International Journal of Instruction *October 2023 ● Vol.16, No.4*
e-ISSN: 1308-1470 ● www.e-iji.net *p-ISSN: 1694-609X*
pp. 987-1008

Article submission code: 20221205011911
Received: 05/12/2022 Revision: 17/05/2023
Accepted: 08/06/2023 OnlineFirst: 07/09/2023

Promoting Collaborative Learning in Elementary Mathematics through the Use of Gamification Flipbooks: A Mixed-Methods Study

Fery Muhamad Firdaus
Universitas Negeri Yogyakarta, Indonesia, *fery.firdaus@uny.ac.id*

Rahmat Fadhli
Universitas Negeri Yogyakarta, Indonesia, *rahmat.fadhli@uny.ac.id*

Zaenal Abidin
Universitas Muhammadiyah Surakarta, Indonesia, *za825@ums.ac.id*

This study examined student acceptability and experience with gamification in an elementary school mathematics course utilizing flipbook digital learning media. The technology acceptance model (TAM) (Davis, 1989) was used to assess student acceptability in digital learning media, which consisted of four components: perceived utility, perceived ease of use, behavioral intention, and actual use. The study employed a mixed-method approach, including a quantitative approach to student acceptance of technology and a qualitative approach to analyzing student experiences. The participants in this study were second-year students from the department of elementary school teacher education who took mathematics education courses in elementary school. There were 222 students in the research sample. Structural equation modeling (SEM) was used for quantitative analysis, while interactive models were used for qualitative analysis. All of the research variables were found to be positively and significantly correlated in this study. The gamification of flipbooks was well received by students, and it was backed up by the pleasant experiences that students had with gamification flipbooks during the instructional period. Significantly, the gamification flipbook's wide range of characteristics were found to contribute to its effectiveness in promoting student engagement and collaborative learning. The study revealed that gamification flipbooks can be an effective tool for promoting collaborative learning. Also, the study contributes to the growing body of literature on the use of gamification in education. The findings of this research highlight the potential benefits of incorporating gamification in the classroom, and suggest that educators should consider utilizing gamification flipbooks as a collaborative learning tool.

Keywords: student acceptance, student experience, gamification flipbook, technology acceptance model, educational innovation

Citation: Firdaus, F. M., Fadhli, R., & Abidin, Z. (2023). Promoting collaborative learning in elementary mathematics through the use of gamification flipbooks: A mixed-methods study. *International Journal of Instruction*, *16*(4), 987-1008. https://doi.org/10.29333/iji.2023.16454a

INTRODUCTION

This study analyses the students' acceptance of collaborative instructional media and their experience using it in the classroom. Acceptance in information technology refers primarily to the end-user. User acceptance can be defined as the willingness of user groups to use information technology products or devices to complete their projects (Adell et al., 2018). The existence of a user acceptance study needs to be carried out in line with the development of a new information technology system. (Adiyarta et al., 2018) explain that user acceptance can predict the level of use of information systems and technology. Users will determine the success of a new information technology product to determine the extent to which users can use the system or technology and what factors affect its use (Noh & Amron, 2021). This means that the advancement of information technology must be applied not only directly to users but also through a series of processes, particularly for user acceptance studies. Furthermore, user experience refers to the satisfaction component of product usability as well as user impressions that can be quantified objectively or subjectively (Zarour & Alharbi, 2017). The combination of user acceptance and user experience will demonstrate the level of acceptance and experience with information technology development products (Hodge, 2022). As a result, it is intended to be able to determine whether information technology products need to be enhanced or are ready for widespread usage.

User acceptance and experience studies can also be conducted in a variety of settings, including education (Presti et al., 2021). Teachers primarily use new media advancements to create a more engaging learning environment during online learning. Several current media generated by the instructor, particularly those related to technology, are thought vital to investigate factors of student acceptance and experience (Santos et al., 2022). As a result, it is appropriate and suited for students participating in the online learning process. The "technology acceptance model" (TAM) is a concept used to forecast and explain how people will use technology. As a result, the TAM model is perfect for assessing the outcomes of the gamification flipbook creation in this study.

The phenomenon of online learning during a pandemic raises many problems faced in higher education. Based on Giatman et al., (2020) research results, university students' readiness in Indonesia was only 43.9% in the first year. Online learning certainly has advantages for both students and teachers. However, the disadvantages have become more prominent. The hierarchy of problems that arise is a technical issue students and teachers face. Thus, the lack of interaction between students and teachers is the main problem that causes a lack of student participation in learning (Chung et al., 2020; Coman et al., 2020; Fernando et al., 2020).

As a result, online learning environments indirectly encourage educational innovation. The innovations generated in online learning led to the use of technology. The impact of the pandemic effect on learning disruptions decreased access to education and research facilities; educators and students relied on technology to ensure learning continued during the pandemic (Onyema, et al.., 2020). Therefore, innovation in education has begun to be needed to overcome gaps in the learning process in the educational

environment. Teachers in schools and higher education must be able to design and produce learning media to optimize the learning process according to the characteristics of the course. Thus, the digital learning environment must be developed through the integration of ICTs, the use of local and global networks and resources, the support and development of qualitatively new information processing technologies, and the active use of modern educational means, methods, and forms of teaching (Pinchuk et al., 2019).

Student engagement in the online learning process will also improve various aspects, including student happiness, increased drive to learn, a decreased sense of isolation, and improved performance in online courses (Martin & Bolliger, 2018). Learning media constraints that improve student involvement are currently a subject of concern in online learning. Capuno, et al., (2019) revealed that although there is no relationship between learning media and student performance, teachers need to use varied ways to increase student engagement in the learning process. Learning media development is undoubtedly one way to increase engagement in the learning process (Ilin, 2022). The online learning process has several weaknesses and mostly utilizes the learning management system (LMS). The lack of interaction (Arosyd & Rizman, 2020) and lack of physiological relationship between lecturer and students (Gunawan et al., 2020) are particularly concerning.

The social, educational, organizational, physiological, and didactic possibilities of traditional/face-to-face education can be improved by online learning (Gafurov et al., 2020). To improve these elements and encourage student collaboration, teachers must provide online learning resources. In addition, learning management systems and video conferencing platforms are frequently used for online education in universities nowadays, which has a number of disadvantages (Correia et al., 2020; Gladović et al., 2020; Wlodarczyk et al., 2020). In order to create novel learning media, an interactive and collaborative learning process must be designed.

