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The Implementation of Game-Based Learning to Improve Student Engagement and Learning Outcomes in the Topic of Matter and Its Changes

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Abstract. Low student engagement and learning outcomes in physics education are often caused by monotonous teaching methods, highlighting the need for a more innovative approach. This study aims to implement Game-Based Learning (GBL) assisted by Kahoot and examine its influence on student activity and learning outcomes in the physics topic of Substances and Their Changes. A quantitative approach with a Classroom Action Research design was employed, conducted in two cycles consisting of planning, implementation, observation, and reflection stages. The research subjects were 22 seventh-grade students. Data on learning activity were collected through observation sheets covering visual, oral, listening, writing, and mental activities, while learning outcome data were gathered through cognitive tests administered at pre-cycle, cycle I, and cycle II. Data were analyzed using descriptive analysis, paired sample t-test, Friedman test, and effect size calculations. The results showed that GBL significantly improved student learning activity across all indicators, and learning outcomes also increased significantly. Thus, Game-Based Learning assisted by Kahoot is proven effective in enhancing student activity and learning outcomes. These findings imply that a game-based learning approach can serve as a practical alternative for educators to create more interactive and student-centered physics instruction.

Keywords: Game-based learning, kahoot, activity and learning outcomes

1. Introduction

Physics is one of the branches of Natural Science (IPA) that plays an important role in helping students understand various natural phenomena as well as train their logical thinking and problem-solving skills. Through learning physics, students study basic concepts, such as the properties and changes of matter, which serve as the foundation for understanding natural events and technological developments around them [1]. A good understanding of physics also contributes to equipping students with scientific thinking skills to face the advancement of science and technology [2]. Physics learning should be presented contextually so that students can connect the concepts they learn with real-life experiences in daily life [3].

Active student involvement in the context of physics learning becomes an important aspect in helping students understand concepts more deeply. Learning that is designed to directly engage students in the thinking process allows them to build an understanding of concepts independently [4]. Learning activities that encourage the exploration of concepts and contextual problem-solving can create more meaningful learning experiences for students [5]. Through active and meaningful learning, students not only understand physics concepts better but are also able to apply them in various learning situations [6], [7].

Efforts to improve the quality of learning are also supported by national education policies. Minister of Education and Culture Regulation Number 13 of 2025 emphasizes the importance of enjoyable learning, which is learning that creates a positive, challenging atmosphere and motivates students to engage actively. In line with this policy, the Merdeka Curriculum gives teachers the flexibility to implement various innovative learning approaches and utilize digital technology to make learning more diverse and student-centered [8], [9] .

In reality, physics learning in schools has not fully met expectations. Needs analysis results at SMP Adhyaksa 1 Jambi show that most students still face difficulties in learning physics, particularly in the topic of Matter and Its Changes. This condition affects the low level of student participation during the learning process. Moreover, learning is still dominated by lecture methods with limited activity variations, causing students to tend to be passive and less actively involved [10].

Students show a high interest in learning that utilizes games and digital technology. Game-based learning media is considered capable of creating a more engaging and enjoyable learning atmosphere, thereby encouraging student participation in learning [11]. This aligns with the characteristics of junior high school students who are part of Generation Alpha, a generation that grows up amid the development of digital technology and is accustomed to using digital devices from an early age. This generation tends to enjoy learning that is visual, interactive, and involves active participation, including the use of educational games [12]; [13].

One of the learning approaches that can be applied to address these problems is Game-Based Learning (GBL). Game-Based Learning is a learning approach that combines elements of games with learning objectives so that students can learn actively and enjoyably [14]. The implementation of GBL has been proven to enhance student engagement and learning outcomes in science learning because students are directly involved in the process of understanding concepts through game-based activities [15], [16].

One of the media that can support the implementation of Game-Based Learning is Kahoot. Kahoot is a digital game-based learning medium that integrates learning materials into interactive quiz activities designed according to learning objectives [17]. Through Kahoot, physics materials, particularly matter and its changes, are presented in the form of conceptual questions, visual illustrations, and game-based challenges that encourage students to think and understand concepts during the learning process. The use of Kahoot has been proven to enhance student engagement, motivation, and learning outcomes because it creates a learning environment that is competitive, interactive, and enjoyable [18]. Learning engagement has a close relationship with students' learning outcomes. Learning outcomes indicate the level of students' understanding of the material after participating in learning, while learning engagement is related to the level of student involvement during the learning process. Actively and meaningfully designed learning has been proven to have a positive impact on improving students' learning outcomes [19].

