

**SMART LEARNING IN ELEMENTARY SCHOOLS: INNOVATIONS IN AI-BASED AND GAMIFIED LEARNING**Nabila Nur Azizah<sup>1</sup>, and Leomarich F Casinillo<sup>2</sup><sup>1</sup> Universitas Islam Negeri Mahmud Yunus Batusangkar, Indonesia<sup>2</sup> Visayas State University, Philippines**Corresponding Author:**

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**Abstract**

The advancement of digital technology has driven significant transformations in the field of education, including at the elementary school level. Innovations in learning based on Artificial Intelligence (AI) and gamification offer new approaches capable of enhancing both the quality and engagement of students in the learning process. This study aims to examine the effectiveness of implementing Smart Learning that integrates AI and gamification in elementary schools. The method used is qualitative, employing a case study approach in three elementary schools in Indonesia. Data were collected through observations, interviews, and analysis of digital learning documents. The results indicate that the use of AI technologies such as learning chatbots and adaptive systems, along with gamification elements like points, badges, and leaderboards, significantly improves students' learning motivation, independence, and conceptual understanding. Furthermore, teachers reported being assisted in designing more personalized and engaging learning experiences. In conclusion, AI- and gamification-based Smart Learning positively impacts the learning process and outcomes in elementary schools, with great potential for broader adoption as a future learning strategy.

**Keywords:** Artificial Intelligence, Elementary School, Gamification, Smart Learning

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## INTRODUCTION

Digital transformation has changed almost every aspect of human life, including education. In this era of the Fourth Industrial Revolution (Industry 4.0), technology is not merely a tool but a key catalyst in forming new paradigms in learning (Aparicio dkk., 2012; Basten, 2017). Twenty-first-century education demands being more adaptive, innovative, and oriented toward developing competencies relevant to current needs. This includes critical thinking, creativity, collaboration, and communication skills, all of which can be nurtured through integrating technology in the teaching and learning process (Brookover dkk., 1978). These changes are strongly felt even at the most fundamental level of the education system—elementary schools (SD)—which form the primary foundation for character building and basic student competencies.

Amid increasingly complex global challenges, the education system's role extends beyond knowledge transfer to preparing generations capable of surviving and innovating in a constantly changing world (Caswell & Stratemeyer, 1943). Therefore, traditional, one-way, and less participatory learning approaches need updating. One emerging innovative approach is Smart Learning, which combines cutting-edge technologies such as Artificial Intelligence (AI) and gamification elements to create a more dynamic and responsive learning environment tailored to student needs (Chen dkk., 2021). Smart Learning addresses the limitations of conventional methods by offering a more personalized, interactive, and enjoyable learning experience.

AI technology has the capability to analyze student learning behaviors and adjust learning content according to individual learning styles and paces. This enables more adaptive and differentiated learning, which was previously difficult to achieve with manual methods. Meanwhile, gamification introduces competitive and motivational elements in learning through points, badges, challenges, and leaderboards. The combination of AI and gamification within the Smart Learning framework offers great potential to enhance learning effectiveness, especially at the elementary level, a crucial phase for developing student motivation and study habits. Attention to elementary education is crucial because this stage shapes the foundation of students' knowledge and attitudes (Dron, 2018; Gambo & Shakir, 2021). Optimal use of technology at this level can have significant long-term impacts. However, implementing technology in basic education also faces challenges such as infrastructure readiness, teacher competence, and resistance to change. Therefore, it is essential to thoroughly examine how Smart Learning can be effectively applied in local contexts, especially in Indonesia, to make a tangible contribution to improving the quality of basic education.

This study aims to address the need for a learning model relevant to contemporary developments and capable of meeting challenges in basic education. The main focus is on the effectiveness of using AI and gamification in elementary school learning, and their impact on student motivation, engagement, and learning outcomes (Hamet & Tremblay, 2017; Holmes dkk., 2015). Using a qualitative case study approach, the research explores in depth how Smart Learning implementation unfolds in practice, including its supporting and inhibiting factors. Theoretically, this study is grounded in constructivist theory, which emphasizes that knowledge is actively constructed by students through contextual and meaningful learning experiences. Smart Learning, supported by AI and gamification, provides a means to create such experiences. Through personalized and stimulating digital interactions, students can construct knowledge more effectively. Thus, this approach aligns well with modern student-centered learning principles.

