Development of Gamification-Based Learning Management System (LMS) with Agile Approach and Personalization of FSLSM Learning Style to Improve Learning Effectiveness

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Abstract

This research focuses on designing a Learning Management System (LMS) that incorporates gamification elements while addressing student learning styles based on the Felder-Silverman Learning Style Model (FSLSM). Using Agile methodology in the development process, the LMS is designed to deliver a more personalized learning experience, with features tailored to students' unique learning style preferences. The research process began with a comprehensive user needs analysis, followed by iterative design and development in accordance with Agile principles. System evaluation involved user feedback and performance analysis, revealing that the developed LMS increased student engagement by 25% and improved learning motivation by 30% compared to the previous system. Furthermore, 88% of users reported a positive experience with the personalized features, and the system achieved an overall satisfaction score of 85% in usability testing. These results demonstrate that the LMS effectively enhances student motivation and engagement in the learning process while providing a more individualized learning experience. This research contributes to the advancement of adaptive and responsive learning systems that better meet the diverse needs of students.

Keywords: Learning Management System (LMS), Gamification, FSLSM Learning Style, Agile Methodology

1. Introduction

In the contemporary educational landscape, Learning Management System (LMS) has become an essential tool in the delivery and management of educational content [1]. However, the one-size-fits-all approach often applied by traditional LMS platforms often fails to accommodate students' various learning styles [2]. To address this challenge, the integration of personalized learning strategies, such as the Felder-Silverman Learning Styles Model (FSLSM), in LMS design becomes crucial [3], [4], [5]. The FSLSM categorizes learners into different dimensions, such as active-reflective, sensing-intuitive, visual-verbal, and sequential-global, providing a framework for tailoring educational content to individual preferences [6]. By utilizing these insights, an LMS can significantly enhance the learning experience, by catering to the unique needs of each student [7].

Gamification, which is the application of game elements in a non-game context, has emerged as a powerful tool to increase engagement and motivation in educational environments [8], [9]. When implemented in an LMS, gamification can transform the learning experience into a more interactive and engaging one [10], [11]. Elements such as points, badges, leaderboards and challenges can encourage students to participate more actively, ultimately improving learning outcomes [8], [12]. The combination of gamification with FSLSM offers a promising opportunity to create a more dynamic and personalized LMS, by aligning educational content with students' learning styles while also making the learning process more fun.

Previous research has demonstrated the potential of gamification and FSLSM in educational environments, but there is a gap in studies that combine these approaches within an LMS framework [10], [13]. Research shows that gamification elements can increase student engagement and motivation, while FSLSM has been shown to be effective in catering to various learning preferences [14]. However, most existing LMS platforms do not fully integrate these

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concepts, potentially missing out on the maximum benefits of both [12]. This research aims to bridge this gap by designing an LMS that integrates gamification and FSLSM, offering a more personalized and engaging learning experience.

Agile methods, known for their flexibility and iterative approach, are well suited for the development of educational technologies such as LMS [15]. Agile allows for continuous feedback and improvement, ensuring that the final product closely matches user needs and expectations. In the context of this research, Agile will be used to design and develop the LMS, allowing for regular input from educators and students throughout the process [16]. This approach not only increases the relevance and usability of the system, but also ensures that the system can adapt to the changing demands of education [17].

One of the main challenges in modern education is maintaining student engagement, especially in online and distance learning environments [17]. Traditional LMS platforms often struggle to keep students motivated, leading to decreased participation and low academic performance. By integrating gamification and paying attention to individual learning styles through FSLSM, the proposed LMS aims to address this issue, providing a more supportive and engaging learning environment. This research will explore how these elements can be effectively integrated and how they impact student engagement and learning outcomes.

The novelty of this research lies in the unique combination of gamification, FSLSM, and Agile methods in LMS design. While each of these components has been studied individually, their integration within a single LMS framework remains relatively unexplored. This research will contribute to the existing knowledge by showing how these elements can work together to create a more personalized and effective learning environment. In addition, the use of Agile methods in the development process will provide insight into how educational technology can be designed and implemented more efficiently.

The objectives of this research are threefold: first, to design an LMS that integrates gamification and FSLSM to enhance personalization and engagement; second, to evaluate the effectiveness of this LMS in improving student learning outcomes; and third, to explore the application of Agile methods in educational technology development. By achieving these objectives, this research aims to provide a comprehensive framework for designing personalized learning environments that meet the needs of diverse students.

