



GAMIFICATION-DRIVEN E-LEARNING MANAGEMENT FOR IMPROVED SELF-REGULATED LEARNING: MEDIATING EFFECTS OF MOTIVATION AND ENGAGEMENT WITH LEARNING ANALYTICS SUPPORT

Lia Saniah^{1*}, Siti Saodah Susanti²

¹Universitas Muhammadiyah Sukabumi, Sukabumi, Indonesia

³STAI Yamisa, Bandung, Indonesia

*Corresponding Author: 📧 liasaniah2@ummi.ac.id

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Abstract. Independent learning process management is commonly expected of students in online learning contexts; however, many students struggle to maintain motivation and engagement, which may hinder the development of Self-Regulated Learning (SRL). Students' motivation, engagement, and self-regulation in digital learning contexts need to be supported by instructional approaches, as this condition emphasizes. This study aims to explore the impact of integrating Learning Analytics Support into gamification to enhance student motivation and engagement, thereby strengthening Self-Regulated Learning (SRL) in online learning. This quantitative study uses Structural Equation Modeling (SEM) to analyze data collected from 100 students in senior high schools in Cianjur Regency. The results show that gamification greatly enhances SRL by raising student involvement and motivation. Motivation and engagement act as key mediators in the relationship between gamification and SRL, with gamification enhancing these factors through elements such as points, badges, and leaderboards, which encourage active participation and sustained effort. While Learning Analytics Support (LAS) did not show a significant direct effect on SRL, its role in providing real-time feedback and tracking progress supports the development of self-regulation when combined with gamification. These findings suggest that integrating gamification with learning analytics can create a learning environment that supports students' motivation, engagement, and self-regulated learning in online education. This study offers insights into the potential of combining these approaches to improve the effectiveness of digital learning strategies and enhance students' ability to manage their own learning processes.

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Correspondence address:

Jl. R. Syamsudin, SH. No. 50 Kota Sukabumi Indonesia 43113.

📧 liasaniah2@ummi.ac.id

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Program Studi PGSD Universitas Flores. Jln. Samratulangi, Kelurahan Paupire, Ende, Flores.

✉ primagistrauniflor@gmail.com

INTRODUCTION

Students' ability to self-regulate their learning (SRL) is a critical component of their academic performance, particularly in digital classrooms. Students who are able to self-regulate their learning (SRL) are able to do things like plan their own lessons, create their own study spaces, come up with their own tactics, keep track of their own time, ask for and accept assistance when they need it, and assess their own progress (Nieva & Prudente, 2022). This ability is particularly important in remote learning contexts where students must take greater responsibility for their learning (Santoso et al., 2022). Previous studies also show that intrinsic motivation, cognitive and affective regulation, and learning engagement are consistently associated with better performance in online and hybrid classrooms (Han et al., 2022). In addition, active instructor support and positive perceptions of the learning process can further enhance student motivation and strengthen SRL in online education (Aryati et al., 2024).

Effective curriculum implementation in various school settings can increase student motivation and engagement, which plays an important role in supporting their SRL development (Yafie et al., 2024). Although participation in learning has increased, many students find it difficult to maintain motivation and engagement when learning online, which contributes to a decline in SRL levels. Studies during and after the pandemic report increased psychological stress, decreased face-to-face interaction, and a greater need for SRL support for students learning online; these conditions correlate with decreased use of self-regulation strategies and decreased

satisfaction with the online learning experience (Anazifa et al., 2023). Similar research also shows variations in online SRL patterns influenced by individual conditions and course design, indicating that the decline in SRL is not homogeneous across the globe.

Recent research highlights that SRL competence is critical in improving students' academic achievement, particularly in learning environments that combine face-to-face instruction and digital technology. Xu et al. (2023) found that effective SRL strategies, such as time management and self-evaluation, significantly enhance learning outcomes. However, many secondary schools still face challenges in fostering students' motivation and engagement, which are crucial for developing optimal SRL. Limited technological support and difficulties in maintaining student engagement remain key barriers. Consistent with these findings, Khiat & Vogel (2022) note that although SRL is positively associated with improved learning outcomes, students' motivation and involvement in both face-to-face and technology-supported learning situations greatly determine its efficacy.

