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The role of gamification implementation in improving quality and intention in software engineering learning

Tri Wahyuningsih, Eko Sediyono, Kristoko Dwi Hartomo, Irwan Sembiring
Department of Computer Science, Faculty of Information Technology, Universitas Kristen Satya Wacana, Salatiga, Indonesia

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ABSTRACT

Gamification can make learning more fun and engaging for students. Software engineering can utilize gamification to help students learn and improve their skills from the complexity of software engineering. This study used quantitative research to examines perceived ease of use, student satisfaction, and perceived usefulness to measure gamification quality, which can have an impact on software engineering intention, namely intention, loyalty, and participation in following and understanding software engineering materials. The data was collected based on an online questionnaire survey, 90 data were collected and then measured and analyzed using SmartPLS 3. The results showed that perceived ease of use, student satisfaction, and perceived usefulness have a significant influence on gamification quality, which also leads to a positive impact on software engineering intention. This research guides teachers and educational institutions that gamification is very successful as a learning medium to simplify complex information to be more interactive.

Corresponding Author:

Tri Wahyuningsih
Department of Computer Science, Universitas Kristen Satya Wacana
Salatiga, Indonesia
Email: 982022001@student.uksw.edu

1. INTRODUCTION

One of the major challenges in improving software engineering as a profession is ensuring that future software engineers are adequately trained and prepared. To achieve this goal, efforts have been focused on two areas: defining and establishing software engineering curricula that cover the knowledge and skills needed in professional practice, and improving the methods and techniques used to teach software engineering [1]–[3]. Examples of initiatives aimed at defining software engineering curricula include undergraduate and graduate education standards, competency models, and expert opinions on what should be included in software engineering education. In addition to these efforts, the software engineering education community has also been working to find more effective ways to teach software engineering, including traditional methods such as tombstone projects, and newer approaches such as project-based learning, case-based teaching, and research-based teaching. Other innovative pedagogical strategies that have been discussed within the community include swapped classrooms and the use of game-related approaches based on serious play or gamification [4], [5].

Gamification, which involves incorporating elements of game design into non-game contexts, has become a popular teaching technology in education in recent years [6], [7]. This approach aims to create experiences that engage and motivate learners in the same way that a game does, but for educational purposes. While gamification has been around since 2008, it has gained widespread adoption in the education sector since 2010. However, research on the effectiveness of gamification in education is still limited, and there are

concerns about the potential risks of this approach. Several studies [3]–[6] have found that up to 80% of gamification applications may not meet their intended goals, often due to poor implementation.

The idea that gamification can enhance academic learning by motivating and engaging students has gained traction in the education field [8]–[10]. However, implementing gamification in education can be challenging for educators due to the time and effort required. Additionally, there is a lack of standardization in the approaches used to gamify learning activities, which has led to mixed results in gamification experiments. Several studies [4]–[8] have even reported negative impacts on learning processes and outcomes due to ineffective gamification methods [11].

This research aims to investigate the use of gamification in software engineering education as a way to revitalize the learning experience for students. Many software engineering students may find traditional teaching methods to be monotonous or demotivating, and this study seeks to understand how gamification can be implemented in a way that can help to motivate and engage these students. Through a comprehensive review of the existing literature on gamification in software engineering education, this research aims to identify the challenges and opportunities presented by this approach to learning. The ultimate goal is to improve the learning processes and outcomes for software engineering students through the use of gamification.

The purpose of this research was to systematically map the use of gamification in software engineering education, following the guidelines and recommendations of Petersen *et al.* [12]. The research questions were designed to provide insight into the current state of gamification in software engineering education, including its potential benefits, trends, and challenges. This information will be useful for software engineering academics as they seek to understand the field and identify areas for further research and development. Additionally, the research aims to help educators analyze current trends and identify any gaps in the use of gamification in software engineering education.

RQ1. In which software engineering education contexts has gamification been applied?
RQ2. How has gamification been implemented in software engineering education courses?
RQ3. What is the evidence of the impact of gamification on software engineering education?

The main goal of the first research question (RQ1) was to understand the context in which gamification has been applied in software engineering education. Specifically, the study examined the types of software engineering classes or courses that have been gamified, the educational activities that have been gamified, and the most commonly adapted software engineering processes. The second research question (RQ2) aimed to investigate how gamification is being implemented in practice in software engineering education. This question looked at the different approaches and methodologies used to gamify software engineering education, the game elements that have been incorporated into these courses, and the tools, if any, that are being used to apply gamification. This information is valuable for software engineering courses that are considering using gamification, as it can help them decide whether to use existing methods or design new approaches based on the strengths and weaknesses of current solutions. Additionally, understanding the technical support (tools) needed for gamification can provide important data on the cost of gamification and which gamification components from the literature have been utilized. Finally, the third research question (RQ3) focused on the existing evidence on the impact of gamification on software engineering education, specifically which software engineering education goals have been gamified and what evidence exists on the results. This information can help to determine whether gamification in software engineering education has positive or negative effects on software engineering learning processes and outcomes.

