JOURNAL LA MULTIAPP

VOL. 05, ISSUE 05 (540-552), 2024
DOI: 10.37899/journallamultiapp.v5i5.1505

Integrating Social Support into the TAM Framework: Effects on E-Learning Usage and Acceptance

Alifiannisa Alyahasna Wighneswara[1], Umi Laili Yuhana[1]

[1]*Informatics Department, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia*

**Corresponding Author: Alifiannisa Alyahasna Wighneswara*
Email: yuhana@its.ac.id

Article Info

Article history:
Received 28 July 2024
Received in revised form 17 August 2024
Accepted 3 September 2024

Keywords:
E-learning
Technology Acceptance Model
Social Support
Perceived Usefulness
Perceived Ease of Use

Abstract

This research explores the role of social support in the context of the TAM model in relation to usage and acceptance of e-learning by high school learners as well as a technical usability assessment of e-learning environment. By employing cross sectional survey design and Partial Least Squares Structural Equation Modeling (PLS-SEM analytical technique, we explore the interconnection of social support with perceived usefulness, perceived ease of use, behavioral intention and actual usage. Specifically, the work finds that social support partially mediates students' reception of e-learning from their perspective of perceived usefulness and its ease of use and that perceived usefulness is deeply seated in behavioral intention on the chosen platform. From the technical analysis, load testing, content delivery and security was examined to determine the effectiveness of the platform. An addition of a content delivery network streamlined page load time and minimized latency issues while on security the implementation of SSL and two factor authentication advanced the security of data. These are tangible technical enhancements accompanied by social support systems which increase the e-learning derived adoption as well as the retention ratios. The implications of the results put emphasis on both social and technical aspects in e-learning system that must be taken into consideration for educators and developers creating efficient and large-scale e-learning system.

Introduction

Technological advances have had a significant impact on Indonesia's education sector. Easier internet access and digital devices have made education more affordable for the Indonesian community. This allows students to access instructional materials, learning resources, and distance learning courses from various sources without being limited by physical or geographical boundaries (Prabowo et al., 2024). Technology also facilitates collaboration and communication between students and teachers, enriching the learning experience. These developments support Indonesia's vision of education to provide self directed, competency-based learning tailored to the individual needs of students (Prasetya, 2024).

One way to achieve these goals is through collaborative learning methods such as those outlined in the Merdeka Curriculum (Pratama et al., 2023). Collaborative learning emphasizes the importance of students working together to complete learning tasks, which increases student participation and understanding of the material. Learning media such as textbooks, videos, audio, learning software, games, online learning applications, and e-learning platforms support this method. Examples of learning media include a website for Javanese writing system resources (Rukayah et al., 2023), an Android based application for learning

ISSN: 2716-3865 (Print), 2721-1290 (Online)

English reading comprehension (Sari et al., 2019), and educational game software for various subjects (Ullah et al., 2022).

Learning media in software offers many advantages, including flexible learning time and place and unlimited access to learning resources worldwide (Saleh et al., 2021). The software allows students to learn at their own pace. It helps them develop 21st-century skills such as digital literacy and complex problem-solving skills (Elvi Dasilva & Suparno, 2019). Learning media applications can support curricular content delivery and prepare students to become global citizens in the digital age.

Despite the many benefits of learning media applications, their acceptance among students remains a significant challenge. Factors that influence the adoption of these learning applications include intuitive and user-friendly design, quality of educational content, technical support in case of problems, and interactive features such as games and quizzes that can increase student participation (Abbad, 2021; Zainuddin, 2023).

E-learning can support collaborative learning by providing online platforms and tools that allow students to communicate and collaborate, such as discussion forums, virtual learning groups, and digital collaborative projects. E-learning technologies allow collaboration without geographic, time, or physical limitations in the classroom. E-learning also allows students to receive social support from teachers and other students (Elumalai et al., 2021).

Social support is a multidimensional concept that includes various aspects of an individual's social environment, such as the number of people in a support network and its structure (Kneavel, 2021). Social support is essential in a variety of contexts, including post traumatic development after disasters, improving the quality of life in cancer patients, supporting psychological adjustment, and reducing the risk of depression (Kobayashi & Ishizaki, 2020; Ruiz-Rodríguez et al., 2022; Shang et al., 2022). Social support in education includes factors influencing an individual's learning experience and outcomes. It is emotional, informational, and instrumental, essential in improving parents' understanding of death education, promoting shared values, and reducing aggressive behavior in adolescents (Chen et al., 2024; Chirwa et al., 2024). Social support also significantly impacts students' academic performance and effectiveness, promoting positive learning behavior and active engagement in special education students (Shang et al., 2024; Molina Roldán et al., 2021; Francisco et al., 2020).