A decline in student motivation and engagement can negatively affect Self-Regulated Learning (SRL), including students' ability to plan study time, seek help, and think critically on how they are learning (Nguyen & Chen, 2023). This indicates that students' intrinsic motivation and level of involvement significantly influence the relationship between SRL and learning outcomes. Therefore, efforts to strengthen SRL in senior high schools should focus on increasing intrinsic motivation and engagement, while providing support such as time management tools and guidance on SRL strategies. Such an approach can improve the effectiveness of both face-to-face and technology-based learning and support better academic achievement (Sedrakyan et al., 2020).

A viable approach to enhancing SRL in online education is integrating gamification into learning management systems. Gamification is a teaching method that uses game mechanics to motivate and engage students, such as point systems, badges, and leaderboards (Handayani et al., 2021). This method fosters SRL development by making learning more participatory and encouraging students' intrinsic motivation. In addition, learning analytics support can provide real-time feedback that helps students monitor their progress and regulate their learning independently (Lee et al., 2025). The combination of gamification, increased engagement, and data-driven feedback can structure the learning process and strengthen students' ability to manage their learning strategies in online environments.

Previous research shows that motivation and engagement play a significant mediating role in improving SRL. Various studies have confirmed that gamification is effective in improving both factors, thereby strengthening students' SRL. For example, a study by Alrashedi et al. (2024) shows that platforms that use gamification can increase student engagement and learning ambition, thereby improving their SRL abilities. Furthermore, the use of learning analytics support has also been proven effective in increasing student engagement, as found in a study by Ateş & Gündüzalp (2025), which showed that augmented reality (AR)-based gamification can increase teacher motivation and engagement. Although these studies examine gamification, motivation, engagement, and learning analytics separately, no research has combined these three factors into a single integrated learning model to improve SRL in online learning.

This study offers empirical novelty by integrating learning analytics with gamification to enhance student motivation and engagement, thereby strengthening SRL. Previous studies have rarely examined these three elements simultaneously in technology-based learning at the secondary school level. Methodologically, this study applies the SEM-PLS approach to analyze the relationships among variables, extending prior research that mainly used descriptive or simple experimental methods. Focusing on high school students in Cianjur Regency, this research examines how secondary school students can better leverage technology-based learning through the application of gamification and learning analytics.

This study aims to explore the impact of integrating Learning Analytics Support into gamification to enhance student motivation and engagement, thereby strengthening Self-Regulated Learning (SRL) in online learning. This research focuses on senior high school students in Cianjur Regency to investigate how gamification elements and learning analytics feedback can enhance students' motivation and engagement, thereby strengthening their SRL. The findings are

expected to contribute theoretically by developing an integrated framework of gamification, learning analytics, motivation, engagement, and SRL, and practically by shedding light on how schools and teachers may improve digital learning practices that encourage pupils to work independently.

RESEARCH METHODS

The researchers in this study used a correlational design and a quantitative methodology. Utilizing the SmartPLS software, data were examined by Structural Equation Modeling (SEM) to examine the relationships among Gamification-Driven E-Learning Management (X), Self-Regulated Learning (Y), Motivation (Z1), Engagement (Z2), and Learning Analytics Support (M), as well as their influence on technology-based learning management in senior high schools in Cianjur Regency. The research design is presented in Figure 1.