2. LITERATURE REVIEW

2.1. Gamification in education

Gamification is a way to make an activity more fun by adding game elements to the activity. In education, gamification can be applied to help increase student motivation and improve their learning outcomes [13]–[15]. The application of gamification in education can be done by giving rewards to students who successfully achieve learning goals or complete certain tasks. These rewards can be in the form of points, levels or badges that can increase students' motivation to continue learning and improve their learning outcomes [16].

In addition, gamification can also help improve student creativity and collaboration. By adding game elements such as missions and adventures in learning, students will be more interested and engaged in learning activities. They will also learn faster by helping each other to complete tasks or achieve learning goals. Gamification can also help reduce students' boredom and saturation in learning [17]. With fun game elements, students will be more interested in learning and will more easily understand the subject matter. Gamification can also help improve students' concentration during learning, so their learning outcomes will be better [4], [7]. In general, incorporating gamification into education can be an efficient method to enhance students' motivation and augment their academic achievements. By integrating game-like features into educational

practices, learners are likely to become more invested and involved in the learning process, resulting in more favorable learning outcomes.

2.2. Gamification adoption in education

Gamification adoption in education refers to the integration of game elements into the learning process to enhance student engagement and motivation. This trend has gained significant traction in recent years as educators have recognized the value of game-based learning in promoting active participation and achieving better learning outcomes. The use of gamification techniques in education can range from simple rewards systems for completing assignments to more complex, immersive simulations that replicate real-world experiences.

One of the key benefits of gamification in education is that it can help to create a more dynamic and engaging learning environment. By incorporating game elements such as points, badges, and leaderboards, educators can provide students with immediate feedback and a sense of achievement, which can help to increase their motivation and enthusiasm for learning. Additionally, gamification can help to foster a sense of community and collaboration among students, as they work together to achieve common goals and objectives.

Another advantage of gamification in education is that it can help to personalize the learning experience for individual students. By incorporating game mechanics that adapt to the unique needs and interests of each student, educators can create a more tailored and effective learning experience. For example, gamification can be used to create personalized learning paths that allow students to progress at their own pace and receive targeted feedback based on their performance.

However, it is important to note that gamification in education is not without its challenges. Educators must carefully consider the appropriateness and effectiveness of game elements in different contexts, and ensure that they are aligned with learning objectives. Moreover, the use of gamification should not be seen as a replacement for traditional teaching methods, but rather as a complementary approach that can be used to enhance the learning experience. Overall, the adoption of gamification in education represents an exciting development in the field of learning and pedagogy. By leveraging the power of game-based learning, educators can create more engaging and effective learning experiences that help to improve student outcomes and prepare them for success in the 21st century.

Based on several studies, gamification is a process that incorporates game elements into non-game systems such as education [9], [10]. This theory emerged as one of the methods to increase motivation and improve one's learning. In its implementation in education, gamification can be used to increase students' interest in the subject matter. By adding game elements such as scores, rewards, and increasing difficulty levels, students will be more challenged and excited to complete the assigned tasks [18]–[20].

In addition, gamification can also improve collaboration between students. For example, by using shared games, students can learn together and support each other in completing the challenges. This will help students to learn in a more fun and less boring way. Not only that, gamification can also improve students' critical problem-solving skills. By solving challenges in the game, students will be trained to think critically and find the right solution. This will help students in solving problems in everyday life [12]. Overall, gamification is an effective method in improving student motivation and learning. By adding game elements, the learning process becomes more fun and less boring so that students are more challenged and excited about learning.

2.3. Gamification of software engineering

Gamification is a learning method that utilizes game elements in the learning process. By using gamification, the learning process becomes more fun and challenging, helping to increase learning motivation and improve learning outcomes. In the field of software engineering, gamification can play a very important role in the learning process. By using gamification, students can learn about the basics of programming in a fun and challenging way that helps them understand the basic concepts of programming better [21].

In addition, gamification can also help improve students' skills in creative and innovative problem solving. By using game elements in learning, students will be tested with various challenges that require creative and innovative problem solving [22]. This will help students develop these skills so that they can better solve problems that arise in the software development process. In addition, gamification can also help improve students' collaboration skills. In software engineering, teamwork and collaboration are very important. By using gamification, students can learn about the importance of working together with others to solve a challenge or problem. This will help students develop the collaboration skills needed in software engineering. Table 1 explain the constructs and the definision of construct.