According to (Ilmadi et al., 2020), online learning, particularly mathematics learning, does not run properly in Indonesia. During the learning process, the biggest hurdle in studying mathematics is the usage of e-learning (Qashou, 2022). In addition, it is necessary to develop e-learning or learning management systems to optimize mathematics learning. The same thing was also revealed that online mathematics learning at universities in Indonesia predominantly uses LMS. However, it is less attractive and has many limitations, such as multimedia-based learning media (Irfan et al., 2020).

Developing a flipbook was carried out based on a significant gap in the use of learning media in online learning (Sumarmi, et al., 2021). The use of flipbooks as learning materials is a form of innovation and encourages the learning process to be interactive (Sumarmi, et al., 2021). In addition, the gamification flipbook is becoming "an innovation." Gamification is widely applied to the discipline areas of technology, engineering, and mathematics (STEM) to increase student engagement and student feedback. Several research have looked at how gamification might be used in STEM (Indriasari et al., 2020; López et al., 2021; Playfoot, 2016). Gamification relies on

activities such as student reflection (Indriasari et al., 2020). Additionally, gamification flipbooks stimulate student collaboration (Bal, 2019).

During the trial stage of this research, an examination of student acceptance and experience in constructing the gamification flipbook was performed. The primary focus of the research is the creation of gamification flipbooks for university students. This research, on the other hand, focuses on the amount of students' acceptance and experience with gamification flipbooks. The MIKiR technique was used to create the applied gamification flipbook. One of the learning approaches is the MIKiR approach, which consists of four stages: experience, interaction, communication, and interaction (Prastyo, 2021).

There haven't been any research discovered that look at how well-liked gamification flipbooks are among students. Prior research centered on the creation of e-modules as interactive learning media (Fauziah & Wulandari, 2022; Hamid et al., 2021). However, there hasn't been much study on students' experiences and acceptance of it. The focus of this study will be on how well gamification flipbooks are received by students. The findings of this study are believed to be useful in creating flipbooks with a variety of other concepts, such as the gamification notion. The technological acceptance model (TAM), which may be used to gauge the efficiency of gamification in learning, will be employed for the acceptance analysis on the gamification flipbook in this study (Rahman et al., 2019). Thus, this study will investigate the perceptions of perceived utility, perceived usability, behavioral intention, and actual use of gamification flipbooks among students. Additionally, this research investigates how students perceive using gamification flipbooks.

METHOD

This research was conducted using a mixed-method approach that combines quantitative and qualitative methods (Molina-Azorin, 2016) of data collection and analysis in a study (Creswell, 1999). The mixed-methods research process in this study focuses on the acceptance of new learning media for students with a quantitative approach. It then analyses student responses as supporting data related to learning media with a qualitative approach.

An Indonesian public university called Universitas Negeri Yogyakarta is the location of this study. This study was carried out at UNY to carry out initial research and product development. The Elementary School Teacher Education Study Program is the precise location where the data gathering is taking place (ESSP). The participants in this study were ESSP second-year students. pupils taking math classes in elementary school, specifically. An intentional sampling method was used in this experiment. In this study, 222 students' responses to the research questions were gathered via total sampling. Participants in this study were all UNY students who attended lectures on teaching primary mathematics. They are instructed to use the gamification flipbook both individually and in groups, and then they are asked to complete an online survey at home about how they felt about the gamification flipbook developed and used in lectures. The gamification flipbook questionnaire was developed using references based

on a literature review. There were 25 questions related to students' acceptance of information technology products such as gamification flipbooks. The reviewers of the questions involved scholars and professionals in information technology, educational technology, and library science. The final version of the questions consisted of 25 questions established based on reviewers' feedback and covering four aspects of research variables.

Table 1
Cross-reference for the literature used in the questionnaire

Item	Operational definition	Literature	Number of items
Perceived of usefulness	The system is able improve work performance	(Alsabawy et al., 2016; Davis, 1989; Elkaseh et al., 2016)	6
Perceived ease of use	Users are easy to understand and use the system	(Davis, 1989; Elkaseh et al., 2016)	6
Behavioural intention	Behavioural tendencies to keep using technology	(Davis, 1989; Liao et al., 2018; Sánchez-Prieto et al., 2017)	4
Actual use	Actual usage of using the system	(Davis, 1989)	5

The quantitative analysis was processed using the modelling technique, namely structural equation modelling (SEM), and analysed using the SmartPLS application. The acceptance aspect will be analysed with variables in the TAM model: perceived usefulness (PU), perceived ease of use (PEOU), behavioural intention (BI), and actual use (AU). The degree to which a person believes that using a certain technology can boost job or academic performance is known as perceived usefulness. The degree to which one believes that using information technology may be comprehended simply is known as perceived ease of use. The actual usage of an information technology, which includes its frequency and duration, differs from behavioral intention, which is a person's behavioral propensity to use it continuously.

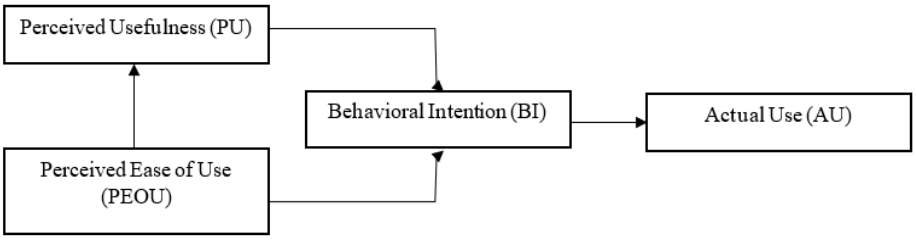

Figure 1
Technology acceptance model (TAM) (Davis, 1989)

H1: The Perceived ease of use (PEOU) of users has a significant effect and is positively correlated with perceived usefulness (PU) in using the gamification flipbook;

H2: The perceived ease of use (PEOU) of users has a significant effect and is positively correlated with behavioural intention (BI) in using the gamification flipbook;

H3: The perceived usefulness (PU) has a significant effect and is positively correlated with behavioural intention (BI) in using the gamification flipbook;

H4: The behavioural intention (BI) has a significant effect and is positively correlated with actual use (AU) in using the gamification flipbook;

The four hypotheses above are based on the results of research, which found that the three indicators are mutually correlated and positively affect actual use, which refers to the results of previous studies (Abdullah et al., 2016; Rachman & Napitupulu, 2018).

Furthermore, a qualitative approach was also used in this study to delve into ESP students' experiences in using gamification flipbooks. In this study, 23 students were interviewed using a semi-structured approach to obtain an overview of the use of gamification flipbooks, including its benefits, challenges faced, and limitations. The qualitative data was then analyzed to support the quantitative analysis using an interactive analysis model, namely data reduction, data presentation, and conclusion drawing/verifying.