Practically, this research is expected to provide real contributions for educators, policymakers, and educational technology developers in designing and implementing innovative and effective learning strategies at the elementary level (Holzinger dkk., 2019). The findings are also expected to serve as a foundation for decision-making in formulating sustainable and inclusive technology-based education policies. Consequently, basic education in Indonesia will be better prepared to face 21st-century challenges. Moreover, AI's presence in Smart Learning enables real-time data collection useful for analyzing student learning progress. This data can assist teachers in providing targeted feedback and guiding students more efficiently. The integration of data supports data-driven learning approaches, now a standard in modern education. This approach offers dual benefits: facilitating teachers in monitoring student progress and enabling students to understand their strengths and weaknesses in the learning process.

Gamification also plays a significant role in creating a fun and competitive learning atmosphere (Huynh-The dkk., 2023). For children, play is a favored activity and an integral part of daily life. By integrating game principles into learning, students are more encouraged to actively participate in every learning activity. Elements such as challenges, rewards, and ranking systems motivate students to continuously improve their performance. This has proven effective in reducing boredom and enhancing perseverance in completing learning tasks. Implementing Smart Learning also provides significant opportunities for teachers to improve their professional competencies. Through training in educational technology use and digital content development, teachers are encouraged to continually learn and innovate (Hwang, 2014). The teacher's role in Smart Learning shifts from the primary source of information to facilitator, mentor, and manager of the learning process. This transformation requires mindset changes and new skills, which, when mastered, will strengthen the quality of learning in elementary schools.

Furthermore, AI- and gamification-based Smart Learning enables large-scale personalized learning. Students can learn according to their individual learning styles—visual, auditory, or kinesthetic. AI systems can recognize student learning patterns and present materials in the most suitable way for each individual. This contrasts with the classical, uniform approach that tends to overlook individual differences. Thus, every student has an equal opportunity to optimally develop their potential. Nevertheless, adopting Smart Learning in elementary schools is not without technical and non-technical challenges. Technical challenges include limitations in technology infrastructure such as internet access, hardware, and supporting software. Non-technical challenges involve stakeholders' attitudes and perceptions toward technology, teacher readiness, and limited policy support from the government and educational institutions (Jiang dkk., 2022; Johnson dkk., 2000). Overcoming these challenges requires synergy among all relevant parties, including educational institutions, government, technology developers, and the community.

Understanding these aspects means that Smart Learning implementation at elementary schools must be carried out comprehensively and sustainably. Strategies are needed that cover teacher capacity building, infrastructure provision, supportive curriculum development, as well as ongoing monitoring and evaluation. Only through a systemic and integrative approach can digital transformation in basic education be optimally realized and yield significant results for student development. Beyond internal school factors, parental support is also key to the successful implementation of Smart Learning. Parents need to be educated about the benefits and workings of AI- and gamification-based learning to support their children's learning at home. Parental involvement is crucial in elementary education because children are still in early developmental stages and require guidance from their family environment.

In the Indonesian context, adopting Smart Learning must also consider local social and cultural aspects. Each region has different characteristics, ranging from resources, language, to cultural values held by the community. Therefore, the development and implementation of learning technology must be adapted to the local context to be optimally accepted and utilized by users. This approach will strengthen the relevance and effectiveness of Smart Learning in improving the quality of basic education. Overall, Smart Learning is a promising innovative step to transform basic education. Integrating AI and gamification technology not only provides solutions to the limitations of conventional learning methods but also opens the way for more inclusive, adaptive, and enjoyable learning. This study contributes importantly to filling gaps in literature and practice related to Smart Learning implementation at the elementary level in Indonesia.

By presenting comprehensive data and analysis, this article is expected to provide a clear picture of the potentials and challenges of Smart Learning. The findings are hoped to serve as references for developing better educational policies and practices in the future. Such learning innovations will become an integral part of the national education system if supported by appropriate policies and consistent implementation.

## RESEARCH METHOD

This study employs a qualitative approach with a case study design aimed at deeply exploring the process and impact of implementing AI- and gamification-based Smart Learning in elementary schools (Kibbe dkk., 2011). Three elementary schools in Indonesia that have adopted digital learning technologies were selected as the study subjects. The selection considered variations in geographical location, socio-economic background, and technological infrastructure readiness (Kim dkk., 2011). This exploratory study seeks to understand the experiences, challenges, and implementation strategies used by teachers as well as students' responses to this new learning method.

Data collection was conducted through direct classroom observations of learning activities, in-depth interviews with teachers, principals, students, and parents, as well as analysis of digital learning documents such as AI modules, student progress reports, and learning management systems (LMS). Observations aimed to capture classroom interaction dynamics, how technology was used by teachers and students, and students' responses to gamification elements in learning. Interviews were used to explore perceptions and experiences from various stakeholders.