Table 1. Definition of concepts

Construct	Definition	Source
Perceived ease of use (PEU)	Perceived ease of use is the level of ease felt by users when using a product or system.	[3], [23]
Student satisfaction (SSG)	Student satisfaction is the level of student satisfaction with the services, facilities, and teaching provided by a school or educational institution.	[3], [23], [24]
Perceived usefulness (PUG)	Perceived usefulness is a person's level of trust in the usefulness of a product or system that is believed to provide benefits to its users.	[3], [20], [23]
Gamification quality (GQ)	Gamification quality is the quality of the process of using game elements in a system or activity to increase motivation and engagement.	[25], [26]
Technology anxiety (TA)	Technology anxiety is the fear or anxiety that comes with technological change and how it affects one's life.	[3], [23], [24]
Software engineering intention (SEI)	Software engineering intention is a process of planning and developing software systems that pay attention to technical aspects, quality, and efficiency to produce quality software products and in accordance with user needs.	[1], [2], [27]

3. HYPOTHESES DEVELOPMENT

Gamification is a technique that incorporates game elements in a system or activity to increase user motivation and participation. One of the factors that influence the quality of gamification is perceived of use. Perceived of use is a person's assessment or response to the ease of use of a system or activity. In the context of gamification, perceived of use refers to how easily users understand and follow the games offered by the system [5].

If perceived of use is high, the quality of gamification will be better. Users will find it easier to understand and follow the game offered, so user motivation and participation will increase. This will result in a more enjoyable and effective game experience in achieving the gamification goals. Thus, the role of perceived of use is very important in improving the quality of gamification. System developers should pay attention to perceived of use in designing the game to be offered, so that the game is easy for users to understand and perform. Thus, gamification can be more effective in increasing user motivation and participation.

- H1: Perceived ease of use has a significant role on gamification quality.

Gamification is one of the techniques used in the learning process to increase students' motivation and participation in learning activities. By using game elements such as points, levels and rewards, gamification can make learning more fun and interactive. Based on the results of a survey conducted on a number of students, it turns out that the majority of students feel very satisfied with the quality of gamification implemented in the learning process. They feel more challenged and encouraged to study harder by the gamification system. In addition, they also feel happier and less bored in following the learning process [6], [10].

However, there are also many students who are dissatisfied with the quality of gamification. They feel that the gamification system is too complicated and confusing, which does not help in the learning process. Therefore, it is necessary to improve and evaluate the gamification system so that it can be more effective and make a significant contribution to the learning process.

- H2: Student satisfaction has a significant role in gamification quality.

Perceived usefulness is one of the factors that influence the quality of gamification. Gamification is a technique that uses game elements to increase motivation and engagement in an activity. First, perceived usefulness is a factor that affects the success rate of gamification. Gamification that is perceived as useful will be more easily accepted by users and provide more optimal results. This is because users will be more involved and have higher motivation to complete the given activity [3].

Second, perceived usefulness also affects the level of user interest in gamification. Gamification that is perceived as useful will be more interesting and fun for users, so they will be more interested in trying and using it. This will increase user engagement and make them more involved in the given activity.

- H3: Perceived usefulness has a significant role on gamification quality.

Gamification is one of the strategies often used in improving the quality and intensity of use of a system or service. By inserting game elements into the system, someone will feel more interested and actively involved in using it [3]. One example that can be mentioned is gamification in fitness apps. By adding a feature that counts the number of steps taken throughout the day, and rewards people with badges or virtual awards when they reach certain targets, people will feel more motivated to continue exercising and using the app regularly.

However, keep in mind that gamification is not always effective in increasing intention of use. For this reason, it is necessary to have the right combination of game features that are inserted, as well as designs and user interfaces that are attractive and easy to understand by users. Thus, gamification can be an effective strategy in increasing the intention of use of a system or service.

- H4: Gamification quality has a significant role on software engineering intention.

Gamification is the process of adding game elements into everyday activities to increase motivation and engagement. Technology is an integral part of modern life and has increased efficiency and productivity in various fields [3]. However, there are concerns about the negative impact of using too much technology, known as technology anxiety. Gamification can reduce technology anxiety by providing clear structure and goals to technology users. This helps them to focus on the desired goal and improves concentration. In addition, game elements can provide rewards and recognition that increase user motivation and satisfaction.

- H5: Gamification quality has a significant role on technology anxiety.