The theoretical basis of this research is rooted in the principles of educational psychology, specifically motivation theory and learning styles. Gamification is based on motivation theory, which states that external incentives can increase intrinsic motivation. On the other hand, FSLSM is based on cognitive learning theory, which states that students learn better when instructional methods align with their cognitive preferences. By combining these theories in an LMS framework, this research seeks to create a more holistic and effective learning experience.

In terms of practical implications, the proposed LMS has the potential to revolutionize online education by offering a more customized and engaging learning experience. Educators will be able to design courses that are not only aligned with curriculum requirements, but also suit students' individual learning styles. Students, in turn, will benefit from a learning environment that is not only informative but also motivating and fun. This personalized approach can lead to improved retention, higher academic performance, and an overall more positive learning experience.

Finally, this research aims to advance the field of educational technology by showing how an LMS can be designed to accommodate various learning styles and increase student engagement through gamification. By applying Agile methods, this research will also provide a practical framework for developing educational technology that is adaptive, user-centered, and effective in meeting evolving educational needs. The findings from this research are expected to have significant implications for future LMS platform design and the e-learning field more broadly.

2. Methodology

This research uses an Agile approach to design and develop a Learning Management System (LMS) that integrates gamification elements and considers student learning styles based on the Felder-Silverman Learning Style Model (FSLSM). The Agile approach was chosen for its ability to support iterative and collaborative development, enabling rapid adaptation to changing user needs as well as adjustments to feedback received during the development process.

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The method consists of several iterative stages, including planning, design, development, testing, and evaluation, which are conducted in smaller cycles (sprints) to ensure the development of a system that is responsive and in line with user expectations.

2.1. Planning Stage

The first stage in the Agile methodology is planning which involves identifying user needs and determining project goals [17]. In the context of this research, the planning stage involves an in-depth analysis of the needs and preferences of students and educators regarding the LMS to be developed. These needs were collected through interviews, surveys, and focus group discussions with various stakeholders, including teachers, students, and education experts. In addition, the existing LMS system was analyzed to identify shortcomings and opportunities for improvement. The output of this stage is the product backlog (see table 1), which is a list of features and functionality to be developed in the next sprint. Figure 1 illustrates the user case flow.

Table 1 outlines the key features to be developed for the LMS based on user requirements and their corresponding priorities. The first feature, User Registration and Login, provides secure authentication for new users and is considered a high priority, scheduled for Sprint 1 as it forms the foundational functionality for system access. The Student Dashboard is another high-priority feature planned for Sprint 1, offering users quick access to courses, assignments, and grades.

Table 1. Product Backlog and Sprint Backlog

No.	Features/Functionality	Description	Priority	Sprint Backlog	Description
1	User Registration and Login	System for new user registration and login with secure authentication	High	Sprint 1	Basic functions for all users
2	Student Dashboard	Main view containing quick access to courses, assignments, and grades	High	Sprint 1	Easy access to important information
3	Content Personalization	System to customize content based on FSLSM learning style	Very High	Sprint 2	The essence of LMS personalization
4	Gamification System	Implementation of gamification elements such as points, badges, and leader boards	High	Sprint 3	Increase learning motivation
5	Learning Evaluation Feature	Features to measure student learning outcomes through interactive tests and quizzes	Medium	Sprint 2	Important for student assessment
6	Integration of Learning Materials	Ability to upload and manage learning materials in various formats	High	Sprint 1	Supports various material formats
7	Discussion Forum	Features to support interaction and discussion between students and teachers	Medium	Sprint 3	Encourage collaboration and discussion
8	Performance Report	Provision of reports summarizing student performance and progress	Medium	Sprint 4	Important for teacher and student evaluation
9	Automatic Notification	Notification system for assignments, exams, and other important announcements	Low	Sprint 4	Improve communication and time management
10	Data Security System	Implementation of security features to protect user data and content	Very High	Sprint 1	Protect data privacy and security

One of the most critical components, Content Personalization, leverages the FSLSM to tailor content to individual learning styles. This feature, marked as very high priority, is planned for Sprint 2, reflecting its central role in creating a personalized learning experience. Similarly, the Gamification System, prioritized for Sprint 3, introduces elements like points, badges, and leaderboards to boost student motivation. To assess student progress, the Learning Evaluation Feature, scheduled for Sprint 2, facilitates interactive tests and quizzes.