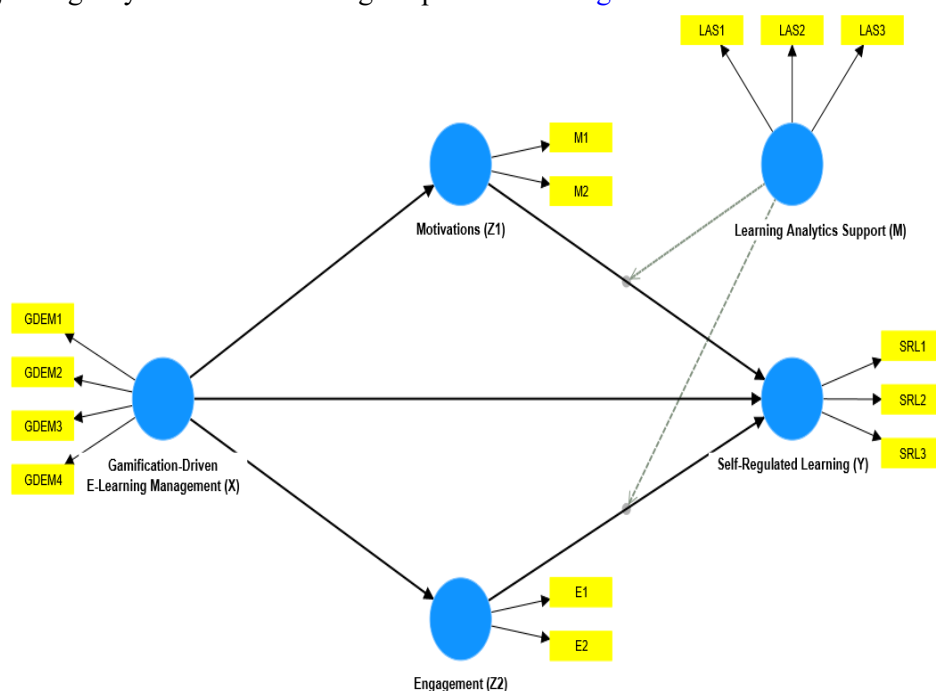


Figure 1. Flow of Research Design

The study population consisted of high school students in Cianjur Regency involved in gamification-based learning. The sample was selected using purposive sampling, targeting students with experience in technology-based and gamified learning supported by learning analytics platforms. A total of 100 students who met these criteria participated in the study, providing representative data for evaluating the proposed model. Data were collected through questionnaires distributed to students, using a 1–5 Likert scale to measure perceptions of gamification use, learning motivation, engagement, self-regulated learning (SRL), and learning analytics support. The questionnaire items were adapted to the high school learning context and were pre-tested to ensure validity and reliability.

Data analysis employed the SEM-PLS (Partial Least Squares) approach to examine relationships among variables in the research model. The measurement model was evaluated using convergent validity, discriminant validity, composite reliability, and Cronbach's alpha. The structural model was then analyzed using t-tests and the coefficient of determination (R^2). The SmartPLS program was used to conduct all of the analyses.

RESULTS AND DISCUSSION

Table 1 presents the mean, standard deviations (SD), reliabilities, and correlations for each variable. Cronbach's Alpha, Composite Reliability (pa), and Average Variance Extracted (AVE) were used to assess the reliability and validity of the constructs in the research model.

Table 1. Descriptive Statistics and Correlations Between Variables

Variabel	Mean	SD	Cronbach Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE	Correlations		
							Motivation (Z1)	Engagement (Z2)	Self-Regulated Learning (Y)
Gamification-Driven E-Learning Management (X)	3,39	0,72	0,902	0,909	0,932	0,774	0,613	0,451	0,600
Motivation (Z1)	3,51	0,82	0,836	0,841	0,924	0,859	1,000	0,514	0,681
Engagement (Z2)	3,37	0,79	0,896	0,912	0,95	0,906	0,514	1,000	0,671
Learning Analytics Support (M)	3,50	0,77	0,833	0,885	0,899	0,748	0,149	0,328	0,145
Self-Regulated Learning (Y)	3,53	0,87	0,866	0,868	0,918	0,789	0,681	0,671	1,000

Based on [Table 1](#), Motivation (Z₁) and Self-Regulated Learning (Y) show the highest mean values (3.51 and 3.53), indicating strong motivation and SRL in online learning. Gamification-Driven E-Learning Management (X) has a mean of 3.39, suggesting moderate acceptance of gamification. A reliability coefficient (Cronbach's Alpha) greater than 0.80 indicates very high levels of internal consistency. Learning Analytics Support (M) shows the lowest association with other variables, indicating a limited effect on SRL and Engagement. Motivation (Z₁) and Engagement (Z₂) are strongly associated with SRL, highlighting their importance in students' independent learning. The measurement model results, including outer loadings, are presented in [Figure 2](#).

