORM, only 64% supported a current launch mechanism such as LTI (62%) or cmi5 (13%). Nevertheless, a development towards current interface standards can be observed. Thus, it can be assumed that hardly any LMS is currently working on

SCORM support, but many have planned support for cmi5 which was first released in 2016. Cmi5 is based on the xAPI specification which is already supported by 58% of LMS and enables consumer-side control of collecting user interactions vs. provider-side control in LTI by requiring the LRS endpoint to be passed in the launch URL. It is also interesting to note that only 25% of the LMSs surveyed were made available under a common open-source license and only 30% can be used without license fees.

6 Implementation of AI Use Cases

We have developed the Common Learning Middleware (CLM) [15] and successfully applied it in various contexts[4]. In 2021, the CLM was selected by the German Federal Ministry of Education and Research as one of three prototypes of the German National Education Platform within the framework of the "mEDUator" project[5] to demonstrate the successful concept of an interoperable middleware for connecting distributed education ecosystems. In the "EXPAND+ER WB^3" project[6] the middleware is used to interconnect the learning platforms of education providers with a superordinate continuing education search platform without making them directly dependent on each other. Moreover, the CLM was used in an investigation of the prototypical use of artificial intelligence techniques (learning recommendations, chatbots, adaptive assignments, learning analytics dashboards for educators) using the example of course-based individual training in the German Army[7]. Here we outline a use case for distributed adaptive training on cybersecurity in context of the TripleAdapt project. In the following, we describe the way in which the most important distributed components interact and their typical data flows, followed by some evaluation results from public user tests.

6.1 Middleware-Based Approach

Following the reasoning given above, we developed the orchestrating, standard-enabling Common Learning Middleware that promotes the BoB strategy as well as the usage of standard-compliant interfaces and data sources. The users (learners) are placed in the center, and all the services and data flows are designed for and built around them. They can access content and services from different providers without interruption, and their data (e.g., tracking data, tokens) is handled by the middleware approach in the background. As a service, the middleware provides interfaces for decentralized connections of different platforms, i.e., coupling and orchestration. Providers of learning content can register their systems – and hence their learning material – with the help of the middleware, i.e., regarding LTI as a tool or service provider (Fig. 1).

[4] See: Fraunhofer Common Learning Middleware: https://www.fokus.fraunhofer.de/en/fame/clm/.

[5] mEDUator Project (Sponsored by BMBF; Funding Number: 16INB3006): https://www.fokus.fraunhofer.de/en/fame/project/meduator/.

[6] EXPAND+ER WB3 (Sponsored by BMBF; Funding Number: 21INVI31): https://www.fokus.fraunhofer.de/en/project/fame/expander_2021-12.

[7] AI in Learning Management Systems (German): https://kilms.fraunhofer.de/ki-funktionen/.

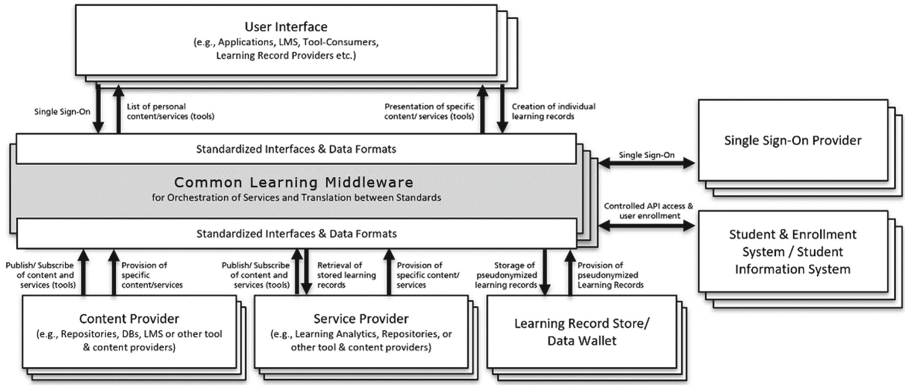

Fig. 1. Architecture of the AI-enabling Interoperable Infrastructure

A repository acts as a digital asset store that essentially contains course structures, learning objects and their metadata (e.g., as IEEE LOM, 1EdTech QTI, CC or CP). Learning objects, i.e., learning content, media and services, can be integrated into platforms and applications of the end users. Specifications such as cmi5 or LTI can be used to interconnect learning objects. It is a secure launch of learning objects and reflects the trust relationship between a client, also called tool consumer, platform or application for end users, and a service, also known as tool or tool provider. A retrievable learning object may contain either pre-rendered HTML elements or content metadata based on specifications such as LOM (also considering CP or QTI) which must then be appropriately rendered by the application. In the case of a launch request, the request data is signed with the user's information (as with LTI) or based on the user's token (as with cmi5) and transmitted to the content provider.

The middleware checks the user data, the associated role and access rights for each interface request. In the case of a launch request (i.e., the request for the application to present a launchable object to the user), the request data is signed using the user information (LTI) or based on the user's token (cmi5) and transmitted to the launchable object via the service provider. The middleware also makes it possible to translate between different launch mechanisms, such as LTI v1.1, LTI v1.3, LTI Advantage, and cmi5. This means that providers can, for example, make cmi5 objects available in their applications by utilizing LTI (or vice versa).

The learning records can be recorded in the application or in the respective learning objects. To enable the tracking in a launchable object, the application is required to supply the user information to this object - this is transmitted with the two "launch" mechanisms. For the capturing of learning records, xAPI and CALIPER are supported. These learning records can be persisted in LRSs, where educational institutions can register their own LRS with the middleware. Institutions can configure which users send which type of learning records to which LRS when interacting with which tools. The middleware orchestrates and ensures the trustworthy interaction between learning record providers (which produce new learning records from the interaction), learning record stores (as databases for managing pseudonymized interaction data) and learning record consumers (which process stored learning records e.g., AI services). The middleware manages the permissions of services and their access to the learning record stores. However, it is also possible that users hold their personal in a local data wallet. From the perspective of the middleware, storing data locally at the user's site, for example, makes no conceptual difference, since the accessing services handles the required access information independent of the endpoint providing the data. In scenarios where the tools themselves are not (yet) able to generate xAPI statements, but support the LTI Assignment and Grade Services, the middleware can be actively used to translate these learning state callbacks send to the middleware into a minimal set of activity data reported to the according LRS.

All interfaces of the middleware are RESTful APIs[8] which follow the paradigm for software architectures of distributed systems. The interfaces have been specified according to the OpenAPI specification. Relevant interfaces, such as the provision of LTI-based tools as tool providers, have been implemented with validating functions. The middleware checks new learning objects according to their specification when being integrated into the middleware.

6.2 Integration of AI Services

AI services process different data with the aim of analyzing, evaluating, and reacting to it. Examples for usable data are learning records, learning content descriptions (for example as LOM, QTI or CC), learning objectives, learning progress, competencies, skills & qualifications. Just like repositories, AI services are connected to the middleware in the form of encapsulated services and can present their results directly in the applications via the presented launch mechanisms.

In the case of AI components, it should be noted that in addition to personal learning records, anonymized learning records of other, similar participants often need to be evaluated - for example, to identify and transfer successful learning behavior (collaborative filtering in recommender systems). Learning path generators and learning analytics services also require this advanced data evaluation. Accordingly, concepts for handling, releasing, and disclosing other users' data (for example, user-adjustable or always anonymized after release) must also be considered when designing user-sovereign data stores.

Search engines can also be easily integrated into the applications. For the findability of content for the search service, the learning objects registered in the middleware are accessed, called up individually and indexed for the search index like the work process of popular search engines. To ensure that users only receive results for content that they can access, the access rights stored in the administrative data are compared and all restricted content is removed from the results lists.

One AI component frequently used in our ecosystem provides dynamic difficulty adjustments (DDA, also called Rubber Banding). The DDA AI has been integrated into an educational game for gamified training and it controls the game's difficulty setting, e.g., number and semantic complexity of answer options or available time budget. The

[8] RESTful API: Representational State Transfer Application Programming Interface.

AI functionality has been implemented using an AI adaptivity framework which provides adaptivity responses as a service (adaptivity-as-a-service). Information primarily from xAPI observation data is made available through the middleware when calculating target difficulty levels. This specifically includes the measured performance value, i.e., how well an individual user performed on a task. The target value for the control loop is implicitly assumed to be one hundred percent which means that the aim is to continuously improve the users' performance. DDA is calculated based on the performance trend using a harmonic sum. The AI adaptivity framework is designed using established interoperability standards and generalized models, hence it is easily applicable to other assistance systems. The gamified trainings component was also used in the context of the public field trial.

7 Findings of the Public Field Test

In the TripleAdapt Project, a public field test was carried out in December 2022. In the field test, we presented an adaptive training course on cybersecurity that unites different learning platforms and learning technologies into a common infrastructure with the help of the proposed middleware architecture approach. Participation in the test was free of charge and open to all interested parties. Registered users received a personal certificate of participation upon request after the test. During the test 186 visitors were observed, 650 accesses took place, and 48 people took part in a subsequent formal survey. Most of the survey participants fall in the age category of 30–39 and worked in the education industry.

The adaptive training on cybersecurity offered participants a choice of four different learning paths: beginner with plenty of time, beginner with limited time, expert with plenty of time and expert with limited time. The AI is part of the interconnected, middleware-based architecture, and the respective services offered adaptive learning paths as well as recommendations.

The subsequent survey included questions about the participants' experience with the different learning platforms and tools, the ease of switching between them, their satisfaction with the navigation and the layout of the combined platforms, suggestions for improvement, and their demographic information. While many participants (31 out of 48) noticed that they were using multiple platforms during their learning path, most participants (44 out of 48) felt that they were able to navigate all offerings well and that they were able to handle visual changes in the layout of the platforms. 17 out of 48 participants even found it to be a very pleasant experience.

The responses to the question "What did you like about the learning path and content?" are generally positive, with many participants noting that they appreciated the variety of tasks and media used to present the content. They liked the design of the platform and the way the information was organized in an orderly manner, which made it easy to navigate. They also enjoyed interactive components like a crypto-quiz and an interactive hacking lab. Some participants commented that they liked the multimedia offerings of text, videos, and quizzes. They also liked the way the platform adjusted to their progress and the fact that the content is up to date and relevant. Some people found the course basic and repetitive, but overall, the positive feedback was consistent.

We asked participants what they would improve in the interaction of the learning platforms. From the responses provided, it appears that users have several suggestions for improving the way that the different learning platforms interact with one another. Some common themes that appear include:

- Navigation and user feedback: Five users would like to see more information provided in the navigation sidebar, such as which learning content they have already viewed or completed. Additionally, two users found the branding or menu bars of certain platforms to be distracting.
- Consistency between platforms: Eight users found it difficult to switch between platforms and suggested that more information about the type of content (e.g., videos, learning modules) or a more consistent layout would help with this.
- Loading times: Seven users noted that the loading times for certain elements or platforms were slow and suggested that this could be improved.
- Login issues: Two users reported issues with logging into certain platforms and suggested solutions such as automatic retries or warning messages.
- Quiz formatting: Five users suggested that the quiz could be better integrated into the overall layout of the platform.
- Consistent design: Four users suggested that a more consistent design across platforms would be beneficial to the overall user experience.
- Navigation to next point: Six users suggest having better navigation structure after completion of a course or a chapter.

In general, it seems that users are seeking a more seamless and consistent experience across the different learning platforms, with clearer navigation and faster loading times. They also want better integration between different platforms and more consistency in design and layout.

In conclusion, the field test proofs the technical feasibility of such a middleware-based architecture and highlights the importance of user experience and ease of navigation when integrating multiple learning platforms. The feedback provided by the participants in terms of their experience with the different learning platforms and tools, and their suggestions for improvement, can help guide future developments in the TripleAdapt project and similar endeavors.

8 Discussion on the Challenges of Developing Educational Infrastructures

Challenges for the development of sustainable AI-supported educational infrastructures are diverse: On the one hand, the interests of the users should always be in the foreground and efforts should be made to adapt the technical systems to their needs as efficiently and effectively as possible. On the other hand, there are also many challenges on the side of the content providers and course leaders. These usually concern the sustainable use, accessibility, and reuse of content, which is increasingly taking place across institutions.

Due to market fragmentation and the diversity of data, technologies, and interoperability standards, it seems almost impossible to combine different learning repositories and advanced technologies directly into a central learning experience. Equal access to educational services, on the other hand, is essential and must be ensured by considering national and international initiatives.

However, educational ecosystems usually need to process diverse categories of data, which have different characteristics - for example, in terms of the frequency with which new data is generated and the possibility of subsequent changes: Certificates are created once and usually not changed, competencies, on the other hand, change regularly, and activity data/learning records are regenerated very frequently. The corresponding characteristics have a direct impact on the suitability of certain solution and architecture approaches - for example, using centralized or decentralized data structures, data vaults or data wallets, and so on.

The proposed CLM represents a middleware-based solution for orchestrating data flows in service-oriented educational architectures. It translates between different interoperability standards and thus serves the sustainable networking of services. A middleware is not directly perceptible to end users but performs many essential tasks of modern educational ecosystems in the background. It eliminates the need to manually switch between different apps and websites: All content and functions can be presented in one place - for example, via a central access point of the provider. Searching for the specific login credentials for a particular service becomes unnecessary: The same global identities can be used for all services connected to the middleware. And end users benefit from full protection and control of their personal information: Data is processed throughout the ecosystem in a privacy-compliant manner, and users can determine for themselves which services they grant access to their data.

For the providers, the middleware-based solution is accordingly not to be understood as another separate ecosystem, but rather as an additional enabler and multiplier for reaching new customers and realizing new educational journeys. A key requirement here is that the connection of existing systems can be realized without major technical and organizational hurdles, i.e., with little effort. Providers who also rely on the single sign-on offered or the concept of user-sovereign data management will benefit from more secure and satisfied end customers in the future. In this way, the middleware contributes to an established, sustainable, and self-sustaining platform economy to offer both users and providers long-term added value.

Especially in the field of education, it is important to point out that a well-thought-out didactic concept is required for cross-platform data processing, as well as a strongly independent use of technology [17]. In the future, computer systems will not take over human learning, nor should learners blindly trust every feedback from an assistance service - even if this can already be very precise nowadays. An undifferentiated acceptance by users of AI-driven decision systems can be problematic. The computer system would also be to blame if, for example, learners fail their exams because they rely unquestioningly on the recommendations of the AI-driven learning platforms.

Well-networked learning technologies cannot and will not replace teachers but should rather be understood as supporting regular processes that lead to an increase in efficiency and effectiveness in the learning process. Modern, networked architectures in educational ecosystems help to shift the focus away from the technology to the learners, which on the one hand promotes self-activating and self-determined learning and on the other hand can better support the independent organization of the learning process according to individual inclinations and interests.

9 Conclusion

This article discusses two approaches to designing educational technology systems: monolithic systems ("Best-of-Suite") as well as specialized and service-oriented systems ("Best-of-Breed"). The research question of this work is how AI features can best be incorporated into modern educational system landscapes to create sustainable system architectures. The contribution of this work is the model for a middleware-based, AI-integrating software architecture and its application and evaluation in a public field test. The model has evolved over time from integrating various standard software in heterogeneous system landscapes. It formulates a so-called Best-of-Breed approach which describes the combination of well-tested, high-quality (AI) systems in a standardized manner for effective use in applications. We describe how to create a technically seamless learning experience for the users, an interoperable and flexible educational infrastructure, and how to incorporate widely used standards and specifications. These approaches have been applied in various contexts, including professional training and public education. The middleware-based approach involves the use of standard-compliant interfaces and data stores to facilitate the exchange of data between different platforms. Thereby, learning object repositories as well as AI services register their functions to the middleware, which, in turn, can be integrated into platforms and applications using specifications such as xAPI, cmi5 or LTI. An important result of the field test is the need for a uniform appearance of the various platforms and service offerings, which will be considered in future work through the use of common style sheets.

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Distance Learning Technology Acceptance, a Case of Ph.D. Students' Experiences Post COVID-19

Nour Mattour[1,2](✉) and Souad Kamoun-Chouk[3]

[1] Faculty of Law and Public Administration, Birzeit University, Birzeit, Palestine
nmattour@birzeit.edu
[2] ECCOFIGES, University of Manouba, Campus Universitaire Manouba, Manouba, Tunisia
[3] ESCT, LIGUE, University of Manouba, Campus Universitaire Manouba, 2010 Manouba, Tunisia
souad.chouk@esct.rnu.tn

Abstract. This study aims to examine the challenges faced by higher education students in distance learning using remote communication technologies and how they could affect the quality of education. In addition to examining the challenges, higher education students face when dealing with technology acceptance. The purpose of this analysis is to emphasize the importance of technology acceptance as a necessary fact in gaining knowledge during experiences of distance learning and the use of remote communication technologies. The main objective of this study is to identify, from students' remote focus group experiences, elements that could highlight the actual situation of technology acceptance among future Ph.D. students and the skills that are thought to be necessary to reinforce the quality of distance learning processes.

Keywords: Distance learning in high education · remote communication · social distancing · Technology acceptance · Digital literacy

1 Introduction

In the spring of 2020, the concept of e-learning continued developing till this day, especially after the traditional classroom-based setting has been facing a shock when the COVID-19 pandemic took place (Li 2022). Consequently, high education institutions were forced to consider the use of distance and online communication platforms just to make sure students were able to continue their education while in quarantine (Ali 2020).

University students everywhere are becoming more diverse and more demanding of distant learning-based courses (Volery and Lord 2000), plus distant learning initiatives are persuasive in higher education. High-education learners who are engaged in different Ph.D. programs worldwide and are dispersed geographically, require flexibility in their access to courses, resources, flexibility in their course schedules, and learning methods.