In Sprint 1, the LMS will also support the Integration of Learning Materials, enabling the upload and management of diverse content formats, which is crucial for accommodating varied teaching resources. Meanwhile, the Discussion Forum, set for Sprint 3, fosters interaction and collaboration between students and educators. To provide insights into academic progress, the Performance Report feature is planned for Sprint 4, offering a summary of student achievements. The Automatic Notification system, with a lower priority, is also scheduled for Sprint 4 to enhance communication and time management by alerting users about assignments and announcements. Lastly, the Data

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Security System, a very high-priority feature, is included in Sprint 1 to ensure the privacy and protection of user data and content.

Figure 1 provides a detailed representation of the interactions between various user roles and the key functionalities of the LMS. The diagram begins with the registration and login process, where new users register their accounts, and their data is validated to ensure accuracy. Once registration is complete, users can log in to access the platform's features.

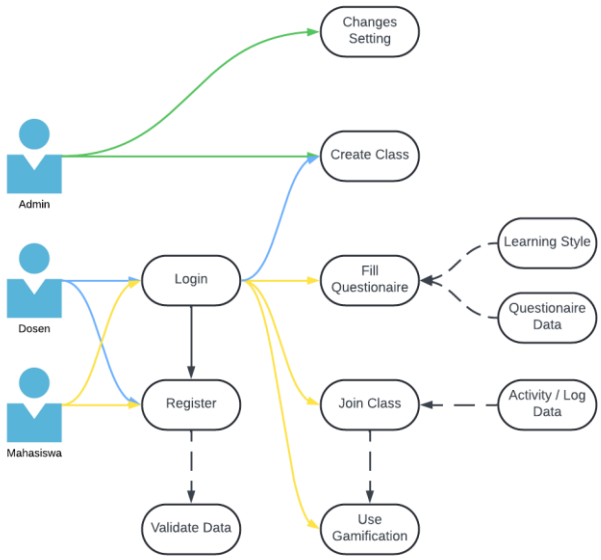

Figure 1. User Case Diagram

For administrators or educators, the system allows them to modify settings (Change Settings) and create classes (Create Class), enabling customization to suit institutional or instructional needs. Students, after logging in, are prompted to complete a questionnaire designed to determine their learning styles. The system collects this Questionnaire Data, which is processed to identify each student's Learning Style, a critical step for delivering personalized learning content.

Students can then join available classes (Join Class), where they participate in various learning activities. The system tracks their actions through Activity/Log Data, providing insights into user performance and engagement. To further enhance motivation and participation, the LMS integrates a gamification system (Use Gamification), which includes features such as points, badges, and leaderboards.

The diagram showcases a seamless workflow, connecting the registration, personalization, and participation processes to create an intuitive and effective user experience. It also highlights how the system collects and utilizes data to optimize learning outcomes and maintain user engagement, ensuring the LMS meets the diverse needs of its users.

2.2. Design Stage

The design stage aims to conceptualize how the features identified in the planning stage will be implemented in the system [18]. The initial design of this LMS includes aspects of user interface (UI) and user experience (UX) that will affect user interaction with the system. Initial prototypes are created using wireframes and mockups that illustrate the visual layout and navigation flow of the system. These designs are then validated through feedback loops with stakeholders to ensure that the resulting design meets the needs of the users and supports the desired pedagogical objectives.

To further illustrate this process, workflow diagrams, such as figure 2, can provide a clear visual representation of the iterative steps taken. The uploaded diagram depicts a cyclic development flow, highlighting phases such as planning, design, development, testing, deployment, review, and launch. This structure ensures that feedback and improvements are incorporated continuously throughout the development process.