The use of digital learning media in physics education is considered capable of improving the quality of learning at the junior high school level. Digital media allows learning to take place in a more interactive and visual manner, which can help students understand abstract physics concepts [20]. Technology-based learning media can also increase students' learning motivation through visualization and animation that concretize physics concepts [21]. The use of technology-based media in science learning has also been proven to enhance motivation, engagement, and students' learning outcomes [22], [23]. The implementation of Game-Based Learning assisted by Kahoot is expected to serve as an alternative solution to increase student engagement and learning outcomes in physics lessons on Matter and Its Changes at the junior high school level.

While previous studies have shown the effectiveness of Game-Based Learning (GBL) and the use of Kahoot in improving student engagement and learning outcomes, a research gap remains. Much of the existing research has focused primarily on increasing motivation or cognitive learning outcomes, without comprehensively examining how GBL assisted by Kahoot simultaneously affects various indicators of student learning activity, including visual, oral, listening, writing, and mental activities. In addition, classroom action research that applies this approach continuously over two cycles with effect size calculations is still limited. Therefore, this study aims to implement the Game-Based Learning approach assisted by Kahoot media and to determine its effect on student activity and learning outcomes in the physics topic of Substances and Their Changes at the junior high school level.

2. Method

This study used a quantitative approach with a Classroom Action Research design aimed at analyzing the improvement of student activity and learning outcomes through the application of Game-Based Learning (GBL). The research was conducted in two cycles, each consisting of the stages of planning, action implementation, observation, and reflection [24], involving 22 seventh-grade junior high school students as subjects in the science topic of substances and their changes.

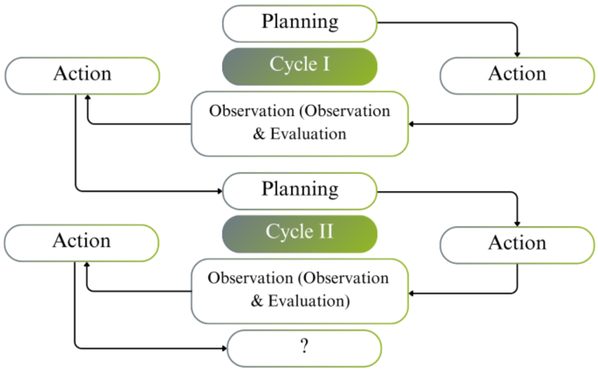

Figure 1. Classroom action research model [24].

The implementation of Game-Based Learning assisted by Kahoot was carried out over two cycles. In cycle I, each meeting began with the delivery of learning objectives, motivation, and triggering questions, followed by an interactive game using Kahoot. In the first meeting, network constraints caused Kahoot to be implemented classically, which prevented group discussions from running optimally. In the second meeting, students were able to access Kahoot through their respective devices and showed high enthusiasm, although participation in group discussions remained low because the Student Worksheets used were not interactive enough. During the learning process, student activity was observed using an observation sheet covering five indicators: visual activities, oral activities, listening activities, writing activities, and mental activities [25], using a Likert scale of 1–4 and observed by two observers. Based on the reflection results, improvements were made in cycle II through more effective time management, the development of interactive Student Worksheets in the form of puzzles, and the addition of demonstration and simple experiment activities. In cycle II, learning was more structured, and students were actively involved in various activities, ranging from Kahoot games, group discussions, puzzle completion, demonstrations, simple experiments, to presentations of their work, which ultimately showed an increase in student activity and learning outcomes.

The instruments used in this study were student activity observation sheets and cognitive learning outcome tests. The learning outcome test consisted of 20 multiple-choice questions developed based on the revised Bloom's taxonomy at the levels of C3 (applying) and C4 (analyzing), administered at three stages: pre-cycle, the end of cycle I, and the end of cycle II. Student activity data were analyzed descriptively by calculating the percentage of each indicator, while differences in activity before and after the implementation of GBL were tested using a paired sample t-test after normality testing using Kolmogorov-Smirnov and Shapiro-Wilk, with the effect size analyzed using Cohen's d. For learning outcomes, data were analyzed descriptively using mean, median, and standard deviation, while differences in learning outcomes across the three measurement times were tested using the Friedman test [26], with the effect size analyzed using partial eta squared (η^2) and post hoc analysis using Bonferroni correction.

