Indonesia Journal of Learning Education and Counseling
homepage: https://journal.ilininstitute.com/index.php/IJoLEC
Vol 8, No 2, March 2026, pp 192-203
p-ISSN:2460-1497 and e-ISSN: 2477-3840

Digital Game-Based Learning and Student Engagement in Elementary Science: Evidence from a Quasi-Experimental Study Using Wordwall

Muhammad Amran[1*], Nur Ilmi[2], Israyanti Ahmad[3]
[1] Elementary Education, Universitas Negeri Makassar, Indonesia
E-mail: neysaamran@gmail.com
[2] Elementary Education, Universitas Negeri Makassar, Indonesia
E-mail nurilmi@unm.ac.id
[3] Elementary Education, Universitas Negeri Makassar, Indonesia
E-mail: israyantiahmad@gmail.com

Article info

Article history:
Received: 14-01-2026
Revised: 20-02-2026
Accepted: 24-03-2026
Publish: 30-03-2026

Keywords:
Game Based Learning;
Learning Activity;
Student Engagement;
Elementary Education;
Digital Learning;

Abstract

This study investigates the effectiveness of Game-Based Learning (GBL) in enhancing student engagement in elementary integrated science learning, addressing the issue of limited active participation commonly observed in classrooms. Using a quantitative approach, the study employed a quasi-experimental design with a posttest-only control group. The sample consisted of two fourth-grade classes at UPTD SD Negeri 28 Pare-pare. Class IV.2 served as the experimental group and Class IV.1 as the control group. The experimental group received instruction using a Game-Based Learning approach supported by the Wordwall digital platform, whereas the control group was taught using conventional instructional methods. Data on student engagement were collected through observation and analyzed using an independent samples t-test. The results revealed a statistically significant difference in student engagement between the two groups ($p < 0.05$). This indicates that students who were taught using the Game-Based Learning approach demonstrated higher levels of engagement compared to those who received conventional instruction. These findings suggest that integrating digital Game-Based Learning tools such as Wordwall can effectively promote active participation and enhance student engagement in elementary science learning.

* Corresponding author at: Elementary Education, Universitas Negeri Makassar. Indonesia, Graha Surandar G2 No.11d, Makassar, 90221, Indonesia.
E-mail address: neysaamran@gmail.com
DOI: https://doi.org/10.31960/ijolec.v8i2.3366

INTRODUCTION

The goal of studying Natural and Social Sciences (IPAS) is to enable students to understand social and natural phenomena in encountered in their daily lives. IPAS learning lets students develop knowledge that is meaningful and applicable in real-life contexts. Natural science is considered a component of human thought processes and knowledge-generating practices that help individuals interpret and interact with their environment

(Yasa, 2024). Therefore, learning processes in IPAS should be designed to promote both mental and physical engagement, allowing students to actively participate in meaningful learning experiences (Puspitasari & Patonah, 2024). Active participation helps students build knowledge independently and increases their engagement in the learning process.

IPAS holds a significant position in elementary education by facilitating students' understanding of the interactions between humans and their environment, the functioning of the universe, and the ways scientific knowledge can improve the quality of life (Zakarina et al. 2024). Science education also seeks to cultivate students' curiosity, critical thinking, and problem-solving skills. Students are expected to engage actively in learning activities that promote exploration of concepts through observation, discussion, and experimentation. However, the implementation of IPAS in elementary schools often fails to fully support active participation. Students commonly encounter difficulties in comprehending concepts, particularly when instruction is predominantly teacher-centered (Wouters et al., 2013; Boyle et al., 2016).

Students might perceive IPAS, a subject taught in elementary schools, as challenging. According to the Ministry of Education, Culture, Research, and Technology, (2025), "Natural and Social Sciences (IPAS) is the study of living and non-living things in the universe and their interactions, and/or the study of human life as both individuals and social beings interacting with their environment". Science is generally defined as a synthesis of diverse information organized rationally and methodically, with consideration for cause and effect (Dichev & Dicheva, 2017). This body of knowledge encompasses both social science and natural science.

One of the main challenges in education is the low level of student engagement during learning. Contributing factors may include teacher-centered instruction, students' insufficient understanding of fundamental science concepts, and limited use of instructional media or and students-led activities. Elementary students often exhibit passivity in science classes when the lessons lack stimulation and do not promote inquiry or active participation (Rokhanah et al. 2021).