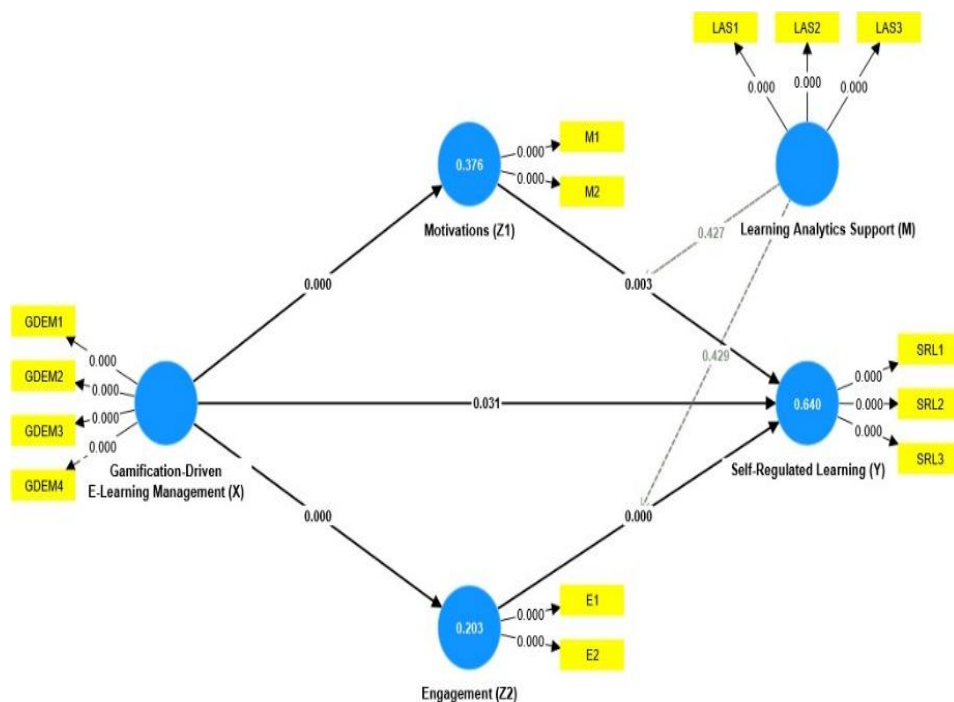


Figure 2. Result of Outer Loadings

Outer-loading values were used to evaluate convergent validity; indicators with loadings above 0.70 were considered valid. The results are presented in [Table 2](#).

Table 2. Outer Loading Test Results

Variable	Indikator	Length in Percent	Interpretation
Engagement (Z_2)	E1	0,959	Valid
	E2	0,944	Valid
Gamification-Driven E-Learning Management (X)	GDEM1	0,860	Valid
	GDEM2	0,854	Valid
	GDEM3	0,908	Valid
	GDEM4	0,895	Valid
Learning Analytics Support (M)	LAS1	0,808	Valid
	LAS2	0,917	Valid
	LAS3	0,865	Valid
Motivation (Z_1)	M1	0,920	Valid
	M2	0,934	Valid
Self-Regulated Learning (Y)	SRL1	0,869	Valid
	SRL2	0,894	Valid
	SRL3	0,901	Valid
Moderasi	Learning Analytics Support (M) $\times$ Motivation (Z_1)	1,000	Valid (interaction)
	Learning Analytics Support (M) $\times$ Engagement (Z_2)	1,000	Valid (interaction)

Based on [Table 2](#), all indicators have outer loadings above 0.70, indicating good convergent validity. Engagement indicators show the highest loadings (0.959 and 0.944), while other variables range from 0.808 to 0.934. The interaction variables have loadings of 1.000 as they represent products of latent constructs. Overall, all indicators are valid for structural model analysis. The results of the validity and reliability tests for the constructs are displayed in [Table 3](#).

Table 3. Results of Construct Reliability and Validity Tests

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	Interpretation
Engagement (Z_2)	0,896	0,912	0,950	0,906	Reliable and Valid
Gamification-Driven E-Learning Management (X)	0,902	0,909	0,932	0,774	Reliable and Valid
Learning Analytics Support (M)	0,833	0,885	0,899	0,748	Reliable and Valid
Motivations (Z_1)	0,836	0,841	0,924	0,859	Reliable and Valid
Self-Regulated Learning (Y)	0,866	0,868	0,918	0,789	Reliable and Valid

The constructs in question exhibit robust internal consistency, as seen in [Table 3](#), where Cronbach's Alpha and Composite Reliability both exceed 0.70. All AVE values exceed 0.50, with Engagement (Z_2) and Motivation (Z_1) showing the highest values (0.906 and 0.859). These results confirm that all constructs are reliable and meet convergent validity requirements for structural model analysis. Table 4 below shows the result of the discriminant validity test.

There is sufficient discriminant validity, as shown in [Table 4](#), since all HTMT values are less than 0.85. The highest value is 0.797 (SRL–Motivation), and the lowest is 0.181 (LAS–Gamification), confirming that all constructs are distinct.