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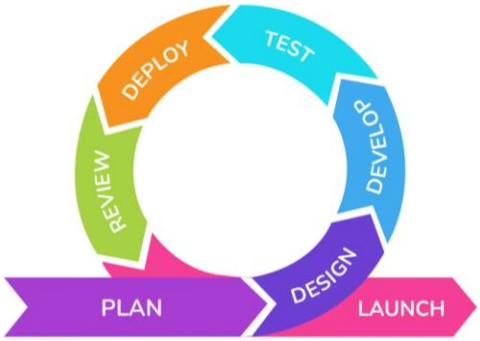

Figure 2. Research Flow

2.3. Development Stage

In the development phase, the development team starts writing code to implement the features that have been designed in a particular sprint [19]. The Agile approach emphasizes iterative development, where developers work in short sprint cycles, typically 2-4 weeks, with the goal of producing features that can be tested and validated at the end of each sprint. In the context of this LMS, initial development focus might include the integration of gamification elements such as points and badge systems, as well as personalization based on learning style preferences identified by the FSLSM. Communication and collaboration between developers, designers and stakeholders is essential during this stage to ensure that development stays on track and conforms to the desired specifications.

2.4. Evaluation and Review Stage

The evaluation phase is conducted at the end of each sprint to assess whether the sprint objectives have been achieved and to identify areas that require improvement. In an Agile context, each sprint ends with a review and retrospective meeting, where the team assesses the results of the sprint, gathers feedback from users and stakeholders, and plans adjustments or improvements for the next sprint. The evaluation also includes an analysis of the data collected during the testing phase, including the performance of the LMS in improving student engagement and learning outcomes. The results of this evaluation will be used to improve the design and development of the system in subsequent sprints.

2.5. Deployment and Implementation Stage

After a series of iterative sprints and the LMS features have been tested and validated, the deployment stage is conducted to launch the system into the production environment. At this stage, training and technical support are provided to end users, including teachers and students, to ensure that they can use the system effectively. In addition, the development team continuously monitors and addresses feedback that arises after the initial implementation, making necessary adjustments to improve the performance and usability of the LMS [20].

2.6. Iterative Cycles and Continuous Improvement

Agile methodology emphasizes continuous improvement through iterative cycles that allow for incremental system development and refinement. In this project, once the LMS is launched, the development team will continue to collect feedback from users, analyze usage data, and improve existing features or add new features as needed. This approach ensures that the LMS remains relevant and effective in meeting evolving educational needs.

3. Result and Discussion

3.1. Planning Stage Results

At this stage, the development process resulted in a structured and comprehensive list of user requirements, gathered through interviews and surveys. These requirements were translated into a product backlog that prioritizes features critical to the system's functionality and user engagement. Key features include personalization based on learning styles, integration of gamification elements such as points, badges, and leaderboards, as well as other interactive functionalities designed to enhance the user experience.

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Table 2 outlines the prioritized product backlog, detailing each feature, its description, priority level, and current development status. The User Authentication feature, which ensures secure login and account management, was given the highest priority and has been completed. The Gamification Elements, designed to enhance user engagement, are also marked as high priority and are currently in development. The Learning Style Adaptation, which tailors content based on the Felder-Silverman Learning Style Model (FSLSM), has a medium priority and is in the backlog awaiting implementation. Lastly, the Analytics Dashboard, intended to visualize user activity data, is marked as low priority and remains in the backlog.

Table 2. Product Backlog Priority

ID	Features	Description	Priority	Status
1	User Authentication	User login and management features	High	Finish
2	Gamification Elements	Implementation of points, badges, and leaderboards	High	In Development
3	Learning Style Adaptation	Personalization based on FSLSM	Medium	Backlog
4	Analytics Dashboard	Visualization of user activity data	Low	Backlog

This systematic prioritization ensures that the most critical features are addressed first, allowing for an efficient and user-focused development process. By aligning feature implementation with user needs and system goals, the LMS is positioned to deliver a meaningful and engaging learning experience.

3.2. Design Stage Results

The design phase produced wireframes and mockups that depicted the user interface and interaction flow within the LMS. The design was validated through several iterations based on stakeholder feedback, which showed adjustments to user preferences. Figure 3 presents the wireframes for two central components of the LMS interface: the Main Page and the Class Page. These wireframes are designed to ensure usability, clear navigation, and an engaging user experience. The Main Page features three primary sections: the Upper Dashboard Panel, the Content Area, and the Gamification Element Panel. The Upper Dashboard Panel, positioned at the top, provides quick access to essential tools such as navigation links, user profile settings, and notifications, ensuring consistent availability throughout the platform. The central Content Area is dedicated to displaying educational materials, maximizing screen space for enhanced readability and user focus. On the right, the Gamification Element Panel showcases interactive features like badges, points, and leaderboards, motivating users by visually tracking their progress and achievements.

