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ADAPTIVE LEARNING MANAGEMENT SYSTEM WITH GAMIFIED TUTORING AND PREDICTIVE ANALYTICS FOR SPECIAL EDUCATION NEEDS

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ABSTRACT

This study presents the development and evaluation of an Adaptive Learning Management System (ALMS) designed to support learners with Special Educational Needs (SEN). The system integrates adaptive learning, gamified tutoring, and predictive analytics to improve learner engagement and provide early identification of students who may require academic intervention. The development of the system followed the Agile Development Model to allow iterative refinement based on stakeholder feedback. The system was evaluated using the ISO/IEC 25010 Software Quality Model by Information Technology (IT) experts and end-users composed of teachers, administrators, and students with SEN. Results show that the system achieved high ratings across software quality characteristics with an overall mean of 3.68 from IT experts and 3.68 from end-users, indicating that the system is highly functional, efficient, and usable. The findings suggest that the proposed ALMS can effectively support inclusive education by providing personalized learning pathways, enhancing learner motivation through gamification, and assisting teachers in monitoring student performance through predictive analytics. .

Keywords*:Adaptive Learning Management System, Special Educational Needs, Gamified Learning, Predictive Analytics, Inclusive Education*

1. INTRODUCTION

Education plays a vital role in promoting equitable learning opportunities for all students. In the Philippine education system, the Department of Education promotes Inclusive Education to ensure that learners with diverse abilities, including those with Special Educational Needs (SEN), receive appropriate educational support. Inclusive classrooms often contain students with varying levels of cognitive ability, attention span, comprehension, and communication skills. These differences present significant challenges for teachers who must address diverse learning needs within a single classroom environment.

Traditional instructional methods often rely on uniform teaching strategies that may not effectively support students with special educational needs. Learners who experience difficulties in attention, comprehension, or emotional regulation may struggle to remain engaged in conventional classroom activities. Consequently, there is a need for instructional technologies that can support differentiated learning and provide personalized learning experiences for students.

One promising approach is the development of Adaptive Learning Management Systems that dynamically adjust learning content and difficulty levels based on learner performance. Adaptive learning allows students to progress at their own pace while ensuring that instructional materials match their individual capabilities.

Gamified tutoring mechanisms can further improve learner engagement by incorporating game elements such as rewards, progress indicators, and achievement levels. These features encourage active participation and sustained motivation among learners.

In addition, predictive analytics can be used to analyze learning data and identify students who may be at risk of academic difficulty. By analyzing learner performance patterns such as quiz scores, time spent on activities, and number of attempts, the system

can provide early warnings that allow teachers to intervene promptly.

To support the development of such a system, this study utilized the Agile Development Model, which allows continuous improvement through iterative design and stakeholder feedback. Through the integration of adaptive learning, gamified tutoring, and predictive analytics, the proposed Adaptive Learning Management System aims to support inclusive education practices and improve learning outcomes for students with Special Educational Needs.

Literature Review

Adaptive Learning Systems (ALS) are digital platforms that personalize instruction according to each learner's ability, pace, and learning style. According to Johnson, Becker, and Cummins (2021), these systems utilize algorithms to analyze performance data and dynamically adjust content delivery. Adaptive learning helps address diverse student needs by providing differentiated pathways that align with learners' progress. Similarly, Kumar and Singh (2020) found that adaptive systems enhance learner motivation and retention by ensuring instructional materials remain appropriately challenging. For learners with special educational needs, adaptive learning promotes inclusivity by tailoring lessons to cognitive and developmental levels, reducing frustration, and improving engagement.

Artificial intelligence (AI), particularly predictive analytics, has further strengthened the effectiveness of adaptive learning environments. A recent review on AI in education (2025) highlighted how AI-driven systems can analyze data from Learning Management Systems (LMS), attendance records, and assessment results to predict academic risks and support early intervention. These technologies enable educators to identify behavioral patterns, personalize learning pathways, and make data-driven decisions that improve learner outcomes. The review also emphasized the relevance of predictive analytics in resource-constrained educational settings, including Philippine Special Education (SPED) programs, while noting challenges related to infrastructure, data privacy, and teacher preparedness.

The integration of assistive technology also contributes significantly to inclusive education. A qualitative study published in the International Journal of Pedagogy, Development, and Lifelong Learning (2023) reported that SPED teachers commonly use multimedia tools, computers, educational applications, speech-to-text software, and gamified learning platforms to improve learner participation and engagement. While educators recognized the benefits of these technologies in enhancing learning outcomes, challenges such as inadequate resources, insufficient training, and unstable internet connectivity limited their full implementation. These findings highlight the importance of designing adaptive and accessible educational technologies that support diverse learner needs.

Effective use of educational technologies also depends on data-driven decision making. According to Mandinach and Gummer (2016), teachers are more likely to utilize analytics data when information is presented through clear visualizations accompanied by practical instructional recommendations. Their findings suggest that predictive analytics systems should emphasize usability and accessibility rather than technical complexity. This consideration is particularly important in special education settings where teachers require straightforward tools that can support timely interventions and instructional planning.

Accessibility remains another critical factor in digital learning implementation. Cruz and Mendoza (2020) found that many digital learning platforms used in Philippine public schools lack essential accessibility features such as audio support, simplified interfaces, customizable display options, and assistive functionalities. These limitations create barriers for learners with special educational needs, reducing participation and increasing the risk of learning gaps. The study further emphasized that infrastructure limitations and unequal access to digital devices continue to affect inclusive education efforts. Consequently, educational technologies should prioritize accessibility and inclusivity to ensure meaningful participation for all learners.

