Effects of mobile learning games on students' self-regulated learning

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Abstract

This paper investigates the impact of using a mobile learning game on students' self-regulated learning (SRL). This research study uses a research and development approach by adapting the 4D model (defined, designed, developed, and disseminated). Data analysis was carried out using descriptive statistics. This study explored 120 students from 2 schools in Surakarta, Indonesia. Data collection was carried out using questionnaires and interviews to see the effectiveness of the mobile learning game on SRL. This research shows that the application of the mobile learning game is quite effective as a learning medium and supports distance learning. The results indicate that the mobile learning game positively promotes SRL and has a significant increase in each indicator of SRL. The game provides a different atmosphere in learning so that students are enthusiastic when participating in learning with games. This study contributes to the concept of self-regulated studying with games.

Keywords: Games; game-based learning; mobile learning game; self-regulated learning.

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1. Introduction

Online learning has been practiced for the last few years. In 2022, several schools hold blended and online learning with a rotating class system. The most important role of blended and online learning is for students. Distance learning, which has prevailed since the pandemic, requires students to find a strategy to organize their learning to succeed in an online learning environment. Students must actively create self-regulated learning (SRL) because learning is the process of reading, observing, and constructing conceptual frameworks from one's own experiences and those of others. The interpretation of the knowledge formed makes sense because it is based on the student's analysis and practical knowledge. Constructivism is a useful concept for students to advance their knowledge to understand what they are experiencing (Dalimunthe et al., 2021).

There needs to be motivational encouragement from teachers and parents in building students' SRL. Facilitating SRL in students has become a concern in recent years. The reason for this is the behavior of the students, which demonstrates SRL (Zimmerman, 1990). SRL is a process of students activating, and maintaining cognition, behavior, and influence systematically directed to achieve a goal and generally includes motivational components that are metacognitive and strategic (Schunk, 2008). Empirical evidence is found in research by Barry and Wenjuan (2018) identifying the positive effects of using students' self-study strategies, using game-based learning as emphasized by Wan et al., (2021) in their research. Mental activity increases a student's Increases autonomy, self-efficacy, and desire for learning as well as confidence in completing learning tasks and a sense of control over learning. Digital platforms are learning solutions that educational institutions currently carry out to implement distance learning (Williamson et al., 2020).

Using technology can facilitate the advancement of structural knowledge while facilitating metacognition by providing opportunities to track knowledge acquisition (encouraging students to think about how ideas are connected). Several studies highlight the potential of various technologies to facilitate SRL (Stevenson et al., 2017). Mobile phones are more often seen as learning tools because of their ease of use (Pulla, 2017). Games with educational content have a significant and expanding body of evidence suggesting they can improve academic performance (Clark et al., 2016; Udeozor et al., 2023; Videnovik et al., 2023; Pondee 2021). GBLE is the right environment for SRL. This environment allows autonomy and control in setting goals, monitoring and evaluating actions taken to achieve learning goals, and changing learning goals if necessary (Nietfeld, 2018). Since others do not regulate this environment, there is an added benefit of SRL. Therefore, motivation is needed if students want to achieve GBLE's pedagogical goals. Thus, GBLE has the potential to motivate because of the inherent characteristics that captivate students' attention and thus can provide an engaging learning experience (Syal & Nietfeld, 2020; El Mawas et al., 2022).

Barry and Wenjuan (2018) researched the use of SRL strategies having an important and positive impact on learning. However, in this research, the media was not used. Samaniego (2019) determined that the frequency of using several SRL strategies increases when using games. In this study, only two SRL indicators were used. Zhang et al. (2020) researched game-based SRL literature, which is an independent learning strategy that can be done with GBL.