The development of learning and communication technologies has radically reshaped teaching and learning methods in higher education (Khan et al. 2012). Technologies

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for learning are more serious today than ever before since their growing power and capabilities are causing a change in the learning environments available for education (Al-Senaidi et al. 2009). However, acquiring digital competence is also considered a challenge to distance learning to guarantee the quality of education.

Our question: How is the quality of distance learning education affected by the perceptions of Ph.D. students in the School of Commerce/University of Manouba in Tunisia while using remote communication techniques? We are looking at whether negative perceptions of distance learning among Ph.D. students might affect the quality of education.

The paper is structured in four parts. First, the conceptual framework of distance learning in higher education. Secondly, the research methodology is specified and the themes to be used in the investigation are discussed. In the third part, the results of the study are presented and discussed. The paper concludes with a summary of the findings and considers some implications for high education institutions.

2 Conceptual Framework

2.1 Distance Learning in High Education

The Britannica encyclopedia defines distance learning also called distance education, e-learning, and online learning, which is a form of education in which the main features include the physical separation of teachers and students during teaching and the use of various technologies to enable student-teacher and student-student communication (Berg and Simonson 2023). e-learning in higher education has been growing since the inception of the first web-based courses in the mid to late 1990s (Sarkar 2020). The increasing significance of distance learning brought the potential to access non-location bounded and time-independent instructions (Williams and Shea 2003). It also promotes flexibility at any time regardless of context and availability to learners and educators at any time regardless of the time of content, distance learning led to many higher education institutions implementing courses on the Internet that has provided an opportunity to meet the demands for education has been expanded to worldwide (Canaran and Mirici 2020).

In distance learning environments for higher education, students typically participate in synchronous lectures and asynchronous exercises (Fabriz et al. 2021). In a synchronous course, learners are engaged in interactive and focused opportunities which are for helping learners build a basic understanding of technology-enhanced instruction, the use of technology in courses, and effective online design. On the other hand, asynchronous activities and tasks include activities such as quizzes, group work assignments, group discussions, feedback, and homework (Malik et al. 2017). Some higher education institutions provide distance and e-learning services centrally or they could benefit from buying tools or services provided by educational software programs that have been recently developed, especially after the COVID-19 pandemic (Rawashdeh et al. 2021).

2.1.1 Overcoming Barriers to Distance Learning

As the world shifted to e-learning due to the pandemic, it was clear that many countries were not prepared for the change. The lack of adequate technological and practical basics created many problems for all involved (Zarei and Mohammadi 2021). Distance learning can be difficult, especially for those who lack self-discipline or motivation. It can be difficult for teachers to help struggling students without being able to meet with them in person. To address these issues, many high education institutions have implemented virtual study groups, online discussion boards, and other tools to help keep students engaged and motivated (OECD 2020). Additionally, teachers are providing additional resources and using new methods to help ensure that students are getting the knowledge they seek. With these tools and resources in place, students can still get a quality education and achieve success with distance learning (OECD 2020). Using Bloom's Taxonomy in flipped classroom pedagogy is one of the increasingly popular methods in e-learning in which students participate in online activities outside the classroom. This style of learning emphasizes the student's engagement and active participation, allowing them to interact with the material in a more meaningful way (Talbert 2017). With flipped classroom learning, students watch lectures, take quizzes, and complete assignments online before coming to class, allowing for more in-depth, interactive discussions and activities while in the classroom (James et al. 2014). Flipped classroom learning has been found to increase student engagement and academic performance, as the students are more actively involved in the material they are learning (Chouk 2019).

2.2 Remote Communication Technologies

The law insider defined remote communication as communication implemented through the use of electronic programs, video conferences, the internet, or such other ways by which persons not physically present in the same location may communicate with each other on a significantly simultaneous basis. Remote communication technologies are seen as important tools to support new methods of teaching and learning. It should be used to develop students' skills for communication, problem-solving, and lifelong learning (Afshari et al. 2009). During the late pandemic and since emergency decisions offered no time to devise a properly designed techno-tool, universities opted for already existing software that was tested by trial and error. Professors and students had no option but to take it or leave it; soon after, this turned into liking it or not.

2.3 Social Distancing

In the spring of 2020, at the outbreak of the COVID-19 pandemic, most countries started introducing new education technologies (Sava 2022). The decision to temporarily close Higher education institutions was prompted by the principle that large gatherings of people constitute a serious risk to the protection of public health during a pandemic. HEIs were forced to close their doors in situations where some form of isolation or quarantine has been legislated (UNESCO IESALC 2020).

2.4 Technology Acceptance

According to Davis (1989), the TA model has continually been adapted and has been one of the most influential methods of technology acceptance, there are two major factors affecting an individual's intention towards the use of new technology: perceived ease of use and perceived usefulness. The student's attitude towards using the actual usage of technology is also addressed in TAM, Therefore, the student's behavior is the function of both attitudes and beliefs (Almulla 2021) (Fig. 1).

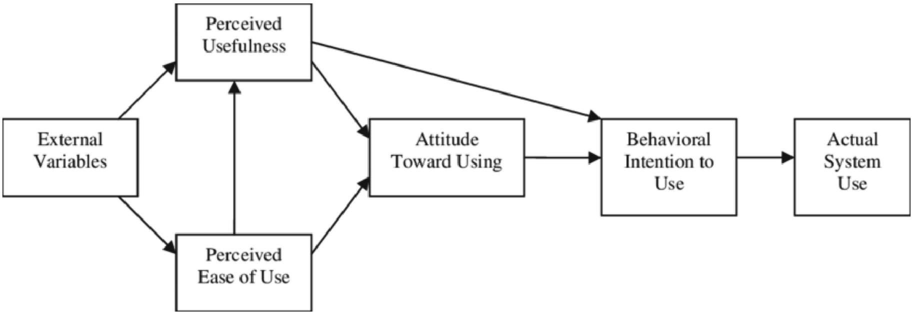

Fig. 1. Illustration of the Technology Acceptance Model (TAM), (Davis 1989)

2.5 Digital Literacy

The term "digital literacy" has become popular in 1997 after being highlighted by Paul Gilster (Kamoun-Chouk 2019). "Digital literacy" is currently used to label our commitment to the use of digital technologies as they facilitate most of our interactions (Lankshear and Knobel 2015). It also entails possessing the skills essential for using technology in teaching-learning processes, reaching, producing, and sharing information (Hamutoglu et al. 2019). Digital literacy involves the ability to use software or operate a digital device; and contains a large variety of complex mental, motor, sociological, and emotional skills, which users need to function effectively in digital environments (Eshet-Alkalai 2004). Digital literacy is becoming more important in the 21st century as students nowadays need the skills to access information in digital environments, administer information, explanation, and representation of information, and the transmission of information (Gutiérrez-Ángel et al. 2022). Successful digital learners have a high level of self-motivation and empowerment, and a desire for active approaches to learning and they exercise the ability to learn how to learn. Maintaining and learning new technical skills also benefits learners in the digital age and an attitude of exploration and play will help learners stay engaged and energized in a world where the speed of change and volume of information could otherwise become tremendous (Dede 2014).

3 Methodology

In this study, we adopt an interpretative epistemological stance. We have adopted a descriptive qualitative design guided by a phenomenological approach, as this approach is analogous to the aim of this study, which was to describe in-depth the participants' lived experience in using the distance education approach. It is also used when we want to answer questions about meaning and perspective, mostly from the standpoint of the participants.

3.1 Participants

The participants in our remote focus group included 17 Ph.D. students originally from five different countries, i.e. Palestine, Jordan, Tunisia, Iraq, and Yemen, between the ages of 37–52 both males and females. The participants enrolled in an online education course entitled (research methods) offered by the Ph.D. School of commerce/University of Manouba (Tables 1 and 2).

Table 1. The distribution of the participants according to the place of residence

Variable place of residence	Number	Percentage %
Tunisia	1	5.9%
Iraq	11	64.7%
Palestine	3	17.6%
Yemen	1	5.9%
Jordan	1	5.9%
Total	17	100.0

Table 2. Distribution of the doctorates by gender variable

Gender variant	Number	Percentage %
Male	15	88.2%
Female	2	11.8%
Total	17	100%

3.2 Ethical Considerations

All issues related to ethical considerations were considered students were informed about my role as a facilitator in addition to being a student during classes. The researchers gained written and verbal consent from all participants that meetings were going to be recorded at the beginning of each virtual class. All recorded meetings could only be accessed through both researchers.

4 Data Collection

4.1 The Remote Focus Group Technique

A focus group can be defined as a “type of group discussion about a topic under the guidance of a trained group moderator (Stewart 2018). While the remote focus group is a technique that has its origins in an approach to group interviewing described by

Merton et al. (1956). Since then, it has been increasingly used in qualitative research and evaluation (Morgan 2021).

In this study, we created two focus groups, one remote focus group where students were gathered through chat and the researcher played the researcher observer role.

The other remote focus group was gathered through the use of the communication and videoconferencing tool where I was playing the role of the facilitator. It was an audio-based asynchronous focus group where participants participated via a popular video conferencing and communications platform.

The online "research methods" course lasted for a month (four classes every Friday of every week) during October 2022. Each virtual class lasted for four hours and was fully recorded via video conferencing and communications platform recordings after the researchers were provided with the full consent of all participants before class.

Participants were engaged in a flipped classroom teaching pedagogy. This pedagogical approach opened space for the participants to experience a dynamic, interactive learning environment where the Professor guided the Ph.D. students to apply concepts and engage creatively in the subject discussed (Chouk 2019) (Table 3).

Table 3. Going through Bloom's Taxonomy in flipped learning, we broke it into thirds as follows

Pre-virtual class work in flipped learning focuses on the bottom 1/3 of Bloom's taxonomy (remembering and understanding)	In our case, Ph.D. students were provided with readings and learning materials (online articles, YouTube videos, and PowerPoint presentations) via an online learning platform. Students had to read, research, and learn on their own prior to each virtual class
In-virtual class work: (applying and analyzing)	Ph.D. students were asked to give opinions and participate via chat and the use of virtual raise hand to ask or speak during the online class, applying what they learned and read ahead of the virtual class. During their attendance, participants were also asked to engage in higher cognitive levels of learning with peers and the professor
Post-virtual class work, (evaluating and creating)	Students were asked to prepare a PowerPoint presentation where they mirrored the information learned pre and during virtual class. PowerPoint presentations should be uploaded via Moodle and should be presented online during class to present the knowledge acquired

4.2 Participant and Peer Observation

This qualitative technique is used to observe participants' behaviors during virtual classes. However, both researchers (one teacher and one facilitator also participated in this study, the facilitators' cross-role focused on helping students during virtual classes, monitoring chatroom use, leading students to avoid making mistakes and ensuring assignments and Participant observation provided us with naturally occurring data. It also provided us with in-depth contextualized data which allowed us to get to know participants more for longer periods (Moerman 2019). In our case, we were able to collect audio recordings during classes, In addition to documents in the form of assignments, and chat conversations during classes.

4.3 Surveys

A structured survey has been used, and the questions of the survey were validated by two Ph.D. students (one male and one female researcher). It focused on three main areas, the quality of distance learning, the effective use of the distance learning platform, and the effective use of the videoconferencing and communication platform (Table 4).

Table 4. Matrix showing the perception of the 17 doctorates on the three main areas of study

	The quality of distance learning (D.L.)					**The effective use of the distance learning platform**					**The effective use of video conferencing and communication platform**			
the Measure Scale	Distance learning	Continuous communication	Achievement of the required knowledge remotely	saving time	D. L, techniques help to efficiently communicate knowledge	Familiarity with the platform	Familiarity with the platforms' tools (use of chatrooms)	Easy resource downloading	Coping with autonomy	Easy Access to the platform	Easy access to the online	Easy teacher-student interaction	Familiarity with the available tools	gaining knowledge
Neutral	5	3	2	6	0	1	0	5	1	1	5	0	1	1
Disagree	3	1	0	1	1	1	1	2	2	5	0	1	0	0
Agree	6	6	9	3	9	10	8	4	8	8	2	6	10	8
Strongly agree	3	7	6	7	7	5	8	6	6	3	10	10	6	8
Total	17	17	17	17	17	17	17	17	17	17	17	17	17	17

5 Results Analysis

The Findings of the study are given under each related research area as follows, results were analyzed manually, because of the limited number of Ph.D. students in this course (17 students). The analysis was done using an excel sheet and Google Forms Analysis.

5.1 The Quality of Distance Learning

Only 52% of doctorates showed satisfaction with the quality of distance learning as being equal to that of in-person education. 76% of doctorates agreed that continuous education was always available during the experience of distance learning. 88% of doctorates were able to achieve the required knowledge remotely and agreed that it is equivalent to achieving knowledge acquired during in-person education experiences. 59% of doctorates agreed that distance learning is efficient and it saves time. 94% agreed that distance learning techniques help to communicate knowledge efficiently and effectively.

5.2 The Effective Use of the Distance Learning Platform

88% of participants agreed that they had high familiarity with the distance e-learning platform. And 94% of participants agreed that they were familiar with the tools available from the distance e-learning platform such as chatrooms. While only 58% of doctorates were able to download and deal with available resources easily, 53% were able to cope with autonomy, and 53% expressed having easy access when signing up and into the platform.

5.3 The Effective Use of the Video Conferencing and Communication Platform

70% of doctorates agreed they had easy access to the communication platform, and 94% of the doctorates found themselves satisfied with the level of interaction between the teacher and themselves, 94% of the doctorates agreed that they were familiar with the use of tools available from the online communication platform such as the use of (chatrooms, whiteboard use, and raise hand). 94% of students agreed they were able to gain knowledge using this time of communication platform.

5.4 Emerging Deviant Cases

One of the good practices according to Moerman (2020) is looking for contradictions, Moerman emphasized how we shouldn't only look for evidence, we should also look for counter-evidence, that is deviant cases. The reason for that is to provide additional support. Our study emerged two main contradictive deviant cases (Table 5).

5.5 Analysis

While survey results show that most students expressed agreeableness towards having easy access to e-learning and video communication platforms, one case emerged and showed dissonance between attitudes and behavior in a case of cognitive dissonance (Festinger 1962). The facilitator asked deviant case 2 to follow certain steps to sign up to the e-learning platform to get access to the online course, the doctorate showed no interaction but asked his 13-year-old son to help him through the signing up process, explaining how hard it is to come up with a password and the difficulty he is facing going through the multi-steps required to sign up, meanwhile, deviant case number 1

Table 5. Emerging deviant cases

	Digital literacy	Dependence	Commitment to course	Need for technical assistance	Downloading resources	Submitting assignments
Deviant Case 1	Positive	Negative	Positive	Negative	Positive	Positive
Deviant Case 2	Negative	Positive	Negative	Positive	Negative	Negative

was able to go through the signing up process smoothly and showed full independence going through the process of e-learning and was able to deliver the required assignments when asked to and without the need of any help (Table 6).

Table 6. Comparison of distance learning perceptions vs traditional in-person learning perceptions among Ph.D. students

	Distance learning	Traditional in-person learning
Flexibility and Convenience	perceived as flexible and convenient since they can attend classes from anywhere with an internet connection and at their own pace	perceived as less flexible since they needed to attend classes physically, and class schedules may not be very convenient to them
Level of Interaction	Some Ph.D. students felt isolated in distance learning since communication is mainly through technology, and interaction with instructors and classmates may be limited	perceived as more interactive since they were able to actively participate in classroom discussions, ask questions, and receive immediate responses from the instructor and peers
Quality of Education	perceived as lower since they may not have access to the same range of resources and opportunities as with traditional in-person learning	perceived as higher since they have access to face-to-face interactions with instructors and peers, access to campus resources and facilities, and opportunities to participate in research work or other activities
Technical Challenges	many of the Ph.D. students faced technical challenges when attending the virtual classes remotely, such as internet connection issues, audio or video problems, etc	The majority of Ph.D. students mentioned not usually facing any significant technical challenges in traditional in-person learning

In conclusion, Ph.D. students perceive distance learning and traditional in-person learning differently. While distance learning provides flexibility and convenience, traditional in-person learning according to interviewed students offer more interaction, opportunities, and a better quality of education. However, the perceptions can differ based on personal preferences, professional goals, and individual circumstances.

6 Discussion

Some observations emerged during this study, when looking into the technology acceptance model (TAM), perceived usefulness (PU) refers to the degree to which the user believes that using the technology will improve his or her work performance, while perceived ease of use refers to how effortless he or she perceives using the technology will be. Both are considered distinct factors influencing the user's attitude toward using the technology (Davis et al. 1989). When applied to e-learning, the TAM can help educators design and implement more effective e-learning systems by understanding how to improve the perceived usefulness and ease of use of the technology. For example, by providing clear instructions and support, and by designing e-learning platforms that are intuitive and easy to navigate, educators can increase the likelihood that students will adopt and use the platform. In our study, most doctorates according to the TAM model had agreed with the Perceived usefulness (PU) of distance education, one student said: *"In my opinion, the quality of e-learning knowledge is equivalent to that of in-person education"*, and most also agreed with the perceived ease of use of using technology *"this platform is very easy to use and it is very easy to access information too"*. However, we observed that most doctorates' behavior showed otherwise, doctorates always tried to show the professor they accepted this method of learning, however during the collective interviews, where the professor was not available, the doctorates expressed otherwise. One doctorate commented, *"we have to engage in those online courses only because the Ph.D. department offers us no other choice to obtain Ph.D. credits"*). So, their perception of technology is a negative one and they view it as a barrier to their learning. In addition to believing that technology is complex and difficult to use, it is easier to blame technology than to admit to their lack of skills.