Table 4. Discriminant Validity Test Results

	Engagem ent (Z2)	Gamificat ion- Driven_E- Learning Managem ent (X)	Learnin g Analyti cs Suppor t (M)	Motiv ations (Z1)	Self- Regul ated Learn ing (Y)	Learning Analytics Support (M) x Engageme nt (Z2)	Learning Analytics Support (M) x Motivatio ns (Z1)
Engagement (Z2)							
Gamification- Driven_E-Learning Management (X)	0,489						
Learning Analytics Support (M)	0,369	0,181					
Motivations (Z1)	0,592	0,707	0,186				
Self-Regulated Learning (Y)	0,758	0,671	0,164	0,797			
Learning Analytics Support (M) x Engagement (Z2)	0,275	0,111	0,341	0,154	0,144		
Learning Analytics Support (M) x Motivations (Z1)	0,142	0,108	0,121	0,152	0,161	0,726	

Table 5 below shows the result of the multicollinearity test.

Table 5. Multicollinearity Test Results

	VIF
E1	2,936
E2	2,936
GDEM1	2,425
GDEM2	2,464
GDEM3	3,493
GDEM4	3,302
LAS1	1,650
Outer LAS2	2,259
Model LAS3	2,185
M1	2,065
M2	2,065
SRL1	1,926
SRL2	2,562
SRL3	2,575
Learning Analytics Support (M) x Motivations (Z1)	1,000
Learning Analytics Support (M) x Engagement (Z2)	1,000
Engagement (Z2) -> Self-Regulated Learning (Y)	1,594
Gamification-Driven_E-Learning Management (X) -> Engagement (Z2)	1,000
Gamification-Driven_E-Learning Management (X) -> Motivations (Z1)	1,000
Inner Gamification-Driven_E-Learning Management (X) -> Self-Regulated Learning (Y)	1,674
Model Learning Analytics Support (M) -> Self-Regulated Learning (Y)	1,218
Motivations (Z1) -> Self-Regulated Learning (Y)	1,822
Learning Analytics Support (M) x Engagement (Z2) -> Self-Regulated Learning (Y)	2,444
Learning Analytics Support (M) x Motivations (Z1) -> Self-Regulated Learning (Y)	2,212

According to Table 5, there is no multicollinearity in the model since all Variance Inflation Factor (VIF) values are less than 5. The lowest VIF value is 1.000, suggesting weak correlations among variables and stable parameter estimates. The structural relationships among constructs are presented in Figure 3.

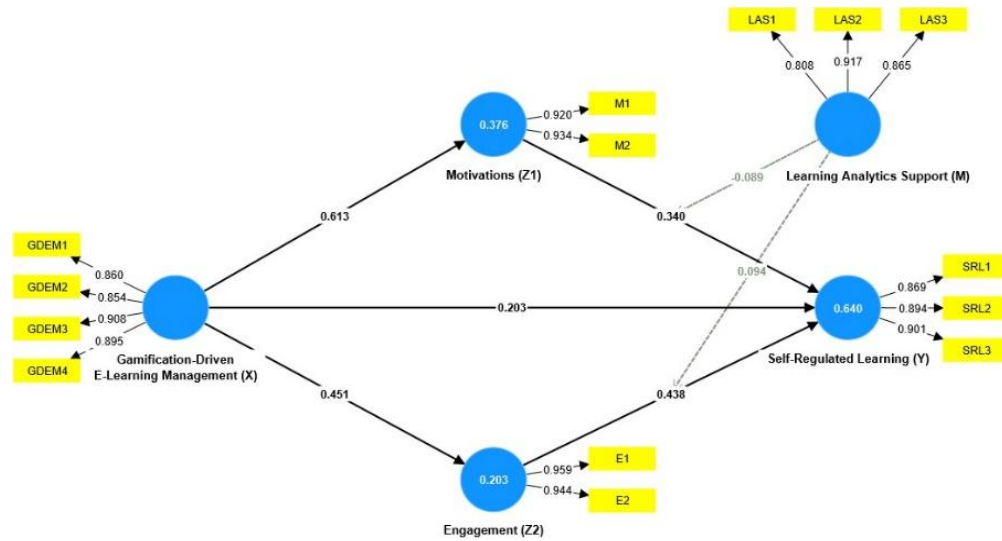


Figure 3. Result of Inner Loadings

Table 6 below shows the R-Square Value.