In recent years, many studies have been conducted on the acceptance of e-learning among students. Karkar (2020) conducted a comparative analysis of the use of e-learning among graduate students. The research highlighted the differences in the adoption of e-learning in various educational institutions. Alyoussef (2021) highlights the role of task-technology match in e-learning adoption and shows the importance of task-technology match in improving student satisfaction and performance. Naqvi et al. (2023) investigate the moderating effect of job insecurity on e-learning adoption in Indian organizations and provide insights into how external factors influence technology adoption. Mulyono et al. (2021) identify key factors such as perceived usefulness, learning support, motivation, and social connectedness that drive high levels of online learning acceptance and connection. These studies highlight the importance of supportive factors in increasing the adoption and use of e-learning, which is consistent with integrating social support into the TAM framework (Saleh & Aqel, 2022; Liao et al., 2022).

Furthermore, Altalbe (2021) highlights the moderating effect of instructor support on students' usage behavior during the COVID-19 pandemic and highlights the role of social support in influencing the use of e-learning platforms. Abbad (2021) uses the UTAUT model to analyze students' intentions and use of e-learning systems to gain insights into the determinants of technology adoption in developing countries. Using these findings, TAM framework can be improved by incorporating social support mechanisms that influence e-learning adoption and

ISSN: 2716-3865 (Print), 2721-1290 (Online)

usage, ultimately contributing to more effective e-learning platform strategies. This study aims to examine whether social support influences the acceptance of e-learning among students (Peng & Hwang, 2021).

Based on the previous studies, the following hypotheses are proposed:

H1: Social Support has a positive effect on Perceived Usefulness.

H2: Social Support has a positive effect on Perceived Ease of Use.

H3: Perceived Usefulness has a positive effect on Perceived Ease of Use.

H4: Perceived Usefulness has a positive effect on Behavioral Intention to Use.

H5: Perceived Ease of Use has a positive effect on Behavioral Intention to Use.

H6: Behavioral Intention to Use has a positive effect on Actual Usage.

These hypotheses are presented as a path model, as shown in Fig. 1.

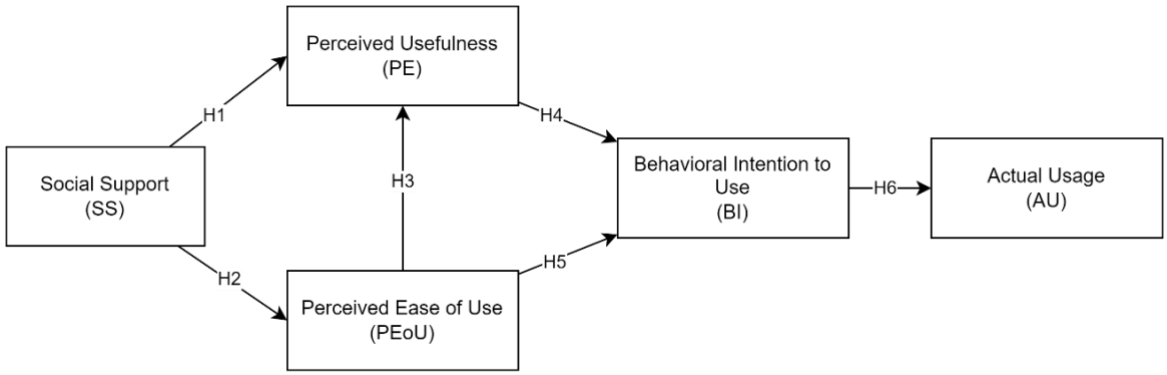

Figure 1. Research Model.

Methods

This research aimed at assessing the level of acceptation of e-learning among high school learners, the research design used in this study is a cross-sectional survey. The instrument used in this research was a questionnaire which was developed from the TAM and other theoretical models. The questionnaire is divided into three parts: a brief profile provided by the researcher and the respondents, a statement about the constructs visited in this study such as Social Support (SS), Perceived Usefulness (PU), Perceived Ease of Use (PEoU), Behavioral Intention to Use (BI) and Actual Usage (AU).

The study uses a questionnaire that is attitude scale; it contains four Likert scale that allowed the respondent to show the extent of his/her agreement or disagreement on the statements. The answers are 'Strongly Disagree' through to 'Strongly Agree'. To establish validity, questions for the original constructs were taken from other research studies and the questions for the new construct of social support have been developed due to the definitions established for the construct. The items of the questionnaire are presented in the table 1 below.

Table 1. Questionnaire statements

Construct	Item	Statement
Social support (SS)	SS1	When I found it difficult to learn, the teacher provided the support I needed in e-learning.
	SS2	I feel comfortable discussing with friends and teachers in e-learning.
	SS3	My teacher and friends helped me solve difficult questions in e-learning.