On the other hand, the self-serving bias suggests attributing positive events and successes to our character or actions but blaming negative results on external factors unrelated to our character (Blackwood et al. 2017). Most students had to ask for the facilitators' assistance to get to know how to sign up for both the distance learning platform and the video conferencing and communication platform, it took most of them some time and failed many times to create an account. Doctorates did not want to blame their lack of digital literacy for their failure to access information through the learning platform but blamed the distance learning process and technology for it. On one hand, we analyzed that this could be due to their limited experience with the use of digital tools, this lack of experience may make it more challenging for them to navigate the digital landscape of their program, leading them to blame external factors for their struggles. On the other hand, this could also be due to their fear of being judged, the doctoral students may not want to admit to a lack of digital literacy because they fear being judged negatively by their peers, professor, or facilitator. They may be concerned that admitting to a lack of skills will make them appear incompetent in front of others.

Looking into Festinger's cognitive dissonance 1957 which occurs when two or more attitudes are incompatible or between an attitude and behavior. Emphasizing that behavior does not always follow from attitudes (Robbins and Judge 2017). When answering the survey, most doctorates expressed a favorable attitude towards the quality of distance learning but expressed otherwise during interviews. One doctorate said *"I do not know how to access the platform, it is complicated"*, and *"could you please lead me through the process of signing up?"*, however, the same doctorate strongly agreed that it was easy to access the platform when answering the survey. This is because doctoral students found it difficult to acknowledge their limitations, especially in an academic setting where high standards are expected. They may prefer to blame external factors like technology and the distance learning process rather than confess to their weaknesses.

Additionally, when asked during interviews if the acquired knowledge was of good quality, most seemed to agree, however when they were asked to reflect the acquired knowledge into the required assignments, they were unable to do so and they tended to plagiarize and find resources that are readily available on the internet.

One of the aims of modern technology-based education is to engage students in truly autonomous, life-long learning where the incentive is to attain superiority in learning that leads to higher performance in education. Developing student autonomy in learning is thus one of the major tasks of education (Serdyukova and Serdyukov 2013). In this study, doctorates were unable to show autonomy but showed dependence and sometimes laziness toward uploading the required assignments in due time. Even when given an extension of time to upload them, the facilitator was sometimes obliged to keep on reminding students of the due date through group e-mails or individual contact via phone and sometimes social media applications.

After asking students during interviews, all Iraqi students in this study agreed that e-learning systems were introduced in universities at a late stage compared to the other students from the other countries involved in this study, they added that many times they faced problems with the internet connections they had in their areas of living which had an impact on the quality of e-learning, one student said: *"the internet connection I have is so weak, and because of the numerous cuts in the internet, I am unable to grab all the information in the professors e-class"*. Students living in other countries on the other hand expressed facing no problems with their internet connections which might lead us to make weak internet connections one of the problems that might create negative perceptions towards e-learning in Iraqi students.

7 Conclusion

Looking back on the question of this study, how is the quality of distance learning education affected by the perceptions of Ph.D. students while using remote communication techniques? We can notice that the quality of distance learning is negatively affected by students' low level of technology acceptance. This requires high education institutions to provide digital literacy programs and essential training courses on how to use them. In addition to the essential training on how to use e-learning platforms and the use of the different communication technologies.

The perceptions of Ph.D. students while using remote communication techniques can also considerably influence the quality of the distance learning process. Remote communication techniques, such as video conferencing and online courses, have been increasingly used especially to guarantee to provide educational opportunities to students who live in geographically dispersed areas.

The quality of distance learning education can be affected by the perceptions of Ph.D. students in several ways:

- Student engagement: Ph.D. students who engage in remote communication systems are more likely to feel engaged with their professors and peers, in addition, they would be more satisfied with their learning experiences. If the level of student engagement is higher the quality of distance learning is better.
- Student interaction: Remote communication techniques can make interaction easier and smoother; this would offer them a more personalized experience and this might have a positive impact on the enablement of students to receive timely feedback.
- Access to resources: The use of remote communication programs can provide informational resources for Ph.D. students that may not be available in traditional face-to-face classroom education. For example, guest speakers from around the world could join virtual classes to offer students new information, in addition to students having access to online databases and can also join virtual conferences or workshops as well.

Ph.D. students' perceptions of remote communication techniques can have both positive and negative impacts on the quality of distance learning education. Positive perceptions can improve engagement, interaction, and access to resources, leading to a higher-quality learning experience for students. On the other hand, negative perceptions, such as feelings of isolation or technical difficulties, can undermine the quality of distance learning education.

Therefore, it is important to address the concerns of Ph.D. students and continuously improve remote communication techniques to enhance the quality of distance learning education.

Many graduate students also need the motive to learn and accept new technologies, perhaps new generations who went through the COVID-19 crisis while being enrolled in a graduate program; were forced to accept new learning technologies. However, they were unable to acquire the necessary skills, knowledge, and competencies well to achieve high-quality education, as it was more of a self-learning process than undergoing professional training courses that could make acquiring knowledge smoother and easier for students.

High education institutions should also take into consideration the importance of blended learning methods and make them a part of the daily teaching process. Many education institutions are back to the traditional classroom-based setting teaching methods and disregarded the new learning and teaching technologies that were once - during the COVID-19 crisis - the only methods for learning and communication. Thus, it is important to build on the primary skills students acquired during the Covid-19 crisis, to be prepared for any crisis education might face in the future.

It is necessary to give some insights and suggestions on how to improve distance learning methods in higher education in order to make the e-learning experience more interesting aiming to make the perceptions of Ph.D. students more positive, this could be done through:

- Enhancing Course Design

The design of online courses plays an important role in the effectiveness of the students' learning process. Professors in high education should guarantee that the course materials are well-built, easy to use, and provide an engaging learning experience to the students enrolled in the courses. This can include incorporating online programs, interactive activities, and other resources like simulations or quizzes to promote student engagement.

- Using different e-Learning Tools

  The use of different e-learning tools is essential in distance education, professors should find ways to encourage student-instructor interactions and group work. Using different tools such as online discussion boards, video conferencing, chatrooms, and shared documents can help students stay connected and learn collaboratively, this requires providing strong internet services to students.
- Providing Accessible Course Materials

  Accessibility is critical in distance learning because students come from diverse backgrounds and may have a variety of disabilities. Instructors in high education institutions should ensure that their course materials such as videos, presentations, and documents are accessible by applying Universal Design for Learning principles. This can include captions for videos, transcripts, and alt text for images.
- Offering Personalized Support

  Online students may need personalized support to succeed. Instructors should offer ways for students to seek help outside the classroom, through the use of emails, chat rooms, or online office hours. Additionally, high education institutions should provide support services like academic advisors, and tutors to help students sense an engaging learning experience.
- Monitoring Progress and evaluating courses

  Monitoring student progress and evaluating every course, especially online courses can inform instructors on how to improve distance learning. Instructors should aim to track students' progress, analyze their performance, and suggest improvements.

All in all, applying these strategies could improve effectiveness, student and instructor satisfaction, and improved outcomes for both of them.

This qualitative research is part of broader quantitative research that aims to engage a wider number of graduate students studying in different countries of the Arab region, one of the future insights is to focus on the effect of culture on technology acceptance.

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Influence of Using Electronic Textbooks and Language Immersion Teaching on Primary School Students' Interest in English Language Learning

Hui-Min Lai[1], Pi-Jung Hsieh[2](✉), and Chia-Ching Hsu[3]

[1] Department of Business Administration, National Taichung University of Science and Technology, Taichung, Taiwan, Republic of China

[2] Department of Hospital and Health Care Administration, Chia Nan University of Pharmacy and Science, Tainan, Taiwan, Republic of China

beerun@seed.net.tw

[3] Da Chung Elementary School, Taichung, Taiwan, Republic of China

Abstract. Creating an effective, full English teaching environment is the goal of most English language teachers. Primary school English teachers in Taiwan usually use full English immersion or bilingual teaching environments in tandem, here with the content and vehicles provided by electronic textbooks (e-textbooks). However, there is growing concern over what kind of learning environment effectively promotes students' interest (i.e., liking and engagement) in English language learning. Is student interest greater in full English immersion teaching or traditional bilingual teaching? Does greater interactivity with e-textbooks increase students' interest in learning? To answer these questions, an eight-week English language teaching study was conducted using a quasi-experimental research method. The study subjects were fifth-grade students in a primary school in Taiwan. The experimental group (129 students) was taught using full English immersion and an e-textbook for content and evaluation. The control group (128 students) was taught using the same e-textbook but with a traditional bilingual teaching method. Because the students had different perceptions of the interactivity of the e-textbook, the students' perceived interactivity of the e-textbook was divided into two groups based on the median. Therefore, a 2 × 2 factorial design was created comprising the two teaching methods (full English immersion versus traditional bilingual teaching) and the two levels of interactivity of the e-textbook (low versus high). No significant differences were found between full English immersion and bilingual teaching in terms of students' liking and engagement. Students who perceived the e-textbook to be more interactive were found to have increased their liking and engagement more than students who perceived the interactivity of the e-textbook to be low.

Keywords: Learning Interest · Full English Immersion Teaching · E-Textbook · English Teaching · Language Immersion

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1 Introduction

Being able to speak different languages facilitates wider communication, interaction, and understanding across countries and people [1]. Taiwan's education system has always emphasized the value of learning English as the second language. In the globalization era, English language ability has become an essential tool for international communication and national growth. The age at which Taiwanese students begin to learn English has recently decreased, dropping from junior middle school to the third grade of elementary school. In the initial stage of learning, achieving affective objectives, such as interest and attitude, are the most important; therefore, English language teaching at the elementary school level in Taiwan emphasizes the importance of both learning and pleasure. Here, the focus is not on the rapid development of students' English language ability, but rather on the fun of English language learning such that students are motivated to continue.

It has been found that immersion teaching increases a student's level of exposure to a second language [2]. Thus, English language immersion is intended to create an immersive language environment in which children learn the target language as it is used in daily life and quickly gain the ability to use it fluently. When combined with attractive, interactive, and effective teaching methods, students are consistently exposed to new words and sentence patterns, and their understanding of the information conveyed by the language is emphasized. An immersive language program provides more opportunities for oral practice and an exploration of the cultural and social background of the target language, facilitating the connection of real-life experiences with classroom learning so that students can see the practical role language plays in daily life.

From the 19^{th} century to today, textbooks have been the main teaching tool [3]. The progress of digital technology has led to the widespread use of e-textbooks in classrooms worldwide [4]. In many classrooms, e-textbook programs come with the components for single-gun projectors or electronic whiteboards, allowing the teacher to present the complete contents of the textbook. In addition, e-textbooks facilitate the use of other valuable computer applications, such as an eraser, color pens, a magnifying glass, masks, random number selection, and so forth, which act as digital teaching aids. Such e-textbooks can even be combined with network resources to provide supplementary teaching materials, interactive games, tests, and assessments. Thus, e-textbooks are widely used in English language teaching to diversify English classroom learning activities, enhancing students' speaking and reading skills by providing the opportunities for practice and feedback, and increasing students' interest in learning the language by making the process fun. The present study explored the impact of two teaching methods—immersion versus bilingual—and the degree of interactivity of e-textbooks (high interactivity vs. low interactivity) on students' learning interests (liking and engagement). Immersion teaching refers to a classroom in which only English is spoken, while the traditional bilingual teaching method involves the use of the student's first language (in this case, Mandarin Chinese) and English at the same time.

2 Literature Review

2.1 Immersion Teaching

The earliest immersion program began in the suburbs of Montreal, Canada, in 1965. It was originally developed to teach native English-speaking students to learn French. The program found the students' French language ability greatly improved while their English language ability was maintained, resulting in a gainful bilingual phenomenon [5]. Fortune, Tedick, and Walker [6] pointed out that, for immersion teaching to be effective, teachers must convey both the content and language. Thus, the situation created by the teacher is the mode for conveying the content. Teachers should thoroughly prepare for class, provide students with situational assistance to help them listen to English, and design activities to help students learn the language. Subsequently, teachers should guide students in expressing their understanding of the teaching content in English. Here, the focus of immersion teaching is how long the target language is used in the teaching process. The degree of use of the target language can be divided into two modes: (1) full and (2) partial immersion. Full or total immersion teaching does not use the students' first language in the early stages of learning, instead gradually increasing the subject learning and reading time of English from the second to fourth grades of primary school [6]. Partial immersion means that the students use the target language for at least half of their time in school and with other subjects studied in their first language. In some early examples of partial immersion teaching in the United States, students were taught to read in two languages at the same time. In partial immersion teaching of Chinese and English in the United States, students have been taught to read in their mother tongue and that of the second language. The proportion of Chinese to English used in the classroom is kept at 50:50 in the two languages at the same time [7]. Horne [8] used a quasi-experimental method to compare 70,000 full English immersion students with those in traditional bilingual classrooms. Horne found that the students in English immersion classrooms performed better academically than the students in bilingual classrooms. Using a quasi-experimental method, Luan and Guo [9] found that college students in immersive English programs progressed faster in their ability to speak and write English than those students being taught traditionally; they also found that the immersive English students had acquired social and cultural knowledge and had a more positive attitude toward learning English. Li, Cheng, and Kirby [10] conducted a case study concluding that students whose mother tongue was Chinese and participated in an English immersion program had greater English language listening comprehension and phonological awareness.

2.2 Electronic Textbooks

Because of the rapid development of information technology, e-textbooks are extensively used in the modern classroom [4]. Some scholars have defined e-textbooks as presentations of the contents of books in electronic form [11]; others have defined them as books published in electronic form for teaching and learning [12]. According to [13], textbooks can be used in "personal desktop computers, laptop, or tablet device making it portable for the students" (p. 173). In the present study, the term *e-textbook* refers to an electronic CD-ROM provided by the textbook publisher and sent to a school or teacher for use in teaching. The electronic CD-ROM is integrated with the software and hardware equipment of the classroom, such as a single-gun projector, electronic whiteboard, computer, or television screen display. In addition to providing a digital version of the textbook and practice exercises, the e-textbook provides supplementary materials and related multimedia resources, such as animation, music videos, interactive games, and an image library. Moreover, the e-textbook used in the present study provided many useful computer applications, such as electronic monitoring, color pens, an eraser, masks, a magnifying glass, random number selection, and role-play opportunities.

3 Research Model and Hypotheses

3.1 Research Model

The current study examined the impact of full English immersion compared with traditional bilingual teaching and level of interactivity of e-textbooks on the learning interests of primary school students. The research model is shown in Fig. 1.

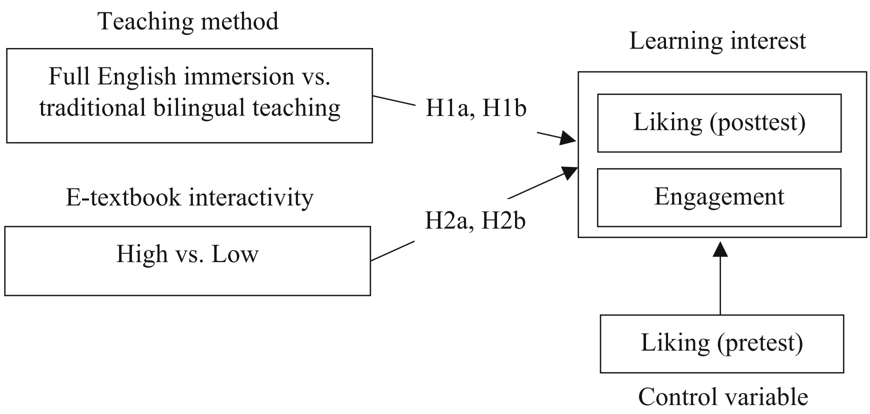

Fig. 1. Research model.

3.2 Research Hypotheses

The Influence of Teaching Methods on Students' Learning Interest

In an immersive English language classroom, teacher–student interaction [6] and the teacher's body language [1, 14] are used to improve students' understanding of the contents. Prior studies have proposed that if students who studied English took English in a full English immersion classroom in early childhood education and showed more confidence and interest in learning English in primary school, they would actively participate in speaking English [15]. Thus, it has been hypothesized that full English immersion teaching would produce students with higher degrees of liking and engagement than a traditional bilingual program would.

H1a: Students taught using full English immersion will have a higher degree of liking than those taught using traditional bilingual teaching.
H1b: Students taught using full English immersion will have higher learning engagement than those taught using traditional bilingual teaching.

The Influence of E-Textbook Interactivity on Students' Learning Interests
With the continuous evolution of technology, the design of multimedia products has changed from providing user information in one direction to emphasizing two-way interactivity. A study conducted by Korat and Shamir [16] found that a combination of e-textbooks and multimedia functions could improve the reading comprehension ability of children. Exquisite illustrations, vivid narration, and animation in e-textbooks have been determined as improving readers' enthusiasm and levels of participation [17–19]. In the design of e-textbooks, various media (i.e., text, sound, sound effects, image, film, and animation) are used to express the course contents because vivid pictures attract students' attention and increase their interest in learning. The interactive nature of e-textbooks increase students' perceived cognitive and affective learning [13]. Therefore, the current study hypothesized that when students perceive the interactivity of the e-textbook used in their class as high, their degree of liking and engagement in the language learning process will be higher than that of students who perceive the interactivity of the e-textbook as low.

H2a: Students who perceive the interactivity of e-textbooks as high have a higher degree of liking than students who perceive the interactivity as low.
H2b: Students who perceive the interactivity of e-textbooks as high have higher learning engagement than students who perceive interactivity as low.