For IPAS education to succeed in elementary schools, several things matter. These include teachers' skills, resources, and infastucture, parents' education, students' home locations, and the support families provide for learning (Dwi Rizkiani at.al. 2023). Despite these factors, teachers might encounter challenges in selecting effective instructional methods. Besides delivering content effectively, teachers need to select and adapt learning models that encourage students to participate and stay engaged. When teachers use traditional, one-way methods, students might become passive, lose interest, and just listen without participating. To make learning more enjoyable and engaging, teachers should use new and relevant approaches that fir their students' needs (Dwi Rizkiani et al. 2023).

the Programme for International Student Assessment (PISA) 2022 shows that Indonesian students still have low performance in science, which reflects their low engagement in learning. Science classes are meant to help students develop scientific literacy. A teacher-centered approach in science classes might make students listen to explanations and memorize information instead of taking part in activities. There is limited interaction between teachers and students, which results in low engagement. This approach does not match the current curriculum, which encourages student-centered learning and active participation.

Initial observations at UPTD SD Negeri 28 Pare-pare revealed that the learning process is still mostly teacher-centered. Students spend most of their time listening to explanations and memorizing material, while there are few opportunities for discussion, problem-solving, or working together. This learning environment can reduce students' motivation and engagement, particularly in Natural and Social Sciences (IPAS), where active exploration of ideas is essential. This approach is inconsistent with the Merdeka Belajar curriculum, which emphasizes meaningful, student-centered learning.

To address these challenges, teachers need to adopt innovative instructional strategies that promote active participation. Incorporating interactive learning strategies within the digital environment might have the potential to increase student engagement. It is recommended that teachers select instructional models that foster active involvement and

create an enjoyable learning experience (Khoerunnisa & Aqwal, 2020).

The selection of appropriate learning models is essential for achieving learning objectives. Ineffective learning models may hinder the learning process and reduce student engagement. Therefore, it is important to use models that encourage students to interact and take part in lessons (Djonomiarjo, 2020). Game-Based Learning (GBL) is an approach that puts students at the center by integrating game elements into instructional activities to create interactive learning experiences. This approach helps students get involved through structured play with clear challenges, rules, and goals. Game-Based Learning can boost students' motivation and focus during class, making the learning environment more dynamic and enjoyable (Amalia et al., 2024). It also helps students develop problem-solving skills and work together.

Game-Based Learning (GBL) represents a pedagogical approach that facilitates student-centered instruction. GBL integrates game elements in lessons to make learning more interactive and engaging. According to Deterding et al. (2011), gamification as the application of game design elements in non-game contexts to enhance engagement. Similarly, Sailer and Homner (2020) report that gamification significantly increases learning motivation and participation. Koivisto and Hamari (2019) also emphasized that gamified systems enhance learner motivation and engagement.

Game-Based Learning is defined as a learning strategy that incorporates game elements into the teaching and learning process to create a more engaging learning environment. The use of games allows students to interact actively with learning materials while receiving immediate feedback. GBL support students to develop both cognitive and social skills, such as communication, collaboration, and decision-making skills (Winatha & Setiawan, 2020). Therefore, the implementation of Game-Based Learning has the potential to improve student engagement during learning. (Widiyanto & Nugraheni, 2022). It can strengthen critical thinking, teamwork, and decision-making skills. Previous studies have shown that GBL increases student engagement and motivation (Buckley & Doyle, 2016; Huang & Hew, 2018). Moreover, interactive learning environments created through GBL contribute to deeper learning experiences (Sung & Hwang, 2018).

Previous research has demonstrated that Game-Based Learning enhances student engagement. Afriani et al. (2025) reported that implementing Game-Based Learning significantly increased students' learning engagement. The results indicated that students in the experimental group higher levels of involvement than those in the control group. Statistical analysis using the Independent Sample T-test revealed a significant effect of Game-Based Learning on student engagement with a significance value of 0.003 ($p < 0.05$). These findings imply that Game-Based Learning might foster a more stimulating learning environment and motivate students to actively participate. These results support the claim made by Zainuddin et al. (2020) that gamified learning environments enhance engagement and participation.

Kumar et al. (2024) reported similar findings. Students demonstrated increased participation in group discussions, responded to questions more rapidly, and exhibited greater motivation to complete assignments presented as games. Additionally, interviews with a number of students and instructors also showed that game-based learning can create a more pleasurable learning environment, which increased students' motivation to study. Building upon these findings, the present study extends the literature by integrating Game-Based Learning (GBL) with the Wordwall digital platform to enhance student engagement in elementary integrated science learning. Meta-analytical studies show that serious games positively affect cognitive and motivational outcomes (Wouters et al., 2013; Boyle et al., 2016).

