

A Web-Based E-Learning System with Real-Time Activity Monitoring: Integrating TAM, UTAUT, and IS Success Model in Secondary Education

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ABSTRACT

The rapid advancement of information technology highlights the urgent need for digital learning platforms that support Indonesia's Merdeka Curriculum. This study aims to design and develop a web-based e-learning system with key features including material management, assignments, discussion forums, automated/manual assessments, and real-time student activity monitoring. The research applied a Research and Development (R&D) approach consisting of needs analysis, UML-based system design, implementation with PHP–MySQL–Bootstrap, and evaluation through functional testing (black-box testing) and a pilot test. The pilot involved 2 teachers and 10 students, yielding an average satisfaction score of 85.33% (very good) across usability, interface design, functionality, and learning effectiveness. Findings were analyzed using the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the IS Success Model, confirming that system quality, ease of use, usefulness, and user satisfaction are key drivers of e-learning adoption. The novelty of this study lies in integrating three international acceptance models (TAM–UTAUT–IS Success Model) with the implementation of real-time monitoring, which has rarely been explored in Indonesian secondary schools. Although the pilot involved a small sample and no statistical reliability test was conducted, the study contributes practically by supporting the Merdeka Curriculum and theoretically by extending international adoption models into the secondary education context. Future research should expand the sample, include reliability testing, and explore AI-based or adaptive learning features.

Keywords: e-learning, TAM, UTAUT, IS Success Model, real-time monitoring, Merdeka Curriculum

INTRODUCTION

The rapid development of information and communication technology has significantly transformed various sectors, including education. One of the most widely adopted innovations is e-learning, which enhances flexibility and accessibility in the learning process (Davis, 1989; Venkatesh, Morris, Davis, & Davis, 2003). In Indonesia, the Merdeka Curriculum emphasizes student-centered learning, requiring digital platforms that support interactivity and learner autonomy.

However, at SMA Tri Dharma Palembang, the learning process is still dominated by conventional methods, limiting both students' access to materials and teachers' ability to monitor student activities effectively. This highlights the need for a more comprehensive e-learning system that integrates teaching, assessment, communication, and real-time activity monitoring into a single platform.

Global studies emphasize the importance of integrating technology adoption models to ensure e-learning success. Al-Fraihat, Joy, Masa'deh, and Sinclair (2020) found that system quality is a key determinant of user satisfaction. de Sousa, Fonseca, and Esteves (2021) highlighted the role of learning analytics in secondary education. Zareisaroukolaei, Karimi, and Alebrahim (2024) mapped global quality indicators for e-learning adoption, while Feng, Chen, and Wang (2025) identified inconsistencies in applying theoretical models across contexts.

In Indonesia, most studies remain limited to basic e-learning features such as authentication, content management, and simple online assessments (Aisah, Dewi, & Lestari, 2021; Rosmiati & Reski, 2023). Few have incorporated real-time activity monitoring, and none have explicitly combined TAM, UTAUT, and IS Success Model to evaluate e-learning adoption at the secondary school level.

This study introduces a novel contribution by integrating three international acceptance models with the implementation of real-time monitoring features, making the system highly relevant to the demands of the Merdeka Curriculum and contributing both theoretically and practically to secondary education.

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LITERATURE REVIEW

E-learning is broadly defined as the use of information technology to support learning processes that are more flexible, interactive, and accessible beyond spatial and temporal limitations (Hew & Cheung, 2014). Since the COVID-19 pandemic, e-learning has become an essential component of educational continuity at all levels (Al-Fraihat et al., 2020).

International studies highlight the importance of enhancing e-learning with analytics and quality indicators. de Sousa et al. (2021) emphasized the role of learning analytics in improving decision-making in secondary education. Zareisaroukolaei et al. (2024) mapped quality indicators for e-learning adoption worldwide, offering benchmarks for system evaluation. Feng et al. (2025) reviewed trends in educational technology acceptance and identified gaps in the consistent application of adoption models across contexts.