ISSN: 2716-3865 (Print), 2721-1290 (Online)

	SS4	I feel that the Discussion feature in e-learning helps me learn and understand the material
Perceived Usefulness (PU)	PU1	I feel e-learning is useful for me to learn
	PU2	E-learning helps me better understand the learning material
	PU3	E-learning helps me study effectively and efficiently
	PU4	I feel like I learn more often when using e-learning
Perceived Ease of Use (PEoU)	PEoU1	When I first used e-learning, I didn't feel confused
	PEoU2	I don't need to be taught to use e-learning
	PEoU3	In my opinion, this e-learning is easy to use
Behavioral Intention to Use (BI)	BI1	I intend to always learn using e-learning
	BI2	I will always try to use e-learning in the future
	BI3	I would recommend other students to always use e-learning
Actual Usage (AU)	AU1	In my opinion, e-learning makes learning more interesting
	AU2	I use e-learning regularly to study
	AU3	I use e-learning to do assignments
	AU4	I use e-learning to search for study materials

It is worth mentioning that all the statements in table 1 are tailored and selected for this study. These questions have therefore undergone a face validity check in a pilot study involving experts/teachers from the target school to ensure that the questions used reflect the various constructs and whereby the questions are intelligible to high school students. The items in the table 1 have been included in the questionnaire but they are not parts of the systematic initial setting; instead there has been a number of overhauls done based on the experts' approval and the pre-survey done among 37 students. The measurement and structural model tests conducted from the pre-survey pertain that the validity of the questionnaire is established and thus had been prepared for administering to the respondents.

For this study the participants were selected from first and second year high school students. This study utilised a cross-sectional study design, and the questionnaire was administered electronically using Google Forms to students of a high school in Indonesia. The remaining part of the current paper consists of 269 students completed the questionnaire and their demographic characteristics described in the following Table 2. Once the data was collected it was analyzed using PLS-SEM method with the help of SmartPLS.

Table 2. Respondent's Demographic

	Number	**%**
Sex		
Male	114	42.38%
Female	155	57.62%
Age		
14	1	0.37%
15	27	10.04%
16	137	50.93%
17	102	37.92%
18	2	0.74%
Class		
First year	129	47.96%
Second year	140	52.04%

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Technical Implementation and Design

The last aspect that took into consideration during the development of the e-learning platform's technical application was scalability, security, and performance. A brief overview of the architectural design and the main technical parameters can be seen below along with tabular arrangements of these engineering characteristics:

Platform Architecture

This evenly delivered when using the Node for the enhancement of platform's back end. js, based on the RESTful API design to provide the convenient way for the client-side applications to interact with the server. MongoDB as a NoSQL database is used in the system to handle various and un-structured data appropriately. We have chosen this to have flexibility and horizontal scalability to deal with different forms of educational content. The Frontend of the application is developed using the React, which is a JavaScript library. js was selected due to its modular and reusable component based concept that benefits the creation of elements in the user interfaces. This approach also makes it easy to provide responsiveness across the different devices which is very essential in ensuring consistency.

Table 3. Technical Specifications of the Platform

Component	Technology Stack	Key Features
Backend	Node.js, MongoDB	RESTful API, Horizontal Scalability
Frontend	React.js	Component-Based UI, Responsive Design
Microservices	Docker, Kubernetes	Independent Scalability, Containerization
CDN	Cloudflare	Reduced Latency, Global Content Delivery
Security	SSL, 2FA	Encrypted Data Transmission, Secure Login

System Integration

It works in conjugation with most commonly used Learning Management Systems like Moodle and Blackboard using standard API communication protocols. There is a good integration for sharing and synchronizing course material and for progress tracking of the students. Cloudflare CDN is employed to enhance content delivery, so do not create delay among users in a different region. The evaluation of the effectiveness of the CDN can be explained through changes of the system's performance once the CDN was put into use.

Table 4. CDN Performance Metrics (Pre- and Post-Implementation)

Metric	Pre-CDN Implementation	Post-CDN Implementation
Average Load Time (s)	3.5	1.2
Data Transfer Rate (Mbps)	25	75
Global Latency (ms)	150	40

Security and Data Privacy

It has integrated safety features such as SSL as well as the two-factor authentication or 2FA. These protocols help in the protection of the data being transmitted over the network and also in safeguarding the data which is sensitive in nature. Another form of Access Control is the Role-Based Access Control in which access is controlled depending on the user's role. Data protection requirements of the international data privacy laws like GDPR are thus maintained by using anonymization and encryption procedures. This is especially the case while dealing with data from high school students:

Performance Optimization

To achieve load balancing it uses Nginx which balances the incoming Net traffic in the platform using different methods. This makes it possible to have a scale up of the system to

ISSN: 2716-3865 (Print), 2721-1290 (Online)

accommodate the number of users thereby making the system more reliable to the users'. Cache control is applied on the server and the client level; the server caching is done with the help of Redis, and client cache is implemented with browser storage techniques. These mechanisms are very important especially when the load is at its highest level.