4 Research Methodology

4.1 Experimental Design

The present study adopted a quasi-experimental design. It was conducted in a field teaching environment from November 19, 2018, to January 11, 2019. The participants were fifth-grade students in 10 classes taught by one of the authors; five classes were randomly selected as the experimental group, with the other five becoming the control group. The experiment took place over eight weeks, with two sessions of 40 min per week per class for a total of 16 classes. The teaching hours of the experimental group and control group were the same. Full English immersion was used for the experimental group, and traditional bilingual teaching was used for the control group. Before conducting the teaching experiment, all students were asked to answer a learning liking questionnaire. After the experiment (week 9), the students were asked to answer a questionnaire on learning liking, learning engagement, and e-textbook interactivity, as shown in Fig. 2. There were 129 students in the experimental group (62 boys and 67 girls) and 128 students in the control group (67 boys and 61 girls).

Fig. 2. Experiment timeline.

4.2 Teaching Materials and Environment

Both the experimental group and control group used the same teaching materials. The teaching materials were Unit 3, Unit 4, Unit 5, and Review 2 of the fifth volume of "Hello! Kids" approved by the Ministry of Education in Taiwan. The unit topics and progress of the weekly classes were the same. Both the experimental and control groups were taught by the same teacher, but immersion teaching in the experimental group was taught in a full English environment, while the control group was taught in a bilingual environment. Both groups used the blackboard, flashcards, and sentence pattern exercises. Both groups used the "Super E-book" produced by Kangxuan Publishing House to access the contents and exercises of a composition textbook and used relevant resources to do exercises and evaluation activities. The students also had the opportunity to operate the resources provided by the e-textbook, such as games. Both groups received teaching instructions in a typical English classroom and there were many visual materials on the wall and blackboard. The arrangements of desks and chairs and of the environment were identical.

4.3 Measurement

In the present study, the experimental group used full English immersion in tandem with e-textbooks for teaching and evaluation, and the control group used bilingual instruction in tandem with e-textbooks for teaching and evaluation. The measurement of learning interest used a questionnaire designed by Tsai, Lin, Hong, and Tai [20], which included two variables: liking and engagement. The questionnaire items of liking included "I like English class," "I like the teaching style of the English teacher in this course," and "I like the teaching method of the English teacher." The engagement items included the following: "Whether I have the right answers to the questions or not, English class is always very interesting," "I focus on English class activities, and time always passes quickly," and "I think that I'm fully focused on the course" Because the learning liking of individuals might change during the experiment, this variable was also measured before the experiment began. Items on the perceptual interactivity of e-textbooks were adopted from Johnson, Bruner II, and Kumar [21]. The items included "When I interacted with the e-textbook for my class, I found the contents and functions it provided to be appropriate," "When I interacted with the e-textbook for my class, I found the contents and functions it provided to be in line with what I wanted," and "When I interacted with the e-textbook for my class, I found the contents and functions it provided to be helpful." The above variables were all evaluated by students using a 5-point Likert scale, where 1 = strongly disagree and 5 = strongly agree.

5 Data Analysis and Results

A total of 259 students participated. After excluding students who did not participate in the whole process, 257 remained. There were 129 students in the experimental group, and 128 students in the control group.

5.1 Reliability and Validity

Reliability analysis was used to check the consistency or stability of the results. Validity analysis was used to determine the accuracy of the results [22]. The reliability coefficient should be between 0 and +1, and the higher the value, the higher the reliability, while Cronbach's α has a minimum acceptable threshold of 0.6 [23]. The Cronbach's alpha values of perceived interactivity, liking (pretest), liking (posttest), and engagement were 0.665, 0.702, 0.742, and 0.666, respectively. This shows that the questionnaire scale had a considerable degree of stability. In terms of convergence validity, because the questionnaire was based on Tsai, Lin, Hong, and Tai [20] and confirmed by three experts, confirmatory factor analysis (CFA) was used. AMOS software was used to perform CFA, and the results are shown in Table 1. The results show that all factor loadings were greater than the threshold value of 0.5 proposed by Fornell and Larcker [24]. In addition, the average explained variance (AVE) threshold value of the variable was usually 0.5; according to previous studies, if reliability is greater than 0.6, an AVE value greater than 0.4 is still considered acceptable [24, 25], confirming that the questionnaire in the present study had convergent validity. In terms of discriminant validity, according to Fornell and Larcker [24], the correlation coefficient between two variables should be less than the square root of the AVE, as can be seen in Table 2, showing good discriminant validity.

5.2 Hypotheses Testing

Multivariate analysis of covariance (MANCOVA) was used to test the hypotheses. Before performing MANCOVA, three preconditions must be satisfied: sample independence, normal distribution, and homogeneity of variances [23], as follows:

1) Independence of samples: From a total of 10 classes, the researchers randomly selected five classes as the experimental group and the other five as the control group. Hence, the samples of the two groups were independent of each other, and the assumption of independent sampling was not violated.
2) Normal distribution: The present study used skewness and kurtosis to test whether the sample had a normal distribution. The mean values for all variables were between 3.696 and 83.891; the standard deviation for all variables was between 0.810 and 20.380; the skewness for all variables was between −0.351 and −1.293; and the kurtosis for all variables was between 0.001 and 1.329, hence meeting the criteria proposed by Kline [26]. The skewness for all variables was less than 3, and the kurtosis for all variables was less than 10, so the data had a normal distribution.
3) Homogeneity of variances: In the current study, Levene's test was used to test the homogeneity of variance of the two samples. The F-values of Levene's test were

Table 1. Convergent validity.

Variables	Factor loading	AVE
Perceived interactivity		.402
1	.550	
2	.683	
3	.661	
Liking (pretest)		.447
1	.753	
2	.654	
3	.588	
Liking (posttest)		.503
1	.747	
2	.743	
3	.632	
Engagement		.464
1	.724	
2	.636	
3	Deleted	

Note: The third question of engagement was deleted to improve AVE value.

Table 2. Discriminant validity.

	1	2	3	4
1. Perceived interactivity	**.634**			
2. Liking (pretest)	.366	**.669**		
3. Liking (posttest)	.544	.584	**.709**	
4. Engagement	.412	.488	.659	**.681**

Note: The diagonal elements (in bold) represent the square roots of the AVEs.

2.162 ($p = 0.093$) for liking and 1.585 ($p = 0.194$) for engagement, indicating that no statistically significant differences existed among the variances of the two groups.

The experimental manipulation was the teaching method, and e-textbook interactivity was measured by a questionnaire distributed after the teaching experiment has been completed. Perceived e-textbook interactivity was divided into high and low, here based on the median. Thus, the independent variables formed a 2×2 design, as shown in Table 3.

The effect of teaching method on liking and engagement were not statistically significant at 0.05, with $p = 0.922$ and $p = 0.369$, respectively. Thus, H1a and H2a were

Table 3. The 2 × 2 study design and number of students.

	High interactivity	Low interactivity	Total
Full English immersion	65	64	129
Traditional bilingual teaching	54	74	128
Total	119	138	257

not supported. This result suggests that liking and engagement were not affected by the teaching method.

The effect of perceived e-textbook interactivity on liking and engagement were found to be statistically significant ($p < 0.001$ and $p < 0.001$, respectively). Thus, perceived high e-textbook interactivity increased the degree of liking (with a mean of 4.331 for high interactivity and mean of 3.928 for low interactivity), and perceived e-textbook interactivity increased learning engagement (with a mean of 4.139 for high interactivity and 3.719 for low interactivity). Consequently, H1b and H2b were supported. Table 4 shows the MANCOVA results.

Table 4. MANCOVA results.

Source	*SS*	*DF*	*MS*	*F*	*p*
Dependent variable: Liking (posttest)					
Covariance: Liking (pretest)	**28.190**	**1**	**28.190**	**92.197**	**.000**
Teaching method (H1a)	.003	1	.003	.010	.922
Interactivity of e-textbook (H1b)	**9.231**	**1**	**9.231**	**30.192**	**.000**
Teaching method * Interactivity of e-textbook	.182	1	.182	.597	.441
Dependent variable: Engagement					
Covariance: Liking (pretest)	**30.619**	**1**	**30.619**	**54.623**	**.000**
Teaching method (H2a)	.454	1	.454	.810	.369
Interactivity of e-textbook (H2b)	**10.063**	**1**	**10.063**	**17.952**	**.000**
Teaching method * Interactivity of e-textbook	.019	1	.019	.033	.856

Notes: SS = sum of squares, DF = degrees of freedom, MS = mean squares

6 Discussion

The present study was conducted using a quasi-experimental design to explore whether full English immersion would increase students' interest in learning more than traditional bilingual teaching. The current study also considered the effect of perceived e-textbook interactivity on students' learning interests. The findings are summarized below.

First, there was no significant difference between the liking and engagement of the students in the full English immersion class and those in the traditional bilingual teaching class. One possible reason for this is that primary school students in Taiwan are generally under great pressure to learn a second language because bilingual children must deal with the additional academic load of learning to read and write in another language on top of learning their mother tongue; this means they will have to work extra hard [27]. Another possible reason is that the teaching experiment was too short, so the students may have needed more time to increase their learning interest.

Second, there was a significant difference between the effect of the perceived interactivity of the e-textbook on the degree of liking and learning engagement. The study found that students who perceived the e-textbook as having high interactivity showed greater learning liking and engagement, meaning that these students enjoyed the English class more and were more willing to participate in classroom activities than their counterparts. Sutherland [28] pointed out that technology can improve learning through integration into classroom learning activities and by facilitating dialogues with peers or teachers. For example, the use of e-textbooks with multimedia teaching materials and instant-response interactive practice questions can benefit the efficacy of teaching and practice, reduce learning burnout, and effectively improve students' concentration, learning engagement, and self-learning motivation.

7 Conclusion

In terms of academic research, the present study provides some research implications. The current study has explored the impact of applying information technology to assist in English language immersion teaching on students' interest in learning. The results confirm that the interactivity of the e-textbook can improve students' learning liking and engagement. The present study reveals that language immersion teaching alone is not enough and that the high interactivity of e-textbooks can enhance students' interest in learning. The current study provides practical implications for English teaching in primary schools: a high interactivity of e-textbooks will make students have a higher interest in learning because the content provided by e-textbooks contains a large number of interactive functions and sound and video multimedia effects, making primary school students feel novel and interesting, which is deeply loved by students. Teachers should treat e-textbooks as an extension of paper textbooks so that students can use more diversified ways to learn and promote students' interest in learning. It is suggested that, for more difficult or monotonous course content, teachers can design interesting teaching activities that can be combined with interactive functions in e-textbooks, hence making it easier for students to understand.

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Lessons Learned: Measurement of the Impact of Covid-19 Post-pandemic

Bohórquez Laura Alejandra[1,2(✉)], Ferro Escobar Roberto[1,2], and Juan Manuel Cueva Lovelle[1,2]

[1] Universidad Distrital Francisco José de Caldas, Bogotá, Colombia
labohorquezg@correo.udistrital.edu.co, rferro@udistrital.edu.co
[2] Universidad de Oviedo (España), Oviedo, Spain
cueva@uniovi.es

Abstract. The spread of highly contagious and deadly viruses like COVID-19 is directly related to several factors that influence epidemiological exposure to the virus. For the construction of this article, 46 publications were consulted, of which 25% were case studies of research related to variables such as population density, asymptomatic individuals, mobility, containment measures, hospital care, and demographic prevention measures. A timeline of events correlated with the containment and spread of the virus, such as quarantines, opening of commerce, mass events, and vaccine rollouts, was constructed using another 25% of the literature consulted. 15.6% of the literature corresponds to the comparison of the effects of different variants. Finally, for the construction of the data that was analyzed, 34.4% of the literature consulted was used, and the correlation of variants and variables with the behavior of infections in the city of Bogota was analyzed.

Keywords: Containment measures · SARS-CoV-2 · Virus · Variables · Hospital care

1 Introduction

COVID-19 is an infectious disease caused by the SARS-CoV-2 virus [1]. On December 31st, 2019, the Wuhan Municipal Health Commission in China reported the first cases of an atypical pneumonia outbreak in the city [2]. By March 11th, 2020, COVID-19 was declared a pandemic due to its spread across continental barriers [2].

The growth of infections within each country became significant. This growth was mainly due to the possibility of transmission from infected individuals to others through the spread of liquid particles released by the mouth or nose [3] leading to rapid transmission of a large number of agents in a short period of time.

As a result, acquiring and transmitting the SARS-CoV-2 virus is easy. In Colombia, the presence of this pandemic produced a series of effects in the social and economic spheres, affecting the internal dynamics of the territory. The first positive case of COVID-19 was reported on March 6th, 2020, from Milan, Italy [4] after which the number of cases has steadily increased. It is also necessary to consider factors such as

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different comorbidities that define a population at risk, installed hospital capacity, epidemiological exposure, among others, which influence the infection rate, as well as the different preventive and containment measures adopted by various governmental entities to mitigate the effects of the new coronavirus.

In addition to the above, through epidemiological monitoring of the pandemic, it has been found that the virus mutates for various reasons, producing virus variants that have been constantly monitored by the World Health Organization, especially given that the emergence of each new variant represents a higher infection rate [5].

Technology has played a key role in the fight against the pandemic, with the implementation of contact tracing applications [6, 7] and the automation of detection and diagnosis processes. Artificial intelligence [8] and data analysis have been used to improve the effectiveness of the pandemic response. In addition, technology has been fundamental in the research and development of vaccines, allowing for genome sequencing of the virus and simulation of clinical trials. Through this work, relevant information was collected regarding the evolution of Covid-19 infections in Colombia, particularly in the city of Bogotá, and a comparative analysis was carried out between different events of relevance.

Information was another important factor in dealing with the pandemic in most countries of the world, however the use of a more systematic approach in dealing with the information, like using a knowledge management model like the SECI model in Colombia would have enhance the communication and information process during Covid-19 period [9].

2 Literature Review

2.1 Factors Influencing the Covid-19 Infection Rate

Using as a starting point the factors recognized worldwide as high-impact variables and variants in the behavior of Covid-19, they were also established as important causes for the case of this study in Bogotá-Colombia.

2.2 Variables

2.2.1 Risk Population

Although all people are at risk of contracting the disease, it has been shown that the clinical severity increases with age [10], since those over 60 years of age represent a greater danger; in addition to those who suffer from some type of comorbidity [11]; among the most common comorbidities are: obesity, hypertension, cardiovascular, renal and respiratory diseases [12]. In addition, a demarcated distinction can be made into three sectional groups that divide the population into young people, adults, and older adults [13]:

1) Young people: All those people under 25 years of age, who can transmit the new coronavirus in a silent way, since it is generally the population with the best state of health.

2) Adults: This group is made up of the population between 26 and 65 years of age. They are characterized by being those who have a greater probability of spreading the virus, since they comprise the majority of the working population, which tends to mobilize in greater proportion in their day to day. Day.
3) Older adults: The population over 65 years of age is the one that suffers the most complications due to strong symptoms, consequently, this population group is the one that most requires hospital care [13].

2.2.2 Epidemiological Exposure

Exposure to the virus (and as a consequence contraction of the disease) is closely related to population density, this factor represents one of the conditions that has the greatest impact on the infection rate in a certain region [13].

Likewise, the duration of exposure to an infected person combined with the closeness and number of household contacts constitute the greatest risks of transmission, especially when conditions of confinement prevail [10].

2.2.3 Virus Spread

The spread of the disease is directly related to several factors influencing epidemiological exposure to the virus; Likewise, studies relate variables such as:

1) The density and mobility of the population [11].
2) Hospital capacity (ICU beds).
3) Effect of asymptomatic individuals, import and export events (virus mobility) [13].
4) The portability of the virus in different population groups by age and its characteristics: young people carry and transmit it silently, adults in greater volume, and the elderly increase the demand for hospital capacity [13].
5) Duration of exposure and distance between social interactions [10].
6) In addition to heterogeneities given by demography, development and actions taken against the disease [10].

On the other hand, more than half of the transmission occurs in the presymptomatic phase (53%) [10], which shows that a representative percentage of infections occur silently; This is why prevention measures are of vital importance, even more so when people do not expect to be infected, or do not feel exposed, since they do not show symptoms in their close contact fence.

2.2.4 Containment Measures. (Preventive and Corrective)

In response to the emergence and spread of Covid-19, different containment measures have been established both globally and locally. These measures can have a preventive or corrective approach, depending on the specific needs of each territory. However, the implementation, omission, and relaxation of the measures imposed by governments generate modifications in the behavior of the contagion rate, which, combined with exposure to the virus and factors associated with its spread, lead to the generation of different contagion trends that must be analyzed in depth in order to understand the influence of government actions with the appearance of contagion peaks, allowing for future not only a greater understanding of the virus behavior but also the establishment of activities or policies whose effectiveness in mitigating the virus is high. As part of the main containment measures implemented during Covid-19 are:

1) Isolation, quarantine, curfew, social distancing, suspension of face-to-face activities (work, academic, cultural, among others) [10, 11, 12, 14].
2) Detection of travelers and contact tracing [10, 14].
3) Local strategies [11], such as the use of masks [10].
4) Teleworking [10].
5) Restrictions on events or activities with crowds [10, 14]
6) Use of masks, proper hygiene, surface disinfection using different disinfecting agents [15, 14]
7) Vaccination against the virus

Several studies have shown that vaccines against COVID-19 are effective in preventing infection and reducing the spread of the virus. Countries that have achieved high vaccination rates have seen the spread of the virus and hospitalization and death rates drop significantly [16, 17]. For this reason, some organizations have developed strategies to promote vaccination using technology to enhance teaching methods in information about vaccines [18].