Kembau et al. (2023) argued that each learning phase designed within a game-based framework encourages students to actively engage in problem-solving and to understand subject matter through enjoyable learning experiences. In line with this perspective, the findings of this study show that the experimental class achieved a mean post-test score of 81.60, indicating that the Game-Based Learning (GBL) model contributed to improved student learning outcomes. This finding suggests that both conceptual understanding and active student participation

in learning can be enhanced through the implementation of the GBL approach.

Numerous studies have shown that GBL improves student motivation, engagement, and learning outcomes. It also promotes critical thinking and collaboration while establishing a fun and engaging learning atmosphere. However, the majority of existing studies primarily focus on improving learning outcomes in general and have not thoroughly examined how GBL affects student engagement, including aspects such as enthusiasm, communication, and the ability to articulate ideas. In fact, learning engagement is a key factor in determining the effectiveness of the learning process. Therefore, further research is needed to comprehensively examine the impact of GBL on student engagement.

This study examines the implementation of the Game-Based Learning (GBL) approach and its effect on the engagement of fourth-grade elementary school students in Natural and Social Sciences (IPAS) learning. GBL was selected because it is enjoyable, interactive, and capable of promoting active student participation through game-based instructional activities. The novelty of this study lies in the integration of the Wordwall digital platform in implementing the GBL model. Through Wordwall, teachers can design engaging educational games that align with learning objectives. This study aims to compare the learning activities of students in classrooms that implement expository learning with those that apply GBL supported by Wordwall. Furthermore, this study contributes to the existing body of literature by integrating Game-Based Learning (GBL) with the Wordwall digital platform as an innovative approach to enhancing student engagement in elementary integrated science learning.

METHOD

Research Design and Procedures

This study employed a quasi-experimental design using a posttest-only control group to examine the effect of Game-Based Learning (GBL) on students' engagement in Natural and Social Sciences (IPAS). This design was used to examine the influence of the independent variable on the dependent variable in a natural classroom setting (Zyra et al., (2022).

A quasi-experimental design was selected because random assignment was not feasible in the school setting. This design involves two groups, one receiving treatment and the other serving as a control group. Ibrahim et al., (2018) The experimental group received instruction using the Game-Based Learning model supported by the Wordwall platform, while the control group received conventional instruction. While the other group does not receive treatment (X), the first group does. The experimental group received instruction using the Game-Based Learning model supported by the Wordwall platform, while the control group received conventional instruction. While the other group does not receive treatment (X), the first group does. The experimental group is the one that receives the treatment, whereas the control group is the one that does not. The following is a description of the research design Posttest-Only Control Design (Khotimah & Kuswandi, 2019).

Based on the research design above, it can be concluded that this quasi-experimental research in the form of a posttest only control design emphasizes the comparison of treatment between the two groups, namely the experimental group and the control group, where the experimental group is the group given special treatment (as an independent variable), while the control group does not receive special treatment (as a dependent variable).

The data collection procedure in this study was carried out in two stages in the experimental and control classes, namely the treatment and posttest stages which were carried out systematically and sequentially. In the treatment stage, the experimental class was given treatment in the form of the application of the Game Based Learning (GBL) learning model in Natural and Social Sciences (IPAS) learning for two meetings, while the control class also carried out IPAS learning in the same number of meetings but without using the GBL learning model. Furthermore, in the posttest stage, data collection was carried out by filling out an observation sheet by observers after the treatment process was completed in both classes. The filling out of the observation sheet was based on the results of observations of student learning activity during the IPAS learning process.

Population and Sample

The population in this study was all students at the UPTD of SD Negeri 28 Pare-pare, with a total of 387 students. The sample is a portion of the population taken using a specific method and capable of representing the characteristics of the population. The sampling technique used in this study wasnon-probabilitySampling in the form of purposive sampling. According to Sugiyono (2019), purposive sampling is a sampling technique used to determine samples for specific reasons or considerations. This technique is carried out based on consideration of certain criteria that have been determined by the researcher. The sample in this study was all fourth-grade students, both IV1 and IV2.

The researcher's consideration in choosing a sampling technique in the form of purposive sampling, which is in accordance with initial observations through interviews with homeroom teachers and direct observation of the learning process, it was found that from the two study groups in class IV of UPTD SD Negeri 28 Pare-pare, problems were found regarding the low learning activity of students in Natural and Social Sciences (IPAS) learning in classes IV1 and IV2. The total number of students in classes IV1 and IV2 is 59 students. Class IV1 has 29 students consisting of 15 male students and 14 female students, while class IV2 has 30 students consisting of 15 male students and 15 female students.