Research instruments were designed as observation guidelines, interview protocols, and document analysis formats. Data validity was ensured through source and method triangulation by comparing information from observations, interviews, and documents to gain a more comprehensive picture (Kinshuk dkk., 2016). Additionally, member checking was conducted by requesting participants to confirm the preliminary interpretations made by the researcher. Data analysis was conducted thematically, following the qualitative analysis procedures of Miles and Huberman: data reduction, data display, and conclusion drawing. Interview data were transcribed verbatim and coded to identify emerging themes related to the use of AI and gamification in learning. These themes were then used to construct the narrative of the research findings.

During the research, the researcher adhered to ethical considerations by obtaining approval from the schools and participants and maintaining the confidentiality of respondent identities. The researcher also ensured that the use of technology in learning did not infringe on students' rights and complied with school policies. The study was conducted over three months during the odd semester of the 2024/2025 academic year. Each school was observed for two weeks to obtain sufficiently representative data. During this period, the researcher attended

teaching and learning activities at least five times per week to document the ongoing learning dynamics.

The research subjects consisted of three classroom teachers, two subject teachers (Mathematics and Indonesian Language), two principals, nine students from three grade levels (grades 3, 4, and 5), and six parents. Subjects were purposively selected to obtain a variety of data to enrich the analysis. In addition to observations and interviews, the researcher also accessed and analyzed features of the Smart Learning software used in the schools, such as AI adaptive features, automated assignment distribution, gamification-based assessment systems, and student progress reports. This was done to understand how technology practically supports the learning process.

Data reliability was maintained through systematic recording and documentation of all research activities (Kumar dkk., 2013). All interviews were recorded with respondents' consent and transcribed for analysis purposes. Visual documentation such as classroom photos, student device screens, and students' work results were also collected to strengthen the descriptive findings. This study aims to comprehensively describe how Smart Learning is implemented at the elementary school level, the challenges faced by teachers and students, as well as the tangible benefits perceived by the schools. The findings are expected to serve as a basis for developing better and more sustainable technology-based learning policies and practices.

## RESULTS AND DISCUSSION

### Results

The results of this study show that the integration of AI- and gamification-based Smart Learning brings significant changes to the learning dynamics in elementary schools. Classroom observations revealed an increase in student enthusiasm when interacting with learning software that includes game elements such as point accumulation and virtual badges. Students actively engaged in answering questions, pursuing achievements, and participating in healthy competition on real-time leaderboards. These features motivated students to study harder; even previously passive students became more enthusiastic and confident in participating in class.

The use of AI in Smart Learning is evident through adaptive learning modules tailored to each student's ability. The system recognizes students' comprehension levels based on their responses and then provides appropriate follow-up exercises. Teachers no longer need to manually prepare remedial questions, as the system automatically directs students to enrichment or review materials (Li & Wong, 2021). The effectiveness of these adaptive modules is demonstrated by the consistent improvement in students' test scores over the three-month study period. In interviews, teachers reported that the system helped them manage heterogeneous classrooms more efficiently and accurately.

Document analysis showed an increase in students' average scores in the three observed subjects (Mathematics, Indonesian Language, and Science). The improvement was not only cognitive but also reflected in students' attitudes and active participation during lessons. The AI-based reporting system enabled teachers and parents to monitor student progress in detail over time. These reports included statistics on study time, number of completed assignments, and score achievements. Parents welcomed this transparency, as it allowed them to be more involved in their children's learning process with better information.

Observations of student behavior indicated that gamification successfully fostered a learning culture that was both competitive and collaborative. In several project-based learning sessions, students were more easily able to work in small groups formed automatically by the system based on shared interests or abilities (Marinova dkk., 2017). Group leaderboards encouraged students to help one another so that all members could reach learning targets. Teachers noted that this approach improved social cohesion within the classroom and reduced social isolation among students who typically lagged behind.

In interviews, students expressed that they enjoyed learning with an application that incorporated game elements more than conventional methods. They felt that learning was more like playing but still educational. One student described the experience as “like going on an adventure in the world of knowledge.” This narrative suggests that Smart Learning successfully shifted the learning paradigm from instructional to exploratory and enjoyable without sacrificing academic goals. Teachers stated that using the AI-based system simplified their lesson planning. Content, exercises, and assessment recommendations provided by the system saved time and enhanced teaching quality. Teachers were relieved from administrative burdens as most activities were automated (Martins dkk., 2022). For example, the system automatically graded assignments and gave feedback to students promptly. This freed teachers to focus on emotional support and character development.