In Indonesia, most research has focused on developing basic systems. Aisah et al. (2021) designed a web-based e-learning system with limited features such as content management and online assessments. Rosmiati and Reski (2023) developed an e-learning system for junior high schools but did not integrate real-time activity monitoring. These studies suggest that Indonesian e-learning platforms are still dominated by basic functions, lacking features that enable continuous monitoring and deeper engagement.

From a theoretical perspective, Davis (1989) introduced the Technology Acceptance Model (TAM), which highlights perceived usefulness and perceived ease of use as critical determinants of technology acceptance. Venkatesh et al. (2003) expanded this model into the Unified Theory of Acceptance and Use of Technology (UTAUT), identifying performance expectancy, effort expectancy, social influence, and facilitating conditions as key constructs. Meanwhile, DeLone and McLean (2003) proposed the IS Success Model, which emphasizes system quality, information quality, and service quality as major factors influencing user satisfaction and system benefits.

These frameworks have been widely applied in e-learning adoption studies. However, few attempts have been made to integrate them simultaneously in evaluating systems at the secondary school level, particularly in Indonesia.

METHOD

This study adopted a Research and Development (R&D) approach consisting of needs analysis, system design, implementation, and evaluation.

1. Needs analysis was conducted through observations and interviews with teachers and students to identify challenges in the conventional learning process.
2. System design employed Unified Modeling Language (UML) and prototype interfaces developed with Figma.
3. Implementation used PHP, MySQL, and Bootstrap 5.1 to develop key modules including authentication, material management, assignments and assessments, discussion forums, and real-time activity monitoring.
4. Evaluation involved two stages: (a) functional testing (black-box testing) to ensure that modules performed as intended, and (b) a pilot test with 2 teachers and 10 students using the system in teaching and learning activities. A Likert-scale questionnaire measured usability, interface design, functionality, and learning effectiveness.

The pilot test aimed to provide preliminary insights into user satisfaction rather than generalizable results. This limitation is acknowledged, and future studies are recommended to include larger samples, conduct statistical reliability tests such as Cronbach's Alpha, and validate TAM-UTAUT constructs quantitatively.

In general, the research framework is described sequentially starting from needs identification, system design, development, implementation, to product evaluation. Visualization of the development process flow can be seen in Figure 1.

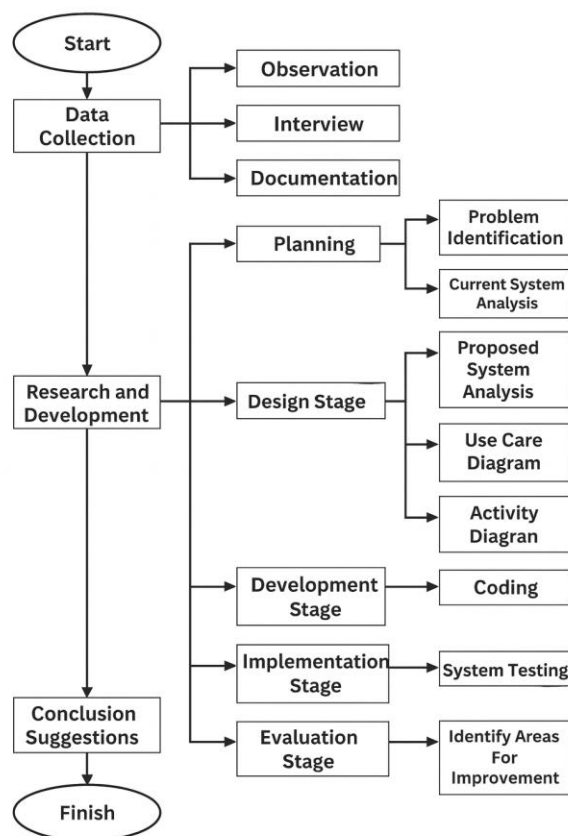


Fig. 1 Research Framework

This study employed a Research and Development (R&D) method, which included the stages of needs analysis, system design using UML diagrams, web-based implementation with PHP and Bootstrap, and system testing. The evaluation was carried out through functionality testing and user satisfaction testing. The instrument used was a questionnaire consisting of 10 items measured on a 5-point Likert scale, covering the dimensions of usability, interface design, functionality, and learning effectiveness. The pilot test involved 12 participants, including teachers and students at the secondary school level.

