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Original Research

Students' Acceptance of Gamification-Based e-Learning in Supporting Web Programming Instruction

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Abstract: The COVID-19 pandemic and the development of the digital age have transformed how students learn. The use of technology such as the internet, social media, and mobile devices also influences university learning activities. Students choose self-paced learning that enables them to study at anytime and anywhere, especially for programming. Hyper Sheets Software (HSS) Learning is gamification-based media for programming learning. The purpose of this study was to analyze student acceptance of HSS Learning to improve their programming skills. In this study, the Technology Acceptance Model (TAM) was used to evaluate students' acceptance of gamification-based e-learning. We employed three external variables, i.e., enjoyment, habit, and social influence. The subjects were 314 fourth and sixth semester students. The results showed that students' attitudes toward the system were unaffected by criteria linked to ease of use. Besides, external factors including enjoyment, habits, and social influence have an impact on students' acceptance of the HSS Learning to help improve their academic outcomes.

Keywords: *Gamification, Learning, Acceptance, Programming, Students*

Introduction

Technology has rapidly developed and permeated many facets of life. It has been widely used in various fields. The use of technology such as the internet, social media, and mobile devices also influences university learning activities (Urh et al. 2015). Technology has also long been used to support education, but since the COVID-19 pandemic hit the world, the technology used in education has increasingly varied. The pandemic has accelerated the paradigm shift from traditional to digital-based learning, where technology is critical (Pinandito et al. 2020). Digital learning has changed the instructional material that used to be paper based into online media and digital content. Meetings with teachers and students are less intense in this scenario. E-learning is an option that requires educators to adopt innovative learning technologies while maintaining student engagement in the digital learning environment so

that learning outcomes can be achieved. Al-Rahmi et al. (2018) argue that e-learning provides a virtual situation where students can participate in several activities. There are broad benefits from e-learning systems, including easy access to material content, team collaboration, and timely discussions (Concannon, Flynn, and Campbell 2005).

In computer science education, programming is one of the competencies that students need to master. Mastering programming requires critical thinking, computational logic, and problem-solving skills (Topalli and Cagiltay 2018). To learn programming languages, students must practice completing the given case studies. However, students often face problems in mastering programming concepts and writing syntax (Rokhmawati and Az-zahra 2019). One problem often encountered is low student engagement (Topalli and Cagiltay 2018). In a typical classroom setting, a lecturer explains the content and gives examples for the students to follow and try. Students must learn programming by doing more than just writing program code in class and under the supervision of educators. Students should be able to practice intensely in writing program code independently and repeatedly until they reach an advanced level (Pradana, Bachtiar, and Priyambadha 2018). Student learning outcomes in programming are also directly proportional to these conditions. The average programming proficiency score for first-year students is 30 out of 100, and the attrition rate is 30 percent, suggesting that students struggle to comprehend programming (Beaubouef and Mason 2005).

The industry increasingly needs graduates with strong programming skills (Vaca-Cardenas et al. 2015). As the demand for programming skills increases, proficiency in programming has become a crucial requirement for students pursuing engineering study programs or majors (Topalli and Cagiltay 2018). Programming fields are generally divided based on their role in the industry, including backend, frontend, and mobile programming (Montandon et al. 2021). Front-end programmers, especially in the field of web programming, are the fields most needed by the industry (Montandon et al. 2021). The job prospects for web developers and web design are projected to increase by 8 percent from 2019–2029, faster than the average for all existing professions. Hyper-Text Markup Language (HTML) and Cascading Style Sheets (CSS) are primary technologies that front end programmers must master. HTML and CSS are the main technologies that underlie website construction. Nevertheless, under the present circumstances, some students lack enthusiasm for acquiring programming techniques that are often standard and lack entertainment value. According to a study carried out at the Fakultas Ilmu Komputer (FILKOM), Universitas Brawijaya, 76 percent of the students expressed interest in courses other than programming courses (Pradana, Bachtiar, and Priyambadha 2018). In order to enhance student engagement and knowledge of programming, it is imperative to increase their motivation in learning programming.