3. Results and Discussion

Before the research instruments were used in the learning process, they were first validated by experts to ensure their quality and feasibility. The validation process involved three validators, consisting of two learning instrument validators and one validator for the teacher and student activity observation sheets. The validation results of the learning instruments showed an improvement in feasibility from the fairly good category to very good after revisions. The first validator's assessment increased from 78% to 94.44%, indicating a significant improvement in the quality of the instruments. Meanwhile, the second validator's assessment increased from 63.3% to 70% in cycle I and further improved to 85% in cycle II. This increase indicates that the instruments were refined progressively across each cycle.

These improvements were made based on feedback from the validators, including enhancing the introductory questions to better align with the material on changes in states of matter, refining the applying aspect so that it not only connects concepts to daily life but also emphasizes their application in real-life situations, and improving the wording of the questions to better stimulate students' thinking skills. In addition, the learning assessment was strengthened by incorporating indicators of student learning activeness, and the activities in the LKPD were reorganized to be more structured and easier to understand.

F. ASESMEN PEMBELAJARAN

➢ **Asesmen Diagnosis, Formatif, dan Sumatif**

Jenis	Waktu Pelaksanaan	Bentuk
Asesmen Diagnosis	Sebelum pembelajaran	Guru menanyakan pemahaman awal siswa tentang konsep zat dan perubahannya untuk mengetahui pengetahuan awal mereka.
Asesmen Formatif	Selama pembelajaran	Observasi keaktifan dan kerja sama siswa dalam diskusi kelompok serta kuis Kahoot
Asesmen Sumatif	Setelah pembelajaran	Tes hasil belajar

➢ **Kisi-Kisi Soal (Untuk Asesmen Sumatif)**

Level Kognitif	Jumlah Soal	Keterangan
C3	6	Menerapkan
C4	4	Menganalisis

➢ **Kisi-Kisi Indikator Keaktifan Belajar Siswa (Untuk Asesmen Formatif)**

No	Sub variabel	Item Observasi
1	*Visual Activities*	Memperhatikan penjelasan dan media pembelajaran yang disajikan pendidik Memperhatikan presentasi teman
2	*Oral Activities*	Menunjukkan keberanian untuk mengajukan pertanyaan dan memberikan respons kepada peserta didik lain/pendidik.
3	*Listening Activities*	Mengikuti instruksi yang diberikan. Peserta didik mendengarkan pendapat teman kelompok ketika berdiskusi.
4	*Writing Activities*	Menuliskan rangkuman dari diskusi. Mengerjakan tugas.
5	*Mental Activities*	Aktif berpartisipasi dalam diskusi kelompok.

Figure 2. Revision of the Assessment Instrument by Integrating Learning Engagement Indicators

In addition to the learning instruments, validation was also conducted on the teacher and student activity observation sheets to ensure the clarity and appropriateness of the indicators used. In the first stage, the instrument obtained a score of 14 with a percentage of 44%, which was categorized as poor. Therefore, revisions were made, particularly in terms of language and sentence structure, such as adjusting sentences to follow the subject predicate object pattern, simplifying the wording to make it more concise, and reducing the use of passive sentences. After revision, the second-stage evaluation showed a significant improvement, with a score of 27 and a percentage of 84%, which was categorized as very good. Overall, the validation results indicate that all research instruments met the required feasibility criteria and were appropriate for use in the learning process. The revised instruments were considered capable of measuring students' learning activeness and supporting effective learning implementation.

After the instruments were declared feasible, learning was carried out according to the planned schedule. In cycle I, science learning in physics using the Game-Based Learning approach was conducted in two meetings on the topic of substances and their changes. The learning utilized Kahoot as a medium to enhance student activity. Observation results showed an increase in student activity, but its implementation was not yet optimal due to limited time, internet connection issues, and low student participation in group discussions. The average student learning activity in the first meeting was 46.14% with a sufficient criterion, then increased to 65.91% in the second meeting with a good criterion. Although there was an increase, student activity in this cycle was still not optimal, especially in the indicators of oral activities and mental activities. Some students still appeared hesitant to ask questions, give responses, and actively participate in group discussions. This condition showed that students were still in the adaptation stage to game-based learning patterns and the use of Kahoot media. Therefore, improvements in learning were needed in the next cycle so that student engagement could increase more evenly.

Based on the reflection results in cycle I, the learning process continued to cycle II with several improvements. In cycle II, physics science learning using the Game-Based Learning approach was conducted based on the reflections from cycle I on the topic of substances and their changes. The learning utilized Kahoot media, puzzle-based student worksheets, as well as demonstrations and simple experiments. Student learning activity showed a more significant increase. The average activity in the first meeting reached 77.27% and increased to 88.18% in the second meeting, both of which fell under the very good category. Students showed active participation in games, group discussions, and the confidence to provide answers and share discussion results. This improvement indicated that the learning enhancements made based on the results of cycle I reflection were able to create a more interactive and participatory learning environment.