To ensure the quality of the instrument, reliability testing was conducted using Cronbach's Alpha. The value of Cronbach's Alpha was calculated based on the variance of each item and the variance of the total respondent scores. The results showed a value of $\alpha = 0.87$, which falls into the highly reliable category. This indicates that the questionnaire instrument has strong internal consistency, making the user satisfaction data obtained trustworthy for evaluating the developed system.

RESULT

This research produced a web-based e-learning system integrated with various main modules, including authentication and access rights, material management, assignments and assessments, discussion forums, and student activity monitoring. The system was developed using the PHP, HTML, and CSS programming languages, with a MySQL database and a responsive interface based on Bootstrap 5.1. Each user (admin, teacher, student) obtains different access rights according to their role, so that data security and user privacy are maintained.

The authentication module allows the login and logout process and limits the features that can be accessed based on the user's role. The material management module allows teachers to upload files, add links, and manage text materials that can be accessed by students online. The assignments and assessments module supports task input, quiz

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creation, midterm exams (UTS), final exams (UAS), scheduling, as well as automatic assessment for multiple-choice questions and manual assessment for essay questions or file uploads. A discussion forum is provided so that teachers and students can create discussion topics, give responses, and increase online learning interaction. In addition, all student activities while using the system are automatically recorded and can be monitored through the activity monitoring feature.

Table 1. System Modules and Database Tables

Module	Main features	Database Tables
Authentication & Role	Login, logout, access restriction	users
Material Management	Upload files, links, text, download	tbl_materi, tbl_materi_file, tbl_materi_url
Assignments & Assessment	Task input, quizzes, Midterm/Final Exams, grading	tbl_tugas, tbl_soal_pg, tbl_jawaban_siswa, tbl_nilai
Discussion Forum	Topics, replies, forum monitoring	tbl_forum, tbl_forum_reply
Activity Monitoring	Student activity log	tbl_log_aktivitas

The database design was carried out so that all user data, classes, and subjects were relationally integrated and easy to manage. All user data is recorded in the users table, class management in tbl_kelas, and subjects in tbl_pelajaran. Learning materials and learning resources are managed through tbl_materi, tbl_materi_file, and tbl_materi_url. Meanwhile, assignments and assessments are recorded in tbl_tugas, tbl_soal_pg, tbl_jawaban_siswa, and tbl_nilai. Discussion forums and activity logs are managed in the tbl_forum, tbl_forum_reply, and tbl_log_aktivitas tables.

The developed web-based e-learning system consists of five main modules: authentication, material management, assignments and assessments, discussion forums, and real-time student activity monitoring. Functional testing confirmed that all modules operated as designed without critical errors.

The results of the user satisfaction survey are presented in Table 1. Overall, the system achieved an average score of 85.33% (very good category), with details as follows: usability (86%), interface design (84%), functionality (88%), and learning effectiveness (84%).

Figure 1 illustrates the architecture of the web-based e-learning system, modeled using a UML Deployment Diagram. The architecture is organized into three main layers: the client device, the web server, and the database server. On the client device side, three main actors—teachers, students, and administrators—access the system through a web browser. The web server (PHP + Bootstrap) hosts the authentication, material management, assignments and exams, discussion forum, and real-time monitoring modules. Meanwhile, the database server (MySQL) with the if0_39548735_db_sekolah2 schema stores data in a structured format, grouped into several categories, including Users & Roles, Learning Content, Assignments & Evaluation, Collaboration, Monitoring, and Administration. The integration of these three layers ensures that teaching, interaction, and monitoring activities can be carried out in a centralized and measurable manner.