Table 6. Length Weight of Sections

	R-square	R-square adjusted	Interpretation
Engagement (Z2)	0,203	0,195	Low category
Motivations (Z1)	0,376	0,370	Medium category
Self-Regulated Learning (Y)	0,640	0,617	Strong category

Based on Table 6, the R^2 value for Engagement (Z_2) is 0.203, indicating a low level of explanation. Motivation (Z_1) has an R^2 of 0.376, showing moderate explanatory power, while Self-Regulated Learning (Y) has an R^2 of 0.640, indicating strong explanatory power. Overall, the model explains SRL better than Engagement and Motivation. Table 7 below shows the result of the path coefficients test.

Table 7. Path Coefficients Test Results

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values	Interpretation
Engagement (Z2) -> Self-Regulated Learning (Y)	0,438	0,421	0,109	4,027	0,000	Significant
Gamification-Driven E-Learning Management (X) -> Engagement (Z2)	0,451	0,453	0,114	3,965	0,000	Significant
Gamification-Driven E-Learning Management (X) -> Motivations (Z1)	0,613	0,617	0,072	8,512	0,000	Significant
Gamification-Driven E-Learning Management (X) -> Self-Regulated Learning (Y)	0,203	0,207	0,094	2,155	0,031	Significant
Learning Analytics Support (M) -> Self-Regulated Learning (Y)	-0,058	-0,053	0,097	0,604	0,546	Insignificant
Motivations (Z1) -> Self-Regulated Learning (Y)	0,340	0,348	0,115	2,965	0,003	Signifikan
Learning Analytics Support (M) x Engagement (Z2) -> Self-Regulated Learning (Y)	0,094	0,069	0,119	0,791	0,429	Insignificant
Learning Analytics Support (M) x Motivations (Z1) -> Self-Regulated Learning (Y)	-0,089	-0,057	0,112	0,794	0,427	Insignificant

The results of the path coefficient test are presented in [Table 7](#). It can be concluded that:

1. Engagement (Z_2) has a significant positive effect on Self-Regulated Learning (Y) with a path coefficient of 0.438 ($t=4.027$; $p<0.001$), indicating that the higher the level of student engagement, the higher their level of self-regulated learning.
2. Gamification-Driven E-Learning Management (X) has a significant positive effect on Engagement (Z_2) with a path coefficient of 0.451 ($t = 3.965$; $p < 0.001$), which means that the application of gamification in e-learning contributes to increasing student engagement.
3. Gamification-Driven E-Learning Management (X) also has a significant effect on Motivation (Z_1) with a path coefficient of 0.613 ($t=8.512$; $p<0.001$), indicating that gamification has a strong influence on increasing student motivation.
4. Gamification-Driven E-Learning Management (X) has a significant positive effect on Self-Regulated Learning (Y) with a path coefficient of 0.203 ($t = 2.155$; $p = 0.031$), although the effect is smaller than the other relationships.
5. Learning Analytics Support (M) does not have a significant effect on Self-Regulated Learning (Y) (path coefficient = -0.058; $t = 0.604$; $p = 0.546$), indicating that learning analytics support does not have a significant effect on self-regulated learning.
6. Motivation (Z_1) has a significant positive effect on Self-Regulated Learning (Y) with a path coefficient of 0.340 ($t = 2.965$; $p = 0.003$), indicating that motivation plays an important role in improving students' self-regulated learning.
7. Both moderation interactions, Learning Analytics Support (M) $\times$ Engagement (Z_2) and Learning Analytics Support (M) $\times$ Motivation (Z_1), did not show a significant effect on Self-Regulated Learning (Y) ($p = 0.429$ and $p = 0.427$).

Based on the path coefficient test outcomes, most of the model's relationships are significant, with Engagement (Z_2) and Motivation (Z_1) as the most influential factors on Self-Regulated Learning (Y). [Table 8](#) shows the result of the indirect and total effects

Table 8. Indirect Effects Test Results

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (O/STDEV)	P values	Interpret ation
Gamification-Driven E-Learning Management (X) -> Motivations (Z_1) -> Self-Regulated Learning (Y)	0,209	0,213	0,071	2,938	0,003	Significant
Gamification-Driven E-Learning Management (X) -> Engagement (Z_2) -> Self-Regulated Learning (Y)	0,197	0,191	0,072	2,752	0,006	Significant

Based on [Table 8](#), both indirect effects are significant. The path $X \rightarrow$ Motivation (Z_1) $\rightarrow$ SRL (Y) shows a coefficient of 0.209 ($t = 2.938$; $p = 0.003$), while $X \rightarrow$ Engagement (Z_2) $\rightarrow$ SRL (Y) shows 0.197 ($t = 2.752$; $p = 0.006$). These results indicate that motivation and engagement significantly mediate the effect of gamification on Self-Regulated Learning.