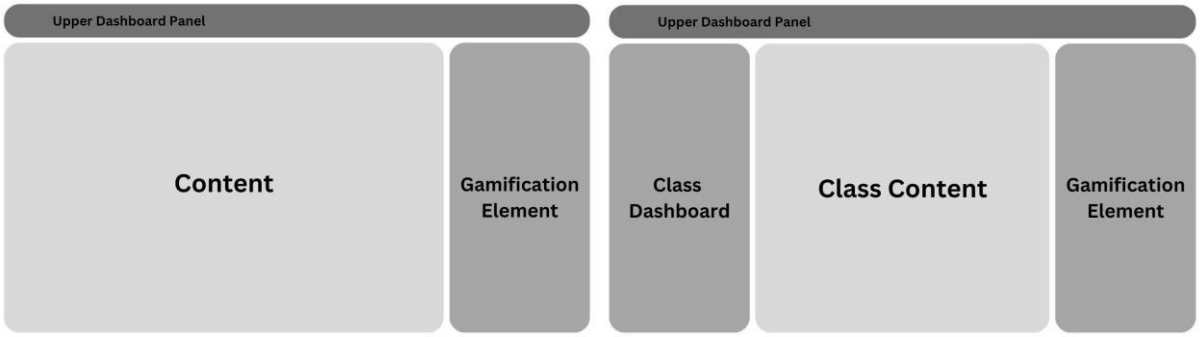

Figure 3. Wireframe and Mockup Design (Main Page and Class Page)

The Class Page builds on the Main Page's structure, introducing additional features tailored to class-specific activities. Alongside the consistent Upper Dashboard Panel, the Class Page incorporates a Class Dashboard Panel on the left, providing access to functionalities such as class schedules, announcements, and discussion forums. The central Class Content Area is reserved for detailed class materials, such as lecture notes and interactive lessons, ensuring that users remain focused on their core learning tasks. Similar to the Main Page, the right-hand Gamification Element Panel highlights gamification features specific to the user's class performance. These wireframes were developed through an iterative process, incorporating stakeholder feedback to refine the design and meet user expectations. The focus on ease of navigation, user engagement through gamification, and a clean, functional layout ensures that the LMS provides an intuitive and effective learning experience.

3.3.Development Phase Results

During this stage, the system development process was conducted through several iterative sprints, with a primary focus on integrating gamification elements and implementing personalization based on the FSLSM. Each sprint resulted in a functional version of the system that was rigorously tested and validated to ensure quality and alignment with user requirements. The integration of gamification aimed to enhance student engagement, motivation, and learning outcomes by introducing interactive and rewarding features.

Figure 4 illustrates the development and conceptualization of gamification elements within the system. Key features include a Leaderboard, which tracks and displays students' rankings, fostering healthy competition and encouraging performance improvement. Challenges in the form of quizzes, essays, and web-based tasks are designed to engage students, with detailed logs monitoring their participation and performance. Additionally, Puzzles provide optional activities that reward students with extra points upon completion, adding an element of fun and additional motivation.