Technology anxiety is a phenomenon that often occurs today. Many people feel anxious and worried about technology that is increasingly sophisticated and complex [3], [28]. This can affect their intention to use the technology, including gamification. Gamification is a method that incorporates game elements in a non-game activity, such as in business or learning. The goal is to increase user motivation and participation. However, the technology used in gamification often makes people feel anxious and worried.

One of the main causes of technology anxiety towards gamification is anxiety about personal data security. Many people are worried that their data will be misused by irresponsible parties. This may discourage them from using gamification to increase motivation and participation.

- H6: Technology anxiety has a significant role on software engineering intention.

4. METHODOLOGY

For this research, an online survey using a self-assessment questionnaire was conducted from July to October 2022 to gather information from students and teachers in Indonesia who have utilized gamification in their learning process, specifically in the field of software engineering. The data collected was filtered to exclude those who had no experience with gamification. Out of the 134 initial respondents, 90 were determined to have utilized gamification in their learning. The demographic makeup of these respondents is shown in Table 2.

Table 2. Respondent demographics

Characteristics	Item	Frequency	Percentage
Gender	Men	45	50%
	Women	45	50%
Age	16 - 20	32	35.6%
	21 - 25	40	44.4%
	> 26	18	20%
Education Level	High School	30	33.4%
	S1	32	35.5%
	S2	28	31.1%

The survey consisted of two sections: the first focused on gathering basic demographic data, while the second aimed to test specific hypotheses. The questions included in the survey were designed based on prior research and had already been proven to be reliable through validation procedures. In order to increase the accuracy of the measurements taken, the survey utilized seven Likert scales. The overall validity of the questionnaire was also confirmed before it was administered. Research framework used in this research are proposed on Figure 1.

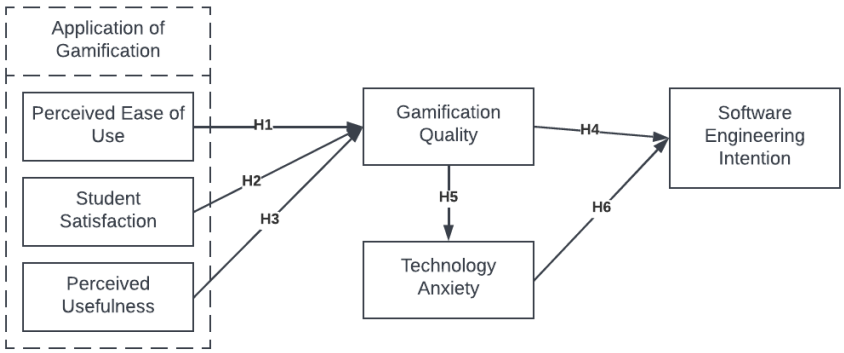

Figure 1. Research framework

To assess multicollinearity between constructs, variance inflation factor (VIF) analysis was conducted in Table 3. The analysis results show that the inner VIF value ranges from 1.000 to 2.580, indicating that there is no potential multicollinearity between latent constructs. This is supported by the recommendation of Hair *et al.* [28], which suggests that the VIF value should be less than 5.0 to ensure the relevance of the model.

Table 3. Inner VIF results

Construct	VIF
PEU → GQ	4.344
SSG → GQ	3.768
PUG → GQ	4.269
GQ → SEI	2.898
GQ → TA	1.000
TA → SEI	2.898

5. DATA ANALYSIS

This study uses SmartPLS 3 to conduct measurement and partial least squares (PLS) analysis. Table 4 describes the measurement items used in this study. Reliability and validity analyses were conducted during the measurement stage, and the path coefficients and strength of the structural model were tested and examined during the analysis stage. To confirm the reliability and validity of the constructs and to investigate the interactions between them. This study focused on the causal relationships between PEU, SSG, PUG, GQ, TA, and SEI practices, each of which contains various measurement items that have been previously studied. Questionnaire measurement items are presented on Table 4.