Utilizing gamification-based platforms for learning innovation can significantly enhance students' productivity and engagement (Pradana, Bachtiar, and Priyambadha 2018; Yildirim 2017). Gamification is gaining popularity due to its shown ability to enhance behavior and

cognitive processes by fostering engagement through a game-like experience (Huotari and Hamari 2017). Research discussing the use of learning platforms in helping students in the context of learning programming, especially web programming, is still minimal. Most studies use common media such as Kahoot and Quizizz (Orhan Göksün and Gürsoy 2019), Ribbon hero (de-Marcos, Garcia-Lopez, and Garcia-Cabot 2016), and gamified plugin integration on Moodle (Kyewski and Krämer 2018). Gamification-based e-learning in the field of web programming called HTML and CSS Learning (Hyper Sheets Software [HSS] Learning) has been developed to support web programming learning (Pradana et al. 2023). Through the utilization of HSS Learning, students can engage in autonomous practice of creating program code while studying the content. The gamification components comprise experience points, leaderboards, badges, avatars, and challenges. Students have the freedom to work on pre-existing questions at their own preferred speed.

The implementation of gamification-based e-learning technology in the programming industry has yet to be utilized (Fajri et al. 2021; Mee et al. 2022). Analyzing student attitudes and intents about their acceptance of adopting HSS learning as a supporting learning media in web programming can be a challenging task. Technology Acceptance Model (TAM) is extensively employed for the analysis, quantification, and depiction of user acceptability toward novel platforms and software, encompassing teaching and learning technologies (Salloum et al. 2019). Several academics have challenged the TAM for the omission of certain aspects that might enhance the understanding of technology acceptance. These researchers propose the inclusion of additional components to better explain the determinants of acceptance for specific technologies (Teo 2009). This study attempted to assess and measure the validity of the TAM method in gamification-based e-learning. It examined how the added external variables (enjoyment, habit, and social influence) could impact student acceptance of HSS Learning as a support for programming learning. This study offers recommendations for enhancing and advancing HSS Learning in the future. Additionally, it provides references for comparable research conducted in a gamification-based learning environment utilizing the TAM model.

Literature Review

HSS Learning: Gamification-Based E-learning.

HSS Learning, which stands for HTML-CSS Learning, is a web-based system implemented in the Basic User Interface Design course (Pradana et al. 2023). In HSS Learning, students can learn front-end programming material, especially HTML and CSS. This programming language is the main technology in website construction. HSS Learning applies various game elements, e.g. playgrounds, learning journeys, levels (basic, intermediate, advance), challenges, badges, experience, leaderboards, hints, points, and courses. An interactive gamification framework (Jianu and Vasilateanu 2017) states that utilizing the latest technology enables learning to be more productive, fun, and enjoyable. In addition, learning

platforms that implement game mechanisms and mechanics can increase engagement and create entertaining e-learning (Hassan et al. 2021). This is to respond to the stigma circulating among students that programming is scary and difficult to learn.

The HSS Learning platform facilitates the learning process of HTML CSS programming through three distinct phases: preparation, learning, and exercise. Every stage incorporates gamification aspects as supporting components.

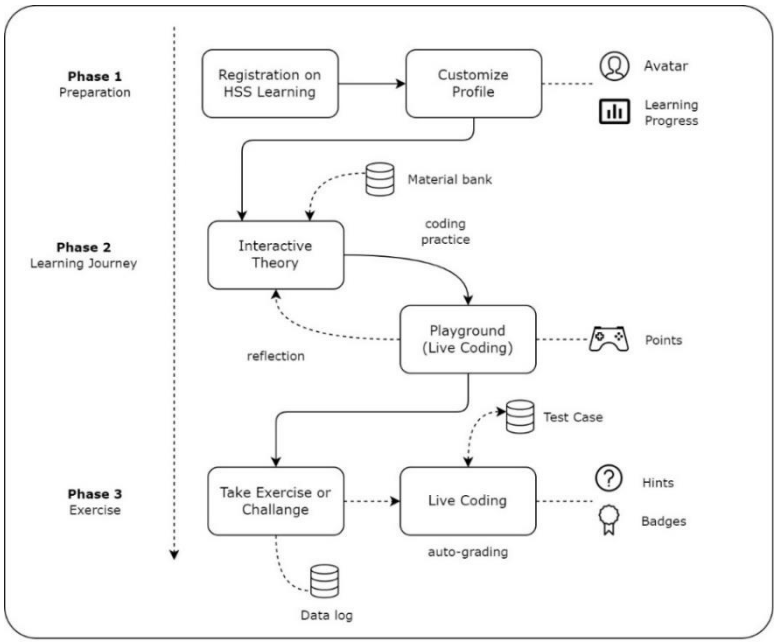

Figure 1: Learning Process

Figure 1 shows the learning process in HSS Learning; a detailed explanation of each stage is as follows:

1. During the *preparation* phase, students complete the registration procedure on the platform. Upon achieving success, students will be instructed to update their profiles. Students can substitute their avatar with a personal photograph or any other picture of their choosing by editing their profile to reflect their personal preferences.
2. During the *learning* phase, students are instructed to engage with study resources that align with the selected topic. The resources provided are interactive, allowing students to make changes by pressing interactive buttons and view the resulting modifications in the lines of code.
3. During the *exercise* phase, students could engage in various activities and challenges. Exercise is a task that students can complete for each learning topic offered. Every topic has one to two exercises that need to be finished. The topics are categorized into three degrees of difficulty: basic, intermediate, and advanced.

Use of TAM

The TAM was initially created by Davis (1989) to examine the elements that impact users' acceptance of technology adoption. This model demonstrates that the implementation of IT systems is contingent upon the user's inclination to utilize the system, which is influenced by the user's perspective toward such technology. The theory of planned behavior (TPB) is an expansion of the theory of reasoned action (TRA), which was originally formulated by Fishbein and Ajzen in 1975.

Intuitively, the easier it is to use, the more acceptable the technology is to users. The attitude is influenced by two variables: the perceived ease of use (PEOU) and the system's perceived usefulness (PU). PU and PEOU are two well-known variables in the TAM model (Davis, Bagozzi, and Warshaw 1992; Davis 1989). The TAM model has been widely adopted and developed more than four thousand times by many researchers (Hong and Yu 2018), including from an educational technology point of view. However, researchers have voiced criticism toward the TAM model because of its perceived incompleteness. They propose expanding the TAM model to specific situations by incorporating other characteristics that are relevant to adapted technology (Teo 2009; Chen, Liu, and Lin 2013). The application of TAM as a method for measuring technology acceptance has been widely used in various fields and contexts. Nevertheless, the validity of TAM must be reconfirmed when applied to the realm of gamification in the context of programming education. This study aimed to respond to this need by examining a model that will explain gamification in the context of e-learning in web programming. External variables added were enjoyment, habit, and SI.

Enjoyment, Habit, and Social Influence as the External Variable

The e-learning market is experiencing an increase in popularity in the field of education (Al-Aulamie et al. 2012). However, further investigation is required to examine the individual's intention to continue using e-learning. Furthermore, there is empirical data indicating a rise in the prevalence of underused e-learning systems (Hsia and Tseng 2008). Therefore, identifying factors that influence user's acceptance of IT will help the implementation of an IT strategy in an organization. Research reveals that acceptance of new technology is influenced by extrinsic and intrinsic motivation (Yang, Asaad, and Dwivedi 2017). Internal motivation encourages behavior that results in achievement or internal perceptions such as enjoyment or other positive feelings (Yang, Asaad, and Dwivedi 2017). We sought a relationship between external variables and the use of game elements in HSS Learning. In this research we tried to add external variables related to gamification so that the results will be more accurate in detecting external factors that might influence students' acceptance of new technology in the classroom. Enjoyment is also an important motivator in online game playing (Koo 2009). Even though gamification is applied to non-game contexts, which are different from games, it has adopted the application of game elements so that enjoyment

becomes very closely related to gamification use. Regarding game elements such as levels, missions, and challenges, several studies state that increasing task difficulty could significantly increase engagement and enjoyment (Banfield and Wilkerson 2014; Li, Grossman, and Fitzmaurice 2012). We assume that attitudes or behavioral intentions of students toward technology, systems, or services can be generated not only from functional usability but also from perceived enjoyment. Users who do not enjoy gamification-based e-learning are unlikely to be involved anymore. Enjoyment can explain people's intentions or attitudes (Yannakakis and Hallam 2007). Previous research also shows that enjoyment can indirectly affect intentions through other variables (Yang, Asaad, and Dwivedi 2017). For example, Venkatesh et al. (2012) found that enjoyment significantly influences continuance intention in using technology through PEOU.