FINDINGS AND DISCUSSION

Student' acceptance to gamification flipbook

Outer model

The outer model in Structural Equation Modeling (SEM), also known as the Measurement Model, refers to the construction of observed variables or indicators in the SEM model that function to measure latent constructs that cannot be directly observed (Jr Hair & Hopkins, 2014). Therefore, the outer model is used to measure observed variables and determine the extent to which indicators measure the constructs represented by latent variables. Several stages are conducted in this aspect, starting with examining outer loading, composite reliability (CR), AVE, and discriminant validity (cross loading).

The outer loadings represent the strength of the relationship between each indicator and its corresponding latent construct. Outer loadings can be assessed by examining the standardized factor loadings in the measurement model. A loading greater than 0.5 is generally considered acceptable (Hair Jr et al., 2017).

Table 2
Outer loading

	Actual Use	Behavioral Intention	Perceived Ease of Use	Perceived Usefulness
AU1	0.767			
AU2	0.799			
AU3	0.825			
AU4	0.810			
AU5	0.851			
BI1		0.868		
BI2		0.823		
BI4		0.823		
PEOU1			0.739	
PEOU2			0.751	
PEOU3			0.743	
PEOU4			0.785	
PEOU5			0.700	
PEOU6			0.815	
PEU1				0.749
PEU2				0.828
PEU3				0.789
PEU4				0.756
PEU6				0.784

The table above shows that all indicators have values above 0.5 and are therefore accepted. Another expert states that an outer value above 0.7 indicates indicator reliability (Hulland & Ivey, 1999). This means that all indicators in this study have values above 0.7.

The CR is a measure of the internal consistency reliability of the latent construct. It indicates how well the indicators of a construct are related to each other and how consistently they measure the construct. CR can be calculated by squaring the sum of the standardized factor loadings and dividing by the sum of the squared factor loadings and the residual variance. A CR value greater than 0.7 is considered acceptable (Hair Jr et al., 2017). The AVE is a measure of the amount of variance in the indicators that is explained by the latent construct. It indicates the degree of convergent validity of the construct. AVE can be calculated by summing the squared factor loadings for a construct and dividing by the sum of the squared factor loadings and the residual variance. An AVE value greater than 0.5 is considered acceptable (Hair Jr et al., 2017).

As a result, the validity test was carried out to determine whether the research instrument used as a measuring instrument was appropriate to achieve the target. The convergent validity test was carried out based on the outer loadings and average variance extracted (AVE) values. The indicator can be declared to meet convergent validity and have a high level of validity if the outer loading value is > 0.7 and the value of the average variance extracted (AVE) is > 0.5

Table 3
The average variance extracted (AVE) and composite reliability value

Variable	Average Variance Extracted (AVE)	Composite Reliability
Actual Use	0.658	0.906
Behavioural Intention	0.703	0.876
Perceived Ease of Use	0.572	0.889
Perceived Usefulness	0.611	0.887

As a result, all variables met the minimum value of Average Variance Extracted (AVE). The reliability test is then performed using composite reliability (CR), which is determined for each construct and completed with a cut-off value of 0.6. (Bagozzi, 1988). Table 1 revealed that the value of all variables was more than 0.6, indicating reliability.

The following figure 2 shows the results for the outer loading value.

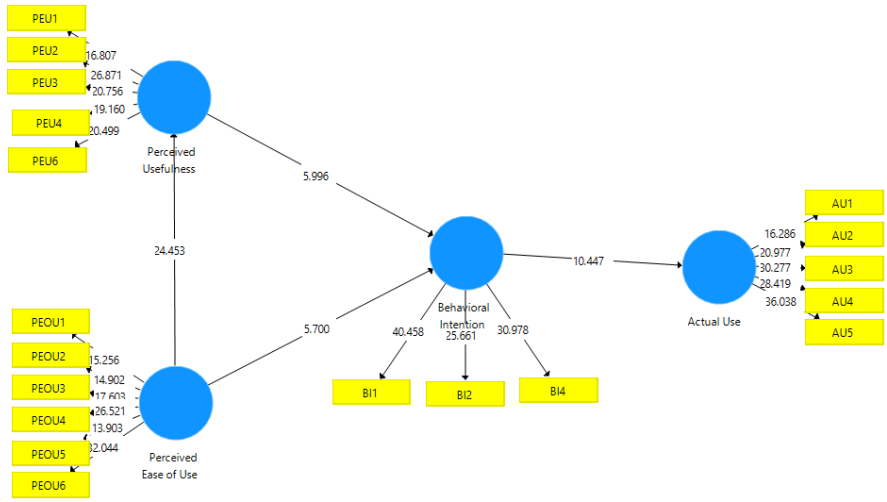

Figure 2
Validity test

The assessment of outer loadings, CR, and AVE is important in evaluating the measurement model and ensuring that the indicators are reliable and valid measures of the underlying latent constructs. These measures also provide information on the degree of consistency among the indicators and the extent to which they contribute to the measurement of the construct.

Cross-loading assessed by examining the standardized factor loadings of each indicator on all the latent constructs in the measurement model (Achjari, 2004). If an indicator has a high loading on its intended construct and low loadings on other constructs, it is said to have good discriminant validity. On the other hand, if an indicator has high loadings on multiple constructs, it may indicate poor discriminant validity.

Cross-loading assessment is typically conducted after the assessment of CR and AVE. This is because cross-loading can be affected by the reliability and convergent validity of the construct. If the CR and AVE values are low, it may indicate poor reliability and convergent validity, which can lead to higher cross-loadings. Therefore, it is important to first assess the reliability and convergent validity of the construct using CR and AVE before examining cross-loading. If cross-loading is found to be problematic, revisions to the measurement model may be necessary to improve the discriminant validity of the construct.

Table 4
Cross-loading

	Actual Use	Behavioral Intention	Perceived Ease of Use	Perceived Usefulness
AU1	0.767	0.395	0.377	0.272
AU2	0.799	0.408	0.372	0.310
AU3	0.825	0.550	0.403	0.391
AU4	0.810	0.434	0.293	0.276
AU5	0.851	0.481	0.418	0.373
BI1	0.503	0.868	0.627	0.637
BI2	0.487	0.823	0.638	0.658
BI4	0.433	0.823	0.684	0.658
PEOU1	0.300	0.479	0.739	0.539
PEOU2	0.317	0.549	0.751	0.563
PEOU3	0.273	0.641	0.743	0.658
PEOU4	0.400	0.659	0.785	0.697
PEOU5	0.410	0.469	0.700	0.466
PEOU6	0.399	0.668	0.815	0.668
PEU1	0.294	0.603	0.605	0.749
PEU2	0.341	0.613	0.621	0.828
PEU3	0.369	0.633	0.590	0.789
PEU4	0.202	0.562	0.671	0.756
PEU6	0.378	0.624	0.649	0.784

The results in the table above indicate that all indicators have high loading values on their corresponding constructs. Thus, discriminant validity in this study has been fulfilled.