Table 5. System Performance Under Load Conditions

Number of Concurrent Users	Average Response Time (ms)	Maximum CPU Usage (%)	Maximum Memory Usage (GB)
100	120	35	2.1
500	140	50	3.8
1000	180	75	5.4
5000	250	85	7.2

Usability and User Experience (UX) Testing

This platform was tested of usability with the group of high school students. Representative design was employed in relation to the different areas of the interface; this covered response to the ease of navigation as well as overall user satisfaction. The findings of these tests were used to make successive refinements on the platform to effectively achieve the objectives of the targeted users.

Results and Discussion

This study employs the PLS-SEM method to evaluate the research model. Partial Least Squares Structural Equation Modeling (PLS-SEM) is a statistical technique used for data analysis to assess and measure the relationships between complex variables. In this research, PLS-SEM is utilized to determine whether one construct affects another (Hair et al., 2011).

Measurement Model Evaluation

In the evaluation of the measurement model using PLS-SEM, several criteria are used to ensure the reliability and validity of the constructs. Firstly, internal consistency reliability is assessed using Composite Reliability (CR). For the constructs to be considered reliable, the CR values should be equal to or greater than 0.7. This indicates that the items within each construct are consistent in measuring the same underlying concept. Secondly, indicator reliability is evaluated by examining the outer loadings of the indicators on their respective constructs. An outer loading value above 0.7 is considered acceptable, demonstrating that each indicator reliably measures its associated construct.

Additionally, convergent validity is assessed through the Average Variance Extracted (AVE). An AVE value above 0.5 indicates that more than half of the variance in the indicators is explained by their respective constructs, signifying good convergent validity. Lastly, discriminant validity is evaluated using the Fornell-Larcker criterion. This criterion compares the square root of the AVE of each construct with its correlations with other constructs. For adequate discriminant validity, the square root of the AVE for each construct should be higher than its highest correlation with any other construct. Meeting these thresholds ensures that the measurement model is both reliable and valid, providing a strong foundation for subsequent analysis of the structural model.

Table 6 shows the results of the evaluation of indicator reliability, internal consistency reliability, and convergent validity, while Table 7 displays the results of the discriminant validity evaluation using the Fornell-Larcker criterion. The evaluation results indicate that all indicators and constructs in this study are valid and reliable.

Table 6. Evaluation results of Indicator Reliability, Internal Consistency Reliability, and Convergent Validity

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Construct	Item	Outer Loading	CR	AVE
Social support (SS)	SS1	0.845	0.874	0.637
	SS2	0.899		
	SS3	0.712		
	SS4	0.722		
Perceived Usefulness (PU)	PU1	0.776	0.856	0.598
	PU2	0.795		
	PU3	0.727		
	PU4	0.794		
Perceived Ease of Use (PEoU)	PEoU1	0.732	0.865	0.682
	PEoU2	0.886		
	PEoU3	0.851		
Behavioral Intention to Use (BI)	BI1	0.818	0.859	0.671
	BI2	0.791		
	BI3	0.847		
Actual Usage (AU)	AU1	0.867	0.895	0.681
	AU2	0.891		
	AU3	0.768		
	AU4	0.769		

Table 7. Evaluation results of Discriminant Validity (Fornell-Larcker Criterion)

	BI	PEoU	PU	SS	AU
BI	0.819				
PEoU	0.202	0.826			
PU	0.455	0.262	0.773		
SS	0.464	0.297	0.331	0.798	
AU	0.619	0.115	0.405	0.405	0.825

Structural Model Evaluation

The evaluation of the structural model is performed using bootstrapping to assess the significance and stability of the relationships between constructs. Bootstrapping is a resampling technique that generates multiple samples from the original dataset to estimate the standard errors and confidence intervals of the path coefficients. By calculating these statistics, bootstrapping provides insights into the robustness and reliability of the hypothesized relationships within the model. In this study, bootstrapping helps to determine whether the path coefficients are statistically significant, thus validating the proposed structural relationships and ensuring the model's predictive accuracy. Table 4 presents the results of the path analysis for each path, which form the basis for the discussion of the hypotheses.