Instrument and Data Analysis

The data collection instruments in this study used complementary observation and documentation techniques. Observation is a data collection technique carried out through direct observation of the objects being studied in the field. Referring to Apriyanti et al. (2019), observation was used to obtain data regarding student learning activity in Natural and Social Sciences (IPAS) learning. The observation was carried out using an observation sheet that had been prepared based on a four-point Likert scale, consisting of positive and negative statements with the categories of very good (worth 4, good worth 3, quite good worth 2, and poor worth 1, as stated by Taluke et al. (2019). In addition to observation, documentation techniques were also used to complete the research data in the form of supporting information such as student data, a list of fourth-grade student names, and documentation in the form of photos and videos during the learning process

The data analysis technique in this study uses descriptive and inferential statistics. Descriptive statistics are used to describe student learning activity data through mean, median, mode, range, standard deviation, and variance values as well as assessment scale grouping. Meanwhile, inferential statistics are used to test the hypothesis regarding the influence of the Game Based Learning (GBL) model by first conducting prerequisite tests in the form of normality tests (Kolmogorov-Smirnov) and homogeneity tests (Levene Test) using SPSS version 27. Furthermore, hypothesis testing is carried out with Independent Samples T-Test at a significance level of 0.05, with the criteria if the sig value ≤ 0.05 then H0 is rejected and H1 is accepted, and vice versa if sig > 0.05 then H0 is accepted

RESULTS AND DISCUSSION

Student Learning Engagement

Descriptive statistical analysis techniques were used to calculate the data. The purpose of the descriptive statistical analysis was to determine and review the level of student learning engagement using the Game-Based Learning model in science lessons in grade IV of the UPTD of SD Negeri 28 Pare-pare. The categories of student learning engagement can be seen in the following table 2.

Table 2. Learning Engagement Categories of Experimental Class Students

Value Interval	Number of Students	Description
40 – 48	15	Very high
33 – 39	13	High
26 – 32	2	Moderate
19 – 25	0	Low
12 – 18	0	Very Low

Table 3. Category of Student Learning Engagement in Control Class

Value Interval	Number of Students	Description
40 – 48	1	Very high
33 – 39	2	High
26 – 32	16	Moderate
19 – 25	10	Low
12 – 18	0	Very Low

The descriptive statistical results also showed differences in mean scores between the experimental and control classes. The distribution of student engagement levels based on descriptive statistical analysis in both groups is presented in Table 2 and Table 3. The experimental class obtained a mean score of 40.40, while the control class obtained a mean score of 27.62. The median and mode values in the experimental class were also higher than those in the control class. These findings show that implementing Game-Based Learning improve student engagement in learning activities. The higher mean score in the experimental class reflects increased participation, interaction, and involvement in learning. Students in the experimental class actively participated in discussions, responded to questions, and engaged in collaborative activities. These findings suggest that Game-Based Learning creates a more interactive learning environment that promotes active participation.

The table below presents the descriptive statistics of students' post-treatment learning activity scores in Grade IV at UPTD SD Negeri 28 Pare-pare for both the experimental and control classes in table 4.

Table 4. Differences in the Description of Student Learning Activity Data

Descriptive Analysis	Experimental Class	Control Class
Number of Samples	30	29
Mean	40.40	27.62
Median	39.50	26
Mode	39	25
Range	16	20
Standard Deviation	4.03	4.71
Maximum	48	40
Minimum	32	20

The histogram below presents the comparison of learning activity levels between students in the experimental class and those in the control class in figure 1.

The experimental class outperformed the control class. The experimental class achieved higher central tendency values than the control class. The mean, median, and mode of the experimental class were 40.40, 39.50, and 39, respectively, all of which were higher than those of the control class. The standard deviation of 4.03 indicates that student engagement scores in the experimental class were relatively consistent, while the range of 16 reflects a moderate spread of data. The highest score obtained was 48, and the lowest was 32. Furthermore, Figure 1 illustrates a clear shift in the distribution of student engagement scores toward higher levels in the experimental group compared to the control group. This pattern indicates that the implementation of the Game-Based Learning (GBL) model effectively increased overall student engagement. In contrast, the control group demonstrates lower central tendency values and a wider variability, suggesting less consistent and lower engagement levels

The results of the descriptive statistical analysis indicate that the average student learning engagement score in the experimental class was higher than that of the control group. Thus, it can be said that students who were taught using GBL in science classes performed different levels of learning engagement. These findings are consistent with previous research, which suggests that the use of GBL can

enhance students' learning engagement, as evidenced in a study involving Grade XI students at SMKN 1 Lembah Gumanti (Afriani dkk., 2025).