Inner model

The inner model is the second component of a structural equation modeling (SEM) analysis, and it involves specifying the relationships between latent constructs in the model. The inner model represents the substantive theory being tested in the analysis. The inner model used to test hypotheses and make predictions about the relationships between the latent constructs. The results of the inner model also used to draw conclusions about the substantive theory being tested and provide insights into the underlying mechanisms that drive the relationships between the constructs. The stages involved in the inner model are to examine the R2 and F2 values using the bootstrapping method.

R^2 measures the amount of variance in the endogenous variables that can be explained by the exogenous variables. A high R2 value (above 0.3) indicates a good fit of the model and suggests that the exogenous variables are good predictors of the endogenous variables (Hair Jr et al., 2017).

Table 5
R Square analysis

	R Square	R Square Adjusted
Actual Use	0.321	0.318
Behavioral Intention	0.669	0.665
Perceived Usefulness	0.644	0.643

Table above showed that the exogenous variables in the model are good predictors of the endogenous variables, and that the model has a good fit. Then, it analyzes F^2 which measures the effect size of the exogenous variables on the endogenous variables.

Table 5
F square analysis

	Actual Use	Behavioral Intention	Perceived Ease of Use	Perceived Usefulness
Actual Use				
Behavioral Intention	0.472			
Perceived Ease of Use		0.195		1.811
Perceived Usefulness		0.203		

The results showed that that the exogenous variables in the model have a moderate effect on the endogenous variables, and that the model has a good fit.

The bootstrapping method is used for hypothesis testing. The significance value (two-tailed) t-value in this study was 1.96 (significance level 5%). The results of the analysis are shown in the following figure:

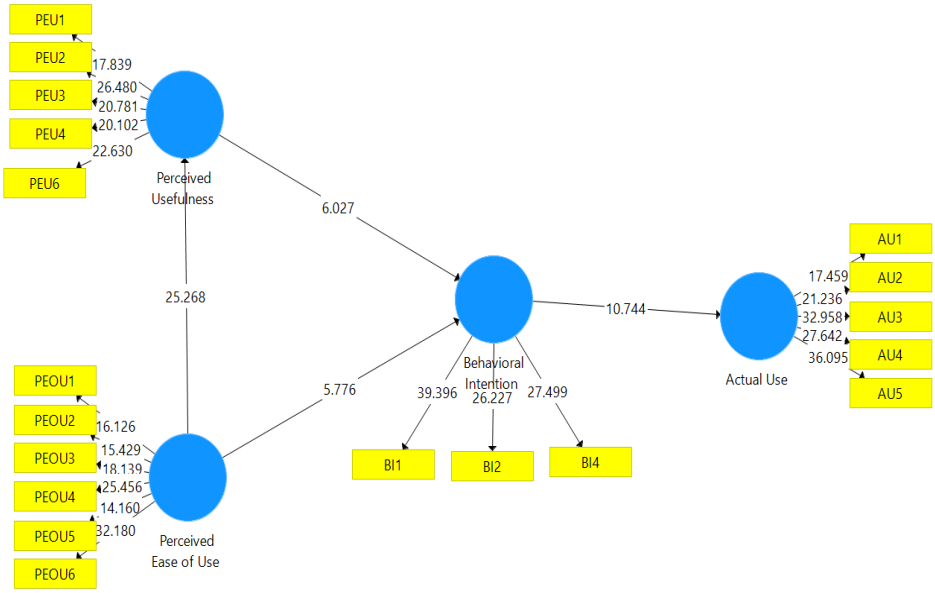

Figure 3
Bootstrapping method

Figure 3 above shows the results of testing the research hypothesis. The significance value between perceived usefulness and behavioural intention, which is 6.027 (higher than 1.96), and the significance value between perceived ease of use and behavioural intention show that each indicator has a significant effect on behavioural intention when taken together. i.e., 5.776 (greater than 1.96). Additionally, the behavioural intention has a beneficial impact on actual use, as seen by the significant value of 10.744 between behavioural intentions and actual use (greater than 1.96). Furthermore, the correlation value of 25.268, greater than 1.96, shows a positive correlation between perceived usefulness and ease of use. Moreover, path coefficient analysis is carried out to test the significance of the path. As a result, here is the t statistic score and variable significance.

Table 6
T statistic score and variables' significance

	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values	Significance
Behavioural Intention -> Actual Use	0.053	10.744	0.000	Significant
Perceived Ease of Use -> Behavioural Intention	0.074	5.776	0.000	Significant
Perceived Ease of Use -> Perceived Usefulness	0.032	25.268	0.000	Significant
Perceived Usefulness -> Behavioural Intention	0.072	6.027	0.000	Significant

The substantial association between the four variables is seen in Table 3. The test results proved that in the context of gamification flipbooks, the four hypotheses proposed in this study are accepted.

In this study, the simplicity of use of the gamification flipbook was found to influence students' perceptions of their utility in the learning process. The usability of instructional media is critical and must be considered. The simplicity of use of the medium will offer children a favourable impression, especially when learning mathematics (Ardani et al., 2018). In this study, the major characteristics of media usability are instructions, features, and access. The flipbook gives directions for users, particularly students, to follow in order to carry out activities that will help them achieve the learning objectives in each chapter. Following that, various additional features make it easy for pupils to complete activities required for lesson reasons.

Meanwhile, flipbook access is designed to be used offline by downloading and accessing online in order to eliminate the flaws that occur during online learning. With instructor and student participation, student attitudes, and good technological acceptance, a good perceived usefulness condition can be designed. As a result, gamification flipbooks must include collaborative activities between students and teachers or fellow students.

The same factors that influence perceived usefulness influence student adoption of gamification flipbooks. According to (Alsabawy et al., 2016), the most important element impacting perceived utility is service quality. This indicates that the services offered when adopting this gamification flipbook influence perceived usefulness. Tutors guide students to provide support and solutions to issues encountered while utilizing flipbooks in the classroom during the research.