Table 1. Results of the student learning activity observation sheet.

No	Sub variable	Observation Item	Cycle I		Cycle II	
			P1	P2	P1	P2
1	Visual Activities	Paying attention to the explanations and learning media presented by the teacher Paying attention to friends' presentations	65.91%	77.27%	80.68%	95.45%
2	Oral Activities	Students show the courage to ask questions and respond to other students/teachers.	45.45%	78.41%	73.86%	99.18%
3	Listening Activities	Students follow the instructions given. Students listen to their group members' opinions during discussions.	45.45%	53.41%	69.32%	77.27%
4	Writing Activities	Students write summaries of the discussions. Students complete assignments.	48.86%	42.05%	82.95%	81.82%
5	Mental activities	Students actively participate in group discussions.	25.00%	78.41%	79.55%	93.18%
Average			46.14%	65.91%	77.27%	88.18%
Criteria			C	B	A	A
Total			56.03%		82.73%	

When viewed from each indicator, visual activities increased significantly, as shown by the growing attention of students to the teacher's explanations and learning media. This indicates that the applied learning is able to capture students' attention and focus them on the material being studied. Oral activities experienced the most notable increase, reflecting the growing courage of students to ask questions and respond, both to teachers and peers. This improvement signifies that students feel more comfortable and confident in expressing their opinions.

In the listening activities indicator, students show increasingly better ability in following instructions and listening to their peers' opinions during discussions. This indicates an improvement in mutual respect and cooperation in group learning. Meanwhile, writing activities have also improved, as seen from the students' diligence in writing summaries of discussion results and completing assigned tasks. This condition indicates an increase in students' responsibility and understanding of the learning material. A very significant increase is also seen in mental activities, indicating that students are becoming more active in thinking, participating, and engaging mentally in group discussions. This serves as an important indicator of learning success, as mental engagement is the foundation for developing a deeper understanding of concepts.

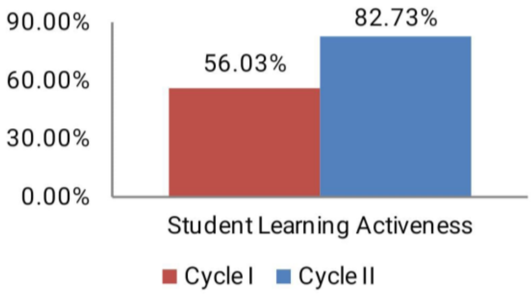

Figure 3. Graph of the increase in student learning activeness.

The increase in the average level of student learning activeness from the moderate category in cycle I to the very good category in cycle II proves that the implemented learning actions were effective in enhancing student learning activeness. These results confirm that learning designed to be interactive and reflective can encourage students to actively engage visually, orally, through listening, writing, and thinking throughout the learning process.

During the implementation of Game-Based Learning in cycle I, several challenges were found that affected the optimal execution of learning. The main challenges included limited learning time, internet connectivity issues, and students' adaptation to the use of game-based learning media. These conditions impacted the suboptimal implementation of group discussions and the uneven student participation, particularly in the indicators of oral activities and mental activities.

The use of Kahoot media in the early implementation did not fully involve all students individually, so student participation was still dominated by certain students. In group discussion activities, some students also showed low engagement and still relied on their groupmates. This indicates that although game-based learning can increase student enthusiasm, more structured learning management is needed to promote balanced student activity.

Based on these findings, reflection and improvements were made to the learning process in cycle II. The improvements included more effective time management, adjustments in the use of media according to network conditions, refinement of the student worksheets to be more interactive, and the addition of learning activities based on direct experiences. These improvement efforts proved capable of significantly increasing student engagement, as evidenced by the improvement in learning activity across all indicators as well as the improvement in student learning outcomes in cycle II.

Table 2. Students' cognitive learning outcomes.

Stage	Average	Median	Lowest	Highest
Pre Cycle	55.45	55	30	90
Cycle I	67.27	70	20	100
Cycle II	70.45	75	40	90

Students' cognitive learning outcomes showed an improvement from the pre-cycle to cycle II. In the pre-cycle, the students' average score was 55.45 with a median of 55, indicating that the students' ability to understand the material was still low. The lowest score was 30, signaling that many students were still experiencing difficulties in learning, which corresponded with the low student activity at the initial stage.