Habit is defined as the extent to which a person tends to perform behavior automatically due to learning (Limayem and Hirt 2003). The literature says that adopting new technology will complement user habits when they experience the necessary knowledge about the technology's purpose and the extent to which they can achieve an expected goal (Alsharo, Alnsour, and Alabdallah 2020). In gamification, game elements such as points, rewards, leaderboards, and badges can increase the habitual aspects of users (van Elderen and van der Stappen 2020). Habits are used as a component of research conducted by Hubert et al. (2017). In this study, habit has a significant relationship to PU and PEOU, which are the primary constructs in the TAM model. This study used habit as one of the external factors because gamification-based e-learning is used as a learning media and practicing web programming. Habit provides an automatic assessment of coding done by students.

Social influence (SI) refers to the degree to which a person perceives a system as important when others and their environment endorse the adoption of the new system (Venkatesh et al. 2012). Fishbein and Ajzen (1975) proposed the construct of SI. They extended a new adoption model of intentioned behavior called the TPB, where SI is the primary variable of intentional behavior to adopt an innovative technology. In the context of learning, social gaming has an impact on experience in social relatedness; learners can play in groups and share their results and their scores in their social networks (external) (Koivisto and Hamari 2019). Gamification of social elements can even trigger a fear of missing out (van Roy and Zaman 2019). Elements of game mechanics also have a positive impact on SI. For example, individuals will be more likely to engage in behavior that they think others are doing (Sjöblom et al. 2017).

Methodology

The present study investigated the effect of TAM variables (Perceived Usefulness [PU], Attitude [AT], Perceived Ease of Use [PEOU], and Continuance Intention [CI]) on students' acceptance of HSS Learning. In addition, this study added three external variables based on

the literature review, which were considered to have the effect on the context of a gamification-based learning platform. These variables were Enjoyment (E), Habit (H), and SI. Figure 2 shows the TAM model and the three external variables proposed in this study.

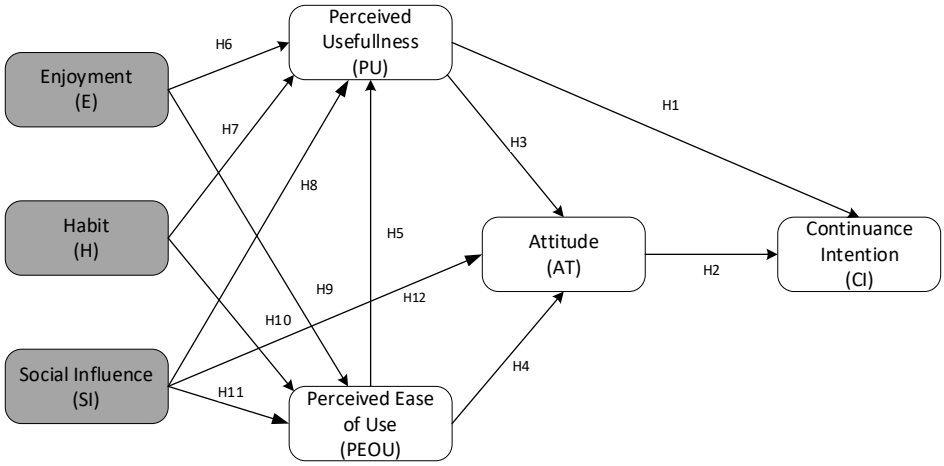

Figure 2: Proposed TAM Model and Three External Variables

Enjoyment, Habit, and SI as the External Variable

The model provided in this study examines the hypotheses listed in Table 1, drawing on the literature review and the original TAM model.

Table 1: Hypotheses

Code	*Hypotheses*
H1	PU will have a significant effect on students' CI to use HSS Learning.
H2	AT will have a significant effect on their CI to use HSS Learning.
H3	PU will significantly influence students' AT toward HSS Learning.
H4	PEOU will significantly influence students' AT toward HSS Learning.
H5	PEOU will have a significant effect on students' PU of HSS Learning.
H6	Students work E will have a significant effect on students' PU of HSS Learning.
H7	Students' H in using tools will significantly influence students' PU.
H8	Students' SI will have a significant effect on students' PU of HSS Learning.
H9	Student work E will have a significant effect on students' PEOU of HSS Learning.
H10	Students' H in using tools will significantly influence students' PEOU.
H11	Students' SI will have a significant effect on students' PEOU of HSS Learning.
H12	Students' SI will significantly influence students' AT toward HSS Learning.

Context, Data Collecting, and Participants

This research was conducted with the Information Systems Department, Faculty of Computer Science, Brawijaya University. The subjects were fourth and sixth semester students who took Basic-Information Systems Development, Basic UI Design, and IS Analysis and Design courses.