According to the research of Mustafa et al., (2014), three aspects contribute to perceived usefulness and perceived use. The first consideration is interface design, which encompasses font style, font size, colour, display size, and layout. Similar to gamification flipbooks, interface design is critical to the success or failure of electronic book offerings. Second, interoperability refers to the media's ability to adapt to different

systems. The third category includes features like hyperlinks, citations, downloads, bookmarking, highlighting, cross-referencing, and so on.

These two variables, perceived ease of use and perceived usefulness, have a strong influence on behavioural intention. This is in response to the findings of the (Elkaseh et al., 2016; Jin, 2014). They discovered that these two characteristics were significant predictors of student and user behavioural intentions toward technological media. Students' sentiments for continuing to use technology are related to behavioural intention. The valuable experience and interaction of using e-books will promote satisfaction and strong intentions to use the media in the future (Jin, 2014). The findings of this study are also consistent with the findings of Liao et al., (2018), who discovered that system-related factors influence users' behavioural intention to utilize the system.

Finally, there is a high positive association between behavioral intention and gamification flipbook use. The experience was an important predictor of the usage of technology, particularly flipbooks. Users' perceived utility and ease of use might lead to experience. According to past study, individuals who have had positive experiences with technology have a positive attitude toward technology (Alfadda & Mahdi, 2021; Alharbi & Drew, 2014; Blackwell et al., 2014). The positive response to this gamification flipbook indicates that media tools can be developed further and become fresh ideas for instructors to produce learning media. It is demonstrated by the high level of student adoption of this learning medium. This could be a STEM-related breakthrough that can be developed and applied.

Gamification flipbooks are a modern instructional tool that has proven to have a positive impact on students' engagement and academic performance. The use of gamification techniques in educational contexts has increased in recent years as it enhances student motivation and participation. The TAM research validates the effectiveness of gamification flipbooks, as students perceive them as useful for presenting complex information in an interactive manner. They are user-friendly, easy to access and can be used on various devices, making them an accessible and convenient learning resource.

Incorporating interactive features such as quizzes, videos, and interactive images in flipbooks can enhance student participation and engagement in class or asynchronous learning. Teachers have recommended the development of interactive flipbooks to create a more immersive and engaging learning experience for students. This approach can reinforce fundamental concepts and provide students with immediate feedback, resulting in better academic outcomes. Consequently, gamification flipbooks are becoming increasingly prevalent as an instructional tool in universities worldwide and are expected to shape the future of education.

Student' experience to gamification flipbook

Many teachers have created and modified interactive flipbooks since they were first utilized as teaching resources in the learning process (Abror et al., 2020; Solikhatun & Widihastrini, 2018). Online learning, in particular, motivates teachers to be creative in

producing instructional media. Innovative digital flipbooks can also help pupils improve their literacy levels during the learning process (Roemintoyo, & Budiarto, 2021).

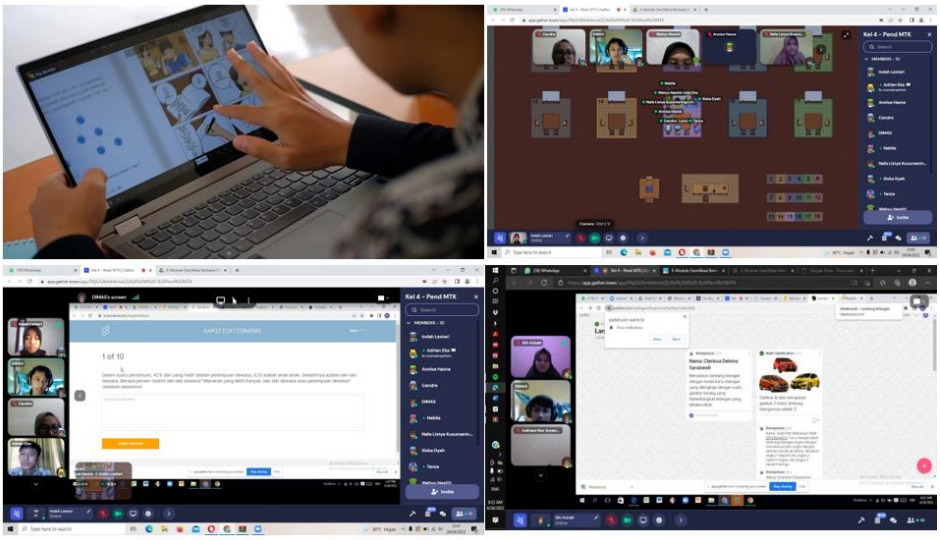

Figure 4
The utilization of flipbooks in online learning

Students' experiences with flipbooks vary after three months of use. Based on interviews with students who utilize this flipbook gamification, the majority of the students provided good reactions and experiences with this digital media.

> "Flipbooks are really easy to use, and the content is easily legible. Flipbook elements also include animations, photos and sketches, and movies to give a unique experience. Several quizzes help to strengthen thinking skills and assess learning results in relation to the content being taught "(DA, Interviewed, April 21, 2022).

This highlights that the facilities supplied by the flipbook learning media encourage pupils to use it. Mustafa et al., 2014) discovered that e-books now provide users with a variety of features. Links, hyperlinks, citations, downloads, and other services are examples of facilities. Several elements, similar to those accessible on the gamification flipbook, including links or barcodes, learning films, animations, quizzes, and collaborative places for students to debate. Furthermore, this gamification flipbook presents students with fresh learning media experiences, such as the following interview snippet.

> "This flipbook is a brilliant idea that should be replicated and adapted to other classes. This is also the first time I've used a flipbook with a lot of exercises in it. I previously just used a standard e-book flipbook. I am very excited to put this to use" (PM, Interviewed, April 18, 2022).

The current media development trend is gamification-based learning media. Educational gamification has the ability to improve academic achievement, motivation, and student engagement (Manzano-León et al., 2021). Gamification is one of the modern educational tactics for increasing student enthusiasm to learn. One of the advantages of gamification is that it makes studying more interesting and engaging for pupils, thanks to the influence of interactivity. As a result, using gamification flipbooks can improve students' learning experiences. In fact, employing gamification to learn mathematics efficiently achieves learning objectives and boosts understanding of the content (Sakai & Shiota, 2016).

Using gamification flipbooks as a learning medium provides numerous benefits for students. Firstly, it offers an interactive and engaging way to learn that can help students to retain information better. The use of interactive features such as quizzes, videos, and interactive images can make learning more enjoyable and immersive, keeping students engaged for longer periods. Secondly, gamification flipbooks can be accessed on a wide range of devices, making them accessible and convenient for students. This flexibility allows students to study and learn on their own time, in their own preferred environment. Finally, gamification flipbooks can be customized to meet the specific needs of individual students, making it a personalized learning tool.