2.3 Variants

As viruses spread through a population, they generate mutations, and when one or more mutations occur, a variant of the original virus is produced. A mutation occurs when changes in the genetic code being replicated during the process of multiplying the genetic material present in a virus begin to appear [19]. During the pandemic, the Covid-19 virus has mutated, developing various variants, each with distinct characteristics that directly influence the epidemiological behavior of the virus [10], although the characteristic symptoms of the disease such as cough, fever, headache, and respiratory tract pain remain in each of them [14].

The WHO classifies these variants into two types: i) variants of interest, which include all variants that produce a high change within the genome of the disease; and ii) variants of concern, which include all those characterized by the transmissibility capacity of the disease [14].

As of January 2023, five variants of concern have been identified, which have been the subject of various studies since they represent a greater impact on the rate of contagion. The main characteristics of each of these variants are presented below.

2.3.1 Alpha

A United Kingdom was identified, in September 2020 [6]; since its identification it was considered extremely contagious [4, 15], since, together with the delta variant, they stand out for the number of mutations presented at the level of the spike protein, which makes them more infectious [4]. The alpha variable is considered a mild to moderate disease that impacts the upper respiratory tract; however, it can be classified as serious when acquired by elderly patients.

2.3.2 Beta

This variant was first identified in South Africa in May 2020 [20]; one of its main characteristics is its retransmission rate [21], in addition to that, the mutations present within its spike protein allow this immune variant to escape neutralizers, also reducing the efficacy of vaccines [22] and increasing the probability of reinfection.

2.3.3 Gamma

The Gamma variant was identified in November 2020 in Brazil [20]; the Gamma variant is similar to the Beta variant in terms of the symptoms presented by those who contract the disease (general fatigue, fever and cough) [14], on the other hand, it is transmitted 16% faster than the alpha variant.

2.3.4 Delta

Identified in India in October 2020 [19], the Delta variant is characterized by being rapidly transmissible, but of moderate intensity [14], in addition to presenting a high probability of reinfection [23]. The Delta variant and its sub-variants have led countries like Russia and China to resume strict quarantines to control outbreaks [24]; since due to the high mutations that this variant has evidenced in the spike protein, it provides a high transmissibility of the disease [14]. The Delta variant has also been shown to be associated with a higher risk of hospital admission compared to the Alpha variant [25], as well as being 60% more contagious than the Alpha variant [14].

2.3.5 Omicron

Omicron was identified in several countries around the globe in November 2021 [20], this is one of the variants with the most mutations at the spike protein level [14]; people who acquire it generally present mild symptoms, which means that transmissibility can be silent, in addition to the fact that the multiple mutations in its genome structure and in its spike protein confirm it as one of the variants with the highest transmissibility [19], which is why it has the capacity to infect 3 to 6 times more people than the Delta variable [26].

Omicron is very contagious but it is much milder, from the point of view of mortalities [14, 26], however, it has partial resistance capacity to immunity due to infection [26], since tests initially conclude that it is usually in general, the risk of reinfection for this variant is higher than for other variants of concern [14].

3 Methodologies

3.1 Input Data

As of January 31, 2022, the number of accumulated infected cases in Colombia reached 5,855,858, of which 33,832 died [27], with Bogotá, as the capital of the country, being the city that contributes the most in active cases, having as of the same date 1,847,478 confirmed cases and 28,525 deaths [28], corresponding to 31.5% and 21.3% of the infections and deaths at the national level, respectively.

Bogotá is a city with a population census of approximately 7.4 million inhabitants in 2018, who live in 20 localities and 112 UPZ. It is also characterized by 99.7% of its population living in the municipal head and 0.3% in scattered rural population centers [29].

For the elaboration of this analysis in the established time period, the information available in the Open Data Bogotá system [30] was used as a source of information, where the information generated by the Bogotá Health Observatory [28] with data from the District Health Secretariat and processed by the District Laboratory Network is compiled.

This database presents, with daily updates, up to January 2, 2023, as the last download for this study, the variables of date of symptom onset, date of diagnosis, city, locality, patient age, sex, type of contagion, and patient status (recovered, active, or deceased). The data was loaded in csv format into Origin Pro software for the compilation and analysis of the available information.

For this study, the period of interest was taken from March 6, 2020, the date when the first case of Covid-19 was registered in Bogotá, until January 31, 2022, because, as shown in Fig. 1, from the beginning of 2022, there was a drastic decrease in Covid-19 infection cases, which continues to this day, with some contagion peaks that do not exceed 5,000 weekly cases, which are excluded due to their low impact.

3.2 Timeline Events of Interest

As part of this study, different events of interest were selected to determine their influence on the Covid-19 infection rate in Bogotá. Table 1 shows the events to be analyzed.

Table 1. Events of interest for the study of the behavior of Covid-19 in Bogotá

Week	Date	Event
1	6/03/2020	Confirmation of the first case in Bogotá. [4]
2	16/03/2020	closure of schools and universities. [31]
3	20/03/2020	Quarantine begins in the city of Bogotá. [32]
10	11/05/2020	Gradual opening of some shops [33]
14	8/06/2020	Full reopening of trade. [34]
16	19/06/2020	First day without VAT, crowds in shops.[35]
18	3/07/2020	Day without vat. [35]
19	16/07/2020	Day without vat. [35]
19–21	13/07/2020–26/07/2020	Strict quarantine: Ciudad Bolívar, San Cristóbal, Rafael Uribe Uribe, Chapinero, Santa Fe, Usme, Los Mártires and Tunjuelito. [36]

(*continued*)

Table 1. (*continued*)

Week	Date	Event
21–23	26/07/2020–9/08/2020	Strict quarantine: Bosa, Kennedy, Puente Aranda and Fontibón. [36]
24–26	16/08/2020–30/08/2020	Strict quarantine: Usaquén, Chapinero, Teusaquillo, Puente Aranda, Antonio Nariño, Santa Fe and La Candelaria. [37]
28–29	9/09/2020–21/09/2020	Protests against police violence caused crowds in various parts of the city. [38]
50	17/02/2021	Stage 1 of vaccination begins, Health workers and care support to COVID-19 areas, and people over 80 years of age.[39]
53	8/03/2021	Stage 2 of vaccination begins, Other health workers, support personnel who do not work in COVID-19 areas and people between 60 and 79 years of age. [39]
64	22/05/2021	Stage 3 of vaccination begins, People between 50 and 59 years old. Teachers, managers and educational personnel, Military Forces and Police, Indigenous Guard and Cimarrona, and people between 16 and 59 years old with comorbidities or hypertensive diseases: Diabetes, Kidney failure, HIV, Cancer, Tuberculosis, COPD, ASTHMA, Obesity, on the list of waiting for vital organ transplantation or Post-transplantation of vital organs. [39]
67	17/06/2021	Stage 4 of vaccination begins, People between 40 and 49 years old. People deprived of liberty, institutional caregivers, population at risk of outbreaks, in high-risk occupations, firefighters, lifeguards, pilots, and auxiliaries. [39]
72	17/07/2021	Stage 5 of vaccination begins, population over 16 years of age not prioritized in stages 1 to 4. The order of application will be maintained, beginning with adults between 50 and 59 years of age, until reaching young people and adolescents who are within the target population of the National Vaccination Plan.. [39]
75	7/08/2021	It is confirmed that the Delta variable is circulating in Bogotá (it will become dominant in the month of October).[39]
86	28/10/2021	Day without vat.. [35]
90	19/11/2021	Day without vat.. [35]
92	3/12/2021	Day without vat.. [35]
94	20/12/2021	The first cases of Omicron in Colombia are confirmed. [40]

4 Results

According to the information in Fig. 1, since the first report of a Covid-19 case in Colombia, four peaks of infection can be identified: in August 2020, January and June 2021, and in January 2022. These peaks may have originated from different causes, which are explored below.

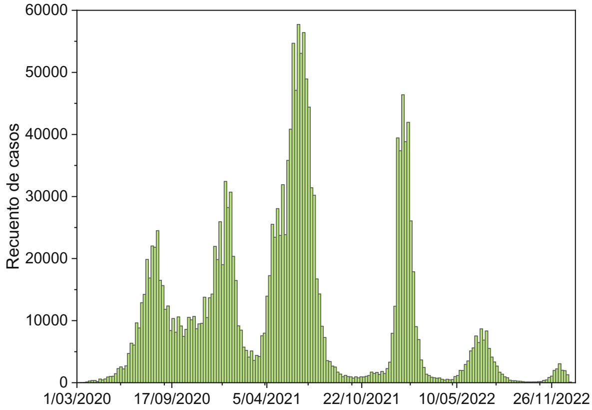

Fig. 1. Distribution of positive cases for Covid-19 between the first case reported on March 6, 2020 to January 2, 2023.

In order to simplify the data analysis, they were classified into 7-day ranges to facilitate temporal analysis, dividing the data obtained from the database for the time interval of interest into 100 study periods, in order to have the variable "Study Week", as shown in Fig. 2. Additionally, as a starting point, the incidence of cases in each locality was related, as shown in Fig. 3, for the established period.

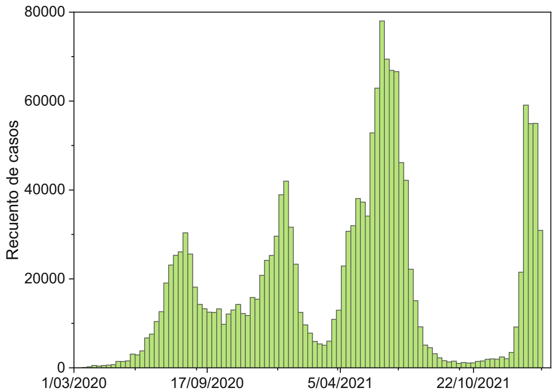

Fig. 2. Distribution of positive cases for Covid-19 from the first reported case on March 6, 2020 until January 2022.

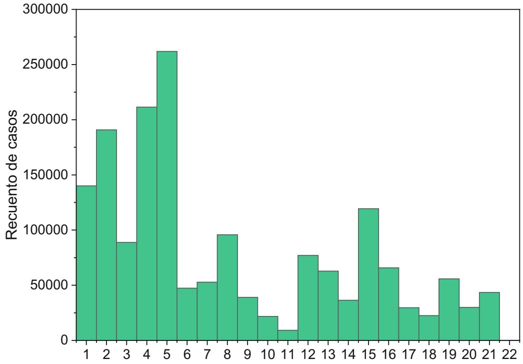

Fig. 3. Count of positive cases for Covid-19 from the first reported case on March 6th, 2020 until January 2022, for the localities of Bogotá, which are: 1. Usaquén, 2. Engativá, 3. Fontibón, 4. Kennedy, 5. Suba, 6. Teusaquillo, 7. Chapinero, 8. Ciudad Bolívar, 9. Barrios Unidos, 10. Los Mártires, 11. La Candelaria, 12. Rafael Uribe Uribe, 13. Puente Aranda, 14. Tunjuelito, 15. Bosa, 16. San Cristóbal, 17. Santa Fe, 18. Antonio Nariño, 19. Usme, 20. Outside of Bogotá, 21. No data, 22. Sumapaz.

4.1 Correlational Results

Taking the previously presented data as a starting point, correlation was performed on different relevant events that occurred in Bogotá, such as lockdowns, reopening of commerce, mass events, opening of vaccination, and detection of new variants of the virus, in order to find a correlation between each of them and the incidence in the behavior of Covid-19 contagion. The following provides further information on each of the correlated variables.

4.1.1 Covid-19 Variants

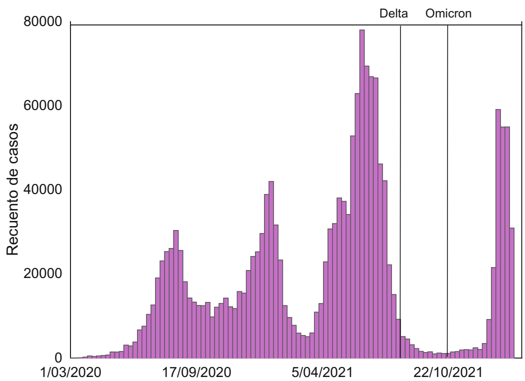

Fig. 4. Correlation of the influence of the appearance of the Delta and Omicron variants, against the distribution of positive cases for Covid-19 between the first case reported on March 6, 2020 to January 2022

Figure 4 shows the results for the correlation of the identification of the Delta and Omicron variants in Bogotá with the number of reported cases. As observed, after the appearance of the Delta variant, there is no increase in the cases of Covid-19, and even a decrease in the reported positive cases is evident in the following weeks. It is not until the appearance of the Omicron variant that a significant increase in contagions is observed, reaching a new peak of contagions in the months of December 2021 and January 2022

4.1.2 Opening of Economic Activities

Due to the staggered economic reactivation, it is necessary to review the impact of each of these stages on the spread of Covid-19. Figure 5 shows the main activities that were identified as having an impact on the increase in positive cases.

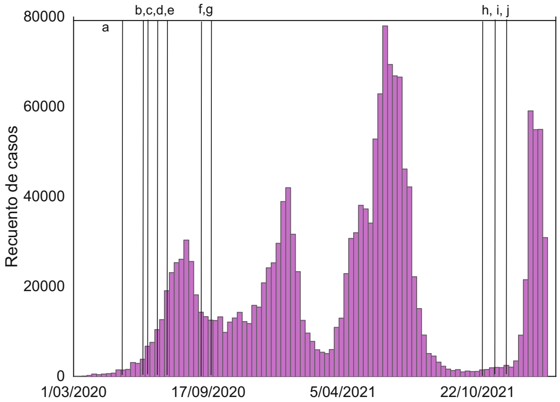

Fig. 5. Correlation of the influence of the opening of different economic activities, compared to the distribution of positive cases for Covid-19 between the first reported case on March 6, 2020, and January 2022. a. Gradual opening of some businesses; b. Full reopening of commerce; c. Tax-free day 1 2020 (with crowds); d. Tax-free day 2 2020; e. Tax-free day 3 2020; f-g. Range of dates with crowds in protests; h. Tax-free day 1 2021; i. Tax-free day 2 2021; j. Tax-free day 3 2021.

Based on the information from Fig. 5, it can be observed that the reopening of economic activities had a significant effect on Covid-19 infections, showing a growing trend of cases from the gradual reopening of some businesses, with a peak in infections after the third tax-free day in 2020. Once the tax-free days were over, the trend of infections decreased, even with the development of events related to protests with crowds. This indicates that the tax-free days in 2020 were especially significant for the increase in Covid-19 cases, especially compared to events with crowds such as protests, which may be related to the fact that the former refer to events with crowds in enclosed spaces, while the latter mainly took place outdoors. For the three tax-free days in 2021, a trend towards an increase in positive cases was identified again, reaching a peak of infections in the months of December 2021 and January 2022, which also coincided with the emergence of the Omicron variant in the country.

4.1.3 Opening of Economic Activities

One of the most significant factors in the behavior of Covid-19 was the implementation of vaccination for the entire population. Figure 6 shows the behavior of positive cases as vaccination progressed in the different groups defined by the Ministry of Health.

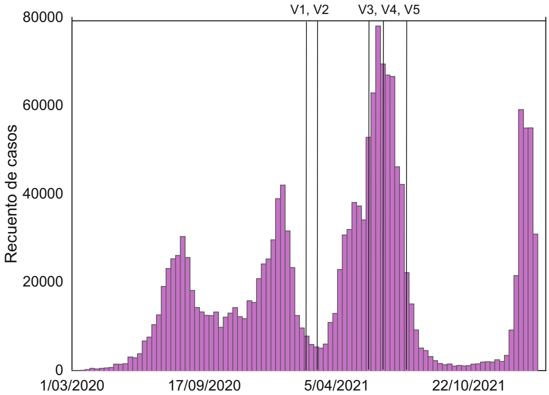

Fig. 6. Correlation of the influence of vaccination of different population groups, in relation to the distribution of positive cases for Covid-19 from the first reported case on March 6, 2020, until January 2022. Where V1: Stage 1 of vaccination; V2: Stage 2 of vaccination; V3: Stage 3 of vaccination; V4: Stage 4 of vaccination; V5: Stage 5 of vaccination.

The vaccination of the first three groups did not have a relevant effect on the reported cases, especially considering that a peak of contagions was observed after stage 3. It was not until after the vaccination of stages 4 and 5, which covered the largest proportion of the population, that the influence of vaccines in reducing contagions became visible. There was a plateau in the number of cases for several months until a new peak of contagions occurred, which can be related to the emergence of the Omicron variant characterized by its resistance to immunization. Thus, the vaccination did not have a significant effect during this period.

4.1.4 Strict Quarantine by Neighborhoods

For events such as strict quarantines by localities, the correlation was made for the specific time interval and location of each one. Figure 7 shows the presence of positive cases in the month prior to the start of quarantines by localities. It can be observed that the localities of Suba, Teusaquillo, Ciudad Bolívar, Bosa, and Engativá had the highest number of cases, which justified the decision to implement quarantines by zones in order to avoid close contact transmission.