The utilization of a Wordwall as an interactive digital platform to implement the GBL model is what makes this research distinctive. Teachers can use Wordwall to make interesting games that complement learning goals. The purpose of this study is to examine differences in learner engagement between classes implementing Game-Based Learning (GBL) supported by Wordwall and classes without its use.

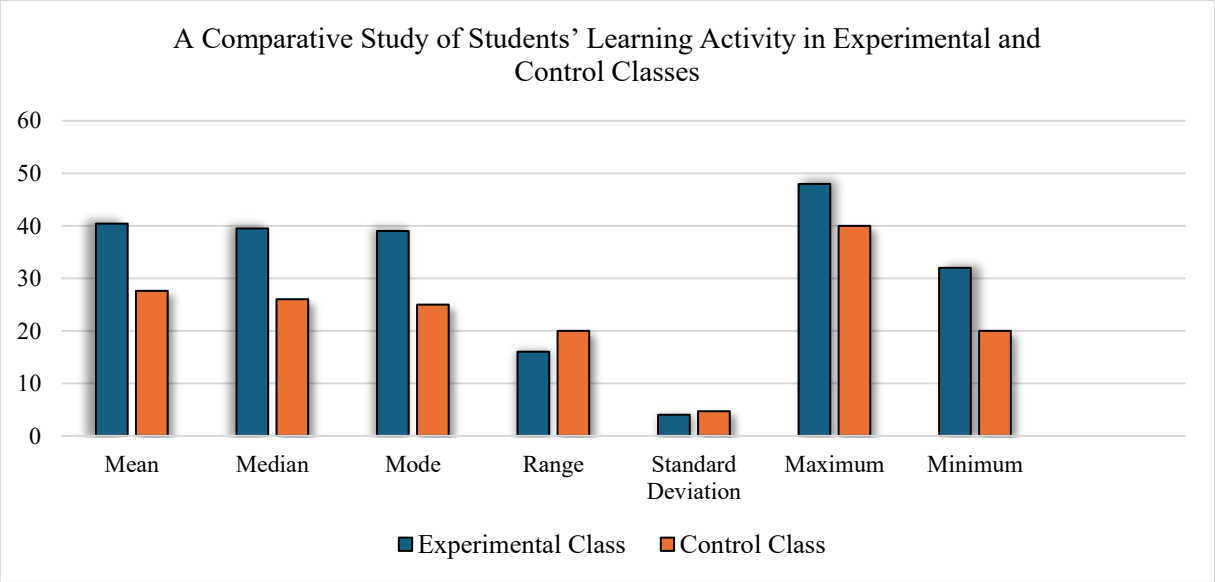

Figure 1. Differences in the Description of Student Learning Activity Data

Differences in Student Learning Activity

Differences in students' learning activity between the experimental and control classes were analyzed using an Independent Samples t-test with the assistance of SPSS, in table 5.

Table 5. Results of the Independent Sample T-test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Student Learning Activity	Equal variances assumed	0,461	0,500	11,201	57	0,001

The findings of this study indicate that the implementation of Game-Based Learning (GBL) supported by Wordwall improved student engagement in Natural and Social Sciences (IPAS) learning. The descriptive analysis showed that most students in the experimental class were categorized in the very high and high engagement levels, while the majority of students in the control class were categorized in the moderate and low levels. In addition, the experimental class achieved a higher mean score (40.40) compared to the control class (27.62). The inferential analysis also revealed a statistically significant difference between the two groups, indicating that students taught using the Game-Based Learning model demonstrated higher engagement.

To complement the inferential results, the effect size was calculated using Cohen's d. The result showed a very large effect size (d = 2.92), indicating that the implementation of Game-Based Learning (GBL) supported by Wordwall had a strong practical impact on student engagement. This suggests that the difference between the two groups is not only

statistically significant but also practically meaningful.

The data from the statistical analysis above is a conclusion based on the results of the hypothesis test through *Independent Samples T-Test*, a significance value (2-tailed) of 0.000 was obtained, which is smaller than 0.05, and a value of 11.201, which is greater than (2.002). Thus, H_0 is rejected and H_1 is accepted. These results indicate that there is a significant influence on student learning activity between groups taught using the model*Game Based Learning*(GBL) and groups that do not use this model in science learning.

These results suggest that Game-Based Learning creates learning environments that encourage active participation, collaboration, and interaction during the learning process.

Discussion

The findings of this study indicate that the implementation of Game-Based Learning (GBL) supported by Wordwall improved student engagement in Natural and Social Sciences (IPAS) learning. The descriptive analysis showed that most students in the experimental class were categorized in the very high and high engagement levels, while the majority of students in the control class were categorized in the moderate and low levels. In addition, the experimental class achieved a higher mean score (40.40) compared to the control class (27.62). The inferential analysis also revealed a statistically significant difference between the two groups, indicating that students taught using the Game-Based Learning model demonstrated higher engagement. These results suggest that Game-Based Learning creates learning environments that encourage active participation, collaboration, and interaction during the learning process.