To provide a clearer overview of the user interface, the dashboards of different user roles (administrator, teacher, and student) are combined into a single composite figure. Figure 2 presents this composite dashboard, highlighting the main features for each role, such as material management, grading, discussion forums, and student access to assignments.

The novelty of the system lies in its real-time activity monitoring feature (Figure 3), which enables teachers to continuously monitor student engagement, login activity, and learning progress. This feature distinguishes the system from most existing e-learning platforms in Indonesia.

Finally, Figure 4 presents the results of the user satisfaction evaluation in the form of a bar chart, providing a clear comparison across dimensions. The visualization shows that functionality received the highest score, while interface design and learning effectiveness were slightly lower but still within the very good category.

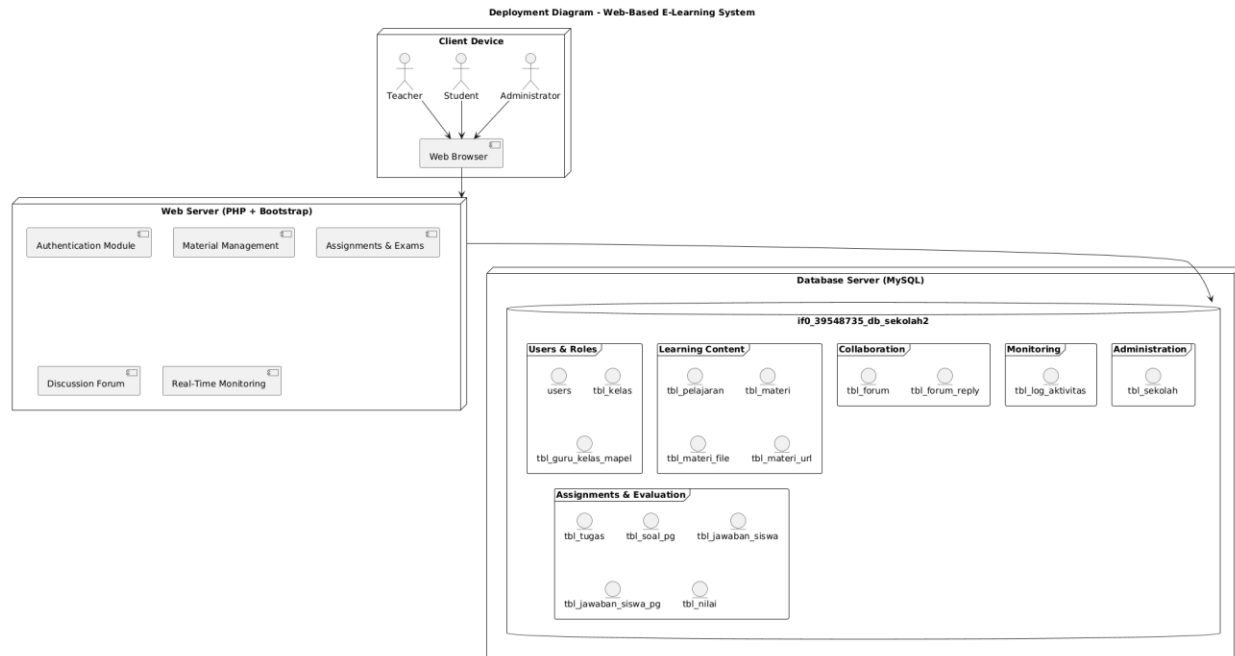


Fig. 1 Deployment Diagram

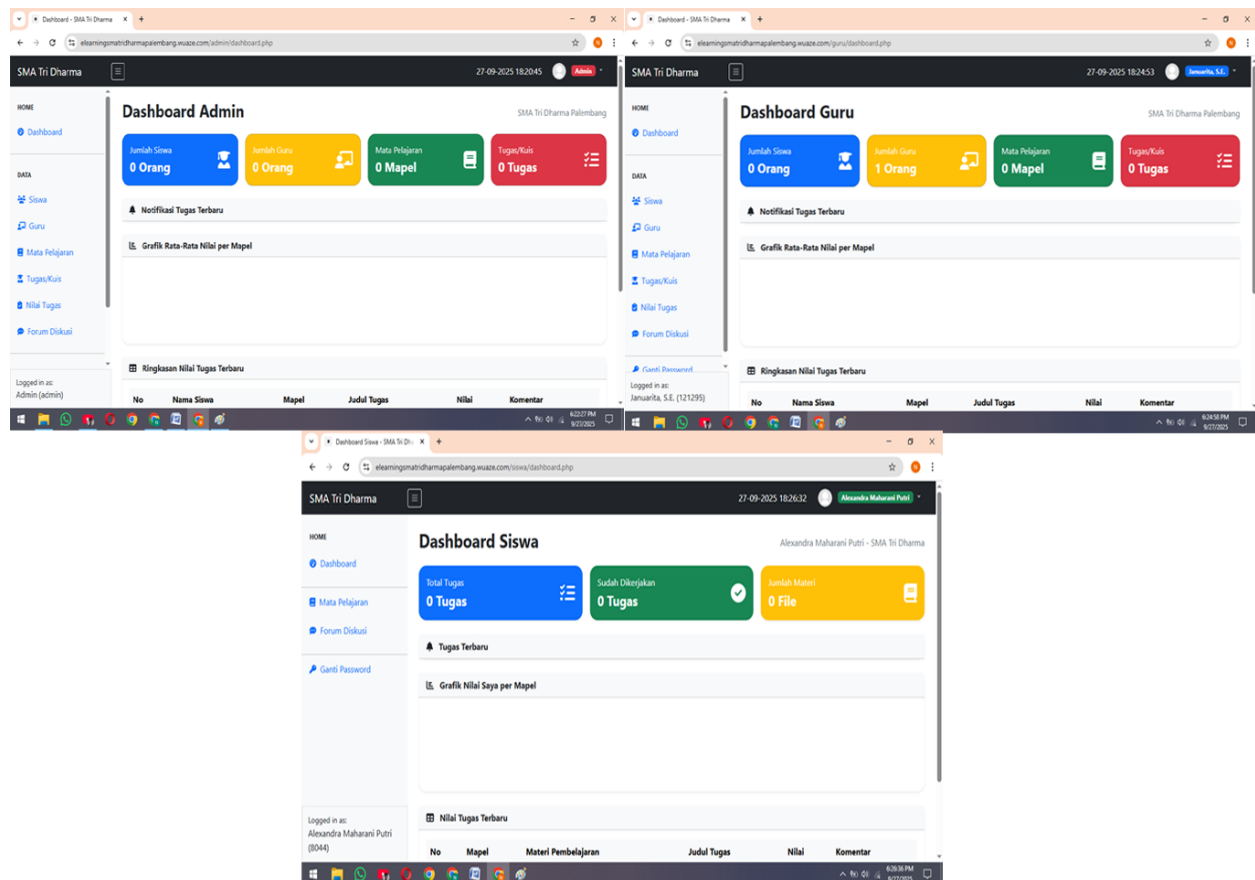
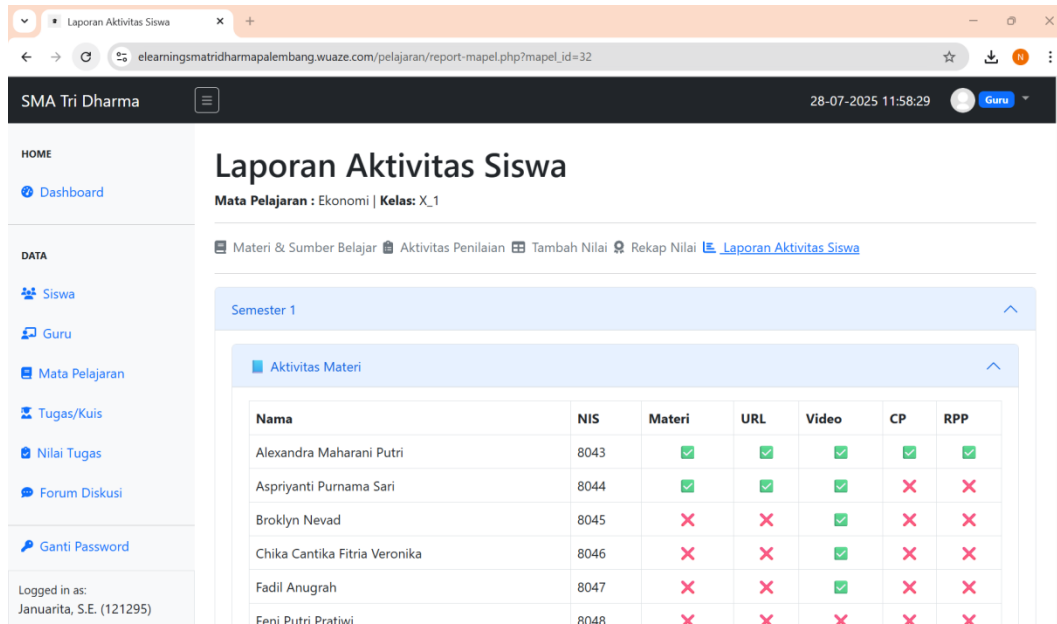