In addition, educational data mining (EDM) and learning analytics provide valuable mechanisms for monitoring learner performance and identifying academic risks. Baker and Inventado (2020) explained that machine learning models can analyze assessment scores, system logs, and engagement metrics to detect students who may be at risk of poor academic performance.

Their findings demonstrated that predictive analytics facilitates early identification of learning difficulties and supports timely educational interventions. Such capabilities are particularly important in special education environments where immediate support can significantly influence learner outcomes. Collectively, these studies demonstrate the potential of adaptive learning, predictive analytics, assistive technologies, accessibility-focused design, and educational data mining to enhance personalized learning and improve educational experiences for learners with special educational needs.

2. METHOD

This study employed a quantitative-developmental research design to develop and evaluate an Adaptive Learning Management System (ALMS) with Gamified Tutoring and Predictive Analytics for learners with Special Educational Needs. The system was developed using the Agile Development Model, which involves iterative planning, design, testing, and refinement. Data were collected through structured survey questionnaires administered to IT experts and end-users, including teachers, students, and school administrators. The ISO/IEC 25010 Software Product Quality Model served as the basis for system evaluation. Data were analyzed using descriptive statistics, particularly the weighted mean, to determine the system's level of functionality, usability, reliability, performance efficiency, security, maintainability, and portability.

3. RESULT AND DISCUSSION

This section presents the results of the evaluation of the Adaptive Learning Management System (ALMS) with Gamified Tutoring and Predictive Analytics for Special Educational Needs. The system was assessed using the ISO/IEC 25010 Software Product Quality Model, which evaluates software based on several quality characteristics including functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability.

3.1 Evaluation by IT Experts

The results of the evaluation conducted by IT experts indicate that the developed system achieved high ratings across all ISO/IEC 25010 quality characteristics. Table 1 presents the overall evaluation results.

Criteria	Mean	Verbal Interpretation
Functional Suitability	3.63	Highly Functional
Performance Efficiency	3.63	Highly Efficient
Compatibility	3.80	Highly Compatible
Usability	3.62	Highly Usable
Reliability	3.63	Highly Reliable
Security	3.70	Highly Secured
Maintainability	3.53	Highly Maintainable
Portability	3.60	Highly Portable

Table 1. . Evaluation of the ALMS based on ISO/IEC 25010 Software Quality Characteristics

The results show that the system obtained high ratings across all evaluated criteria. Compatibility received the highest rating (3.80), indicating that the system operates effectively across different environments and devices. Security also received a high score (3.70), demonstrating that the system provides adequate protection for user data. The overall mean score of 3.68 indicates that the system is highly recommended for use, confirming its readiness for deployment in supporting inclusive learning environments for students with special educational needs.

3.2 Evaluation by End Users

End users, including the school administrator, SEN teachers, and students, also evaluated the system based on functional suitability, performance efficiency, and usability.

Criteria	Mean	Verbal Interpretation
Functional Suitability	3.81	Highly Functional
Performance Efficiency	3.60	Highly Efficient
Usability	3.62	Highly Usable
Overall Mean	**3.68**	**Highly Recommended for Use**

Table 2. End-User Evaluation of the Adaptive Learning Management System

The results show that end users found the system highly functional, efficient, and usable. The high rating in functional suitability suggests that the system effectively supports learning activities, including adaptive lessons and gamified tutoring features. Similarly, the usability rating indicates that the system interface is easy to navigate for both teachers and students. The overall mean score of 3.68 indicates strong user acceptance and confirms that the system supports inclusive learning for students with special educational needs.

3.3 Acceptability of the System

The acceptability of the Adaptive Learning Management System was evaluated by end users to determine the overall effectiveness of the system in supporting inclusive learning.

	Mean	Interpretation
The system provides adaptive learning activities suited to student performance.	3.58	Highly Acceptable
The gamified tutoring features increase learner motivation and engagement.	3.67	Highly Acceptable
The system helps teachers monitor student progress effectively.	3.53	Highly Acceptable
The system is accessible and usable for students, teachers, and administrators.	3.64	Highly Acceptable
The system responds quickly to user inputs during learning activities.	3.64	Highly Acceptable
The system supports personalized learning pathways for SEN learners.	3.71	Highly Acceptable
The system operates reliably without frequent errors or crashes.	3.69	Highly Acceptable
The system integrates well with existing school learning processes.	3.53	Highly Acceptable
Overall Mean	**3.63**	**Highly Acceptable**

Table 3. Acceptability of the Adaptive Learning Management System

The results show that the developed system is highly acceptable to users, with an overall mean of 3.63. These findings indicate that the system effectively supports adaptive learning, gamified tutoring, and inclusive instructional practices. The positive ratings demonstrate that the system can enhance learner engagement, support differentiated instruction, and assist teachers in monitoring student progress.

Overall, the results confirm that the Adaptive Learning Management System with Gamified Tutoring and Predictive Analytics meets high standards of software quality and user acceptability, making it a viable technological solution for supporting inclusive education for learners with special educational needs.

4. CONCLUSION

This study concludes that the integration of adaptive learning, gamified tutoring, predictive analytics, and accessibility-focused design within a single learning management system strengthens inclusive education practices by supporting differentiated instruction, enabling early intervention, and fostering learner autonomy among students with Special Educational Needs. The developed Adaptive Learning Management System provides an effective, equitable, and data-driven digital learning solution that supports teachers, empowers learners, and assists administrators in informed decision-making. As such, the system represents a viable and valuable tool for advancing inclusive education in junior high school settings.

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