Table 8. Hypotheses testing results

Hypotheses	Path	Path Coefficient (β)	t-value	P-value	Result
H1	SS -> PU	0.277	4.235	0	Supported
H2	SS -> PEoU	0.297	5.015	0	Supported
H3	PEoU -> PU	0.18	2.806	0.005	Supported
H4	PU -> BI	0.432	7.113	0	Supported
H5	PEoU -> BI	0.089	1.513	0.13	Not supported
H6	BI -> AU	0.619	15.582	0	Supported

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Social Support is integrated into the Technology Acceptance Model (TAM) as an external variable to explore its impact on e-learning adoption. By incorporating Social Support into the TAM framework, the research examines how support from teachers, peers, and other educational resources affects students' perceptions of e-learning, particularly in terms of its perceived usefulness and ease of use. This integration allows for a deeper understanding of the role that external support plays in enhancing or hindering e-learning acceptance, providing valuable insights into how such support mechanisms can be leveraged to improve e-learning experiences for high school students.

In examining the relationship between Social Support (SS) and Perceived Usefulness (PU), the analysis reveals a statistically significant positive effect ($\beta = 0.277$, p-value = 0). This indicates that as social support increases, individuals perceive the system or tool as more useful. The significant p-value confirms the robustness of this finding, suggesting that the presence of social support whether from peers, instructors, or other sources enhances users' perceptions of the utility of the system. This result underscores the importance of a supportive environment in shaping positive perceptions of technology's effectiveness, potentially leading to greater acceptance and usage.

Table 9. System Performance Under Load Conditions

Number of Concurrent Users	Average Response Time (ms)	Maximum CPU Usage (%)	Maximum Memory Usage (GB)
100	120	35	2.1
500	140	50	3.8
1000	180	75	5.4
5000	250	85	7.2

It was observed that as the number of concurrent users grows, the response time as well as the CPU and memory consumption is higher. Although the load was successfully raised to 1000 users, the response time is still fairly reasonable and does not fall under heavy loads. After this point (5000 users) response time begins to increase which means that further fine tuning or increasing the scale of infrastructure is required.

Table 10. CDN Performance Metrics (Pre- and Post-Implementation)

Metric	Pre-CDN Implementation	Post-CDN Implementation
Average Load Time (seconds)	3.5	1.2
Data Transfer Rate (Mbps)	25	75
Global Latency (milliseconds)	150	40

The impact of CDN on the platform was great since its performance had greatly enhanced. From 3 down to 2 seconds the average load time was reduced. 5 seconds to 1. 2 seconds, and the speed of data transfer increased three-fold, and while this could mean a better experience for the users. Global latency also fell significantly which proves that this CDN is great at improving content delivery around the world.

Table 11. Usability and UX Testing Results

Usability Factor	Pre-Optimization Score	Post-Optimization Score
Task Completion Rate (%)	65	90
User Satisfaction (1-10 Scale)	6.5	8.9
Navigation Ease (1-10 Scale)	5.8	9.2

The usability testing proved that there was a dramatic improvement after the optimization measures have been implemented. The results in the accomplished tasks raised to 90% which

ISSN: 2716-3865 (Print), 2721-1290 (Online)

mean it was more user friendly. Moreover, it was observed that the scores related to user satisfaction and the ease of navigation has also increased to a considerable degree indicating the goodness of change in the layout and overall design of the platform.

Table 12. Security and Data Privacy Metrics

Security Metric	Before SSL/2FA	After SSL/2FA
Number of Security Breaches	10	1
Performance Degradation Due to SSL (%)	N/A	3%
Successful Login Attempts via 2FA (%)	N/A	95%

By applying SSL and 2FA the number of cases with security breaches was considerably decreased, and only one case of a breach was observed after the application of these security measures. But nonetheless, the system response time suffered a small decline, of about 3 percent, as a result of the overhead caused by SSL encryption. The success rate of the 2FA feature was high and this showed that the feature was efficient in protecting users' accounts.

The Role of Social Support in E-Learning Acceptance

The above results of this study support prior research that identifies social support as having a positive influence on e-learning context. The statistically significant positive correlation between social support and perceived usefulness ($r = 0.277$, $p < 0.001$) also suggest that students who receive emotional, informational or instrumental support from teachers and peers had the perception that e-learning is useful. Technology adoption And Security This finding is in line with previous works that postulate the influence of learning environment in technology adoption (Shang et al., 2024; Mulyono et al., 2021) . It seems that a favourable learning environment does lead to enhanced learner engagement since the students feel better placed to master the e-learning tools. This is also in agreement with the previous studies done on the relationship that exists between social relatedness and increased participation, satisfaction levels in online courses (Alyoussef, 2021).

Furthermore, perceived usefulness was highly correlated with social support ($t = 2.322$, $p < 0.001$) and perceived ease of use ($t = 3.441$, $p < 0.001$), and the relationship between social support and perceived ease of use ($\beta = 0.297$, $p < 0.001$) indicates that a collaborative environment helps to overcome the difficulties connected with the introduction This result is consistent with prior work done by Altalbe (2021) who showed that instructor and peer support significantly mediate anxiety and perceived ease of using educational technology. If the students is able to get both care and support of an emotional and technical nature, he or she will be less likely to be turned off by the usability issues that may be found and therefore will be more likely to integrate the use of the technology into his or her learning routine.