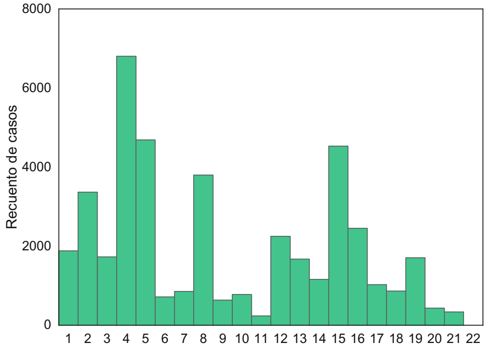

Fig. 7. Count of positive cases for Covid-19 in the period June 1, 2020 to July 12, 2020 (last month prior to the start of strict quarantines by localities), for the different localities in Bogotá, being: 1. Usaquén, 2 Engativá, 3. Fontibón 4. Kennedy, 5. Suba, 6. Teusaquillo, 7. Chapinero, 8. Ciudad Bolívar, 9. Barrios Unidos, 10. Los Mártires, 11. La Candelaria, 12. Rafael Uribe Uribe, 13. Puente Aranda, 14. Tunjuelito, 15. Bosa, 16. San Cristóbal, 17. Santa Fe, 18. Antonio Nariño, 19. Usme, 20. Outside of Bogotá, 21. No data, 22. Sumapaz.

Figure 8 graphically presents the trend of cases in different localities during the strict quarantine period. According to the presented information, the count of Covid-19 contagion cases during the strict quarantine period remained stable. There were no significant variations, especially in the increase of cases in these localities, related to the interaction in the households of infected people (Fig. 9).

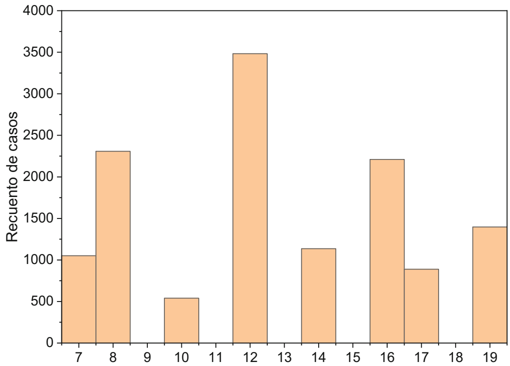

Fig. 8. Count of positive cases for Covid-19 during the strict quarantine of the locations: 7. Chapinero, 8. Ciudad Bolívar, 10. Los Mártires, 12. Rafael Uribe Uribe, 14. Tunjuelito, 16. San Cristóbal, 17. Santa Fe, 19. Usme

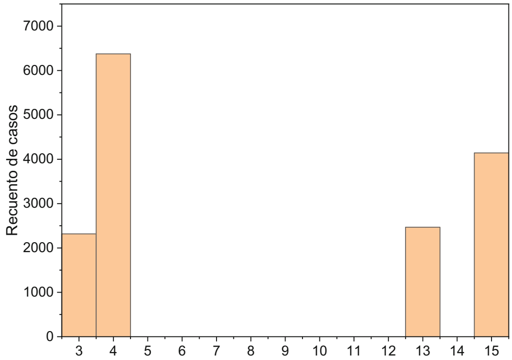

Fig. 9. Count of positive cases for Covid-19 during the strict quarantine of the towns: 3. Fontibón 4. Kennedy, 13. Puente Aranda, 15. Bosa

Figure 10 shows the count of positive cases in localities with strict quarantine during this period of time, where it is identified that for the localities of Usaquén and Puente Aranda the number of positive cases in the midst of strict quarantine is significantly higher than the other localities, so avoiding the mobilization of the inhabitants of these was successful to prevent the spread of the virus to other areas of the city.

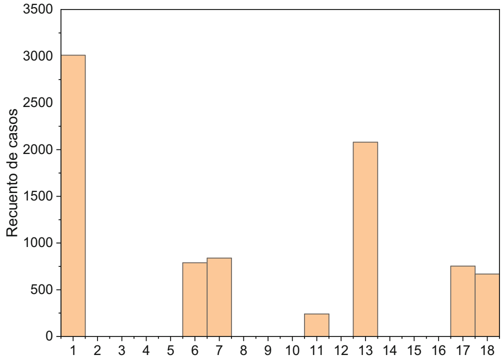

Fig. 10. Count of positive cases for Covid-19 during the strict quarantine of the towns: 1. Usaquén, 6. Teusaquillo, 7. Chapinero, 11. La Candelaria, 13. Puente Aranda, 17. Santa Fe, 18. Antonio Nariño

Figure 11 shows the positive cases by locality in the month following the implementation of strict quarantines, where it can be observed that the localities of Engativá, Kennedy, Suba, Ciudad Bolívar, and Bosa have the highest number of infections. Comparing this information with that obtained prior to the strict quarantines, when the localities of Suba, Teusaquillo, Ciudad Bolívar, Bosa, and Engativá had the highest number of infections, a clear tendency of certain areas of the city to have a constantly higher incidence of the virus is evident. This can be related to factors such as the number of inhabitants, population density, economic activities of their inhabitants, among others, that generate this effect. Thus, implementing strict quarantines did not decrease the number of infections in these particular localities, but it prevented transmission to the rest of the city.

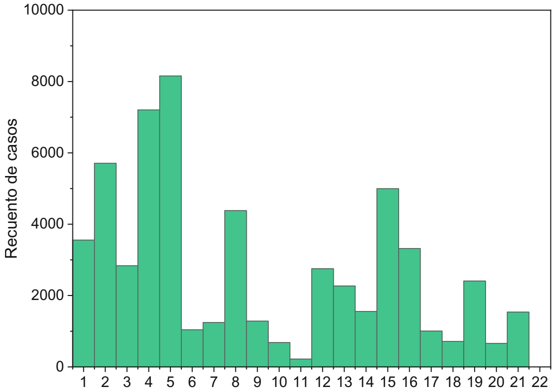

Fig. 11. Count of positive cases for Covid-19 in the period from August 31, 2020 to October 1, 2020 (month after the strict quarantines by localities), for the different localities in Bogotá, being: 1. Usaquén, 2. Engativá, 3. Fontibón 4. Kennedy, 5. Suba, 6. Teusaquillo, 7. Chapinero, 8. Ciudad Bolívar, 9. Barrios Unidos, 10. Los Mártires, 11. La Candelaria, 12. Rafael Uribe Uribe, 13. Puente Aranda, 14. Tunjuelito, 15. Bosa, 16. San Cristóbal, 17. Santa Fe, 18. Antonio Nariño, 19. Usme, 20. Outside Bogotá, 21. No data, 22. Sumapaz

5 Conclusions

This research focused on the search of keywords related to the pandemics, and a space-time analysis of vaccines, variants and mitigation campaigns was made. In this way, it is possible to create geographic models aiming to identify correlations between variables and georeferenced aspects in large and small cities. Finally, the right identification of variables and risk factors allowed us to find and analyze aspects that facilitate the visualization of virus behavior and containment factors that could lower the infection rate and mortality.

For the opening of different economic activities, especially those related to tax-free days in 2020 and 2021, and the emergence of the Omicron variant, had a negative effect on the reported number of cases, generating several peaks of contagion after their occurrence. On the other hand, vaccination, especially starting from stages 4 and 5, had a positive effect on the number of contagions, achieving a decrease in positive cases after its implementation, with the added value that these effects were sustained over time. Local quarantine had the least impact, as although it allowed for containment of positive cases in certain areas of the city, its effect was not sustained in the long term, and contagion trends persisted during and after strict quarantine measures.

The technologies used in detailed data analysis allow public health experts to better understand the spread of the virus. The identification of patterns and trends is crucial for designing strategies for the prevention and treatment of infectious diseases.

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How Teaching Quality and Students' Academic Emotions Influence University Students' Learning Effecitiveness

Yun Wang[1](✉) and Keng-Chih Hsu[2]

[1] Department of Fashion Design and Management, National Pingtung University of Science and Technology, Pingtung, Taiwan, Republic of China
yunw@mail.npust.edu.tw

[2] Language Center, National Pingtung University of Science and Technology, Pingtung City, Taiwan, Republic of China
awilliamhsu@mail.npust.edu.tw

Abstract. With the rapid development of global science and technology and the continuous introduction of new knowledge, coupled with the popularization of higher education, the quality of teaching provided by teachers to students is gradually being valued. University education, as a talent training place where most students are in line with the society, will not only affect the students' learning effectiveness but also their future career development for the emotions and self-affirmation. This study uses the academic emotion theory as the research foundation explores the relationship between teachers' teaching quality, students' academic emotions, and learning effectiveness. University students who took statistics and management requirement courses in the Business school were selected as the research objects. A total of 479 questionnaires were distributed and 417 valid questionnaires were recovered by using the intentional randomly sampling method. SPSS20.0 and SmartPLS3.3.2 statistical software were used to analyze the data, and the analysis methods included descriptive statistics, reliability and validity testing and structural model analysis. The results of the study show that: 1. Teaching quality and academic emotions in pleasant have significant positive effects on learning effectiveness. 2. Academic emotions in boredom has significant negative effect on learning effectiveness.

Keywords: Teaching quality · Academic emotions · Learning effectiveness

1 Introduction

Education can stimulate the development of human civilization while schools are one of the main learning environments for human. The most important activities in schools are "teaching" and "learning", in which teaching is a complicated and continuous process with teachers and students are involved, as well as external factors such as teaching methods, materials, quality, learning environment, learning motivation, learning effectiveness, etc. Education is more than equipping students with knowledge and skills,

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it's the process of increasing one's value. Professional skills of students from different departments are closely related to their general abilities. Thus, as a place for cultivating talents, universities should take factors such as essential professional knowledge, skills, abilities and values into consideration during curriculum planning. Taiwan Ministry of Education [1] show that the net enrolment rate of higher education has increased by 6.59%, from 64.44% in 2008 to 71.03% in 2019, indicating an increasing trend in population with higher education over the past decade. Heynemen [2] mentioned that facing the competitive pressure and crisis due to popularization of higher education, it is important to increase student enrollment rate, meanwhile, improve the quality of education.

Management is a kind of improvisational thinking course that integrates art and science, basic theories, which emphasizes practicality to be valuable and helpful for enterprises [3]. It is a compulsory subject in business schools and an elective subject in other colleges, and is also a required test subject in many business administration institutes and entrance examinations. In practice, management knowledge is also the basic knowledge and skill that employees in any enterprise, factory and industry should possess. Statistics, on the other hand, is a type of applied science, which includes the integration, management, analysis, and interpretation of various data. It is an essential tool in modern society and has taken an important role in various schools and departments. British novelist H.G. Wells also said, "Statistical thinking will one day be as necessary for efficient citizenship as the ability to read and write." [4]. Most of the students think that statistics is just numbers and formulas, and find it terrifying without thorough understanding. Research have found that both college and graduate students are afraid of taking statistics classes, and they also feel anxious and uneasy about learning it [5].

Research on students' emotions include emotion management, emotional intelligence, emotional adjustment, etc. among which academic emotions are inseparable from students' learning experiences [6]. Making students feel happy about learning, have positive academic emotions, be eager to learn, and believe that they can succeed is way more inspiring than simply "teaching". Sparking students' interest and making it last, as well as creating a happy atmosphere is certainly effective, but what is more important is the sense of achievement that students gain during the learning process. As mentioned above, this study taking management and statistics courses students as objects and investigate the relationship among university students' perceptions of teaching quality, academic emotions, and learning effectiveness. The results of this analysis will be used to provide suggestions for teaching in university.

2 Review of Literature

2.1 Academic Emotion Theory

1) Cognitive-motivational model

Pekrun (1992) [7] proposed the cognitive-motivational model, which refers to the cognition of learning motivation, called "cognitive assessment", as a mediating variable between academic emotion and academic achievement. Pekrun et al. (2002) [8] continued Pekrun's [7] point of view, academic emotions mainly affect academic achievement through four changed foctors of the cognitive assessment mechanism which included learning motivation, learning strategies, cognitive resources and self-regulation on learning.

2) Control-Value Theory

After cognitive-motivational model, Pekrun (2000) [9] proposed the "control-value" theory, where control cognition and value cognition are collectively known as "cognitive assessment". Control cognition refers to the subjective cognition of an individual's influence on their own actions and outcomes, including cause and effect expectations, attributions of success and failure and the assessment of one's ability. Value cognition may have intrinsic or extrinsic value for the learner. Intrinsic value is the value of the situation, action, or outcome itself, while extrinsic value is the acquisition of other valuable outcomes. The learner's cognitive assessment is a mediating variable between the environment and academic emotion, meaning that the environment influences academic emotions through the cognitive assessment. Later Pekrun simplifying the environmental variables into teaching quality, value inducement, autonomous support, goal structure expectation, and achievement feedback and outcome. He believed that environmental variables provide learners with important information that motivates them to carry out control and value assessment, therefore provoking academic emotions [10].

Pekrun et al. [8] defined academic emotion as emotions that learners generate while learning, which is related to their academic activities. They also stated that academic achievement is the learning outcome that is transformed from variables such as environment, cognitive assessment, and the influence of academic emotion. Pekrun [10] later integrated the previously proposed Cognitive-Motivational model and Control-Value theory into the Academic Emotion theory, which stated academic emotion mediates the learning environment and the learners' academic achievement. The Academic Emotion theory Pekrun et al. [11] proposed is widely used by researchers, and is one of the comprehensive theories of academic emotion [12], as shown in Fig. 1.

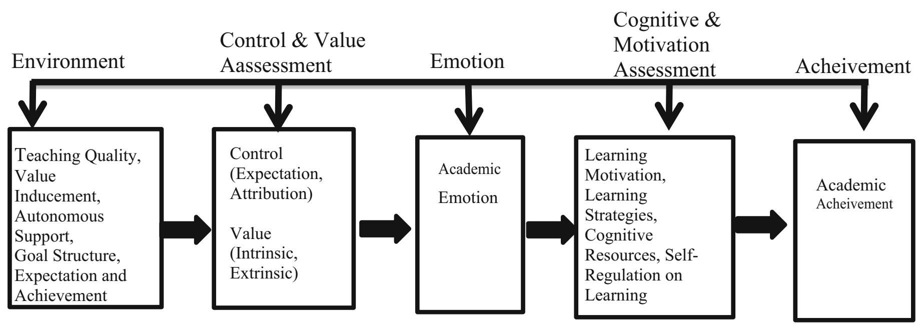

Fig. 1. Acedemic emotion theory framework, *Note.* Adapted from Pekrun, Frenzel, Goetz, & Perry [11].

2.2 Academic Emotions

Emotion is a subjective state of excitement provoked by internal or external stimuli, which is produced by the interaction of subjective feelings, physiological responses, cognitive evaluation and behavioral expressions, and can easily lead to motivated behaviors [13]. According to Pekrun et al. [8], academic emotions are the various emotions related to academic activities that learners generate during learning, including those triggered by listening to lectures, reading textbooks, preparing for exams, and writing assignments. Nine emotions fall within the scope of academic emotion: hope, despair, anxiety, anger, disinterest, shame, pride, happiness, and reassurance. The study also found that emotions can be divided into two aspects according to the level of energy and motivation the individual felt, namely "activation" and "deactivation". These two aspects are as important as positive and negative emotions, where "activation" refers to the stimulation of ongoing learning activities, which allows the individual to get energy and motivation. "Deactivation" on the other hand is the inhibition of ongoing learning activities, making the individual lack energy and motivation.

By pairing positive and negative, activation and deactivation, academic emotions can be classified into the following four categories: (a) Positive activating: Positive events trigger positive activating emotion, which is beneficial to learning and further motivates the learner to continue learning, e.g., feeling happy, hopeful or proud during learning. (b) Positive deactivating: Cessation of negative event triggers positive deactivating emotion. This emotion is beneficial to present learning, but delays the continuity of learning and reduces the formation of learning motivation. In the long run, it enhances the next learning stage, e.g., feeling relaxed or relieved after an exam. (c) Negative activating: This type of emotion motivates learners to generate a stronger motivation to overcome difficulties, or put more effort into learning to avoid failure; on the other hand, learners may also blame others for their failure, e.g., anger, anxiety and shame. (d) Negative deactivating: When learners do not have the ability to change learning activities and results, or lack the willingness to improve, they generate negative deactivating emotions. This type of emotion has a negative impact on learning, no matter in the short term or long term, e.g., hopelessness or boredom. Pekrun et al. [8] designed the Achievement Emotions Questionnaire (AEQ), which was first presented in German and later translated into English. The scale was divided into positive and negative dimensions, and contains nine types of emotions mention earlier which is the first self-report instrument used to assess the academic emotions of university students. It has achieved good reliability and validity, and are now the main instrument for assessing academic emotions [14].

2.3 Teaching Quality

"Teaching" is the imparting of knowledge or skills by the instructor, while "learning" is the behavior or results of a learners during the teaching process. The two of them combined refers to the methods a teacher uses to enhance the cognitive activities of learners [15]. Teachers also need to consider the importance of " teaching quality". Garvin [16] defines quality as the perception of the product or service outcome from the customer's point of view, and Wilson [17] defines teaching quality as the optimal set of plans, lectures and assessments for students from various backgrounds. Chao [18] views "education" as a production system, and believes that "teaching quality" is a tool produced to satisfy the needs of students as well as a key factor that influences the learning outcomes. The pursuit of quality excellence is the most fashionable concept in education today, and every school and every teacher is striving to encourage development to improve the quality of educational output [19]. Yeh [20] thinks that the quality of teachers and students, equipment and other resources, administrative systems and culture, curriculum and activity experiences, school facilities and environment, teaching and learning, and student and alumni performance are all discussed in terms of teaching quality. According to Shang et al. [21], "teaching quality" changes with time and different educational goals, and the following findings were made with regard to the influence of teaching quality: (i) teaching quality has a direct cause and effect relationship with students' learning effectiveness; (ii) teaching quality affects students' learning satisfaction; (iii) teaching quality also influences learning motivation and academic performance.