The total number of participants in this test was 314 students. All students had varying levels of web design skills, including high, medium, and low proficiency. However, it was ensured that all attendees had taken or were taking an introductory HTML and CSS course. At the time of observation, all students used the HSS Learning platform in a hybrid format for six weeks. Participants explored the functionality of HSS learning and completed exercises and challenges. The demographics of the respondents can be seen in Figure 3.

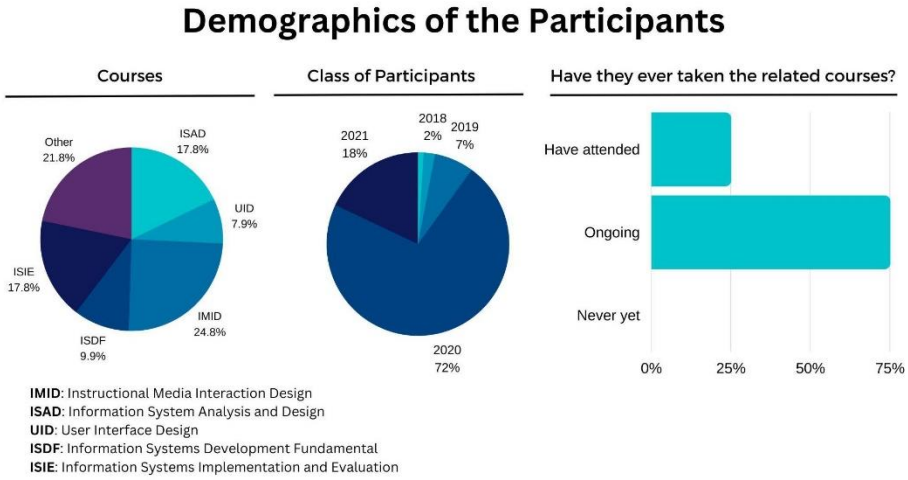

Figure 3: Demographic of Participants

Upon finishing the HSS Learning exercise, participants were given a TAM model questionnaire consisting of twenty items, rated on a five-point Likert scale. Each question corresponds to a TAM component, whereas this survey included thirteen extra questions that reflect external factors. TAM variables included PU, PEOU, AT, and CI. Other factors that were included in the questionnaire were E, H, and SI. Table 2 displays a sample of the questionnaire items included in this investigation.

Validity and Reliability

Reliability is defined as the level of trustworthiness. In a statistical research analysis, a reliability test is applied to determine the level of consistency of a questionnaire used in the research. The questionnaire can be relied upon to measure research variables. Before analyzing the respondents' data, it is necessary to analyze the reliability score test.

Table 2: Sample of TAM Questionnaire

Variable	*ID*	*Question Item*
Perceived Usefulness (PU)	PU2	Using massive open online courses (MOOCs) enhances my learning effectiveness.
Perceived Ease of Use (PEOU)	PEOU3	Interaction with HSS Learning is very clear and easy to understand

Variable	*ID*	*Question Item*
Attitude (AT)	ATU1	I believe that using HSS Learning is a good idea.
Continuance Intention (CI)	CITU2	I will continue using HSS Learning increasingly in the future.
Enjoyment (E)	E2	HSS Learning makes me enjoy learning HTML CSS.
Habit (H)	H1	The use of software has become a habit for me.
Social Influence (SI)	S3	If my classmates like to join the competition, I will do it.

A summary of the reliability analysis of the questionnaire items is shown in Table 3. The result showed that the alpha of PU was 0.87, PEOU was 0.84, AT was 0.85, and CI was 0.9, indicating excellent scores. Meanwhile, the external variables, H, E, and SI fell between 0.8–0.9, indicating good and excellent reliability. The results of the alpha calculations showed that the responses to the set of questions for all variables were reliable enough. Thus, responses data can be analyzed for further evaluation and hypothesis testing.

Table 3: Reliability Analysis

TAM Variable	*Items*	*Cronbach's Alpha*	*Reliability*
PU	6	0.87	Good
PEOU	4	0.84	Good
AT	5	0.85	Good
CITU	3	0.9	Excellent
H	4	0.86	Good
E	4	0.81	Good
SI	5	0.95	Excellent

Result and Discussion

This study utilized the TAM to assess the extent to which students accepted a gamification-based learning platform called HSS Learning. The statistical tools were used to investigate and display the effects among variables in the given conceptual model. However, the results of the questionnaire did not align with Shapiro Wilk's normality test. Thus, this study used nonparametric tests to assess and verify the hypotheses. Table 4 displays a concise overview of the outcomes derived from the regression analysis of the suggested acceptance model.