However, students face challenges while employing this gamification flipbook in its application. In general, the issues that students confront in this gamification flipbook are expired hyperlinks and device specifications.

> "The flipbook is only accessible through a PC or laptop. Because it is not yet compatible with smartphones, learning will be more difficult. Furthermore, some of the offered links are not always fully functional. Some have passed..." (Interviewed by RM on April 24, 2022).

These hurdles must be solved by the development team in order for students' learning processes or autonomous learning to be productive and efficient. Widianto, et al., (2021) contends that in information technology-based learning media, the most prevalent weakness is the usage of the web, which is difficult to access. This, of course, causes student pain, loss of attention in studying, and boredom. However, in general, using gamification flipbooks has multiple advantages, including ease of use, various features that create a fresh experience for students, an interface that is designed like a book in physical form, can be used on offline devices, and is linked to various other learning materials. Students can also use it without restriction.

Despite the benefits of using gamification flipbooks as a learning medium, there are also some challenges that students may face. One of the primary challenges is the need for reliable internet connectivity. As gamification flipbooks are online resources, they require a stable and high-speed internet connection to function optimally. Without a reliable internet connection, students may not be able to access the resource or experience lagging, which can negatively impact their learning experience. Another challenge is the potential for distraction, as the interactive nature of gamification flipbooks may lead to students losing focus and getting sidetracked.

One limitation of using gamification flipbooks as a learning medium is that they may not be suitable for all types of content. While they are useful for presenting complex information in an engaging and interactive manner, they may not be appropriate for content that requires a more traditional approach. Additionally, not all students may have access to the necessary technology required to access gamification flipbooks, which can create a digital divide between those who do and those who do not have access. This can be a particular issue for students from disadvantaged backgrounds, who may not have the same level of access to technology as their peers. Overall, while there are challenges and limitations associated with using gamification flipbooks as a learning medium, the benefits for students are significant and make it a valuable tool in education.

This research provides new insights and contributes to the development of instructional media for university teachers. The experience of online learning encourages teachers' creativity in developing innovative learning approaches (Ahmad et al., 2020; Arnett, 2021). However, in the development of learning media teachers need to pay attention to the characteristics and readiness of students so that they can be optimal.

CONCLUSION

One of the interactive flipbook innovation development items that can be applied to higher education, particularly in the STEM field, is the gamification flipbook. This can be seen in the results of a highly significant correlation between two variables (t count > t table, t count > 1.96). Students' adoption of the gamification flipbook in the learning process in higher education is very high. Students' behavioural intention to use is affected and positively influenced by ease of use and perceived utility. Finally, behavioral intention influences and positively influences flipbook gamification usage. Thus, gamification flipbooks could be a novel approach to developing learning media in the STEM discipline. This is based on the positive student reception of this new learning medium. Additionally, students' experiences and reactions to gamification flipbooks were positive. Students have a fresh experience when using gamification flipbooks, owing to the capabilities present on flipbooks, which allow for student involvement. The creation of gamification flipbooks should also consider activity characteristics based on learning outcomes. This flipbook's collaborative production has proven to deliver a fresh experience for students as well as a collaboration area for students to interact. Meanwhile, the difficulties encountered when using flipbooks are attributable to a lack of compatibility, and some links are difficult to reach. The MIKiR approach is fundamental to the development of activities in this research. Further research in this area could explore the impact of gamification flipbooks on other subjects and grade levels.

Additionally, future studies could investigate how the use of gamification flipbooks can be adapted to meet the needs of students with different learning styles and abilities. Finally, it would be interesting to investigate the long-term impact of gamification flipbooks on student learning outcomes and academic achievement. The practice consequence of this research is that gamification flipbooks can be an effective tool for promoting collaborative learning and engagement in elementary mathematics. Teachers

and educators can use gamification flipbooks as a way to motivate and engage students in learning, while also promoting collaboration and teamwork skills. By incorporating gamification flipbooks into their teaching practices, teachers can create a more dynamic and interactive learning environment that supports student-centered and collaborative learning.

FUNDINGS

Tanoto Foundation's joint research grant for 2021–2022 provided funding for this study with the number TF.JKT/BE/PKS/2021/XII/480.

REFERENCES

Abdullah, F., Ward, R., & Ahmed, E. (2016). Investigating the influence of the most commonly used external variables of TAM on students' Perceived Ease of Use (PEOU) and Perceived Usefulness (PU) of e-portfolios. *Computers in Human Behavior*, *63*, 75–90. https://doi.org/10.1016/j.chb.2016.05.014

Abror, M. A., Suryani, N., & Ardianto, D. T. (2020). Digital flipbook empowerment as a development means for history learning media. *JPI (Jurnal Pendidikan Indonesia)*, *8*(2), 266. https://doi.org/10.23887/jpi-undiksha.v8i2.24122

Achjari, D. (2004). Partial Least Squares: Another Method of Structural Equation Modeling Analysis. *Jurnal Ekonomi Dan Bisnis Indonesia*, *19*(3), 238–248.

Adell, E., Várhelyi, A., & Nilsson, L. (2018). The definition of acceptance and acceptability. *Driver Acceptance of New Technology: Theory, Measurement and Optimisation*, 11–21. https://doi.org/10.1201/9781315578132-2

Adiyarta, K., Napitupulu, D., Nurdianto, H., Rahim, R., & Ahmar, A. (2018). User acceptance of e-government services based on TRAM model. *IOP Conference Series: Materials Science and Engineering*, *352*, 012057. https://doi.org/10.1088/1757-899X/352/1/012057

Ahmad, J., Mahmud, N., Jabbar, A., & Ikbal, M. (2020). Opportunities and challenges in the use of information and communication technology : study for "teaching from home" for pandemic. *Ijstr*, *9*(08), 294–299. http://www.ijstr.org/research-paper-publishing.php?month=aug2020

Alfadda, H. A., & Mahdi, H. S. (2021). Measuring students' use of zoom application in language course based on the Technology Acceptance Model (TAM). *Journal of Psycholinguistic Research*, *50*(4), 883–900. https://doi.org/10.1007/s10936-020-09752-1

Alharbi, S., & Drew, S. (2014). Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems. *International Journal of Advanced Computer Science and Applications*, *5*(1). https://doi.org/10.14569/ijacsa.2014.050120

Alsabawy, A. Y., Cater-Steel, A., & Soar, J. (2016). Determinants of perceived

usefulness of e-learning systems. *Computers in Human Behavior*, *64*, 843–858. https://doi.org/10.1016/j.chb.2016.07.065