Marsh [22] developed the Student's Evaluations of Educational Quality (SEEQ), with nine dimensions included: learning value, instructor enthusiasm, organization and clarity, group interaction, individual rapport, breadth of coverage, grading and examination, assignments and readings, and workload and difficulty. This evaluation has been widely adopted by researchers because of its high accuracy and consistency [23–25]. Ho et al. [25] used Marsh's SEEQ scale and modified it into four dimensions: instructor friendliness, value and enthusiasm, grading and workload, and breadth of curriculum. Lai and Peng [26] investigated the teaching quality on college students majoring in design, and adjusted the nine dimensions of SEEQ to four dimensions: teaching professionalism, teaching value, class interaction, and organization and clarity.

2.4 Learning Effectiveness

Learning is the process of gaining knowledge or changing one's behavior because of experience [27]. Learning effectiveness is a process that results in long lasting changes in one's behavior through practice [28]. Learning effectiveness is an indicator of learning outcome, which enables learners to understand their learning condition and serves as a basis for improvement between learners and instructors [29]. Learning outcomes can be used as an indicator for students to understand their own learning result, and serve as a basis for teachers to improve their teaching and students to improve their learning [30]. To be more specific, any knowledge, skills, values and changes in behavior and attitudes acquired through school-based teaching or other learning experiences can all be considered as learning outcomes [31].

According to Wang and Liao [32], learning effectiveness can be measured by many dimensions, including learning performance, learning satisfaction, learning self-assessment, participation, class assessment, learning achievement, self-efficacy, learning experience, and interest in learning. Lin et al. [33] considered that the learning effectiveness of higher education lies mainly in the cultivation of students' core competencies and competitiveness, and developed a dual-oriented teaching evaluation by integrating "instructors' teaching effort" and "students' learning effectiveness". The contents mainly focus on teaching and learning of general subjects, the instructors' teaching effort includes aspects such as "course content and teaching arrangement", "teaching methods and interaction with students" and "assessment and feedback", while student learning outcomes include "knowledge", "ability" and "attitude".

2.5 Research Hypothesis Development

1) Teaching quality and learning effectiveness - research on college students and found that instructor friendliness, value and enthusiasm, and rating and workload were the key factors in teaching quality that affect the overall learning satisfaction [25]. Li and Jiang [34] investigated the teaching quality, learning satisfaction and learning effectiveness of swimming lessons with high school students and found that teaching quality has a positive effect on learning outcomes. Based on these studies a hypothesis was proposed: H1: Teaching quality has a positive and significant effect on learning effectiveness.

2) Teaching quality, academic emotion, and learning effectiveness – Liu [35] studied academic emotions among 400 university students and found that there were more negative emotions than positive ones. Moreover, the academic performance was negatively correlated with three negative emotions: anxiety, boredom, and disappointment, and positively correlated with five positive emotions: relaxation, pride, happiness, hope, and interest. Yang [36] explored the relationship between emotional intelligence, leisure satisfaction and quality of life among university students in Taiwan, and found that emotional intelligence has a significant positive effect on both leisure satisfaction and quality of life. Huang and Wang [37] targeted on audiences watching a wildlife children's theatre, and used the Stimulus – Organism- Response model to investigate whether the audience's emotion during a play mediates the relationship between theatre service environment quality and audience satisfaction. The results showed that "experiential emotion" had a partial mediating effect on the relationship between "service environment quality" and "audience satisfaction".

Previous studies on quality, emotion and outcome inferred that teaching quality has a significant effect on academic emotion, and academic emotion has a mediating effect on the relationship between teaching quality and learning outcomes. This study divides academic emotion into three dimensions and proposed hypotheses: H2a: Teaching quality has a positive and significant effect on academic emotion in pleasure; H2b: Teaching quality has a positive and significant effect on academic emotion in anxiety; and H2c: Teaching quality has a negative and significant effect on academic emotion in boredom. H3a: Academic emotions in pleasure have a positive and significant effect on learning effectiveness; H3b: Academic emotions in anxiety have a positive and significant effect on learning effectiveness; H3c: Academic emotions in boredom have a negative and significant effect on learning effectiveness.

3 Research Methods

Based on the contral-value theory of achievement emotions [10], this study takes teaching quality as the environmental antecedent variable and academic emotions as cognitive evaluation, to examin the impact on learning effecvitveness. The research framework is shown in Fig. 2.

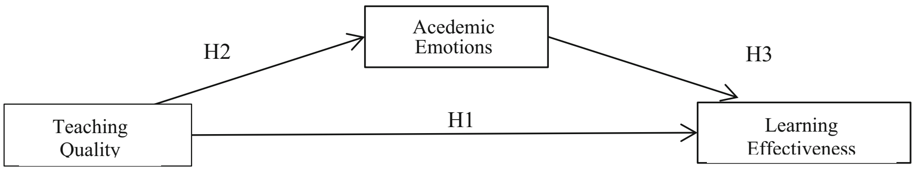

Fig. 2. Research framework

3.1 Measures and Insturments

All variables were measured using items adpted from previous research. In this study, a questionnaire was designed for the research subjects with the five-point Likert scale from 1 "strongly disagree" to 5 "strongly agree" respectively to measure subjects' response. (1) Teaching quality (TQ) scale was adopted from the SEEQ scale of Marsh [22] with modification in its dimensions in accordance with the teaching quality of the curriculum inquiry [24, 25]. Total 16 questions of the teaching quality are divided into 11 questions in "teacher teaching" and 5 questions in"reasonable homework". (2) Academic emotion (AE) scale was edited based on Pekrun et al. [8] four dimensions of positive excitation, positive inhibition, negative excitation, and negative inhibition. Since the academic emotion discussed in this study is the emotional feeling derived from the learning process, positive inhibition belongs to the emotion after learning achievement, was not discussed here. A total 11 questions of the academic emotions are divided into three dimensions with 3 questions of positively excitation in "pleasure", 4 questions of negatively excitation in "anxiety", and 4 questions of negatively inhibition in "boredom". (3) Learning Effectiveness (LE) scale refers to the "Student Learning Outcome" which adopted from Lin et al. [32] with adjustification to match the teaching effectiveness discussed in this research. The learning effectiveness is divided into 5 questions in "professional knowledge" and 4 questions about "attitude".

3.2 Sample and Data Collection

This study used intentional random sampling method, taking the students who are studying the compulsory courses of "Statistics" and "Management" in the School of Management of a southern university as the research objects. The questionnaires were distributed from May 4, 2021 to May 11, 2021. After eliminating incomplete and invalid questionnaires, the valid questionnaires were coded and archived, and SPSS20.0 and SmartPLS 3.3.2 statistical software were used as statistical data analysis tools. A total of 431 questionnaires were collected in this study, and 417 valid questionnaires were remained after deducting the questionnaires which had 2/3 unanswered. About 60% of questionnaires are from statistics course and ohters from management course; 62.3% are female students with the Industrial Management major accounts for majority, 36.2%, followed by the Hospitality Management Department accounted for 22.5%. These data were consistent with the ratio of gender and the students' number of departments in the School of Management.

4 Research Results

Software Smart Partial Least Squares (PLS) 3 was used to analyzed data. The PLS model is analyzed into two phases. First, the measurement model is assessed by examing the reliability and validity of the constructs which are covered in next Sect. 4.1. This composite reliability (CR), Cronbach alpha, and the validity of the constructs wchih included (1) convergent validity: each indicator's standardized factor load belonging to the construct must be greater than 0.5, and significant. And (2) discriminant validity: the average variance extracted (AVE) needs to be larger than the proposed threshold 0.50 was obtained from the square root of AVE and was greater than the correlations between the construct and other constructs in the model.

Second, path analysis in the structural model is evaluated with paths coefficients, R^2, and effect size $f^{\ 2}$ and q^2 which are demonstrated in 4.2 section. Path coefficients indicate the strength of direct relationships between constructs. The determination values of coefficient (R^2) are approximately 0.670 substantial, around 0.333 average and 0.190 weak. The effect size f^2 and q^2 measures if an independent variable has a substantial impact on a dependent variable and has values between 0.020–0.150, between 0.150–0.350 and exceeding 0.350, indicating a small, medium and large effect, respectively.

4.1 Measurement Model's Reliability and Validity

The results of the constructs reliability and validity are shown in Table 1. The research constructs are all first-order constructs except "teaching quality", which is covering "teacher teaching" and "reasonable task". Cronbach's α values of all constructs were between 0.804 and 0.962, and the CR of each construct was between 0.884 and 0.966, which showed that each construct had high reliability [38, 39]. All items' standardized factor loadings of each construct were between 0.772 and 0.957, and p values were all significant ($p < 0.001$) showed the convergent validity for constructs were good [40]. In addition, all constructs had convergent validity since their AVE were high between 0.686 and 0.892, indicating that the average explanatory power of the seven constructs for the indicators is more than 50% [41]. For discriminant validity Table 2 indicated that the square root of each AVE construct was greater than the correlation coefficient between other constructs.

4.2 Accessment Results for Measurement Model

The analysis results show that the measurement model's internal consistency, index reliability, convergent validity and discriminant validity have all met the academic requirements. Next, the structural model and hypotheses were evaluated after receiving a validated measurement model. The causal relationships among research constructs were found, as shown in Table 3. The research hypotheses are all significant with positive or negative path coefficients, excepting H3b, negative emotions in anxiety has no significant impact on learning effectiveness. Teaching quality has significant positive relationships to learning effectiveness, and academic emotion in pleasure and anxiety. Addtionaly, teaching quality has a significant negative relationship to acedemic emotion in boredom. Students' academic emotion in pleasure has positive effect on their learning effectiveness, on the otherside, boredom has negative effect on learning effectiveness.

Table1. Confirmatory factor analysis results

Second-order construct	First-order construct	Item	Factor Loading	α	CR	AVE
Teaching Quality				.962	.966	.686
	Teacher Teaching	1	0.836 ***	.953	.961	.755
		2	0.850 ***			
		3	0.901 ***			
		4	0.884 ***			
		6	0.888 ***			
		7	0.885 ***			
		9	0.866 ***			
		10	0.836 ***			
	Task Reasonable	11	0.772 ***	.906	.930	.728
		13	0.880 ***			
		14	0.872 ***			
		15	0.872 ***			
		16	0.865 ***			
Positive pleasure		1	0.942 ***	.939	.961	.892
		2	0.957 ***			
		3	0.934 ***			
Negative boredom		5	0.832 ***	.804	.884	.717
		6	0.857 ***			
		7	0.852 ***			
Negative anxiety		8	0.908 ***	.894	.927	.760
		9	0.851 ***			
		10	0.907 ***			
		11	0.818 ***			
Learning Effecitveness		1	0.841 ***	.935	.947	.719
		2	0.844 ***			
		3	0.865 ***			
		4	0.815 ***			
		5	0.842 ***			
		6	0.869 ***			
		7	0.857 ***			

Note. *** p-value $<$ 0.001; α = Cronbach's α; CR = composite reliability; AVE = average variance extracted

Table 2. Fornell-Lacker discriminant validity

Construct	TT	TR	PP	NA	NB	LE
TT	**0.869**					
TR	0.837	**0.853**				
PP	0.712	0.669	**0.944**			
NA	0.372	0.356	0.434	**0.847**		
NB	-0.640	-0.597	-0.611	-0.283	**0.872**	
LE	0.636	0.603	0.716	0.406	-0.564	**0.848**

Note. TT = teacher teaching; TR = task reasonable; PP = positive pleasure; NA = negative anxiety; NB = negative boredom; LE = learning effeictveness. The diagonal bold values are the square roots of AVE

5 Explanatory Power for Measurement Model

The assessement results for explanatory power of the model can be found in Table 4. The results indicated we had high explanatory power for learning effectiveness ($R^2 = 0.681$) and moderate explanatory power for positive emotion in pleasure ($R^2 = 0.513$) and negative emotion in boredom ($R^2 = 0.414$). While emotion in negative anxiety only have weak explanatory power ($R^2 = 0.143$) (Hair et al., 2017). We had a larger effect size (f^2) in the paths of "teaching quality on academic emotion pleasure" ($f^2 = 1.052$), and "teaching quality on academic emotion boredom" ($f^2 = 0.706$). Medium effect size was found in the path of "teaching quality on academic emotion anxiety" ($f^2 = 0.168$), and remaining effect sizes are small [42]. The SRMR of the research model is 0.079 < 0.08, which means that the model fit is good; NFI is the standard fit index is 0.810; RMS_theta is 0.127; overall, the model fit is good, which has reached the academic requirements for the overall model fit.

Table 3. Assessment results of research model

Research Hypothese		Relation	Path Coefficients	t	Decision	95% CI LL	95% CI UL
H1	TQ → LE	Positive	$.128^{**}$	2.929	Support	0.042	0.212
H2a	TQ → PP	Positive	$.716^{***}$	24.847	Support	0.655	0.768
H2b	TQ → NA	Positive	$.378^{***}$	8.005	Support	0.274	0.464
H2c	TQ → NB	Negative	$-.649^{***}$	17.692	Support	-0.706	-0.565
H3a	PP → LE	Positive	$.258^{***}$	4.689	Support	0.152	0.363
H3b	NA → LE	Positive	.031	0.841	Not Sup	-0.042	0.103
H3c	NB → LE	Negative	$-.107^{*}$	2.509	Support	-0.190	-0.025

Note. TQ = teaching quality; PP = positive pleasure; NA = negative anxiety; NB = negative boredom; LE = learning effeictveness

Table 4. Structural model evaluation

Relations	R^2	f^2	q^2	Model fit
TQ → LE	0.681	0.021	0.299	SRMR = 0.079
PP → LE		0.077	0.365	
NA → LE		0.002	0.117	NFI = 0.810
NB → LE		0.019	0.230	
TQ → PP	0.513	1.052	0.457	RMS_theta = 0.127
TQ → NA	0.143	0.168	0.099	
TQ → NB	0.414	0.706	0.315	

Note. TQ = teaching quality; PP = positive pleasure; NA = negative anxiety; NB = negative boredom; LE = learning effecitveness

6 Conclusions and Suggestions

6.1 Research Conclusions

The purpose of this study is to investigate the effects of teaching quality, and academic emotion on learning effectiveness of university students, and offer suggestions to improve students' learning situation based on the results and analysis in this study. Teaching quality has a significant positive effect on learning effectiveness, meaning that the teaching quality students perceive in class directly affects their learning effectiveness, which matches the research findings [34]. Teaching quality had a positive and significant effect on academic emotion (happiness), meaning that the higher the teaching quality, the more happy emotion students sense, which is consistent with the study where service quality has a positive significant effect on tourists' positive emotions [43]. Academic emotions (pleasure) have a positive and significant effect on learning effectiveness, meaning that the happier students feel, the better their learning outcomes, which matches the results [44]. In this study, happy academic emotions are closely related to teaching quality and learning effectiveness. Happiness is a positive activating emotion, which benefits current learning and motivates learners to continue learning. From the results of the research, we know that the teaching methods, description of contents, and the degree of difficulty of homework and exams are all important. It affects the happiness and anticipation that students feel during classes, and it also indirectly affects whether students understand the content of the course.

Teaching quality has a negative and significant effect on academic emotions in boredom, meaning that the lower the teaching quality, the more bored students are. Academic emotions in boredom has a negative significant effect on learning effectiveness, meaning that the more bored students are, the lower their learning effectiveness. In this study, bored academic emotions were negatively correlated with teaching quality and learning outcomes. Boredom is a negative deactivating emotion, meaning that it occurs when learners do not have the ability or willingness to improve learning activities, which has a negative impact on learning. When the instructor's teaching content is not clear, the teaching style does not arouse interest, students can't handle assignments, or the teacher's grading is not reasonable, all may lead to negative deactivating emotion and make students feel that the course is not interesting or not useful.

In this study, anxiety is a negatively activating emotion, meaning that this emotion stimulates learners to develop a strong motivation to overcome difficulties they encounter in learning, so when students worry that they will not be able to keep up, they become anxious and work harder in classes. Although anxiety sounds like a negative word, it actually stimulates students to take an active role in learning because of such negative emotions. Teaching quality has a positive and significant effect on academic emotions (anxiety), meaning that the higher the teaching quality, the more anxious students are. This study also found that when students feel anxious, teaching quality did not have a significant effect on learning outcomes, indicating that students' anxiety is not beneficial for the learning process. Students' academic emotions may vary during the learning process depending on the teacher's teaching style, content preparation, and grading rubrics. This study suggests that teachers can generate students' interest and motivation through interactive teaching methods, such as making contents more down to earth, introducing new topics, social issues, giving additional information about recent events, and group discussions. This reduces students' reluctance to learn and to create a happy and anticipating academic emotion, which helps improve learning effectiveness.

7 Practical Management

Traditional views believed that students should study hard and get good grades, but with the development of technology and the popularization of higher education in the modern society, students' emotional management is more important than examination results. Emotions are one of the important factors that affect a person's development, and studies have found that positive emotions (happiness, anticipation, joy) have the most significant and beneficial influence. Therefore, it is recommended that parents and teachers sould encourage students to participate in club and outdoor activities to increase positive thinking through interaction with others, or to express negative feelings through communication, in order to build a confident and happy mood. They can also help students understand how to control their emotions through group interaction. Emotions do not only affect academic performance; positive emotions can also lead to have better performance in the future.