In cycle I, the average score increased to 67.27 and the median to 70. This improvement indicates that most students began to understand the material after learning interventions were applied. Nevertheless, the learning outcomes in this cycle were not yet entirely uniform, as there were still students who obtained low scores. In cycle II, student learning outcomes improved again. The average score was 70.45 with a median of 75, and the lowest score increased to 40. This indicates that the improvement in learning outcomes occurred for many students, not just a few specific ones. This improvement aligns with the increased activeness of students in engaging with the learning, asking questions, and participating in discussions. Overall, the increase in average and median scores indicates that learning that encourages student activeness has a positive impact on students' cognitive learning outcomes.

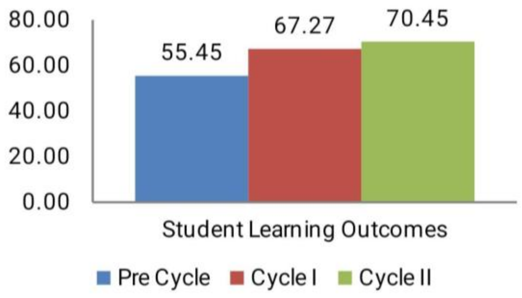

Figure 4. Graph of student learning outcome improvement.

To ensure that the improvement in learning outcomes is statistically significant, the data were analyzed using the SPSS program. Before performing hypothesis testing, a residual normality test was first conducted to determine whether the residuals of student learning outcomes are normally distributed, which is a requirement for using parametric statistical tests.

Table 3. Tests of normality.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference	.183	22	.053	.924	22	.092

a. Lilliefors Significance Correction

The increase in students' learning activeness was analyzed using a paired sample t-test to compare conditions before and after the implementation of Game-Based Learning (GBL). Before testing the hypothesis, a normality test was conducted on the differences in learning activeness data. The normality test using Kolmogorov–Smirnov indicated a statistic value of D (22) = 0.183 with a significance of p = 0.053, while the Shapiro-Wilk test yielded a value of W (22) = 0.924, with a significance of p = 0.092. Based on the results of both tests, the significance values are greater than 0.05 ($p > 0.05$), indicating that the data are normally distributed, thus meeting the assumption for using parametric tests.

Table 4. Paired samples statistics.

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre_Engagement	56.0227	22	7.34600	1.56617
	Post_Engagement	82.7273	22	5.97161	1.27315

The average level of students' learning activeness showed a change, which was further analyzed using a paired samples t-test to determine its statistical significance. The results of this analysis are presented in Table 5.

Table 5. Paired samples test.

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre_Engagement - Post_Engagement	-26.70455	6.78700	1.44699	-29.71373	-23.69536	-18.455	21	.000

Based on the fulfillment of the normality assumption, hypothesis testing on the improvement of student learning activity was continued using a paired sample t-test. The analysis results showed that there was a significant difference between the initial activity scores (M = 56.0227, SD = 7.34) and after learning (M = 82.7273, SD = 5.97), with t (21) = 18.455, P < 0.001. The significance value (2-tailed) was used to determine whether there was a significant difference between the two measurement conditions, namely before and after the treatment, regardless of the direction of change. Since the obtained significance value was less than 0.05 ($p < 0.05$), it can be concluded that the implementation of Game-Based Learning has a significant effect on improving student learning activity.

Table 6. Paired samples effect sizes.

					95% Confidence Interval	
			Standardizer[a]	Point Estimate	Lower	Upper
Pair 1	Pre_Engagement - Post_Engagement	Cohen's d	6.78700	-3.935	-5.181	-2.676
		Hedges' correction	6.91127	-3.864	-5.088	-2.628

To determine the magnitude of the treatment's effect on the increase in student learning activity, Effect Sizes were calculated using Cohen's d values. Effect Sizes are used to provide information about the strength or magnitude of the treatment effect, not just to indicate whether there is a statistical difference [27]. The calculation results showed a Cohen's d value of 3.935, which falls into the very large category. This refers to Cohen's 1988 criteria, which state that a Cohen's d value ≥0.80 indicates a large effect size. It can be concluded that the implementation of Game-Based Learning has a very strong effect on increasing student learning activity.

Table 7. Tests of normality.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Residual for Pre_Cycle_Learning_Outcomes	.139	22	.200*	.951	22	.335
Residual for CycleI_Learning_Outcomes	.181	22	.058	.917	22	.066
Residual for CycleII_Learning_Outcomes	.209	22	.013	.877	22	.010

The analysis of student learning outcomes was conducted at three measurement times, namely pre-cycle, cycle I, and cycle II. Before hypothesis testing was performed, a residual normality test was first conducted to ensure whether the residuals of student learning outcomes were normally distributed as a requirement for using parametric statistical tests.