Table 4. Questionnaire measurement items

	Measured items
	PEU, source: [3], [29]
PEU1	Ease of gamification system is important in my concern
PEU2	The performance I provide depends on the ease of a system
PEU3	In gamification systems ease is important for new users
PEU4	Easy adoption of gamification will have high effectiveness in education
PEU5	Difficult gamification models will only complicate the learning process
	SSG, source: [2], [3]
SSG1	Gamification can increase student satisfaction by providing fun rewards and challenges in the learning process.
SSG2	Gamification can help students feel more engaged and encouraged to learn more.
SSG3	Gamification can improve students' ability to complete tasks and achieve learning goals
SSG4	Gamification can create a more fun and enjoyable learning environment, so students are more interested in learning.
SSG5	Gamification can boost students' confidence and increase their motivation to learn
	PUG, source: [2], [30]
PUG1	Perceived usefulness can increase user engagement and motivation levels in gamification.
PUG2	From the benefits provided, I am interested in using the gamification system.
PUG3	Gamification can be improved by providing features that match the needs and interests of users
PUG4	a high level of usefulness can increase the success rate of gamification implementation
PUG5	The benefits provided from a system will increase the quality of loyalty from its users
	GQ, source: [1], [27]
GQ1	Gamification in learning makes me more interested and excited in learning
GQ2	Gamification makes learning more interactive and fun
GQ3	Gamification helps me retain information better and easier to remember
GQ4	Gamification helps me to focus more and think creatively in completing tasks.
GQ5	Gamification makes learning more fun and keeps me from getting bored
	TA, source: [3], [7], [31]
TA1	I feel anxious when I have to use technology in learning because I am not very fluent with the technology.
TA2	Technology in learning makes it difficult for me to follow the material presented by the teacher
TA3	I worry about losing focus and concentration when using technology in learning
TA4	I am anxious that my ability to use technology is not as good as that of my peers.
TA5	I am worried that there will be technology disruptions during learning so that I cannot follow the material properly.
	SEI, source: [3], [5], [9]
SEI1	Gamification in learning software makes learning more fun and challenging
SEI2	The reward system and levels in gamification make me more enthusiastic about learning.
SEI3	Gamification helps me to understand the material more easily and quickly
SEI4	With gamification, I can practice my skills in using the software better.
SEI5	Gamification in software learning makes me more focused and actively involved in the learning process.

In this research, SmartPLS 3 software was utilized to perform measurement and partial least squares analysis. The measurement items used in the study are detailed in Table 4. To ensure the reliability and validity of the constructs, reliability and validity analyses were conducted during the measurement stage. During the analysis stage, the path coefficients and structural model strength were examined. The purpose of these two stages is to confirm the reliability and validity of the constructs and to investigate the connections between them. The focus of the study was on the causal relationships between PEU, SSG, PUG, GQ, TA, and SEI practices, each of which includes various measurement items that have been previously studied.

Despite the benefits of using PLS methods, there are some limitations to consider. One issue is that model parameter optimization is performed in a two-step process, which may lead to potential bias and error in the estimation of structural model path coefficients. To address this limitation, researchers who are experts in gamification carefully reviewed the questionnaire used in this study to ensure that the measurement items were appropriate for the study. In addition, there is no standard global measure of model fit for PLS-SEM, which may hinder its use for testing and validation. Therefore, it is important to evaluate the results carefully and consider other methods for confirmatory analysis.

5.1. Outer model and validation

The outer model was tested for three main aspects: reliability, convergent validity and discriminant validity. All constructs in the model showed composite reliability criterion values of 0.7 or higher, indicating good construct reliability. In terms of convergent validity, predictor factor loadings were above 0.5 and average variance extracted (AVE) exceeded 0.5, as suggested by Fornell and Larcker. Discriminant validity is also strong, as the factor loadings for each latent item for each assigned construct are higher than the factor loadings for the other constructs, as shown in Tables 5 and 6. Overall, these test results indicate that the outer model has good reliability, convergent validity, and discriminant validity.

Table 5. Reliability analysis and convergent validity

Measurement items	Factor loading	Composite reliability	AVE	Measurement items	Factor loading	Composite reliability	AVE
GQ1	0.760	0.831	0.597	PUG1	0.760	0.826	0.589
GQ2	0.802			PUG2	0.790		
GQ3	0.797			PUG3	0.759		
GQ4	0.735			PUG4	0.776		
GQ5	0.767			PUG5	0.752		
SEI1	0.780	0.834	0.601	SSG1	0.749	0.829	0.594
SEI2	0.764			SSG2	0.787		
SEI3	0.789			SSG3	0.802		
SEI4	0.745			SSG4	0.772		
SEI5	0.798			SSG5	0.743		
PEU1	0.733	0.829	0.594	TA1	0.753	0.819	0.580
PEU2	0.788			TA2	0.777		
PEU3	0.770			TA3	0.766		
PEU4	0.779			PUG1	0.760		
PEU5	0.783			PUG2	0.790		

Table 6. Discriminant validity

	GQ	SEI	PEU	PUG	SSG	TA
GQ	0.889	-	-	-	-	-
SEI	0.821	0.876	-	-	-	-
PEU	0.850	0.851	0.880	-	-	-
PUG	0.838	0.824	0.862	0.821	-	-
SSG	0.846	0.842	0.841	0.808	0.876	-
TA	0.809	0.792	0.828	0.807	0.849	0.864

5.2. Inner model result and hypotheses testing

In this study, the inner PLS model was utilized to test the proposed hypotheses (H). The results, presented in Table 7, indicate that all hypotheses are statistically significant and have positive values. These findings are also visualized in Figure 2, further reinforcing the validity of the hypotheses. The path coefficients, p-values, and t-values in Table 7 provide additional details on the strength and significance of the relationships between the variables. Overall, the results of the inner PLS model analysis support the proposed hypotheses in this research.