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An Analysis of Online Fatigue, Problematic Internet Use, and Perceived Learning Effectiveness Among High School Students in the Philippines

Gregory Ching[1] (✉) and Jenny Lynn Gungon[2]

[1] National ChengChi University, Taipei City, Taiwan
gching@nccu.edu.tw

[2] Malabon National High School, Malabon, Philippines

Abstract. During the pandemic, online learning was challenging in the sense that it was difficult to assess its effectiveness. In the Philippines, not all students are able to study remotely. Various learning modes provide students with different options for achieving their learning objectives. In the context of online learning, the current study will attempt to analyze the level of online fatigue, problematic internet use, and the perception of learning effectiveness among a sample of high school students in the Philippines during COVID-19. Data were collected in January 2022 prior to the start of the gradual transition to face-to-face classes in the Philippines. Students' online fatigue, problematic internet use, and perceived learning effectiveness were collected through a survey, followed by random interviews with students. Interestingly, the results indicate that students' problematic internet use and perceived learning effectiveness are closely related. Although the students believe they are learning, many issues have arisen during the interview that are nuances for at home learning. It can be concluded that despite the fact that students are already digital natives, online fatigue and problematic internet use are still prevalent. Infrastructure and professional development are necessary to effectively handle such situations in the future.

Keywords: COVID-19 · online learning · online fatigue · problematic internet use · learning effectiveness

1 Introduction

School closures are generally observed during COVID-19, similar to the situation in the Philippines [1, 2]. During the time of pandemic, in order for Filipino students to continue learning the government started the learning continuity plan, which is a combination of distance education and remote learning [3]. Nevertheless, many difficulties were observed, leaving many Filipino parents in doubt about the level of learning that their children are achieving [4–6]. As part of remote education in the Philippines, a wide range of teaching methods are offered, including online learning, blended learning, streaming

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media, and printed instructional materials [7, 8]. Recent studies in the Philippines have noted several problems with the current learning continuity plan, such as: the lack of access to effective learning platforms and insufficient internet bandwidth [9–11]. In addition, it is also found that in order to improve the quality of teaching, there is an urgent need for teacher training [12, 13]. It is announced by the Department of Education that a limited number of schools will have the opportunity to offer face-to-face education starting in December 2021 [14–16]. Despite the constant treat of new COVID-19 variants, schools in the Philippines have gradually reopened [17, 18].

For both faculty members as well as students, online learning presents a number of challenges. For example, how to maintain a balance between work and life, disruptions at home, difficulties maintaining a personal bond with students, not being able to read body language and distinguish tone from tone, and having less control over the attendance of students [19]. In reality, the sudden transition to online instruction has left many teachers feeling uncertain, as most teachers have never been trained in online pedagogy [20]. Due to the sudden switch from classroom face-to-face teaching to online instruction and the stress caused by the pandemic, teachers and students alike are most likely to suffer from burnout [21, 22]. In addition, it should be noted that the psychological effects due to the constant use of video-conferencing (more commonly used during COVID-19 are Google Meet, Microsoft Teams, and many others) have led to new situations of occupational distress [23], which symptoms that are indicative of low motivation, physical and mental exhaustion, lack of energy, and poor concentration for both teachers and students alike [24].

With these concerns in mind, the current study examined the levels of online fatigue, problematic internet usage, and perceptions of learning effectiveness among a sample of high school students in the Philippines during COVID-19. Additionally, some qualitative insights were collected to reveal how students experienced online learning during the outbreak of the pandemic. The subsequent section will provide a brief background literature regarding online fatigue and problematic internet use.

1.1 Online Fatigue

Over the course of COVID-19, online fatigue has become quite common [25]. Wicks [26] mentioned that there are several reasons why teaching online or video-conferencing is quite troublesome for many. First of all, a screen full of headshot videos can be difficult to track and interpret vocalizations, gestures, and communication movements. Additionally, students may not turn off screen notifications, and may be distracted or tempted to multitask during class time. Thirdly, when there is a synchronous class meeting, attention is usually shown by looking at the webcam for long periods of time, which may become tiring (p. 6). In addition, the lack of face-to-face communication, socialization, and interaction leads some to lose attention while creating stress, frustration, boredom, and fatigue [27].

Bailenson [28] also proposed several causes for online fatigue. First, *eye gaze at a close distance*, which is typically reserved for close relationship and is now quite common during video-conferencing. A second issue is *cognitive load*; in a face-to-face interaction, non-verbal communication (such as gestures and non-verbal cues) takes place naturally, but is quite complicated and difficult to convey in video-conferencing.

The third will be *an all-day mirror*, whereby every moment of the online instruction will be spent looking at yourself. Lastly, there is *reduced mobility*; unlike traditional face-to-face classes, teachers can move around the classroom, whereas online instruction requires that we sit in front of a computer (pp. 2–4). Furthermore, Riedl [29] also mentioned that the *asynchronicity* (the lack of precisely timed vocalizations, gestures, and movements) *of communication*, *lack of body language and eye contact*, *self-awareness* (tendency of looking into mirror), *multiple-faces*, and *multi-tasking*, as major causes of online fatigue.

Other studies have also found that there are yet plenty of precursors to online fatigue. Some have found that student academic performance, internet connection stability, attitudes towards video-conferencing, frequency and duration of video-conferencing as key indicators of online fatigue [30]. Furthermore, users' attitudes, frequency, duration, and burstiness (time between the sessions) are also some other important determining factors for online fatigue [31]. Online fatigue can be measured with using five different variables: general, social, emotional, visual, and motivational fatigue [31]. Importantly, recent studies show that online fatigue can be prevented by providing teachers with information and training on how to handle pressure, improving their IT competence, and introducing the principles of emotional intelligence, thus preventing burnout in the process [32].

1.2 Problematic Internet Use

Besides online fatigue, another common phenomenon which is amplified by COVID-19 is the problematic internet use [33]. Problematic internet use can be synonymous to the addictive or maladaptive use of the internet [34, 35]. Nowadays, this would also include excessive or addictive use of smartphone and tablets [36]. It has become so common not only among students but also among adults [37]. People tend to spend too much time online during COVID-19, which is a major cause of problematic internet use. Before the pandemic, problematic internet use was common among young people [38]. There is a negative impact of problematic internet use in adolescents, particularly when it comes to issues with emotional regulation [36]. Nonetheless, this can be remedy by developing good internet use habits, which includes monitoring excessive use and identifying signs of impairment in personal, family, social, educational, and occupational [33].

Even before COVID-19, it was well known that the Philippines had the highest internet addiction rate among Asian nations [39]. Furthermore, this was exacerbated by the advent of social networking sites that were at the same time coupled with the popular use of smartphones and other wireless devices. It has been found in recent studies that the fear of missing out is a significant factor contributing to the negative Internet use habits of Filipino adolescents [40, 41]. With students forced to study at home due to the pandemic, the issue of problematic internet usage would become even more prevalent.

2 Methodology

The current study is designed within a mixed-methods approach, with quantitative data including survey information regarding the students' level of online fatigue, problematic internet use, and perceptions of learning effectiveness, whereas qualitative data are obtained from random interviews with volunteer students during COVID-19 regarding their general opinions of online learning. Data were collected in January 2022 prior to the start of the gradual transition to face-to-face classes in the Philippines. Participants are 288 volunteer students studying in a public high school in the northern part of the metropolitan area in the capital city of the Philippines. Furthermore, 14 students (coded either F or M, signifying the participant's gender) volunteered to provide their individual views on their learning experiences while participating in online courses.

For research ethics, the present study was carried out as part of routine educational procedures. All data collected were not graded, and the students were free to participate without any repercussions. The teacher taught the course in the same way as she normally does. Except for the teacher, no one outside the classroom observed or interacted with the students. Additionally, no identifying information was collected. Finally, all participants were informed about the study's objectives and consented to participate.

Survey components included the standard background demographics of the students (gender, age, study level). *Online fatigue* is an eight items scale adapted from Fauville et al.'s [31] study, which is later validated using factor analysis. *Problematic internet use* is a four items scale derived from the Kelley and Gruber's [42] and Demetrovics et al.'s [43]. Lastly, the students' *perceived learning effectiveness* is a single item "*learning online has been effective and helpful for me*". All items were collected using 4 points Likert [44] type scale. The quantitative data were analyzed using descriptive statistics and group comparisons. Alternatively, thematic analysis is used to generate common themes from the qualitative interviews [45].

3 Results and Discussions

3.1 Levels of Online Fatigue

As part of an effort to understand the level of *online fatigue* among select high school students from the Philippines, several after-effect situations have been collected in order to determine the extent of online fatigue. These items were them subjected to factor analysis with Kaiser-Meyer-Olkin Measure of Sampling Adequacy having a value of 0.768 and Bartlett's Test of Sphericity having a value of 378.21 (df = 28, p value < 0.001), both within the valid parameters [46]. Table 1 shows that all parameters for adequate factor analysis were met, including the extracted variance, communalities, and factor loadings. Cronbach [47] Alpha reliability for the online fatigue factors are also acceptable with *general fatigue* = .66 and *motivational fatigue* = .64.

Table 1 also shows the resulting two subscales, namely *general fatigue* (mean = 2.43) and *motivational fatigue* (mean = 2.48), with the motivational mean being slightly higher than general fatigue. Interestingly, item MF3 "*I feel too tired to do other things*", with the highest mean score of 2.58 (moderately high) also coincides with the most prominent problem emerging during the interview. Typically, studying online during COVID-19 have been related to issues such as being more anxious, stressed, overwhelmed, tired, and even depressed [48].

General fatigue that occurs while learning online is usually caused by physical exhaustion. Both teachers and students complained of fatigue and heavy workloads during COVID-19 [49]. In addition, the decrease in face-to-face interactions has resulted in students feeling more negative, which in turn has diminished their motivation [50]; which inevitably leads to motivational fatigue. Additional insights were provided by the students during the volunteer sharing. For instance, students noted "*I'm too tired, I cannot focus anymore…*" [F12], "*After going online, I just want to sleep…*" [M2], and "*I'm just too tired…*" [M6]. The results of this study correspond to numerous studies that have observed that online fatigue occurs because of the increased amount of time spent online (online screen time) [49, 51].

Furthermore, as with the case of the Philippines (limited to the study participants), additional problems that can be considered as a cause of online learning stress are the lack of adequate information technology resources. During the interview, several students noted issues, such as "*having no internet at home…*" [F3], "*I don't have a cellphone…*" [F4], and "*the connection is also choppy… Lags all the time*" [M6]. As a matter of fact, these are among the additional factors that are also being cited as a reason for concern during online learning in the Philippines [52]. In reality, these negative experiences such as poor internet quality, lack of a quiet place to study, and financial difficulties are also noted in other countries [53].

Table 1. Factor analysis of online fatigue subscales.

Code	Variance explained (Alpha) / Items	Mean	SD	Communality	Factor loading
	General Fatigue / 24.92 (0.66)	2.43	0.66		
GF1	My mind feels drained	2.37	0.87	0.53	0.72
GF2	My body feels tired	2.50	0.92	0.55	0.71
GF3	My eyes hurt	2.38	1.08	0.45	0.66
GF4	I feel exhausted	2.47	0.86	0.45	0.65
	Motivational Fatigue / 24.13 (0.64)	2.48	0.67		
MF1	I don't feel like doing anything	2.44	0.94	0.59	0.76
MF2	I want to be alone	2.49	0.98	0.51	0.71
MF3	I feel too tired to do other things	2.58	0.99	0.44	0.63
MF4	I dread doing other things	2.40	0.96	0.40	0.59
	Overall Online Fatigue (0.63)	2.45	0.56		

Notes. N = 288. SD = standard deviation. Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. Rotation converged in 3 iterations.

3.2 Levels of Problematic Internet Use and Perceived Learning Effectiveness

For the students' level of *problematic internet use* and perceived learning effectiveness, several items were collected. Cronbach [47] Alpha reliability for *problematic internet use* is computed at 0.64, also within the accepted value. Table 2 shows that overall problematic internet use is actually high with a mean score of 2.96. Furthermore, the item "*How often do people in your life complain about spending too much time online?*", with a mean score of 3.11, signifies that parents and guardians of the students are already complaining that students are spending too much time online. The results indicate quite high levels of problematic internet use. The findings of this study are in line with what previous studies indicate that Filipino youth tend to spend excessive time online [39], particularly during times of pandemic, when students are at home all day.

In terms of qualitative results, students indicated that they would much prefer to spend their time online since they don't have anywhere to go. For instance, "*besides learning online, I would watch YouTube videos or chat in messenger…*" [F13], "*going online relieves stress…*" [M6], and "*of course, I need to update my games…*" [M2]. Even though students acknowledged that they were tired of studying online, when it comes to spending time online for other reasons than studying, they are quite excited about doing so.

Overall, students gave a moderate rating of 2.55 (on a scale of 1 to 4 with 4 being the most satisfied) for perceived learning effectiveness. As further clarification, students have expressed their desire to study in a face-to-face class if it were not for the pandemic, but they are obliged to study online because of the pandemic. Despite limited resources, the current situation appears adequate, and students are somewhat satisfied. For instance, "*we actually have no choice but to study online…*" [F1] and "*this is still better than getting COVID…*" [M8].

Table 2. Descriptive statistics for problematic internet use and perceived learning effectiveness.

Code	Scale (Alpha) / Items	Mean	SD
	Problematic internet use (0.64)	2.96	0.73
PIU1	How often do you neglect household chores to spend more time online?	2.92	1.16
PIU2	How often do you spend time online when you'd rather sleep?	2.98	1.15
PIU3	How often do you try to conceal the amount of time spent online?	2.84	1.07
PIU4	How often do people in your life complain about spending too much time online?	3.11	1.15
	Perceived learning effectiveness		
EFF	Learning online has been effective and helpful for me	2.55	1.00

Notes. N = 288. SD = standard deviation. Overall Cronbach Alpha = .73.

3.3 Background Demographics Group Differences

To further understand online fatigue, problematic internet use, and the perceived learning effectiveness, several group comparisons were accomplished between the background demographics. Table 3 shows that there are actually no gender and age differences among the perceived general fatigue, motivational fatigue, problematic internet use, and students' learning effectiveness. As a result of these findings, gender and age do not appear to have a significant impact on students' general fatigue, motivational fatigue, problematic internet use, or their ability to learn effectively.

Table 3. Group comparisons of factors between gender, age, and study levels.

Items	*n*	%	GF	MF	PIU	EFF
Gender						
Female	213	74	2.45	2.48	3.00	2.54
Male	75	26	2.38	2.47	2.87	2.56
Group differences (t, p)			0.77 (0.440)	0.04 (0.972)	1.24 (0.216)	0.15 (0.881)
Age						
10	5	2	2.40	2.25	2.70	3.00
11	5	2	2.30	2.05	2.75	1.60
12	32	11	2.30	2.42	2.94	2.81
13	29	10	2.34	2.32	2.79	2.24
14	80	28	2.35	2.45	3.07	2.55
15	75	26	2.58	2.62	2.99	2.56
16	37	13	2.51	2.53	2.99	2.78
17	16	6	2.48	2.39	2.78	2.13
18	9	3	2.33	2.50	2.86	2.44
Group differences (F, p)			0.98 (0.451)	1.05 (0.401)	0.72 (0.678)	1.99 (0.050)
Study level						
Grade 7	66	23	2.32	2.30	2.84	2.67
Grade 8	60	21	2.32	2.29	2.74	2.30
Grade 9	96	33	2.48	2.60	3.04	2.64
Grade 10	66	23	2.56	2.64	3.17	2.52
Group differences (F, p)			2.26 (0.082)	**5.70 (0.001)***	**4.76 (0.003)***	1.82 (0.144)

Notes. N = 288. GF = general fatigue, MF = motivational fatigue, PIU = problematic internet use, and EFF = perceived learning effectiveness.
t = independent samples test, F = analyses of variance, and p = significant value.
*signifies significant group differences (in bold).

It is evident, however, from Table 3 that there are significant differences between students of higher grade levels in terms of motivational fatigue and problematic internet use. Upon further clarification during the interviews, students in high study levels do indeed spent more time online and tends to express more online fatigue. They are also the ones who are more willing to express their opinions. For instance, "*going online* *during the pandemic, takes my mind away from all these …*" [F1] and "*I have many chat friends… I would rather go online instead of studying…*" [F12].

3.4 Correlations Between Age, Study Levels, and the Different Factors

Lastly, Table 4 shows the intercorrelations between age, study levels, general and motivational fatigue, problematic internet use, and students' perceived learning effectiveness. Note that online fatigue factors and problematic internet use are highly correlated (shaded values). Interestingly, the results indicate that students' problematic internet use and perceived learning effectiveness are also closely related (values in bold). There is something quite interesting about this finding and it would make sense to have further studies performed on it. Furthermore, interviews were not able to show this phenomenon exists. The only explanation would be that although the students believe they are learning, many issues have arisen during the interview that are nuances for at home learning.

Table 4. Correlations between age, study levels, and the different factors.

Factors	Study level	GF	MF	PIU	EFF
Age	0.326**	0.096	0.098	0.021	-0.018
Study level		0.145*	0.215**	0.190**	-0.011
GF			0.433**	0.297**	0.113
MF				0.327**	0.078
PIU					**0.140***

Notes. N = 288. GF = general fatigue, MF = motivational fatigue, PIU = problematic internet use, and EFF = perceived learning effectiveness.
**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

4 Conclusions

Overall, the current study provides an insight into how online learning during COVID-19 has impacted a select group of high school students in the Philippines. In spite of the results following the trend of most studies, such as the increase in online fatigue and problematic internet usage during COVID-19, there are also some intriguing findings. Among these are students' acceptance of the emergency online learning situation and the intriguing relationship between problematic internet use and perceived learning effectiveness. To handle such situations effectively in the future, infrastructure and professional development are essential. Ultimately, online learning is still needed even without the pandemic.

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