Fig. 2 Composite Dashboard (admin, guru, siswa).

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Nama	NIS	Materi	URL	Video	CP	RPP
Alexandra Maharani Putri	8043	✓	✓	✓	✓	✓
Aspriyanti Purnama Sari	8044	✓	✓	✓	✗	✗
Brooklyn Nevad	8045	✗	✗	✓	✗	✗
Chika Cantika Fitria Veronika	8046	✗	✗	✓	✗	✗
Fadil Anugrah	8047	✗	✗	✓	✗	✗
Feni Putri Pratiwi	8048	✗	✗	✗	✗	✗

Fig. 2 Real-Time Activity Monitoring Feature

User Satisfaction Evaluation Results

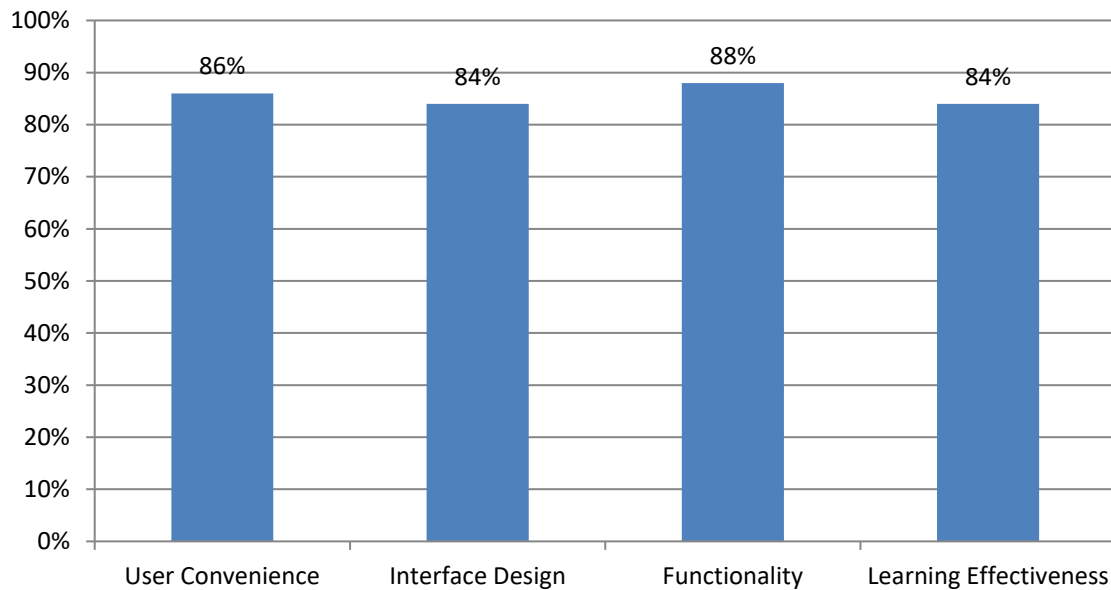


Fig. 4 User Satisfaction Evaluation Results

The system includes role-based authentication, material management, assignments, assessments, discussion forums, and real-time activity monitoring. Functional Testing Results

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Table 2 Functional Testing of the E-Learning System

Module	Expected Output	Result	Status
Login & Authentication	Users can log in by role	Works as expected	Valid
Material Management	Teachers upload/update materials	Works as expected	Valid
Assignments & Quizzes	Students submit assignments	Works as expected	Valid
Assessment	Teachers give/update grades	Works as expected	Valid
Discussion Forum	Users post/reply to discussions	Works as expected	Valid
Activity Monitoring	Teachers track student activities	Works as expected	Valid

Table 3. User Satisfaction Survey Results

Aspect	Mean Score	Percentage	Category
Ease of Use	4.3	86%	Very Good
Interface Design	4.2	84%	Very Good
Functionality	4.4	88%	Very Good
Learning Effectiveness	4.2	84%	Very Good
Overall Average	4.27	85.33%	Very Good

DISCUSSION

The high satisfaction score indicates that the developed system meets user needs and supports flexible learning, aligning with the TAM perspective that perceived usefulness and ease of use are crucial for technology adoption (Davis, 1989).

Within the UTAUT framework, performance expectancy was reflected in teachers' perception that the system simplified content and assessment management. Effort expectancy was evident in students' ability to easily access materials and submit assignments. Facilitating conditions were represented by system stability and the availability of monitoring features, consistent with Venkatesh et al. (2003).