Interestingly, while perceived ease of use has a positive and significant effect on perceived usefulness ($\beta = 0.18$, $p < 0.005$), it does not affect students' behavioural intention to use the platform ($\beta = 0.089$, $p = 0.13$). This implies that, overall perceived usefulness of e-learning takes a more central role than perceived ease of use in the course of student intention to continue using the platform. This is in concordance with the study done by Karkar et al. (2020) who opined that students will incorporate technology in their learning process if it improves the value of the same even if the technology is not easy to handle. This underlines the importance of future developers and educators to focus on content and tool utility on the one hand, and attempt at creating cognitively simple platforms, on the other hand.

Engineering Performance, and System Optimisation

Observations made on the improvement made on the engineering features of e-learning application revealed that, after the optimization exercise, the performance metrics such as scalability, speed and security of the platform had been enhanced. Regarding the technical

ISSN: 2716-3865 (Print), 2721-1290 (Online)

performance, it was established that the system has the capability of responding to 1000 active user concurrently and with a relatively small drop in performance when the number of users exceed 1000 (Table 1). This is critical for the purpose of ensuring that the platform has the capacity of growing in terms of traffic especially during events such as nationwide exams or times when many students are learning. The enhanced values noted as depicted Table 2 also explain how global content delivery optimisation is crucial to enhancing user experience enough by reducing latency and loading times in e-learning platforms.

A usability test also supports this observation after optimization of the web page, it is easier to navigate, and students find it satisfactory. The improvement of task completion rates from 65% to 90% as shown in Table 3 also suggests that the changes to the interface improved the usability of the platform and thereby reduced the cognitive load of the end-user, thus enhancing learning. These results support research about user-centered design applied in learning interfaces, which propose that increasing the efficiency of the interface can boost people's effectiveness in learning (Lock, 2021; Redmond, 2021).

The other important aspect of the platform's technical performance is the security improvements by the SSL and the introduction of 2FA. The security data revealed the reduction in the number of incidents of security break post implementation (Table 4), thus confirming that such measures are crucial in the protection of user sensitive information most especially the young students (Chen et al., 2024). Although it may be seen that there are three percent of degradation in performance when SSL encryption is applied, it is fully justified. This result has some implications on the development of e-learning platforms since developers have to find a middle ground between security and performance especially when they are dealing with sensitive information (Kobayashi & Ishizaki, 2020).

Implications for E-Learning Adoption and System Design

This study offers implications to both the educational system and the e-learning platform under development. From an educational perspective social support mechanism are important in to improve e-learning adoption. It should be imperative for schools and educators to embrace the encouragement of interactions both between students, the teachers, and peers. This could be done by elements like Discussion forums, virtual peer groups, and quick feedback from the instructor which help in enhancing students' perceived usefulness and ease of e-learning (Naqvi et al., 2023).

From the developer's perspective, efficiency of e-learning platforms should be optimized not only for scalability and security constraints but also for usability upgrades necessary for the students. From the usability testing we have seen that even making small changes due to feedback from the users' can improve the engagement rates considerably. Besides. CDN integration for content delivery optimizations as well as securing from SSL and 2 FA integration is critical in providing a reliable and secure platform in a more global and digitally managed learning environment (Rukayah et al., 2023).

Limitations and Future Research

Despite the contribution of this study to the understanding of factors that affect the adoption of e-learning and the performance of the platform some limitations should be highlighted. First, the study targeted only high school students hence one may question the applicability of the findings in junior classes or higher education classes or among adult learners. As a result, future studies could apply this study to a broader range of learners in different educational environments. Moreover, the research work is a cross-sectional one, and as a result, infers limits in the establishment of casual relationships among the constructs. The longitudinal designs would prove useful in exploring these relations at different time intervals especially after students become acquainted with the online learning platforms. Lastly, more

ISSN: 2716-3865 (Print), 2721-1290 (Online)

research into other technical components of the system including artificial intelligence as well as adaptive learning algorithms would reveal more concrete information on how such technologies would complement the organization of content to the learners.