Many SRL models exist (Panadero et al., 2017). Despite these differences, most models deal with processes and conceptualize SRL as a feedback cycle of multiple integrated processes, influencing each

other and adapting to challenges. Based on SRL, Zimmerman (1990) refers to how students are 'actively metacognitively, motivated and behaviorally on their own in the learning process'. This study uses Zimmerman's indicators because it covers a wider spectrum of SRL, namely setting goals and planning, repeating and remembering, organizing and transforming, self-evaluation, self-consequences, seeking social assistance, managing the environment, making and checking notes, looking for information, reviewing notes and textbooks and seeking other assistance.

Several studies have investigated mobile learning games. Troussas et al. (2020) advocate for the creation of unique learning experiences for students, as they can discourage involvement and participation in learning settings that include games. With the backing of constructivism, mobile play has developed into a successful method of student-centered learning that builds on self-awareness and reflects on that experience (Giang & Cuong 2021). In addition, based on the research by Samaniego (2019), using some SRL strategies increases when students take games seriously in educational practice.

1.1. Purpose of study

There have been many studies using SRL like Zimmerman's mobile learning games on the three aspects of SRL, namely metacognitive, motivational, and behavioral at the same time. This paper aims to investigate the effects of mobile learning games using three aspects of SRL from Zimmerman. Therefore, the following are the study's questions:

1. To what extent is SRL after using mobile learning games?
2. How do mobile learning games encourage SRL?

2. Materials and Method

This study uses a research and development approach. This study adopts the 4D model (defined, designed, developed, and disseminated) from (Thiagarajan et al., 1974).

2.1. Participants

This research seeks to examine the facts about SRL by applying mobile learning games to 12th-grade students of vocational high schools. Participants in this research included a total of 120 students from 2 vocational high schools in Surakarta, Indonesia.

2.2. Data collection

The study's quasi-experimental method with two types of class groups, namely control and experimental. Each class group comprised 60 students, who were randomly selected. The Construct 2 application is used to develop games so students can access it from a web browser or an Android phone. The file extensions are .apk and html. With the Android operating system, students only need to install the application. The application has a size of 3 MB, so it is not too heavy to operate. Descriptive statistics were analyzed using the data analysis techniques. Product trials for students, media experts, and material experts were used for game validation. Product trials include one-on-one tests, small tests, and comprehensive tests with 34 participants. The validation results of the mobile learning games are shown in Table. 1.

Table 1

Mobile Learning Games' Validation Results

No	Validator	Percentage (%)	Category
1	Media 1	96	Very good
2	Media 2	87	Very good
3	Material 1	88	Very good
4	Material 2	94	Very good
5	One-on-one test	83	Good
6	Small test	84	Very good
7	Extensive test	85	Very good

Several improvements were made in game development according to input from media experts, materials, and students. The game has a very good category based on media experts, material experts, and product testing validation. The product that has been tested is declared 'worthy' to be used as a medium in the implementation of 12th-grade accounting learning.

In collecting data, the researcher used a questionnaire (5-point scale) with three aspects of SRL (metacognitive, motivational, and behavioral) and interviews to determine students' views on games. Validation of the question instrument using the product–moment correlation technique from Pearson; there were 20 valid questions. As shown in Table 2, the question items are separated into categories that include both good and negative elements.

Table 2

Indicators and Items for SRL

No	Aspect	Indicator	Question item Positive	Negative
1	Metacognitive	Goal setting and planning	2, 5	
		Rehearsing and memorizing	7	18, 15
		Organizing and transforming	11	12
		Self-evaluating	4	13
2	Motivation	Self-consequence	14	3
		Seeking social assistance	8	16
		Environmental structuring	9	
3	Behavior	Keeping records and monitoring	1	20
		Seeking information	10	17
		Reviewing records	6	
		Other/help-seeking	19	

2.3. Analysis

The reliability results using Cronbach's alpha are shown in Figure 1.

Figure 1

Reliability Value

Reliability Statistics

Cronbach's Alpha	N of Items
,881	20

The average value of Cronbach's alpha is 0.881, meaning that the value of *r* is greater so the instrument is reliable.