The Impact of Gamification on Engagement and Motivation

Research shows that gamification in online learning greatly increases student engagement and motivation. Gamification elements such as points, badges, and leaderboards increased student engagement and motivation to learn, according to this study. According to [Handayani et al. \(2021\)](#), gamification has the potential to enhance both the intrinsic and extrinsic motivation of students. These data lend credence to that idea. Intrinsic motivation, which is related to achieving long-term goals, increases through the challenges and rewards provided in gamification. Meanwhile, extrinsic motivation is also driven by gamification elements that provide direct feedback and rewards, creating a pleasant learning atmosphere ([Smirani & Yamani, 2024](#)). In this case, gamification not only strengthens motivation to learn but also creates a more engaging learning experience, which ultimately increases student engagement in both online and classroom learning.



Furthermore, this study shows that gamification not only affects student motivation but also their level of engagement in learning activities. Student engagement, which includes the level of active participation in learning activities, can be increased by using game elements that provide challenges and direct feedback. These findings confirm previous research results stating that gamification can increase student engagement by creating interactive and enjoyable learning experiences (Choustoulakis et al., 2025). These findings align with previous reviews and empirical studies that demonstrate the positive effects of gamification on participation and engagement in b-learning and distance learning (Cavus et al., 2023). By incorporating game elements, students become more enthusiastic about participating in learning activities because the process becomes more interesting and less monotonous. This is particularly important in the context of online learning, where students often lose motivation and engagement due to a lack of social interaction and enjoyable learning experiences.

Gamification plays a role in fulfilling students' basic psychological needs, such as autonomy, competence, and social connection, which in turn increases their motivation and engagement. Gamification functions as a learning design mechanism that can fulfill these three needs, thereby increasing learners' motivation and engagement. Autonomy is created through students' freedom to choose challenges or tasks that suit their abilities, while competence is gained through continuous feedback that helps them feel more confident in their learning abilities (Yang et al., 2024). The social relationship aspect is also strengthened through gamification, with student interactions in the form of competition or team collaboration (Christopoulos & Mystakidis, 2023). When these three basic needs are met through gamification design that considers personalization, real-time feedback, and a balance between pedagogical goals and game elements, the accumulation of theoretical and empirical evidence shows an increase in more autonomous motivation regulation, an increase in behavioral and cognitive engagement, and a more inclusive and conducive learning environment for student self-development.

The Role of Motivation and Engagement in Self-Regulated Learning (SRL)

This study also shows that student motivation and engagement serve as important mediators in the relationship between gamification and SRL. Higher motivation encourages students to be more active in managing and regulating their learning process, while increased engagement makes them more focused and committed to their learning goals. This is consistent with previous findings stating that SRL is highly dependent on students' levels of motivation and engagement (Khiat & Vogel, 2022). Increased engagement, as a direct result of gamification design, reinforces the consistency of effort and the application of metacognitive strategies necessary for SRL in the setting of online, flexible learning, as shown in research linking engagement with self-regulation techniques to academic success. Motivated and involved students are more likely to develop effective study plans, manage their time effectively, and evaluate and reflect on their learning outcomes, all key aspects of SRL.

Students are more likely to self-regulate their motivation and stay committed to their long-term goals when they are given the tools they need through gamification, which appeals to their needs for autonomy, competence, and relatedness (Luria, 2022). Intrinsic motivation, driven by gamification elements, provides a strong foundation for students to independently manage their learning. Students with intrinsic motivation tend to have clear long-term goals and are more persistent in overcoming learning challenges (Smirani & Yamani, 2024). On the other hand, extrinsic motivation, such as rewards or recognition from the gamification system, can provide additional encouragement, helping students remain engaged in learning even when they encounter difficulties (Zhou et al., 2022). Thus, motivation serves as a driver that directs students to use more effective learning strategies, increases their independence in learning, and ultimately strengthens their SRL.