Hypotheses were tested at the 5 percent significance level to see if the null hypothesis should be accepted. If the null hypothesis was rejected, there was a significant effect among the proposed variables. In the present study, we used the non-parametric Generalized Linear Model (GLM) to test the hypotheses and used Nagelkerke pseudo R2 to describe the fitness level of the proposed model.

Table 4: Regression Analysis

Hypothesis		*Coefficient*	*p-value*	*Intercept*	*R2*	*Supp*
H1	PU → CI	0.75154	***	-0.99159	0.5015625	Yes
H2	AT → CI	0.39129	***			Yes
H3	PU → AT	0.39319	***	2.10992	0.3524738	Yes
H4	PEOU → AT	0.06777	0.1630			No
H12	SI → AT	0.10419	***			Yes
H5	PEOU → PU	0.27366	***	1.19051	0.4923919	Yes
H6	E → PU	0.35702	***			Yes
H7	H → PU	0.06779	0.0562			No
H8	SI → PU	0.04027	0.3003			No
H9	E → PEOU	0.49345	***	1.61523	0.4641918	Yes
H10	H → PEOU	0.11546	**			Yes
H11	SI → PEOU	0.03912	0.33188			No

Note: ***p-value < 0.001; **p-value < 0.01; p-value higher than 0.05 denotes non-significant items

GLM nonparametric analysis was used to analyze student responses to the model. The analysis results showed how each independent variable affected the dependent variable. The R2 value represented the proportion of the relationship between the dependent and independent variables in the proposed model. The H1 and H2 hypotheses illustrated that the CI variables depended on PU and AT. Based on the results of multiple analyses on PU and AT variables on CI, both significantly affected CI. Based on the R2 value, the model covered 50.01 percent of the CI variance.

The relationship between PU, PEOU, and SI on AT was analyzed by using the GLM analysis. This analysis was conducted to predict AT from PU, PEOU, and SI. The results indicated that there was a significant relationship between PU and SI. This result was possible because the calculation of linear regression analysis results showed a statistically significant result (p-value < 0.05). At the same time, PEOU did not significantly affect AT. According to the regression results, the value of R2 was 35.24 percent.

Three external variables were proposed, namely E, H, and SI, considering PEOU to identify whether these variables affected PU by using GLM analysis. The results showed that the value of R2 was 0.4923, meaning that 49.23 percent of the PU variant can be predicted by the variables E, H, SI, and PEOU. The analysis results showed that E and PEOU significantly influenced PU. However, H and SI did not considerably affect PU. The results of the GLM analysis showed that the p-value was 0.0562 and 0.3003, which statistically meant that it had no significant effect because the p-value was greater than the significant value of 0.005. H and SI did not affect the PU of HSS Learning. Meanwhile, students' E and PEOU affected students' PU of HSS learning.