Arnett, T. (2021). Breaking the mold: How a global pandemic unlocks innovation in K-12 instruction. In *Christensen Institute* (Vol. 1, Issue January). https://files.eric.ed.gov/fulltext/ED610663.pdf

Arosyd, I. M. R., & Rizman, R.-. (2020). Analysis of weaknesses and strengths online learning faculty of letters state University of Malang. *Journal DaFIna - Journal Deutsch Als Fremdsprache in Indonesien*, *4*(2), 13. https://doi.org/10.17977/um079v4i22020p13-19

Ayu Ardani, R., Humaira Salsabila, N., Handican, R., & Setyaningrum, W. (2018). *The perceptions of students and teachers about the use of edutainment instructional media in mathematics learning*. https://doi.org/10.2991/incomed-17.2018.49

Bagozzi, R. P. . Y. Y. (1988). *On the evaluation of structural equation models. Journal of the academy of marketing science, 16(1), 74-94.* https://link.springer.com/article/10.1007/bf02723327

Bal, M. (2019). Use of digital games in writing education: An action research on gamification. *Contemporary Educational Technology*, *10*(3), 246–271. https://doi.org/10.30935/cet.590005

Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2014). Factors influencing digital technology use in early childhood education. *Computers and Education*, *77*, 82–90. https://doi.org/10.1016/j.compedu.2014.04.013

Capuno, R., Revalde, H., Etcuban, J. O., Aventuna, M., Medio, G., & Demeterio, R. A. (2019). Facilitating Learning Mathematics Through the Use of Instructional Media. *International Electronic Journal of Mathematics Education*, *15*(1). https://doi.org/10.29333/iejme/5785

Chung, E., Subramaniam, G., & Christ Dass, L. (2020). Online learning readiness among university students in Malaysia Amidst covid-19. *Asian Journal of University Education*, *16*(2), 45. https://doi.org/10.24191/ajue.v16i2.10294

Coman, C., Țîru, L. G., Meseșan-Schmitz, L., Stanciu, C., & Bularca, M. C. (2020). Online teaching and learning in higher education during the coronavirus pandemic: students' perspective. *Sustainability*, *12*(24), 10367. https://doi.org/10.3390/su122410367

Correia, A.-P., Liu, C., & Xu, F. (2020). Evaluating videoconferencing systems for the quality of the educational experience. *Distance Education*, *41*(4), 429–452. https://doi.org/10.1080/01587919.2020.1821607

Creswell, J. (1999). Mixed-method research: Introduction and application. In *Handbook of educational policy*. http://www.sciencedirect.com/science/book/9780121746988#ancPT4

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008

Elkaseh, A. M., Wong, K. W., & Fung, C. C. (2016). Perceived ease of use and perceived usefulness of social media for e-learning in Libyan Higher Education: A structural equation modeling analysis. *International Journal of Information and Education Technology*, *6*(3), 192–199. https://doi.org/10.7763/IJIET.2016.V6.683

Fauziah, A., & Wulandari, S. S. (2022). Pengembangan e-modul berbasis flipbook untuk pembelajaran materi ruang lingkup administrasi kepegawaian. *EDUKATIF : Jurnal Ilmu Pendidikan*, *4*(2), 2202–2212. https://doi.org/10.31004/edukatif.v4i2.2363

Fernando, F., Patrizia, G., & Tiziana, G. (2020). Online learning and emergency remote teaching : Opportunities and challenges in emergency situations. *Societies*, 1–18. www.mdpi.com/journal/societies

Gafurov, I. R., Ibragimov, H. I., Kalimullin, A. M., & Alishev, T. B. (2020). Transformation of higher education during the pandemic: Pain points. *Vysshee Obrazovanie v Rossii*, *29*(10), 101–112. https://doi.org/10.31992/0869-3617-2020-29-10-101-112

Giatman, M., Siswati, S., & Basri, I. Y. (2020). Online Learning Quality Control in the Pandemic Covid-19 Era in Indonesia. *Journal of Nonformal Education*, *6*(2), 168–175. https://doi.org/https://doi.org/10.15294/jne.v6i2.25594

Gladović, P., Deretić, N., & Drašković, D. (2020). Video conferencing and its application in education. *JTTTP - JOURNAL OF TRAFFIC AND TRANSPORT THEORY AND PRACTICE*, *5*(1). https://doi.org/10.7251/JTTTP2001045G

Gunawan, I., Hui, L. K., Ma'sum, M. A., & Sukawati, N. N. (2020). Enhancing learning effectiveness by using online learning management system. *Proceedings - 2020 6th International Conference on Education and Technology, ICET 2020*, 48–52. https://doi.org/10.1109/ICET51153.2020.9276553

Hair Jr, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., & Babes, B. (2017). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). In *International Journal of Research & Method in Education* (Vol. 38, Issue 2). SAGE Publications. https://doi.org/10.1080/1743727x.2015.1005806

Hodge, N. (2022). *A peer driven technology adoption model: Using communities of practice to influence technology adoption*. https://keep.lib.asu.edu/_flysystem/fedora/c7/Hodge_asu_0010E_21670.pdf

Hulland, J., & Ivey, R. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal*, *20*(2), 195–204.

Ilin, V. (2022). The role of user preferences in engagement with online learning. *E-Learning and Digital Media*, *19*(2), 189–208. https://doi.org/10.1177/20427530211035514

Ilmadi, I., Zarista, R. H., Aden, A., & Sastro, G. (2020). The effectiveness of online learning for mathematics students during the covid-19 pandemic. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(2), 1273–1282. https://doi.org/10.31004/cendekia.v4i2.372

Indriasari, T. D., Luxton-Reilly, A., & Denny, P. (2020). Gamification of student peer review in education: A systematic literature review. *Education and Information Technologies*, *25*(6), 5205–5234. https://doi.org/10.1007/s10639-020-10228-x

Irfan, M., Kusumaningrum, B., Yulia, Y., & Widodo, S. A. (2020). Challenges during the pandemic: Use of e-learning in mathematics learning in higher education. *Infinity Journal*, *9*(2), 147. https://doi.org/10.22460/infinity.v9i2.p147-158

Jin, C.-H. (2014). Adoption of e-book among college students: The perspective of an integrated TAM. *Computers in Human Behavior*, *41*, 471–477. https://doi.org/10.1016/j.chb.2014.09.056

Jr Hair, J., & Hopkins, L. (2014). Partial least squares structural equation modeling (PLS-SEM) An emerging tool in business research. *European Business Review*, *26*(2), 106–121.