The development of SRL relies heavily on student interaction in the learning process because there is a strong correlation between active participation, improved academic performance, and the adoption of self-regulation practices. An active learning student is more likely to be more responsive to feedback, more organized in time management, and more proactive in seeking help when needed. This is associated with the ability to use metacognitive



skills such as planning and reflecting, which are core components of SRL (Khiat & Vogel, 2022). Furthermore, this engagement also supports improved academic achievement through enhanced planning, monitoring, and post-task evaluation, which have been shown to enhance educational standards (Komoder et al., 2023; Yafie et al., 2020). Instructional designs that utilize gamification elements, such as tiered challenges, real-time feedback, and social interaction, can theoretically and empirically strengthen student engagement. Gamification developed for educational purposes boosts student motivation while enhancing their ability to autonomously control, monitor, and assess their learning process, thereby facilitating more consistent and adaptive SRL development in the context of online learning (Pausch, 2023).

The Effect of Learning Analytics Support on SRL

The study's findings show that Self-Regulated Learning (SRL) is not significantly affected by Learning Analytics Support (LAS), even though LAS provides data and visualizations that enable students to track their progress and activity patterns, and real-time feedback that has the potential to support self-regulation. This finding differs from previous research, which found that LAS can strengthen student engagement by providing more adaptive and personalized feedback (Lee et al., 2025). The lack of analytical abilities and computer literacy among students may explain the insignificance of this direct effect, as it prevents them from effectively using LAS data (Sormin, 2025). Although LAS offers adaptive feedback that, as shown in other studies, increases engagement and academic achievement through gamified dashboards or informative visualizations (Alam et al., 2023), in this research, the effectiveness of LAS in triggering SRL depends on users' capabilities, such as analytical skills and dashboard use training. These findings also reflect barriers to LAS adoption, where uneven integration and resistance at the institutional and student levels reduce the pedagogical impact of LAS (Demartini et al., 2024). Thus, although LAS has great potential to support SRL, its influence will be more significant if it is supported by training students' analytical skills and by visualization designs that facilitate SRL implementation, enabling the data provided to be translated into concrete learning actions.

Although Learning Analytics Support (LAS) can provide relevant data and visualizations to monitor learning progress, such as dashboards that display performance, activity patterns, and real-time feedback, its direct impact on improving Self-Regulated Learning (SRL) is often hindered by contextual factors. Research shows that the use of LAS benefits is highly dependent on how data are presented and understood by students, as well as on the degree of institutional preparedness for integrating LAS into the curriculum (Ifenthaler & Yau, 2020). In addition, students' limited analytical and digital literacy skills play an important role, as those who are not trained in reading dashboards or analyzing learning indicators tend to fail to translate information into self-regulatory actions such as planning, monitoring, and evaluation (Zhidkikh et al., 2023). Therefore, to optimize LAS's potential to support SRL, educational institutions should provide adequate training in reading, interpreting, and using analytical data effectively, as well as pedagogical scaffolding that links data-based feedback to concrete self-regulation steps (Ifenthaler & Yau, 2020).

On the other hand, LAS still has great potential if integrated in a structured manner, for example, through gamified dashboards that offer adaptive feedback and clearer recommendations for action, supported by training in use and instructional support. Students can monitor their progress, modify their learning methods, and enhance their SRL practices more effectively with the aid of LAS, provided it is implemented with a holistic, integrative approach (Zhidkikh et al., 2023). Thus, LAS is not an automatic solution, but it can be a very useful tool when supported by good curricular design, improved student analytical skills, and self-regulation strategies that students can practically implement (Sousa et al., 2021).

CONCLUSIONS AND SUGGESTIONS

This study's conclusions indicate that gamification in online learning environments significantly boosts SRL by enhancing student motivation and engagement. Although Learning Analytics Support (LAS) has little direct impact on SRL, gamification serves as an important mediator in supporting students' self-regulation in learning. Therefore, for further research, it is



recommended to explore how to achieve a more effective integration of gamification and LAS, particularly by incorporating training for students to use analytical data to support their SRL strategies. This work advances our understanding of online learning, especially regarding the roles of gamification and LAS in increasing student motivation and engagement, and its implications for SRL. Strengthening instruction in the use of analytical tools and gamification components, and ensuring that students have a better understanding of how to use these components to autonomously control their learning, are practical recommendations for implementation in educational institutions.

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