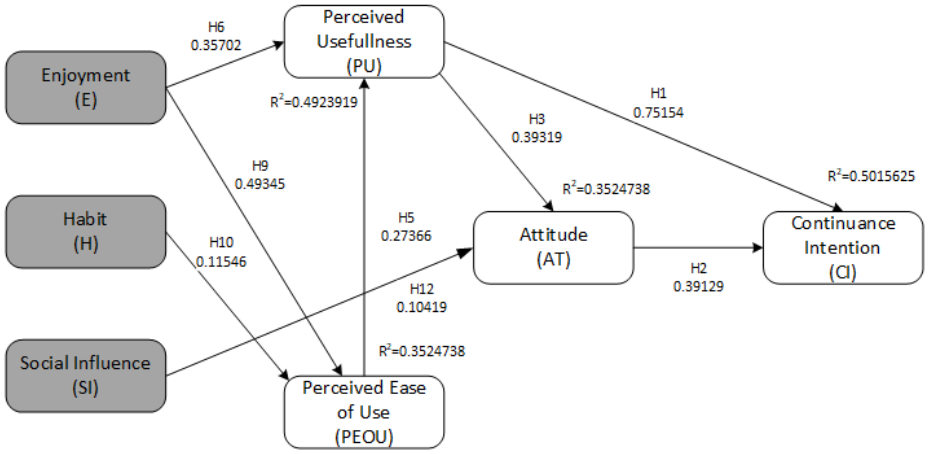

Figure 5: Acceptance Model of HSS Learning

Similar to the previous analysis, the influence of the external variables E, SI, and Hon PEOU was also evaluated using the GLM. The significance of the F-test indicated that the sample data had more evidence for the regression model than the model with no independent variables, with a p-value of 0.000, below the specified significance level of 0.05. Although the test results showed that all external variables could only predict 46.4 percent of the PEOU variance, both E and H variables affected student PEOU. SI had a significant influence on AT. The student acceptance model of HSS was summarized by considering the important correlations and relationships obtained from the GLM analysis. The findings of this investigation are illustrated in Figure 5.

The overall results suggested that most confirmed relationships were in accordance with previous TAM research describing students' intention to use new technologies. Students' PU was positively affecting their attitude toward HSS Learning. Other studies claim that enjoyment is an important motivator in game playing (Koo 2009). Therefore, we applied the game concept in gamification-based learning in web programming. We assumed that student attitudes or behavior toward the use of new technology could result not only from functional use but also from perceived enjoyment. Our findings align with research conducted by Yang, Asaad, and Dwivedi (2017) and Venkatesh et al. (2012), which mentioned that enjoyment was a variable that significantly affected PU and PEOU. Students found HSS Learning enjoyable because of its incorporation of gaming components, which created a sense of familiarity inside the learning environment while disguising the educational aspect.

Other research shows that adopting new technology complements user habits by acquiring the necessary knowledge of how well the technology can achieve its purpose and expected goals (Alsharo, Alnsour, and Alabdallah 2020). In gamification, game elements such as points, rewards, leaderboards, and badges can increase the habitual aspects of users (van Elderen and van der Stappen 2020). The findings in our study showed that H affected

students' PEOU of new technology. These results support the research conducted by Hubert et al. (2017). The participants in this study expressed a sense of familiarity with the user interface of HSS Learning due to frequent utilization of the program to facilitate their tasks. Furthermore, a considerable number of students frequently engaged in gaming activities, so gamification further enhanced the importance of H in relation to PEOU.

Elements of game mechanics can influence SI. For example, individuals are more likely to engage in behavior they believe others are doing (Sjöblom et al. 2017). HSS Learning implements leaderboard, point, and badge elements that allow fellow students to see and show off the results obtained by each other. Our findings indicated that SI had a significant impact on student attitudes toward using the new technology.

Conclusion

The convenience and usefulness of the system are influential aspects in students' motivation in utilizing HSS learning media that incorporate gamification approaches for learning purposes. When students experience pleasure or satisfaction with the system employed, they will evaluate it as valuable and persist in utilizing it for educational purposes. Students' perception of the system's simplicity of use is also influenced by the level of fun they have. The students' prior learning patterns and habits have an impact on how they evaluate the usability of this method. If the system is in accordance with their learning habits, they will find it easy to use. However, students' habits do not affect their usability and behavior in using the system. SIs in this study are known to influence how students use this system. If a significant number of a student's acquaintances or social circle utilize this approach, it will serve as a motivating factor for students to adopt it as well.

The research model analyzed in this study was adapted from the TAM model. The results of the analysis obtained are mostly consistent with the TAM model that has been described in previous studies. However, in this study, factors related to ease of use did not affect students' attitudes toward using this system. In the context of this research, external factors related to enjoyment, study habits, and SI have been proven to influence student acceptance of using the HSS system in supporting learning activities.

The results of the TAM analysis identified aspects that influenced students' intentions to use HSS Learning as a support for learning web programming. HSS learning is an innovative approach to programming education, addressing the scarcity of learning resources available to assist programming instruction. The findings of this experiment indicate that enhancing HSS Learning in the future may be achieved by concentrating on the most influential variables and without giving priority to the less relevant factors. Usability and user experience analysis may be conducted to assess and examine the user experience with HSS Learning.

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AI Acknowledgment

The authors declare that generative AI or AI-assisted technologies were not used in any way to prepare, write, or complete essential authoring tasks in this manuscript.

Informed Consent

The authors have obtained informed consent from all participants.

Conflict of Interest

The authors declare that there is no conflict of interest.

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