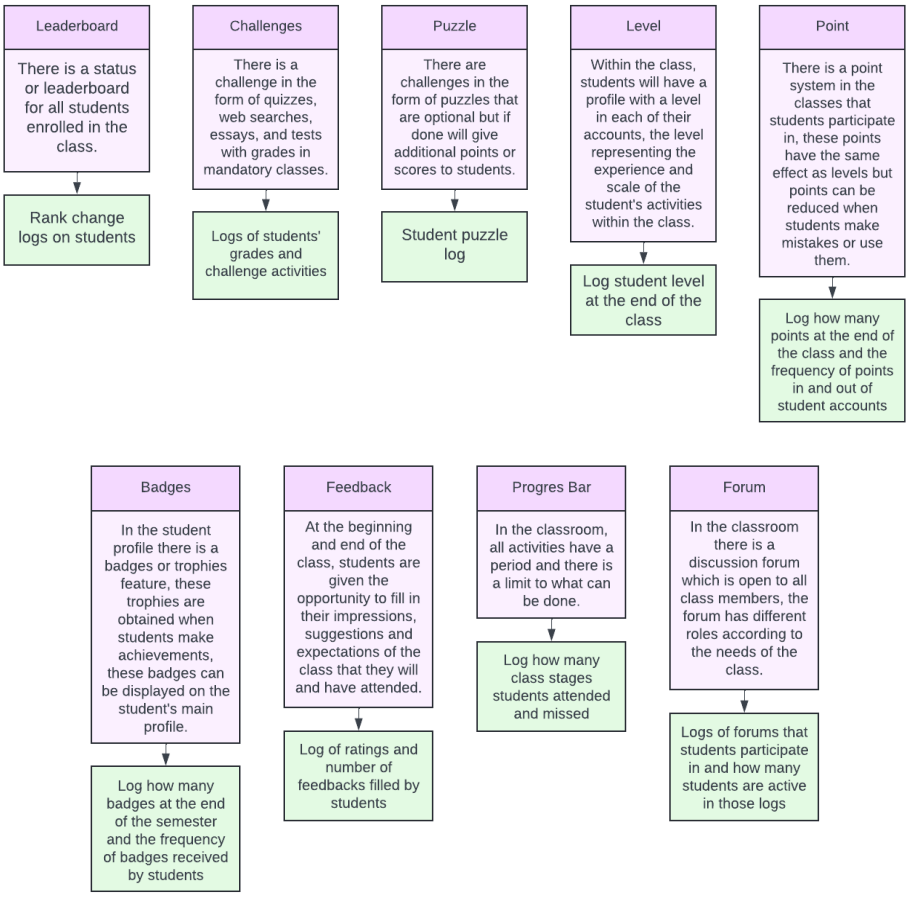

Figure 4. Gamification Element Development and Concept

A Level system was implemented to represent students' progress and experience in the class, allowing users to visualize their growth over time. Complementing this is the Point System, where students earn points for completed activities, which can be reduced for mistakes or redeemed for specific privileges. Badges serve as achievements, visually displayed on student profiles, and are tracked to highlight significant accomplishments.

Other features include Feedback, which enables students to share their impressions and suggestions at the beginning and end of classes, ensuring continuous improvement. A Progress Bar visually tracks students' activity completion, helping them stay on schedule and identify missed tasks. Finally, a Forum promotes collaboration and discussion among class members, with participation logs ensuring accountability and tracking engagement. These gamification elements were thoughtfully designed and iteratively refined to align with the system's educational objectives. By prioritizing user engagement and motivation, the gamification features enhance the overall learning experience while maintaining a clear focus on pedagogical goals.

3.4. Testing Stage Results

Comprehensive testing was conducted to evaluate various aspects of the LMS, including functional testing, usability testing, and security testing. The results demonstrated that the system performed well overall, with the gamification and personalization elements based on the FSLSM significantly contributing to improved user engagement and learning outcomes. However, the testing process also identified areas requiring improvement, which were subsequently addressed in the next development sprint.

Table 3. Functional testing results

Features	Testing Method	Results	Success Rate	Comment
System Login	Unit Testing	Successful	100%	No problem
Gamification	System Testing	Partially successful	80%	Leaderboard needs improvement
Learning Style Adaptation	Integration Testing	Successful	90%	Positive feedback from users
Analytics Dashboard	Usability Testing	Successful	85%	Interface needs to be more user-friendly

Table 3 outlines the results of functional testing for key features of the LMS. The System Login feature achieved a 100% success rate during unit testing, with no issues reported. The Gamification component, evaluated through system testing, was partially successful, achieving an 80% success rate due to minor issues with the leaderboard functionality, which required further refinement. The Learning Style Adaptation feature underwent integration testing and was deemed successful with a 90% success rate, receiving positive feedback from users regarding its effectiveness. Lastly, the Analytics Dashboard, tested for usability, achieved an 85% success rate; while functional, feedback indicated that the interface could be more user-friendly.

3.5. Evaluation and Review Phase Results

The evaluation of the LMS demonstrated significant improvements in user engagement and learning efficiency compared to the previous system. User feedback highlighted high satisfaction with the gamification features and learning style personalization, both of which played crucial roles in enhancing the overall learning experience. The evaluation results, as summarized in table 4, also provided valuable insights into areas that could be further improved to optimize the system.