The Kolmogorov–Smirnov test results showed that the residual data of student learning outcomes in the pre-cycle were normally distributed [D(22) = 0.139, p = 0.200], and in cycle I were also normally distributed [D(22) = 0.181, p = 0.058]. However, the residual data of student learning outcomes in cycle II were not normally distributed [D(22) = 0.209, p = 0.013].

The Shapiro–Wilk test showed that the residual data of students' learning outcomes in the pre-cycle were normally distributed [W(22) = 0.951, p = 0.335] and in cycle I were also normally distributed [W(22) = 0.917, p = 0.066], whereas the residual data of students' learning outcomes in cycle II were not normally distributed [W(22) = 0.877, p = 0.010]. Thus, the results of the Kolmogorov–Smirnov and Shapiro–Wilk tests indicate the same finding, namely that the pre-cycle and cycle I data are normally distributed, while the cycle II data are not normally distributed.

In addition to the residual normality test, the Sphericity assumption test was also conducted as a requirement for using repeated measures ANOVA. The Sphericity assumption is used to ensure that the variance of differences between each pair of measurements is the same, so that the obtained F test results are valid. If the Sphericity assumption is not met, a correction is required, such as Greenhouse–Geisser, to adjust the degrees of freedom in the analysis. The results of Mauchly's Test showed a value X^2 (2) =

1,294, with a significance of p = 0.524. Since the significance value is greater than 0.05 (p > 0.05), it can be concluded that the Sphericity assumption is met.

Table 8. Mauchly's test of sphericity.[a]

Measure: Learning_Outcomes

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Time	.937	1.294	2	.524	.941	1.000	.500

Table 9. Test statistics.[a]

N	22
Chi-Square	10.051
df	2
Asymp. Sig.	.007

a. Friedman Test

Because the assumption of residual normality was not fully met, especially in the cycle II data, the hypothesis testing of student learning outcomes was conducted using the Friedman test as a nonparametric alternative test. The Friedman test is a nonparametric statistical test used to determine differences in medians across three or more repeated measurements from the same subjects, without requiring normally distributed data. The Friedman test results showed a value of X^2 (2) = 10,051, with a significance of *p* = 0,007, indicating that there were significant differences in student learning outcomes between the pre-cycle, cycle I, and cycle II.

Table 10. Tests of within-subjects effect.

Measure: Learning_Outcomes

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Time	Sphericity Assumed	2748.485	2	1374.242	4.378	.019	.172
	Greenhouse-Geisser	2748.485	1.882	1460.310	4.378	.021	.172
	Huynh-Feldt	2748.485	2.000	1374.242	4.378	.019	.172
	Lower-bound	2748.485	1.000	2748.485	4.378	.049	.172
Error (Time)	Sphericity Assumed	13184.848	42	313.925			
	Greenhouse-Geisser	13184.848	39.525	333.586			
	Huynh-Feldt	13184.848	42.000	313.925			
	Lower-bound	13184.848	21.000	627.850			

The calculation of effect size using the partial eta squared (η^2) value resulted in a value of 0.172, which falls into the large category. This result is also supported by repeated measures ANOVA analysis with Greenhouse-Geisser correction, which showed differences in the mean student learning outcomes at different measurement times with an F value of (1.882, 39.525) = 4.378, and a significance of p = 0.021.

Since this test involves three measurement times, namely pre-cycle, learning outcomes of cycle 1, and learning outcomes of cycle II, a further analysis (post hoc) was conducted to determine the differences between each measurement time. The follow-up test was conducted using the LSD test with Bonferroni correction to control for Type I errors due to repeated comparisons.

Table 11. Pairwise comparisons.

Measure: Learning_Outcomes

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	-11.818	5.038	.087	-24.924	1.288
	3	-15.000*	4.957	.019	-27.894	-2.106
2	1	11.818	5.038	.087	-1.288	24.924
	3	-3.182	5.972	1.000	-18.717	12.354
3	1	15.000*	4.957	.019	2.106	27.894
	2	3.182	5.972	1.000	-12.354	18.717

Table 12. Descriptive statistics of student learning outcomes in each lesson.