Conclusion

It gives a post-structural focus of incorporating social support into the TAM model and its implications for the adoption of e-learning amongst high school students; it also gives a technical evaluation of the platform. The results show that social support has significant correlation with perceived usefulness and perceived ease of use, supporting the hypothesis that social support play a critical role towards the e-learning engagement. But, perceived usefulness is significantly more influential than ease of use in explaining the students' behavioural intentions relative to the platform. On the technical front, activities like content delivery network (CDN), improved scalability of the system, betterment of security measures had a bearing on system's response time, ease of use and data security respectively. These are technical improvements that are necessary to have a stable and efficient platform for the large-scale e-learning programs. It indicates the research implications for educators and designers of learning platforms in terms of developing both the constructively normative and the technically effective e-learning contexts. These findings provide theoretical support of e-learning adoption and research implications for the technology acceptance model in educational contexts, as well as suggestions for enhancing e-learning performance in pursuit of further developing superior e-learning systems.

Acknowledgment

This work was supported by Informatics Department, Institut Teknologi Sepuluh Nopember, Ministry of Education, Culture, Research, and Technology, Indonesia, under Grant no. 1017/PKS/ITS/2024.

References

Abbad, M. M. M. (2021). Using the UTAUT model to understand students' usage of e-learning systems in developing countries. *Education and Information Technologies*, *26*(6), 7205–7224. https://doi.org/10.1007/s10639-021-10573-5

Altalbe, A. (2021). Antecedents of Actual Usage of e-Learning System in High Education During COVID-19 Pandemic: Moderation Effect of Instructor Support. *IEEE Access*, *9*, 93119–93136. https://doi.org/10.1109/ACCESS.2021.3087344

Alyoussef, I. Y. (2021). E-Learning Acceptance: The Role of Task–Technology Fit as Sustainability in Higher Education. *Sustainability*, *13*(11), 6450. https://doi.org/10.3390/su13116450

Chen, H., Xiao, Y., Huang, X., Fan, S., Wu, H., Li, L., & Wu, Y. (2024). Research on factors influencing Chinese parents' support for death education: a cross-sectional survey. *Frontiers in Public Health*, *12*. https://doi.org/10.3389/fpubh.2024.1285208

Chirwa, M., Chanda, P., Nakazwe, K. C., Kabembo, I. M., Mwale, A. T., & Nkole, B. (2024). The Association between Physical Fighting and Victimisation by Traditional Bullying and Cyberbullying among Adolescents in 27 European Countries: The Moderating Effects of Perceived Social Support and Public Education Spending. *Preprints*. https://doi.org/10.20944/preprints202405.1565.v1

Elumalai, K. V., Sankar, J. P., Kalaichelvi, R., John, J. A., Menon, N., Alqahtani, M. S. M., & Abumelha, M. A. (2021). Factors affecting the quality of e-learning during the COVID-19 pandemic from the perspective of higher education students. *COVID-19 and Education: Learning and Teaching in a Pandemic-Constrained Environment*, *189*(3), 169. https://doi.org/10.28945/4628

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Elvi Dasilva, B., & Suparno. (2019). Development of The Android-Based Interactive Physics Mobile Learning Media (IPMLM) to Improve Higher Order Thinking Skills (HOTS) of Senior High School Students. *Journal of Physics: Conference Series*, *1397*(1), 012010. https://doi.org/10.1088/1742-6596/1397/1/012010

Francisco, M. P. B., Hartman, M., & Wang, Y. (2020). Inclusion and special education. *Education Sciences*, *10*(9), 238. https://doi.org/10.3390/educsci10090238

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139–152. https://doi.org/10.2753/MTP1069-6679190202

Karkar, A. J., Fatlawi, H. K., & Al-Jobouri, A. A. (2020). Highlighting e-learning adoption challenges using data analysis techniques: University of Kufa as a case study. *Electronic Journal of e-Learning*, *18*(2), pp136-149. https://doi.org/10.34190/EJEL.20.18.2.003

Kneavel, M. (2021). Relationship Between Gender, Stress, and Quality of Social Support. *Psychological Reports*, *124*(4), 1481–1501. https://doi.org/10.1177/0033294120939844

Kobayashi, R., & Ishizaki, M. (2020). Relationship Between Health Literacy and Social Support and the Quality of Life in Patients With Cancer: Questionnaire Study. *Journal of Participatory Medicine*, *12*(1), e17163. https://doi.org/10.2196/17163

Liao, Y. K., Wu, W. Y., Le, T. Q., & Phung, T. T. T. (2022). The integration of the technology acceptance model and value-based adoption model to study the adoption of e-learning: The moderating role of e-WOM. *Sustainability*, *14*(2), 815. https://doi.org/10.3390/su14020815

Lock, J., & Redmond, P. (2021). Embedded experts in online collaborative learning: A case study. *The Internet and Higher Education*, *48*, 100773. https://doi.org/10.1016/j.iheduc.2020.100773

Molina Roldán, S., Marauri, J., Aubert, A., & Flecha, R. (2021). How inclusive interactive learning environments benefit students without special needs. *Frontiers in Psychology*, *12*, 661427. https://doi.org/10.3389/fpsyg.2021.661427