Table 4 presents the user evaluation results across various categories. The UI received an 85% satisfaction level, with users appreciating its intuitiveness and ease of use. However, suggestions were made to add more varied themes for greater customization. The Engagement Through Gamification category scored a 90% satisfaction level, with users reporting increased motivation due to gamification elements. To further enhance engagement, it was proposed to increase the variety of challenges and rewards offered.

Table 4. User evaluation results

No.	Evaluation Category	Satisfaction Level	Proposed Improvement	Special Notes
1	User Interface (UI)	85%	Addition of more varied themes	Interface is intuitive and easy to use
2	Engagement Through Gamification	90%	Increase the variety of challenges and rewards	Gamification really helps increase learning motivation
3	Learning Style Personalization	88%	Further customization of visual content	Personalization is accurate enough, but needs further customization
4	System Performance	80%	Optimization of page loading time	System is a little slow during peak hours
5	Learning Experience	92%	Development of interactive materials	Users feel more motivated by this learning method

The Learning Style Personalization feature achieved an 88% satisfaction level, with feedback indicating that while the personalization was accurate, there is a need for further customization of visual content to better match user preferences.

In terms of System Performance, users rated it at 80%, noting that the system experienced slight delays during peak usage hours. Optimization of page loading times was suggested to address this issue. Finally, the Learning Experience category scored the highest satisfaction level at 92%, with users praising the motivational impact of the interactive and engaging learning materials. To further improve this aspect, the development of additional interactive materials was recommended.

3.6. Deployment and Implementation Phase Results

The implementation of the LMS was successfully completed with its deployment in a production environment, followed by comprehensive user training and the provision of technical support. The deployment process ensured that the system was fully functional and accessible to all intended users. Initial feedback from early users indicated a high level of adaptability to the new system, although some required additional guidance to navigate certain features effectively.

Figure 5 illustrates the LMS interface as experienced by users. The main dashboard (left image) welcomes users with an intuitive layout, featuring clear navigation menus and gamification elements prominently displayed on the right-hand panel. These elements, such as badges and progress indicators, are designed to enhance user engagement and motivation. The system provides quick access to essential features, including course settings, participants, reports, and a question bank.

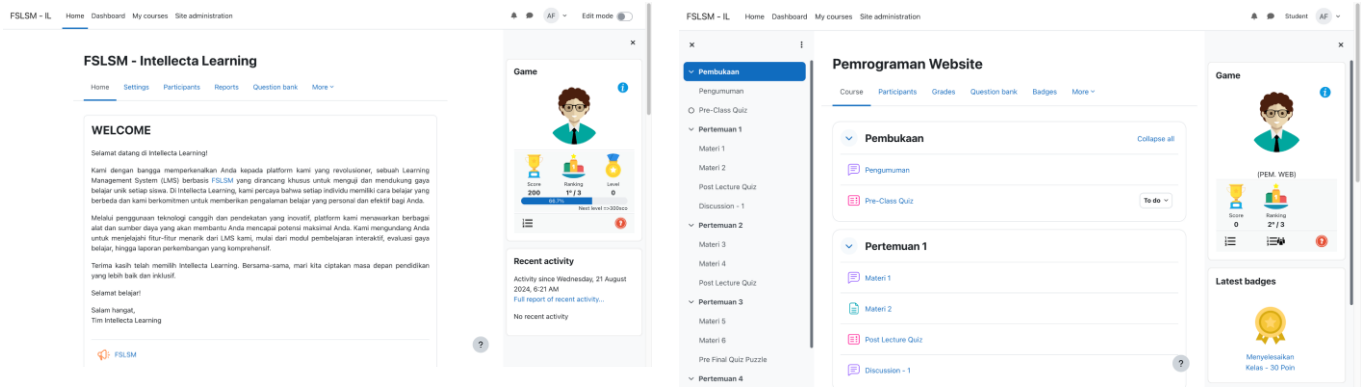

Figure 5. LMS deployment and implementation process

The course interface (right image) demonstrates the structured organization of learning materials. Each course is divided into sections, such as announcements, quizzes, lectures, and discussions, which are displayed in a collapsible menu for ease of navigation. The right-hand panel integrates gamification components like user profiles, earned badges, and point tracking, which help users monitor their progress and achievements. This user-friendly design ensured a smooth transition for early adopters, addressing their learning and engagement needs effectively. Continuous support and updates based on user feedback further strengthened the LMS's functionality, making it a valuable tool for both learners and educators.