Liao, S., Hong, J.-C., Wen, M.-H., Pan, Y.-C., & Wu, Y.-. (2018). Applying Technology Acceptance Model (TAM) to explore users' behavioral intention to adopt a performance assessment system for e-book production. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(10). https://doi.org/10.29333/ejmste/93575

López, P., Rodrigues-Silva, J., & Alsina, Á. (2021). Brazilian and Spanish mathematics teachers' predispositions towards gamification in STEAM education. *Education Sciences*, *11*(10), 618. https://doi.org/10.3390/educsci11100618

Manzano-León, A., Camacho-Lazarraga, P., Guerrero, M. A., Guerrero-Puerta, L., Aguilar-Parra, J. M., Trigueros, R., & Alias, A. (2021). Between level up and gGame over: A systematic literature review of gamification in education. *Sustainability*, *13*(4), 2247. https://doi.org/10.3390/su13042247

Martin, F., & Bolliger, D. U. (2018). Engagement matters: Student perceptions on the importance of engagement strategies in the online learning environment. *Online Learning*, *22*(1). https://doi.org/10.24059/olj.v22i1.1092

Mohd Hamid, S. N., Lee, T. T., Taha, H., Rahim, N. A., & Sharif, A. M. (2021). E-content module for chemistry Massive Open Online Course (MOOC): Development and students' perceptions. *Journal of Technology and Science Education*, *11*(1), 67. https://doi.org/10.3926/jotse.1074

Molina-Azorin, J. F. (2016). Mixed methods research: An opportunity to improve our studies and our research skills. *European Journal of Management and Business Economics*, *25*(2), 37–38. https://doi.org/10.1016/j.redeen.2016.05.001

Mustafa, A. B., Harun, N. H., & Endin, M. Z. (2014). Understanding e-book acceptance

through Technology Acceptance Model (TAM Model). *2014 2nd International Conference on Information and Communication Technology (ICoICT)*, 122–126. https://doi.org/10.1109/ICoICT.2014.6914052

Noh, N. H., & Amron, M. T. (2021). Exploring Cloud Computing Readiness and Acceptance in Higher Education Institution: A PLS-SEM Approach. *Asian Journal of University Education*, *17*(4), 367–376. https://doi.org/10.24191/ajue.v17i4.16193

Onyema, E. M., et. al. (2020). Impact of coronavirus pandemic on education. *Journal of Education and Practice*. https://doi.org/10.7176/jep/11-13-12

Pinchuk, O. P., Sokolyuk, O. M., Burov, O. Y., & Shyshkina, M. P. (2019). Digital transformation of learning environment: Aspect of cognitive activity of students. *CEUR Workshop Proceedings*, *2433*, 90–101. https://doi.org/10.55056/cte.370

Playfoot, J. (2016). Exploring the Role of Gamification Within Stem Teaching As a Mechanism To Promote Student Engagement, Develop Skills and Ultimately Improve Learning Outcomes for All Types of Students. *EDULEARN16 Proceedings*, *1*, 2140–2147. https://doi.org/10.21125/edulearn.2016.1425

Prastyo, E. (2021). Science learning based on the MIKiR approach assisted by whatsApp for junior high school students. *Proceeding International Conference on Science and …*, *4*, 322–326. http://sunankalijaga.org/prosiding/index.php/icse/article/view/679

Presti, A., De Rosa, A., & Viceconte, E. (2021). I want to learn more! Integrating technology acceptance and task–technology fit models for predicting behavioural and future learning intentions. *Journal of Workplace Learning*, *33*(8), 591–605. https://doi.org/10.1108/JWL-11-2020-0179

Qashou, A. (2022). Obstacles to effective use of e-learning in higher education from the viewpoint of faculty members. *Turkish Online Journal of Distance Education*, *23*(1), 144–177. https://files.eric.ed.gov/fulltext/EJ1329784.pdf

Rachman, T., & Napitupulu, D. (2018). User acceptance analysis of potato expert system application based on TAM approach. *International Journal on Advanced Science, Engineering and Information Technology*, *8*(1), 185. https://doi.org/10.18517/ijaseit.8.1.3858

Rahman, A. R., Ahmad, S., & Hashim, U. R. (2019). *A study on gamification for higher education students' engagement towards education 4.0* (pp. 491–502). https://doi.org/10.1007/978-981-13-6031-2_5

Roemintoyo, R., & Budiarto, M. K. (2021). Flipbook as innovation of digital learning media : preparing education for facing and facilitating 21st century learning. *Journal of Education Technology*, *5*, 8–13. https://doi.org/https://doi.org/10.23887/jet.v%25vi%25i.32362

Sakai, K., & Shiota, S. (2016). A Practical Study Of Mathematics Education Using Gamification. *International Conferences ITS*, 353–354.

https://files.eric.ed.gov/fulltext/ED571606.pdf

Sánchez-Prieto, J. C., Olmos-Migueláñez, S., & García-Peñalvo, F. J. (2017). MLearning and pre-service teachers: An assessment of the behavioral intention using an expanded TAM model. *Computers in Human Behavior*, *72*, 644–654. https://doi.org/10.1016/j.chb.2016.09.061

Santos, V. A., Barreira, M. P., & Saad, K. R. (2022). Technological resources for teaching and learning about human anatomy in the medical course: Systematic review of literature. *Anatomical Sciences Education*, *15*(2), 403–419. https://doi.org/10.1002/ase.2142

Solikhatun, R., & Widihastrini, F. (2018). The development of interactive flipbook-formed teaching material to improve the of grade 4 students' social science learning outcomes. *Journal Negeri Semarang*, 83–89. https://doi.org/10.15294/est.v2i2.16802

Sumarmi, Aliman, M., & Mutia, T. (2021). The effect of digital eco-learning in student worksheet flipbook to environmental project literacy and pedagogic competency. *Journal of Technology and Science Education*, *11*(2), 357–370. https://doi.org/10.3926/jotse.1175

Widianto, E., et. al. (2021). Pemanfaatan media pembelajaran berbasis teknologi informasi. *Journal of Education and Teaching*, *2*(2), 213. https://doi.org/10.24014/jete.v2i2.11707

Wlodarczyk, J. R., Wolfswinkel, E. M., & Carey, J. N. (2020). Coronavirus 2019 video conferencing: Preserving resident education with online meeting platforms. *Plastic & Reconstructive Surgery*, *146*(1), 110e-111e. https://doi.org/10.1097/PRS.0000000000007073

Zarour, M., & Alharbi, M. (2017). User experience framework that combines aspects, dimensions, and measurement methods. *Cogent Engineering*, *4*(1), 1421006. https://doi.org/10.1080/23311916.2017.1421006