3. Results

3.1. Findings

A mobile learning game was developed to encourage SRL, especially for 12th-grade students of vocational high schools in accounting subjects. Before developing the game, researchers first looked at students' learning media conditions and needs. It is intended that the media developed is following the needs of students. This study focuses on SRL after using games and the effectiveness of games as learning media for students.

3.1.1. SRL after using mobile learning games

In this study, Zimmerman's indicators are used because they cover more of the spectrum of SRL. The results of SRL after using games can be seen based on the mean, standard deviation, and effectiveness categories in Table 3.

Table 3

SRL After Using Mobile Learning Games

No	Aspect	Indicators	Mean	SD	Category
1	Metacognitive	Goal setting and planning	4.42	0.69	Very good
		Rehearsing and memorizing	4.36	0.64	Very good
		Organizing and transforming	4.43	0.73	Very good
		Self-evaluating	4.39	0.69	Very good
2	Motivation	Self-consequence	4.27	0.77	Very good
		Seeking social assistance	4.32	0.62	Very good
		Environmental structuring	4.43	0.56	Very good
		Keeping records and monitoring	4.42	0.60	Very good
3	Behavior	Seeking information	4.18	0.77	Good
		Reviewing records	4.43	0.59	Very good
		Other/help-seeking	4.33	0.79	Very good

Based on Table 3, of the 11 SRL indicators, information seeking has an average of 4.18. Meanwhile, there are three indicators of SRL with the highest average score of 4.43, namely organizing and transforming, environmental structuring, and reviewing records.

The level of effectiveness of the mobile learning game was carried out through further tests using calculations that refer to the N-Gain score. Table 4 shows the results of statistical testing of N-Gain scores using data obtained from SRL both the control and experimental classes, processed with the help of the Statistical Package for the Social Sciences application.

Table 4

Results of N-Gain Experiment and Control

Class	Test	Total	Mean	Variance	St. dev.
Experiment	Pre-test	4,255	56.11	169.88	13.03
	Post-test	5,238			
Control	Pre-test	4,289	30.59	148.47	12.18
	Post-test	4,820			

Based on the N-Gain test calculation findings presented in Table 4, the average value of SRL that has been analyzed using N-Gain for the experimental class with learning using mobile learning games

is 56.11 or 56%, which is included in the 'effective enough' category, while the results obtained in the control class (not using mobile learning games) were 30.59 or 31%, which is included in the 'ineffective' category.

Based on the statement of the effectiveness test results using N-Gain, the application of mobile learning games in class 12 accounting is included in the category of quite effective to encourage SRL vocational high school students in Surakarta.

3.1.2. How mobile learning games can encourage SRL students

In this study, qualitative data is used to answer how mobile learning games can help students improve SRL. The interview session was used to see how mobile learning games can help SRL. The following are some students' responses regarding the game used during learning.

P1 – 'I like learning about games like this because it is really fun. In the game, there is also material that is clear and easy to understand, even though it is self-study. Thank you.

P2 – 'The game is quite challenging. The rest is good, and there are learning videos too, so you can better understand the material taught in the game'.

P3 – 'Learn first before playing. The game can be opened after reading the material and watching the video. The game is fun, and there are practice questions at each level. The number of questions is increased again, ma'am, so you can practice a lot at home'.

P4 – 'It is fun because it uses the game, so you can learn while playing. There are materials, sample questions, and video tutorials in the game. If you want to re-learn, open it again'.

P5 – 'It is fun to use the game and easy to understand. The level increases, and the games expand to make it more enthusiastic about learning'.

P6 – 'It is fun because the game's learning process is used. Very useful when online learning'.

Based on the interview results, it can be concluded that the development of mobile learning games can encourage SRL when learning online. The use of mobile learning games was rated positively by both teachers and students. Media games are considered relevant if applied to a distance learning environment, where students must organize and transform their learning. Many students who use games can easily repeat the subject matter, summarizing the material obtained. The game also provides a different atmosphere in learning so that students are motivated and enthusiastic when participating in learning with games.