The increased engagement observed in the experimental class can be explained through constructivist learning theory, which emphasizes that students actively construct knowledge through meaningful experiences. The Game-Based Learning model allows students to interact directly with learning materials through challenges, discussions, and collaborative activities. Students are encouraged to participate actively in solving problems and completing game-based tasks. This process promotes active learning and reduces passive behavior commonly observed in teacher-centered instruction. As a result, students become more involved in learning activities and demonstrate higher engagement.

From the perspective of student engagement theory, learning is more effective when students are behaviorally, emotionally, and cognitively involved. The implementation of Game-Based Learning supported by Wordwall facilitates behavioral engagement through participation in interactive game activities. Emotional engagement is reflected in students' enthusiasm and motivation during learning. Cognitive engagement occurs when students actively solve problems and respond to questions within the game-based activities. The use of Wordwall provides interactive features that encourage students to participate actively, thereby increasing engagement during learning.

The findings of this study are consistent with previous research indicating that Game-Based Learning can improve student engagement. Afriani et al. (2025) reported that the implementation of Game-Based Learning significantly increased students' learning engagement. Students in the experimental class showed higher participation compared to those in the control class. Similarly, Kumar et al. (2024) found that students were more enthusiastic and actively involved in learning activities when game-based learning was implemented. Students participated more actively in discussions and responded more quickly to questions. Furthermore, Kembau et al. (2023) reported that Game-Based Learning improved student participation and learning outcomes. These findings support the present study, which demonstrates that Game-Based Learning enhances student engagement.

The novelty of this study lies in the integration of Game-Based Learning with the Wordwall digital platform in elementary IPAS learning. Wordwall supports the implementation of game-based activities by providing interactive features aligned with learning objectives. Students participate in interactive games, receive immediate feedback, and collaborate with peers. This integration creates a more engaging learning environment that promotes active participation. The use of Wordwall strengthens the effectiveness of Game-Based Learning by providing structured and interactive learning activities. The integration of digital learning

platforms in game-based instruction has been shown to enhance interaction, feedback, and learning motivation (Sung & Hwang, 2018; Zainuddin et al., 2020).

However, this study has several limitations. The sample size was limited to two classes in one school, which may limit the generalizability of the findings. In addition, this study focused only on student engagement without examining other variables such as learning outcomes or motivation. The duration of the intervention was also relatively short, which may not fully capture the long-term impact of Game-Based Learning. Future research is recommended to involve larger samples, longer implementation periods, and additional variables to provide more comprehensive findings.

Despite these limitations, this study has important theoretical and practical implications. Theoretically, the findings support constructivist and student engagement theories by demonstrating that interactive learning approaches increase student engagement. Practically, the results suggest that teachers should implement Game-Based Learning supported by digital platforms such as Wordwall to create more engaging and student-centered learning environments.

CONCLUSION DAN SUGGESTIONS

This study demonstrates that the integration of Game-Based Learning (GBL) supported by Wordwall significantly enhances students' engagement in IPAS learning compared to conventional instruction. The findings indicate that the improvement in student engagement is not merely a statistical outcome, but reflects a meaningful learning process in which students become more actively involved cognitively, emotionally, and behaviorally through interactive, game-based activities. This suggests that the effectiveness of GBL is strengthened by the use of digital platforms such as Wordwall, which facilitate structured interaction, immediate feedback, and collaborative learning experiences.

From a theoretical perspective, these results support constructivist learning theory and student engagement theory by showing that learning becomes more effective when students actively construct knowledge through meaningful and interactive experiences. The study also synthesizes prior findings by confirming that digital game-based environments consistently promote higher engagement across different educational contexts.

The scientific contribution of this study lies in providing empirical evidence of the effectiveness of combining Game-Based Learning with the Wordwall platform in elementary IPAS learning, particularly in the Indonesian context. This study extends existing literature by demonstrating that digital game-based integration not only improves engagement levels but also strengthens the quality of learning interaction in primary education settings. Teachers are recommended to systematically integrate structured Game-Based Learning (GBL) activities supported by digital platforms such as Wordwall, as the findings of this study indicate that this approach significantly enhances students' learning engagement and promotes more active, interactive, and student-centered learning environments. Schools are encouraged to strengthen their digital learning infrastructure and provide adequate technological support to facilitate the effective implementation of innovative and interactive instructional strategies, including the use of Wordwall in classroom practice. Furthermore, future researchers are suggested to examine the long-term effects of GBL supported by digital platforms and to include additional variables such as student motivation, academic achievement, and cognitive outcomes, while also expanding the sample size and duration of the intervention to obtain more comprehensive and generalizable findings.