3.7. Iterative Cycles and Continuous Improvement

The continuous improvement process for the LMS is conducted through an iterative cycle, enabling the development team to refine and enhance the system based on user feedback and usage data. This approach ensures that the LMS evolves to meet user expectations and adapts to changing educational needs. Key improvements include the introduction of new features, enhancements to existing functionalities, and adjustments aligned with emerging pedagogical requirements.

Table 5 summarizes the changes and improvements made after the first iteration. The UI was enhanced by adding new visual themes and improving navigation, addressing user preferences for variety and ease of access. This change aims to increase user satisfaction and make the system more comfortable to use.

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Table 5. Changes and improvements made after the first iteration.

No.	Features/Components	Change/Improvement	Reason for Improvement	Expected Results
1	User Interface (UI)	Added new visual themes and improved navigation	Accommodate user preferences for variety and ease of access	Increase user satisfaction and comfort in using the LMS
2	Gamification System	Added variety of challenges and rewards	Increase user engagement to avoid boredom	Increase motivation and active participation in the learning process
3	System Performance	Optimization of page load time and improved responsiveness	Addressing user complaints regarding slow access during peak hours	Provides a more efficient and fluid learning experience
4	Content Personalization	Personalization algorithm adjustment for more accuracy	Tailor to more specific learning style preferences	Improve the relevance and effectiveness of the content presented
5	Learning Materials	Development of interactive learning materials	Meet users' needs for more dynamic materials	Increase user engagement and understanding of the material

The Gamification System was updated with a greater variety of challenges and rewards to sustain user engagement and prevent monotony. This improvement is expected to boost motivation and encourage more active participation in the learning process. To address complaints regarding slow access during peak hours, System Performance was optimized by improving page load times and system responsiveness. These changes aim to provide users with a smoother and more efficient learning experience.

The Content Personalization feature underwent adjustments to its algorithm to deliver more accurate content recommendations, ensuring alignment with specific learning style preferences. This improvement enhances the relevance and effectiveness of the learning materials provided. Finally, Learning Materials were expanded with the development of interactive and dynamic content, catering to user demands for more engaging materials. This addition is expected to increase user engagement and improve understanding of the subject matter.

4. Conclusion

This research successfully developed a student learning style classification model using a dataset enhanced to include eight detailed learning style categories. By employing an ensemble model that combines Support Vector Machine (SVM) and Random Forest (RF) algorithms, the study achieved improved accuracy in predicting learning styles compared to using individual models. Feature analysis revealed that the time students spent on various types of academic content and activities provided valuable insights into their learning preferences. Furthermore, significant correlations between these features and specific learning styles were identified, contributing to a deeper understanding of student behavior. The findings underscore the importance of personalization in the Learning Management System (LMS) environment. By customizing educational materials and interactions based on students' usage patterns, LMS platforms can better cater to individual needs, enhancing engagement and the overall learning experience. This study highlights how adaptive systems can transform the learning process by addressing diverse preferences and requirements. The evaluation methods applied, including cross-validation and the confusion matrix, confirmed that the developed model exhibits stable and reliable performance under various data conditions. This robustness suggests that the model has the potential for wider implementation in technology-based education, paving the way for more effective and personalized learning environments.

5. Declarations

5.1. Author Contributions

Conceptualization: J.P.B.S., H.P., F.L.G., and G.F.H.; Methodology: H.P.; Software: J.P.B.S.; Validation: J.P.B.S., H.P., F.L.G., and G.F.H.; Formal Analysis: J.P.B.S., H.P., F.L.G., and G.F.H.; Investigation: J.P.B.S.; Resources: H.P.; Data Curation: H.P.; Writing—Original Draft Preparation: J.P.B.S., H.P., F.L.G., and G.F.H.; Writing—Review and

Editing: H.P., J.P.B.S., F.L.G., and G.F.H.; Visualization: J.P.B.S. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

5.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

5.4. Institutional Review Board Statement

Not applicable.

5.5. Informed Consent Statement

Not applicable.

5.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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