Table 7 and Figure 2 show that perceived ease of use has a positive and significant impact on gamification quality, which supports H1 (PEU → GQ: $\beta = 0.295$, t-value = 2.339). The analysis shows that

student satisfaction has a positive and significant impact on gamification quality, which supports H2 (SSG → GQ: β = 0.363, t-value = 3.437). The analysis shows that perceived usefulness has a positive and significant impact on gamification quality, which supports H3 (PUG → GQ: β = 0.290, t-value = 2.223). The analysis shows that gamification quality has a positive and significant impact on gamification intention to use, which supports H4 (GQ → SEI: β = 0.523, t-value = 4.110). The analysis shows that gamification quality has a positive and significant impact on technology anxiety, which supports H5 (GQ → TA: β = 0.809, t-value = 3.675). Finally, technology anxiety significantly and positively affects gamification intention to use, which supports H6 (TA → UIG: β = 0.369, t-value = 2.440).

Table 7. Summary of inner model results

Hypothesis		Path Coefficient	T-Value	Results
H1	PEU → GQ	0.295	2.339	Approved
H2	SSG → GQ	0.363	3.437	Approved
H3	PUG → GQ	0.290	2.223	Approved
H4	GQ → SEI	0.523	4.110	Approved
H5	GQ → TA	0.809	3.675	Approved
H6	TA → SEI	0.369	2.440	Approved

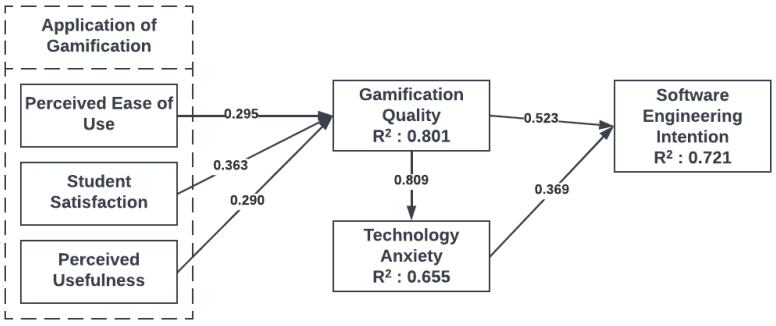

Figure. 2. Framework of inner model results

5.3. Testing the mediation effect

In order to assess the significance of the mediating variable in this study, both path analysis and the Sobel test were employed. The results of the Sobel test, as presented in Table 8, were used to determine the significance of the mediator through the calculation of the Z value and estimated p-values. The results indicated that all of the mediator's Z values were greater than 0.01, indicating a significant mediation effect between the independent and dependent variables. This suggests that the mediating variable plays a crucial role in the relationship between the independent and dependent variables and should be considered in future research on this topic. Mediation test result is presented at Table 8.

Table 8. Mediation test results

Construct	Construct relationship	T-value of path coefficient	Specific indirect effects
PEU → GQ → SEI	PEU → GQ	2.339	0.041
	GQ → SEI	4.110	
PUG → GQ → SEI	PUG → GQ	2.223	0.024
	GQ → SEI	4.110	
SSG → GQ → SEI	SSG → GQ	3.437	0.006
	GQ → SEI	4.110	
GQ → TA → SEI	GQ → TA	3.675	0.005
	TA → SEI	2.440	

6. DISCUSSION

This research focuses on the integration of gamification concept in software engineering learning. Then, both are tested with several research variables in the theory to prove the relationship of these variables. A good learning activity and a good gamification system depend on the quality of learning and how teachers

pay attention to the needs of their students. There are several important findings and contributions from the empirical results of this research, both for academics and practitioners.

6.1. Research question discussion

Gamification, the use of game elements and mechanics in non-game contexts, has been increasingly applied in various educational contexts, including software engineering education. To understand how gamification has been implemented in software engineering education, three research questions are proposed.