4. Discussion

Based on the research results above, this section will discuss two aspects: the ability of SRL after using mobile learning games and how mobile learning games can encourage SRL.

4.1. SRL in mobile learning games

This research was carried out during the online learning process. Recently, many studies have taken on practical urgency and significance in education, given that learning must switch due to the COVID-19 epidemic, face-to-face instruction has been replaced by distance learning and technology has been pursuing online learning (Reich et al., 2020). Digital technology can promote self-regulation

and social skills (Comi et al., 2017; Jeong & Hmelo-Silver, 2016). Digital technology can also motivate a high level of student involvement and increase student discipline in doing assignments (Clark et al., 2016; Jabbar & Felicia, 2015; Zheng et al., 2016). However, it is still not clear whether the adoption of digital technology has a general effect on SRL or only impacts components such as motivating or attracting attention. In addition, little has been discussed about the effects of digital technology on various social skills (Clark et al., 2016). This study focuses on what is in the game that can encourage students towards SRL.

There are many benefits of applying digital technology in learning. However, some challenges must be faced in applying digital technology to the learning process Duckworth and Steinberg (2015) identify digital technology as very strong self-management and self-regulation. The advanced use of digital technology in young children is associated with increased distraction, while for adults it can lead to addiction (Courage et al., 2015). Furthermore, the online disinhibition effect was confirmed by (Aiken, 2016). In this case, Internet and social media users tend to be restrained and unable to accurately assess the appropriateness of their online behavior. Therefore, in developing a game, a developer must know the media needs that students need so that the developed media can be optimal and useful for users.

Based on observations with teachers, the learning process uses WhatsApp and Google Classroom. Teachers often use modules and videos from YouTube in the processes of teaching and learning. Students must monitor and self-regulate their learning process in the learning environment. Wong et al. (2019) stated that students' self-study awareness has not yet been awakened. So far, students are working on assignments even though they have exceeded the allotted time. Some students are not maximal in learning independently, and teachers still have difficulty knowing students' understanding when learning online. The teacher only sees whether or not students are correct in answering questions because the teacher does not know whether students depend on friends or other people to answer questions. Besides that, some students only attend and answer mini-quizzes. Students who take lessons will ask further questions about the material or cross-check answers with the teacher. There needs to be motivational encouragement from teachers and parents in building SRL in students. Independent learning of students in accounting subjects is very much needed. Students' SRL before using games was in the low category. Independent learning is the key when learning online. Therefore, it is necessary to make efforts to apply learning media to students so that they become a means of independent learning.

Learning by simulation or games involves SRL. Self-regulation in learning may be beneficial if students are challenged and motivated. Here, they need additional guidance or support. One possibility to support student self-learning is to encourage the use of cognitive meta-strategies, either with direct or indirect instruction during learning. This study provides an approach to fostering metacognitive processes, motivation, and attitudes to be useful for learning, especially in complex learning environments. Mobile games can improve students' independent learning toward a learning goal (Bartholomew, 2019; Curran et al., 2019; Lai & Zheng, 2018; Żammit 2022). Troussas et al. (2020) determined that Students can benefit from mobile gaming by advancing their knowledge levels and encouraging learning. This is following this study where SRL in students increased after using mobile learning games. Of the 11 indicators, there are 10 indicators in the very good category and 1 indicator

in the good category. Meanwhile, for testing using N-Gain, it is stated that mobile learning games are quite effective as suggestions for students' SRL.

The utilization of digital learning media, in this case in the form of mobile games, can create and provide stimulus to optimize the components that make up the learning system. There is considerable and growing support that games (GBLE), with digital pedagogical content, can positively impact academic achievement (Clark et al., 2016). Based on the research by Samaniego (2019), the use of games can increase SRL. The frequency of self-study increases when using games in educational practice.