Learning Outcomes	Mean (*M*)	Median (*Mdn*)	*SD*	Notation
Pre-Cycle Learning Outcomes	55.45	55.00	15.95	a
Cycle 1 Learning Outcomes	67.27	70.00	24.14	ab
Cycle II Learning Outcomes	70.45	75.00	17.31	b

Further tests using the Bonferroni correction showed that the average student learning during the pre-cycle (M = 55.45, SD = 15.95) was lower compared to Cycle I (M = 67.27, SD = 24.14) and Cycle II (M = 70.45, SD = 17.31). This increase resulted in a significant difference (P = 0.007). Therefore, it can be concluded that the implementation of Game-Based Learning is able to gradually improve student learning outcomes from the pre-cycle to Cycle II.

The increase in student engagement and learning outcomes is inseparable from the role of Kahoot as a supporting tool in the implementation of Game-Based Learning. Kahoot provides learning activities in the form of engaging and competitive interactive quizzes, which can enhance students' attention and focus during lessons. Through the use of Kahoot, students are more encouraged to actively participate, whether in answering questions, discussing, or giving immediate responses. This situation creates a more enjoyable and interactive learning atmosphere, which ultimately has a positive impact on learning engagement and students' understanding of concepts.

4. Conclusion

The implementation of the Game-Based Learning (GBL) approach assisted by Kahoot media in physics learning on the topic of matter and its changes has shown effectiveness in increasing the activity and learning outcomes of seventh-grade students at SMP Adhyaksa 1 Jambi. Student learning activity experienced continuous improvement from cycle I to cycle II across all activity indicators, including visual activities, oral activities, listening activities, writing activities, and mental activities. Analysis using a paired t-test showed a significant difference between student learning activity before and after the implementation of GBL. The Cohen's d effect size, which falls into the very large category, indicates that the influence of GBL implementation on increasing student learning activity is considered very strong. In line with the increase in learning engagement, students' cognitive learning outcomes also gradually improved from the pre-cycle to Cycle II. The results of the Friedman test showed significant differences in learning outcomes across the three measurement times, supported by a partial eta squared effect size in the large category. These findings confirm that game-based learning can enhance student engagement while strengthening the understanding of physics concepts. Thus, Kahoot-assisted Game-Based Learning can be considered as one of the alternative innovative learning strategies that align with students' characteristics and the demands of implementing the Merdeka Curriculum.

References

[1] Zahara L, Suastra I W, Atmaja A W T and Tika I N 2024 Perspektif Filsafat Pendidikan Dalam Mengembangkan Pemahaman Konsep Fisika *CONSILIUM Journal : Journal Education and Counseling* **5** 257–67