RQ1 asks about the contexts in which gamification has been applied in software engineering education. The literature shows that gamification has been used in various software engineering education contexts, including software engineering courses, programming courses, software development projects, and online learning platforms. In these contexts, gamification is used to improve students' motivation, engagement, and learning outcomes. RQ2 asks how gamification has been implemented in software engineering education courses. The literature reports various implementations of gamification in software engineering education, such as using badges, points, leaderboards, quests, challenges, and feedback mechanisms. These game elements are used to create a sense of achievement, competition, and feedback that can motivate and engage students in learning software engineering concepts and skills. RQ3 asks about the evidence of the impact of gamification on software engineering education. The literature suggests that gamification can have a positive impact on software engineering education by improving students' motivation, engagement, and learning outcomes. Result have shown that gamification can increase students' learning performance, satisfaction, and retention rates. However, other studies have reported mixed or inconclusive results regarding the effectiveness of gamification in software engineering education.

The study mentioned in the context employs a quantitative research approach to examine the impact of gamification on software engineering education. The study finds that perceived ease of use, student satisfaction, and perceived usefulness have a significant influence on gamification quality, which leads to a positive impact on software engineering intention, namely intention, loyalty, and participation in following and understanding software engineering materials. This research suggests that gamification can be a successful learning medium to simplify complex information and make it more interactive for students. In conclusion, gamification has been applied in various software engineering education contexts and implemented using different game elements and mechanics. The evidence regarding the impact of gamification on software engineering education suggests that it can improve students' motivation, engagement, and learning outcomes. However, further research is needed to investigate the effectiveness of gamification in different software engineering education contexts and to understand the underlying mechanisms that make gamification effective.

6.2. Theoretical implications

This research adds to the existing knowledge on the relationship between perceived ease of use, student satisfaction, and perceived usefulness in relation to gamification in software engineering subjects. We developed a model to understand the factors that contribute to student learning outcomes using gamification. Additionally, this study is the first to explore the simultaneous impact of perceived ease of use, student satisfaction, and perceived usefulness on gamification quality and its influence on software engineering intention. Previous research has shown that gamification can lead to various educational outcomes, but our study expands on these findings by incorporating perceived ease of use, student satisfaction, and perceived usefulness in the framework towards software engineering intention. Additionally, this research utilizes new data from marketing surveys to contribute to the related literature in this field.

6.3. Theoretical implications

This study makes a special contribution to academics who are considering utilizing gamification as their learning medium. The results suggest to academics the importance of using gamification to influence learning outcomes in software engineering classes. Based on Hypothesis 1, the test found that perceived ease of use has a significant influence on gamification quality, one of the factors that have a significant influence on gamification quality. This is because, perceived ease of use is the level of ease felt by users in using a system or product. The easier the system or product is to use, the higher the level of satisfaction felt by the user. With perceived ease of use, users will find it easier to access systems or products related to gamification. This will make it easier for users to follow the various attractions in gamification. In addition, perceived ease of use will also help users in completing various tasks and challenges in gamification.

Hypothesis 2 testing found that student satisfaction has a significant positive influence on gamification quality. Student satisfaction has a significant influence on gamification quality. This is because, when students are satisfied with the lesson, they are more likely to engage in gamification. Gamification is a method that uses game elements in the learning process to increase student motivation and participation. This can be done by giving rewards to students who excel, as well as creating competition between students to get the highest score in a lesson. However, gamification will only be effective if students feel satisfied with the lesson. When

students feel dissatisfied with the subject matter, they will be less likely to engage in gamification. This will result in low quality gamification, making it ineffective in increasing student motivation and participation.

Then testing hypothesis 3 found that perceived usefulness has a significant positive effect on gamification quality. Perceived usefulness is one of the factors that has a significant influence on gamification quality. This is because perceived usefulness is a concept that refers to users' belief that a system or technology can provide benefits for them in solving problems or meeting their needs. Perceived usefulness is a very important factor in gamification because it provides encouragement for users to continue using and exploring the features available in a game. If users feel that the game does not provide benefits to them, then they will tend to abandon the game and move on to other games that are considered more useful. In addition, perceived usefulness also has a significant influence on the level of user engagement in the game. Users who feel that the game provides benefits to them will be more interested in continuing to play the game and do the activities available in the game. This will increase the level of user engagement in the game and make the game more attractive to users. Together, well-organized perceived ease of use, student satisfaction, and perceived usefulness will create a stable and quality gamification system between teachers and students in software engineering classes, leading to software engineering intention.

Hypothesis 4 testing found that use of gamification has become increasingly prevalent in software engineering education and training. The hypothesis that gamification quality has a significant role on software engineering intention is supported by research. Studies have shown that the use of gamification in software engineering training can improve student motivation, engagement, and performance, leading to increased intention to pursue a career in software engineering. High-quality gamification features such as clear objectives, challenging tasks, and immediate feedback can enhance the learning experience, ultimately leading to a higher intention to pursue software engineering.