This is following Sailer and Homner (2019), who stated that games help students find learning to be fun and enjoyable, stimulating students to perform better. So that students feel facilitated in reaching the intended learning goals, on the other hand, among the functions of learning media are as a complement and a supplement, which can be used as a complement and support for the learning process both in the implementation of learning in class and learning that is done independently.

4.2. How mobile learning games can encourage SRL students

Students are encouraged to learn independently because the application of challenging games and a different atmosphere make students enthusiastic in the learning process. Recently, educational psychologists have recognized the potential of digital games as a platform for studying SRL. For example, in published meta-analyses, the results of the use of games in online education have received a lot of attention (Bai et al., 2020; Putz et al., 2020; Zainuddin et al., 2020).

Still, it raises the question of what future research should consider to comprehend how the idea of games can be addressed to make it more effective in digital learning (Super et al., 2019). Discussion and debates about games-based research change the perspective of researchers, enabling academics to consider the viability of game concepts and comprehend how game concepts stimulate involvement more deeply, making it possible to evaluate how a game could be created with smarter concepts (Hamari et al., 2016; Schobel et al., 2020). The abstract emphasizes the necessity for a thorough examination of earlier research initiatives that will result in an overview of potential future research possibilities. The abstract emphasizes the necessity for a thorough examination of earlier research initiatives that will result in an overview of potential future research possibilities (Santhanam et al., 2016; Super et al., 2019). This game has been revised according to the input of media experts, materials, and trials with 34 students so that the game is feasible and according to the learning needs of students.

The features in the game are easy to use so that students can follow the guidelines coherently and complete the game well. However, at the beginning of use, some students need adjustment. Similarly, Nikou and Economides' (2017) study on mobile educational games found that the effects of perceived ability on cognitive motivation or engagement in learning were not significant in this study. This is due to the possibility that pupils with higher degrees of self-directed learning possess greater levels of self-discipline and perceive mobile learning only as an important learning method for independent learning. Mobile devices and the mobile Internet are becoming a distraction for students as today's mobile app market is flooded with interesting information and content such as mobile games, mobile social communities, and mobile shopping. Students with high levels of self-

management in learning tend to shy away from mobile devices to avoid reviewing habits and addictive behaviors.

Mobile learning game features include questions, videos, teaching materials, and game learning materials where game features are played repeatedly by students, so the use of the games is considered challenging, fun, and easy to understand (de Sousa & Rasmussen 2019). Students compete to get high scores in answering questions. Students also do not forget to work on the structured questions in the material section. Slussareff and Bohackova (2016) suggest that to ensure that a game effectively facilitates learners in achieving, The learning objectives and how the educational material is included in the game must both be taken into account. Plass et al. (2015) stated that when designing games, it is important to combine emotional, cognitive, motivational, and sociocultural perspectives to realize the full potential of GBL (game-based learning). Ravyse et al. (2017) stated that the main factors driving game development are backstory, production methods, realism, artificial intelligence, adaptability, interaction, feedback, and question and answer. Game is also considered effective in online learning because students can study the material, do the practice questions independently and re-read the material discussed in the mobile learning game.

5. Conclusion

The study results show a positive effect obtained by using mobile learning games on SRL. The experimental class's N-Gain test outcomes show that the average SRL value is 56.11 or 56%, and so the use of games for SRL is included in the quite effective category. Meanwhile, the results obtained in the control class (not using mobile learning games) were 30.59 or 31%, which was included in the ineffective category. This media was developed based on the needs of students, especially as a means of online learning. The use of mobile learning games seeks to attract students' interest to be active in managing their learning to achieve learning objectives well. Of the 11 SRL indicators, 10 indicators are in the very good category and 1 indicator is in the good category. This shows that mobile learning games can encourage students' SRL, namely from the metacognitive, motivational, and behavioral aspects.

Researchers can develop mobile educational games in different disciplines, subjects, and domains to see if students can apply what they have learned. Future research should look at how to design mobile learning games for all operating systems and how to create educational content to improve the balance between learning and playing in achieving learning goals.

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