Principals reported that Smart Learning implementation positively impacted the school climate. The learning environment became more dynamic and interactive. Furthermore, student attendance increased because students did not want to fall behind in daily gamification achievements. Attendance data showed a 12% average increase in student presence during the study period. Principals also emphasized the importance of regular teacher training to optimize technology use and keep up with the latest developments. Challenges in implementing Smart Learning included dependence on devices and internet connectivity. Some students faced difficulties due to inadequate devices or slow internet. Schools addressed this by providing digital labs and Wi-Fi hotspots for students to use in shifts. Nevertheless, these issues remain obstacles to equalizing the quality of technology-based learning.

In terms of learning evaluation, AI provided a more accurate and holistic approach. AI did not only assess right or wrong answers but also analyzed students’ thinking patterns based on how they solved problems. These evaluation reports were then used by teachers to provide more precise personal interventions. For instance, students who answered too quickly but often incorrectly were guided to slow down and better understand the material. Students consistently answering correctly were directed to advanced content. Gamification also impacted students’ character development, especially in responsibility, hard work, and sportsmanship. Students learned to strategize point collection, practice independently to climb rankings, and accept defeat gracefully. Several students stated in interviews that they began to create their own study schedules at home to complete daily and weekly challenges. This indicates that learning extended beyond the classroom into students’ daily lives.

Data from the system showed an 18% average increase in formative evaluation scores by the end of the third month. This improvement was higher than in the period before Smart Learning implementation. Teachers noted that students were better prepared for evaluations as they had practiced through various game formats, interactive quizzes, and AI-based simulations. Students’ mental readiness and confidence also increased due to their familiarity with instant, constructive feedback. Teachers also mentioned that Smart Learning helped them quickly identify students who needed special attention (Putri dkk., 2023). The system provided automatic alerts when a student’s performance or motivation declined. This enabled early intervention before problems escalated. Teachers could also customize learning content for specific students with just a few clicks, without having to create materials from scratch.

From parents’ perspectives, most felt more confident about the learning process because the system provided real-time access to their children’s progress. Parents could view scores, completed assignments, and learning recommendations. Some even became actively involved by assisting their children at home following system guidance (Michalski dkk., 1983). The relationship between school and family became more harmonious and integrated thanks to this technology. The use of audio, images, animations, and narration in AI modules was also found effective in reaching students with diverse learning styles. Auditory, visual, and kinesthetic learners could choose the format that suited them best. This system offered flexibility in learning styles not achievable with conventional approaches. Teachers reported that students

understood abstract concepts faster when taught through interactive simulations compared to verbal explanations alone.

Overall, the results confirm that the implementation of AI- and gamification-based Smart Learning creates a more adaptive, engaging, and efficient learning ecosystem. The impact is evident not only in quantitative improvements in academic achievement but also in changes in attitudes, motivation, and student character. This innovation reinforces the idea that technology can be a strategic partner in creating better and more relevant elementary education aligned with today's challenges.

## **Discussion**

The implementation of AI- and gamification-based Smart Learning in elementary schools brings a significant transformation to traditional learning approaches. The combination of intelligent technology and game mechanics shifts the learning paradigm from passive to active and participatory. Students are no longer mere recipients of information but become the main actors who dynamically interact with the learning content (Aparicio dkk., 2012). This aligns with constructivist theory, where effective learning occurs when students actively construct their own understanding. AI provides uniqueness through its ability to analyze and respond to individual learning needs in real time, while gamification injects intrinsic motivation through elements of competition and rewards.

The presence of adaptive learning modules marks a turning point in creating a personalized learning experience. Not all students learn at the same pace or style, and the AI system can carefully accommodate these variations. When students quickly grasp the material, they are directed to higher-level challenges (Mintz & Brodie, 2019). Conversely, students facing difficulties receive repetition and additional guidance. This not only makes the learning process more efficient but also reduces stress and anxiety often experienced in uniform, classical systems. Gamification in Smart Learning is not merely an entertainment tool but a pedagogical strategy that strengthens learning motivation. Elements such as points, badges, and leaderboards not only attract students' attention but also foster a sense of responsibility, healthy competition, and collaboration among peers. In its implementation, these mechanisms need to be carefully designed to avoid creating inequalities or psychological pressure, instead serving as triggers for enjoyable and inclusive learning enthusiasm.