Moreover, Hypothesis 5 testing found the hypothesis that gamification quality has a significant role on technology anxiety is also supported by research. Gamification can help reduce technology anxiety by creating a positive and engaging learning environment. Students who are anxious about technology may feel more confident and motivated when they are presented with gamified learning activities that are challenging, yet achievable. Furthermore, gamification elements such as rewards and recognition can help to reduce anxiety and increase confidence, leading to improved learning outcomes.

The hypothesis 6 found that technology anxiety has a significant role on software engineering intention is also supported by this research. Students who experience high levels of technology anxiety may be less likely to pursue a career in software engineering, even if they have an interest in the field. Technology anxiety can lead to decreased self-efficacy, which can in turn lead to lower intentions to pursue software engineering. However, gamification can help to mitigate technology anxiety by providing a positive and engaging learning experience, which can increase self-efficacy and ultimately lead to higher intentions to pursue a career in software engineering.

7. CONCLUSION

The implementation of gamification in the software engineering learning process is an important thing to implement. It can increase students' motivation and learning ability in software engineering. First, gamification can increase students' motivation in learning. Through gamification, the learning process becomes more interesting and less boring. Students can feel the sensation of playing games while learning, so they will be more interested and eager to complete the material provided. Second, gamification can improve students' learning ability. Through games, students can apply the concepts learned in a form that is more fun and easier to understand. In addition, games can also provide quick and accurate feedback on students' abilities, so that students can know their weaknesses and shortcomings and can improve them. While the current research included a comprehensive framework, methodology, and data collection, there are still areas for improvement in future studies. One limitation is the lack of analysis of different types of gamification models. In order to provide more inclusive findings and consequences, it would be beneficial to include participants from a variety of gamification systems or models. Another potential issue is the potential biases of participants based on their education level and the learning methods they are accustomed to. Future research should delve into whether individuals from different education levels have preferences for certain learning methods and if there are specific motivations behind these preferences. Additionally, examining the relationship between students and instructors or teachers could be enhanced through the use of technology such as eye-tracking movement technology, which can provide insight into the user experience and facilitate psychological self assessment.

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BIOGRAPHIES OF AUTHORS

Tri Wahyuningsih is a doctoral student of computer science program at Satya Wacana Christian University. She has a strong interest in information systems management and decided to pursue her doctoral degree in computer science. She has interests and capabilities in data mining and text mining. Before starting her doctoral program, Tri Wahyuningsih completed her Bachelor and Master degrees in informatics engineering. She has working experience as a system analyst and showed excellent achievements during her work. Now, Tri Wahyuningsih is focusing on her doctoral studies and working on several research projects in the field of information systems management. He can be contacted at email: 982022001@student.uksw.edu, triwahyuningsih@raharja.info.

Eko Sediyono is a professor from Satya Wacana Christian University. He obtained his doctoral degree in Computer Science from the University of Indonesia and currently serves as a professor. His main research interests are information security and artificial intelligence, and he has done more than 120 publications during his education and teaching career. Eko Sediyono has proven himself as an expert in the field of information security and artificial intelligence through the great contributions he has made through his publications as well as his teaching as a professor. He can be contacted at email: sediyono@uksw.edu.

Kristoko Dwi Hartomo is a professor at Satya Wacana Christian University. He earned his doctoral degree in Computer Science from Gadjah Mada University (UGM). Since becoming a professor, Kristoko Dwi Hartomo has a strong interest in spatial statistics research. He has written and published more than 50 scientific papers during his education and teaching career at Satya Wacana Christian University. Kristoko Dwi Hartomo is recognized as an expert in the field of spatial statistics and continues to make significant contributions to the development of science and practice in this field. His work has been accepted and presented in many scientific seminars and conferences, strengthening his position as one of the leading professors at Satya Wacana Christian University. He can be contacted at email: kristoko@uksw.edu.

Irwan Sembiring earned his Bachelor of Engineering degree in informatics engineering from Universitas Pembangunan Nasional "Veteran" Yogyakarta in 2001, Master of Computer Science in computer science from Gadjah Mada University Yogyakarta in 2004, and Doctorate in computer science from Gadjah Mada University Yogyakarta in 2015. His main research interests are computer network security, and he has done more than 40 publications during his education and teaching career. His research interests include computer network security and computer network designing. Currently, he is active as a lecturer at the Faculty of Information Technology, Satya Wacana Christian University Salatiga. He can be contacted at email: irwan@uksw.edu.