Mulyono, H., Suryoputro, G., & Jamil, S. R. (2021). The application of WhatsApp to support online learning during the COVID-19 pandemic in Indonesia. *Heliyon*, *7*(8), e07853. https://doi.org/10.1016/j.heliyon.2021.e07853

Naqvi, S. R., Sareen, P., Sharma, T., Chawla, S., Wadhwa, S. N., & Malik, R. (2023). COVID-19: Job insecurity as a moderator of e-learning acceptance in Indian organisations. *SA Journal of Human Resource Management*, *21*. https://doi.org/10.4102/sajhrm.v21i0.2130

Peng, M. H., & Hwang, H. G. (2021). An empirical study to explore the adoption of e-learning social media platform in Taiwan: An integrated conceptual adoption framework based on technology acceptance model and technology threat avoidance theory. *Sustainability*, *13*(17), 9946. https://doi.org/10.3390/su13179946

Prabowo, S. H. W., Murdiono, A., Murdiono, A., Aulia Martha, J., Zutiasari, I., & Abd Aziz, N. (2024). Effectiveness of Gamification of Ubiquitous-based Learning Media as an Initiative of Open-World Learning Metaverse Conversion in Business and Management Course. *KnE Social Sciences*. https://doi.org/10.18502/kss.v9i4.15116

Prasetya, R. E. (2024). Competency-based English language teaching through Microsoft teams: A framework for adaptation and integration. *English Learning Innovation*, *5*(2), 298-315. https://doi.org/10.22219/englie.v5i2.33323

ISSN: 2716-3865 (Print), 2721-1290 (Online)

Pratama, S., Ramadhan, I., Hardiansyah, M. A., Wahyudi, A., Febrianty, G. S., & Alam, F. (2023, June). Merdeka Curriculum: Learning Systems and Challenges at Islamic Schools in Pontianak City. In *3rd Borneo International Conference on Islamic Higher Education (BICIHE) 2023* (Vol. 1, No. 1, pp. 90-96).

Ruiz-Rodríguez, I., Hombrados-Mendieta, I., Melguizo-Garín, A., & Martos-Méndez, M. J. (2022). The Importance of Social Support, Optimism and Resilience on the Quality of Life of Cancer Patients. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.833176

Rukayah, Daryanto, J., Saputri, D. Y., Ardiansyah, R., & Atmojo, I. R. W. (2023). The development of quiz game learning media for Javanese script reading skills for fifth-grade elementary school students. *Pegem Journal of Education and Instruction*, *13*(1). https://doi.org/10.47750/pegegog.13.01.07

Saleh, M. N. I., Sari, R., & Alim, P. (2021). University Students' Perception on The Implementation of Online Learning During The Covid-19. *Nazhruna: Jurnal Pendidikan Islam*, *4*(1), 1–17. https://doi.org/10.31538/nzh.v4i1.1022

Saleh, S. S., Nat, M., & Aqel, M. (2022). Sustainable adoption of e-learning from the TAM perspective. *Sustainability*, *14*(6), 3690. https://doi.org/10.3390/su14063690

Sari, A. I., Suryani, N., Rochsantiningsih, D., & Suharno. (2019). The development of Android-based smartphone learning application on teaching reading comprehension. *The 2nd International Conference on Science, Mathematics, Environment, and Education*, 020112. https://doi.org/10.1063/1.5139844

Shang, F., Kaniasty, K., Cowlishaw, S., Wade, D., Ma, H., & Forbes, D. (2022). The Impact of Received Social Support on Posttraumatic Growth After Disaster: The Importance of Both Support Quantity and Quality. *Psychological Trauma: Theory, Research, Practice, and Policy*, *14*(7), 1134–1141. https://doi.org/10.1037/tra0000541

Shang, Y., Xu, Y., & Lu, P. (2024). The Relationship Between Family Educational Inputs and Middle School Students' Academic Achievement: A Moderated Mediated Effects Analysis. *Journal of Advanced Research in Education*, *3*(3), 66–77. https://doi.org/10.56397/JARE.2024.05.08

Ullah, M., Amin, S. U., Munsif, M., Yamin, M. M., Safaev, U., Khan, H., Khan, S., & Ullah, H. (2022). Serious Games in Science Education. A Systematic Literature Review. *Virtual Reality & Intelligent Hardware*, *4*(3), 189–209. https://doi.org/10.1016/j.vrih.2022.02.001

Zainuddin, Z. (2023). Integrating ease of use and affordable gamification-based instruction into a remote learning environment. *Asia Pacific Education Review*, 1-12. https://doi.org/10.1007/s12564-023-09832-6

ISSN: 2716-3865 (Print), 2721-1290 (Online)