CRediT authorship contribution statement

Muhammad Amran: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Supervision, Project administration, Corresponding author; **Nur Ilmi**: Investigation, Data curation, Validation, Writing – review & editing; **Israyanti Ahmad**: Methodology, Validation, Formal analysis, Writing – review & editing.

Declaration of competing interests

The authors declare that they have no known financial interests or personal relationships that could give rise to a conflict of

interest or influence the conduct of the research, data analysis, interpretation of results, or the writing of this article. The authorsconfirm that this research was conducted objectively and independently.

Declaration of the use of AI

In the process of compiling this work, the authors used Grammarly to assist with grammar and spelling checks. The entire text has been carefully reviewed and edited by the authors, who take full responsibility for the accuracy and integrity of the published content.

Acknowledgments

The author would like to thank the Rector of Makassar State University, the Head of the Institute for Research and Community Service, the Dean of the Faculty of Education, and the Head of the Primary School Teacher Education Department for their support in carrying out this research. Their support was invaluable in ensuring that the research proceeded smoothly and successfully.

REFERENCES

Afriani, N. F., Nelmira, W., Novrita, S. Z., & Suci, P. H. (2025). The Effect of the Game-Based Learning Method on Students' Learning Activeness in Textile Knowledge Subject for Grade XI Fashion Design at SMKN 1 Lembah Gumanti. *Journal of Authentic Research*, *4*(1), 557–567. https://doi.org/10.36312/jar.v4i1.2877

Amalia, A. R. N., Nurmahanani, I., & Sari, N. T. A. (2024). The Implementation of the Game-Based Learning Model Assisted by the Educandy Educational Game in English Vocabulary Mastery *: Jurnal Ilmiah Pendidikan Dasar*, *09*(1).

Buckley, P., & Doyle, E. (2016). Gamification and student motivation. *Computers & Education, 106*, 28–38. https://doi.org/10.1016/j.compedu.2016.01.001

Boyle, E. A., Hainey, T., Connolly, T. M., et al. (2016). An update to the systematic literature review of serious games. *Computers & Education, 94*, 178–192. https://doi.org/10.1016/j.compedu.2015.11.003

Djonomiarjo, T. (2020). The Effect of the Problem-Based Learning Model on Learning Outcomes. *Aksara: Jurnal Ilmu Pendidikan Nonformal*, *5*(1), 39. https://doi.org/10.37905/aksara.5.1.39-46.2019

Dwi Rizkiani, A., Hariandi, A., Alirmansyah, A., & Zutha Berliana, T. (2023). Improving Students' Learning Activeness through the Index Card Match (ICM) Learning Model in Elementary School Science Conten*t*. *Jurnal Tonggak Pendidikan Dasar : Jurnal Kajian Teori dan Hasil Pendidikan Dasar*, *2*(2),112–124. https://doi.org/10.22437/jtpd.v2i2.28487

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. (2015). Gamification in education: A systematic mapping study. *Educational Technology & Society*, 18(3), 75–88.

Dichev, C., & Dicheva, D. (2017). Gamifying education. *Educational Technology & Society, 20(3)*, 1–13

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From game design elements to gamefulness: Defining gamification. *Proceedings of the 15th International Academic MindTrek Conference*, 9–15. https://doi.org/10.1145/2181037.2181040

Faiella, F., & Ricciardi, M. (2015). Gamification and learning: A review of issues. *Journal of e-Learning and Knowledge Society, 11(3)*, 13–21.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, 54, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hung, H. T. (2017). Clickers in the classroom. *Interactive Learning Environments, 25(5)*,

620–637. https://doi.org/10.1080/10494820.2015.1113709

Huang, B., & Hew, K. F. (2018). Implementing gamification in education. *Computers & Education, 125*, 302–320. https://doi.org/10.1016/j.compedu.2018.06.020

Ibrahim, A., Alang, A. H., Madi, Baharuddin, & Ahmad, M. A. (2018). *Research Methodology*. Gunadarma Ilmu.