The role of teachers in the Smart Learning ecosystem remains crucial despite technology taking over many administrative and technical functions. Teachers act as facilitators and mentors who understand students' social and emotional contexts. Technology helps teachers develop more targeted and adaptive learning strategies. AI provides rich data for teachers to analyze in planning instructional interventions, while gamification offers tools to maintain student engagement (Noh dkk., 2011; Prince, 2013). Both complement and support the creation of an optimal learning environment. From an evaluation perspective, AI introduces a much deeper approach compared to conventional assessments. The system records students' thought processes, not just the final answers. This enables teachers to identify specific difficulties and provide appropriate feedback. This formative evaluation supports continuous learning and gives students opportunities to improve without feeling judged solely by a single final score.

Smart Learning also contributes to shaping students' character. Through gamification, students learn discipline, hard work, perseverance, and sportsmanship. They develop strategies, manage their time, and learn to cope with failure as part of the process. This supports the achievement of character education goals prioritized in the national curriculum. Integrating character values into game elements is proven to be more readily accepted by students than verbal instruction alone (Sarason dkk., 1960; Stevens & Slavin, 1995). The availability of real-time data-driven progress reports makes communication between teachers, students, and parents more open and productive. Parents not only learn about final grades but also the learning processes their children undergo. Consequently, they can provide appropriate support

at home. Parental involvement in children's learning becomes more intensive and higher quality, ultimately strengthening collaboration between home and school.

However, challenges in implementing Smart Learning cannot be ignored, especially regarding infrastructure and digital literacy (Basten, 2017). Not all schools have adequate devices and internet connections. Similarly, not all teachers are prepared to use technology optimally. This highlights the need for policy support and continuous training to ensure equitable and sustainable digital transformation in education. From a pedagogical standpoint, a strong instructional design approach is necessary to ensure that AI and gamification are used to reinforce learning objectives rather than serve as mere technological embellishments. Designing learning materials and activities must remain student-centered and reflect holistic educational values (Fetzer, 1990; Woodcock & Johnson, 2018). A blended learning approach can serve as a solution to integrate the strengths of technology with the social interactions that remain crucial in early childhood education.

This study shows that technology is not merely an auxiliary tool but a strategic partner in designing and delivering learning. Teachers who can adapt to technology and understand its pedagogical potential will hold a strong position in creating innovative learning. Therefore, professional development for teachers is an important agenda to support Smart Learning implementation. Conceptually, the findings strengthen the position of Smart Learning as a future learning model relevant to the digital era. The needs of Generation Alpha students, who grow up with technology, require approaches aligned with their realities. Smart Learning answers this challenge by providing contextual, interactive, and adaptive learning. This aligns with 21st-century education goals emphasizing creativity, critical thinking, collaboration, and communication.

Furthermore, the successful implementation of Smart Learning in elementary schools opens opportunities for replication at other educational levels, including secondary and non-formal education ("A Model of Elementary School Effects," 1994). By adjusting to the characteristics of learners, this approach can be more broadly applied to reach larger populations. However, further research is needed to evaluate its effectiveness in diverse contexts. Smart Learning also raises new discussions about the ethics of AI use in education—for example, how to protect student data privacy, prevent technology dependency, and maintain human relationships within digital learning contexts. These challenges remind us that technology must be managed with ethical and humanistic principles to ensure its benefits are truly positive for all stakeholders.

From a policy perspective, these findings indicate the need for government support in the form of regulations, infrastructure, and incentives for schools and teachers implementing Smart Learning. National digital literacy programs and AI training for educators can accelerate the equitable adoption of this innovation nationwide. Investment in educational technology should be viewed as a long-term investment in human resource development. Overall, this discussion affirms that Smart Learning is not merely a trend but a necessity. The combination of AI and gamification offers solutions to modern educational challenges while paving the way for a more inclusive, effective, and meaningful future in education. This transformation will succeed if supported by synergy among teachers, students, parents, policymakers, and technology developers.

## CONCLUSION

Based on the results of the research and discussion conducted, it can be concluded that AI- and gamification-based Smart Learning has a significant positive impact on the quality of learning at the elementary school level. This approach is able to enhance students' motivation, engagement, and overall learning outcomes. The integration of AI technology allows the learning system to become more adaptive and personalized, adjusting to the individual needs and abilities of each student. Meanwhile, gamification elements create a fun and healthy competitive learning environment, which ultimately encourages students to be more active and consistent in participating in the learning process.

In addition to benefiting students, Smart Learning also reduces the burden on teachers in designing lessons and provides accurate, real-time evaluation data. However, the successful implementation of Smart Learning requires adequate infrastructure support, high digital literacy from all parties, and progressive education policies. Therefore, collaboration among educational institutions, government, technology developers, and the community is necessary to ensure the sustainability and effectiveness of this approach in the future.

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