From the IS Success Model perspective, system quality, information quality, and service quality all contributed to user satisfaction, in line with findings by Al-Fraihat et al. (2020). Compared with Indonesian studies by Aisah et al. (2021) and Rosmiati and Reski (2023), this research offers novelty by integrating real-time monitoring features and evaluating the system through the combined application of three international models.

The findings also align with international research trends. de Sousa et al. (2021) emphasized the role of learning analytics in secondary education, while Feng et al. (2025) called for the consistent application of theoretical models across educational contexts. By integrating TAM, UTAUT, and IS Success Model in a secondary school context, this study makes both theoretical and practical contributions.

CONCLUSION

This study successfully designed and developed a web-based e-learning system with real-time activity monitoring features to support the implementation of the Merdeka Curriculum. The system was functionally validated and achieved an overall user satisfaction score of 85.33% (very good) based on usability, interface design, functionality, and learning effectiveness.

Theoretical contributions include reinforcing the relevance of the Technology Acceptance Model (TAM), Unified Theory of Acceptance and Use of Technology (UTAUT), and the IS Success Model in explaining e-learning adoption at the secondary education level. The integration of these three models, combined with real-time activity monitoring, represents the novelty of this study compared to previous works in the Indonesian context.

However, the study has several limitations. The pilot test involved only 2 teachers and 10 students, making the results indicative rather than generalizable. The evaluation instrument was not tested for reliability using methods such as Cronbach's Alpha. The research also primarily focused on system development, with adoption models applied descriptively rather than quantitatively.

For future research, it is recommended to expand the sample size, conduct reliability and validity testing, and quantitatively examine the relationships among TAM, UTAUT, and IS Success Model constructs. Further development should also consider integrating artificial intelligence (AI) or adaptive learning features and extending the system into a mobile application to enhance accessibility and personalization.

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