Kembau, R. P., Regar, V. E., & Monoarfa, J. F. (2023). The Effect of the Game-Based Learning Model on Students' Learning Outcomes in Probability Material. *Pendas : Jurnal Ilmiah Pendidikan Dasar*, *6*(1). https://doi.org/10.37905/aksara.5.1.39-46.2019

Koivisto, J., & Hamari, J. (2019). The rise of motivational information systems: A review of gamification research. *International Journal of Information Management, 45*, 191–210. https://doi.org/10.1016/j.ijinfomgt.2018.10.013

Khoerunnisa, P., & Aqwal, S. M. (2020). Analysis of Learning Models. *Fondatia : Jurnal Pendidikan Dasar*, *4*(1), 1–27. https://doi.org/10.36088/fondatia.v4i1.441

Khotimah, A. H., & Kuswandi, D. (2019). The Effect of the Problem-Based Learning Model on Students' Civics Learning Outcomes. *JKTP Jurnal Kajian Teknologi Pendidikan*, *2*(2), 158–165. https://doi.org/10.17977/um038v2i22019p158.

Kumar, M., Chang, X. W., & Faqh, A. (2024). Implementation of Game-Based Learning in Improving Learning Motivation of Elementary School Students. International Journal of Educational Insights and Innovations *(IJEDINS)*, *1*(1), 19–23. https://doi.org/10.0000/ijedins.v1i1.2024.19-23

Liu, E. Z. F., & Chen, P. K. (2013). The effect of game-based learning. *British Journal of Educational Technology, 44(4)*, 655–664. https://doi.org/10.1111/bjet.12032

Puspitasari, J. F., & Patonah, S. (2024). Development of STEM-Based IPAS Teaching Modules to Enhance Students' Basic Scientific Thinking Skills in Elementary School. Jurnal Ilmiah Pendidikan Citra Bakti. *8*(2). https://doi.org/10.38048/jipcb.v11i1.2612

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist, 50(4)*, 258–283. https://doi.org/10.1080/00461520.2015.1122533

Rokhanah, N., Widowati, A., & Sutanto, E. H. (2021). Improving Students' Learning Activeness through the Implementation of the Student Team Achievement Divisions (STAD) Cooperative Learning Mode*: Jurnal Ilmu Pendidikan*, *3*(5), 3173–3180. https://doi.org/10.31004/edukatif.v3i5.860

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review, 32*, 77–112. https://doi.org/10.1007/s10648-019-09498-w

Sung, H. Y., & Hwang, G. J. (2018). Facilitating deep learning with game-based learning. *Educational Technology Research and Development, 66*, 1037–1061. https://doi.org/10.1007/s11423-018-9584-7

Widiyanto, R., & Nugraheni, G. W. (2022). The Implementation of Game-Based Learning Using Maze Games to Improve Third Grade Students' Learning Outcomes. *Elementar : Jurnal Pendidikan Dasar*, *2*(2), 158–167. https://doi.org/10.15408/elementar.v2i2.28641

Winatha, K. R., & Setiawan, I. M. D. (2020). PThe Effect of Game-Based Learning on Students' Motivation and Learning Achievementr. *Scholaria: Jurnal Pendidikan dan Kebudayaan*, *10*(3), 198–206.

https://doi.org/10.24246/j.js.2020.v10.i3.p198-206

Wouters, P., van Nimwegen, C., van Oostendorp, H., & van der Spek, E. D. (2013). A meta-analysis of the cognitive and motivational effects of serious games. *Journal of Educational Psychology*, 105(2), 249–265.

Yasa, I. N. J. W. (2024). A Differentiated Instruction Approach Based on the Environment: A Solution to Improve IPAS Learning Outcomes in the Merdeka Curriculum. *Indonesian Journal of Instruction*, *5*(1), 89–97. https://doi.org/10.23887/iji.v5i1.68955

Zakarina, U., Ramadya, A. D., Sudai, R., & Pattipeillohi, A. (2024). Integration of Science and Social Studies in the Merdeka Curriculum to Strengthen Scientific and Social Literacy in Elementary Schools. *Damhil Education Journal*, *4*(1), 50. https://doi.org/10.37905/dej.v4i1.2487

Zyra, S. N., Alamsyah, T. P., & Yuliana, R. (2022). Penggunaan E-Learning Berbasis Edmodo Terhadap Hasil Belajar Kelas 4 Sekolah Dasar. *Jurnal PGSD: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *15*(2), 97–106. https://doi.org/10.33369/pgsd.15.2.97-106

Zainuddin, Z., Shujahat, M., Haruna, H., & Chu, S. K. W. (2020). The role of gamified e-learning in enhancing student engagement. *Education and Information Technologies, 25*, 485–504. https://doi.org/10.1007/s10639-019-09915-5

Huang, B., & Hew, K. F. (2018). Implementing gamification in education. *Computers & Education, 125*, 302–320. https://doi.org/10.1016/j.compedu.2018.06.020