[2] Purwana I G and Saputra E 2025 Efektivitas Pembelajaran Fisika Berorientasi Guided Inquiry Berbantuan PhET Simulasi Terhadap Pengembangan Keterampilan Proses Sains Siswa *Jurnal Pendidikan dan Pembelajaran* **17**
[3] Mawarni S A, Supeno S, Nuha U and Iqbal M 2023 Kajian Fisika Dan Pembelajarannya Pada Proses Pembangunan Rumah *ORBITA: Jurnal Pendidikan dan Ilmu Fisika* **9** 64
[4] Firdausi R N and Suchayo I 2021 Pengembangan LKPD Berbasis Kontekstual dalam Pembelajaran Fisika SMA Pada Materi Elastisitas Bahan *PENDIPA Journal of Science Education* **5** 351–8
[5] Isnaini1 R A, Rahmawati R, Ramadani N O, Martiza S, Saputri Z and Efendi D 2026 Analisis Aktivitas Belajar Siswa pada Pembelajaran Matematika *Aljabar : Jurnal Ilmuan Pendidikan, Matematika dan Kebumian* **2** 01–22
[6] Nyoman N and Armini S 2025 Inovasi Pembelajaran IPA Melalui Game Based Learning Bagi Siswa Sekolah Dasar *INTELEKTUAL: Jurnal Ilmiah Multidisiplin Mahasiswa Dan Akademisi* **1** 1–10
[7] Agusti N M and Aslam 2022 Efektivitas Media Pembelajaran Aplikasi Wordwall Terhadap Hasil Belajar IPA Siswa Sekolah Dasar *JURNAL BASICEDU* **6** 5794–800
[8] Kurniawan I G W A 2024 Fostering independent learners: Kurikulum Merdeka, Merdeka Belajar, the student-centred learning approach and pedagogical reform *Journal of Language, Literature, Social and Cultural Studies* **1** 210–7
[9] Kementerian Pendidikan, Kebudayaan, Riset dan T R I 2025 *Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 13 Tahun 2025 tentang Kurikulum pada Jenjang Pendidikan Dasar dan Menengah*
[10] Huda Y K, Faizah B, Islam A and Asy F 2025 Implementasi Pembelajaran Kooperatif Learning Together Sebagai Upaya Meningkatkan Pemahaman Siswa Kelas V Madrasah Ibtidaiyah Pada Materi Huruf Kapital *QuranicEdu: Journal of Islamic Education* **5** 380–401
[11] Rambe A H, Parapat H F, Hadinata R, Islam U, Sumatera N, Pura T and Medan U N 2024 Pemanfaatan Media Berbasis Game dalam Meningkatkan Aktivitas Siswa pada Pembelajaran Sekolah Dasar *ELSE (Elementary School Education Journal)* **8** 11–2
[12] Gunawan R, Billah M Z, Silalahi R and Tuka H 2024 Gaya Belajar Gen Alpha di Era Digital *Dewantara: Jurnal Pendidikan Sosial Humaniora* **3** 277–97
[13] Puspitasari D A, Ramadhan M R, Malik M, Malang I, Maulana U I N and Ibrahim M 2025 Strategi Penanaman Pendidikan Karakter Generasi Alpha Perspektif Pendidikan Islam dan Psikologi **10** 86–104
[14] Kartika A Y, Pratikno A S and Madura T 2025 Analisis Metode Game-Based Learning Dalam Matematika Kelas IV di SDN Tanjung Jati 2 Bangkalan *Journal of science, education and studies* **4** 86–94
[15] Alfarisi M, Widiono A and Andriyansah 2025 Implementasi Model Game-Based Learning Dalam Pembelajaran IPA Untuk Meningkatkan Keaktifan Siswa SD Muhamad *Firnas* **6** 8–19
[16] Adhinda Mutiara Janah 2025 Penerapan Model Game Based Learning Berbantuan Media Board Game Untuk Meningkatkan Keaktifan Belajar Peserta Didik Pada Mata Pelajaran Ekonomi Kelas XI.10 di SMA N 1 Baturetno *Jurnal Pengabdian Masyarakat dan Riset Pendidikan* **3** 3081–90
[17] Dewanti V and Radyuli P 2025 Pemanfaatan Media Canva dan Kahoot Dengan Model Game Based Learning Untuk Meningkatkan Minat Belajar Siswa Pada Mata Pelajaran Informatika Fase E4 di SMA N 12 Padang *Culture education and technology research (Cetera)* **2** 1–7
[18] Hadijah S, Azis A and Afifah N 2025 Pemanfaatan Aplikasi Kahoot Sebagai Media Pembelajaran Pada Mata Pelajaran SKI di MA Darul Ulum Palangka Raya *Inovasi : Jurnal Sosial Humaniora dan Pendidikan* **4** 555–67
[19] Wirda Y, Ulumudin I, Widiputera F, Listiawati N and Fujianita S 2020 *Faktor-Faktor Determinan Hasil Belajar Siswa Pusat* (Pusat Penelitian Kebijakan, Badan Penelitian dan Pengembangan dan Perbukuan, Kementerian Pendidikan dan Kebudayaan)

[20] Pasaribu V S 2024 Efektivitas Penggunaan Media Pembelajaran Digital Dalam Mendukung Pemahaman Konsep Fisika Pada Siswa SMP IT Bunayya Padangsidimpuan *Jurnal Pendidikan Inovatif* **6** 133–51

[21] Farizi Z Al, Rusdin M E and Fitriani N 2024 Transformation of Physics Learning : The Use of Powtoon Animation and VAK Model to Enhance Learning Motivation Viewed from Students ' Inductive Reasoning Ability *Jurnal Penelitian Pembelajaran Fisika* **15** 288–93

[22] Sa'adah, Nurfahmi A, Prahara T S, Salsabila V V and Yemima C K 2025 Penggunaan Media dan Teknologi Dalam Pembelajaran IPA Bagi Siswa Dengan Disabilitas : Systematic Literature Review *Jurnal Rekayasa Lampung (JRL)* **4**

[23] Alwanda M A 2025 Efektivitas Media Pembelajaran Interaktif dalam Meningkatkan Literasi Sains Siswa Sekolah Dasar : Systematic Literature Review (2020 – 2025) *Advances In Education Journal* **2** 797–811

[24] Kemmis S, McTaggart R and Nixon R 2014 *The Action Research Planner. Doing Critical Participatory Action Research* (Springer Science+Business Media)

[25] Patmawati M 2023 Meningkatkan Keaktifan Belajar pada Pelajaran Biologi Menggunakan Model Problem Based Learning disertai Media Video *Ideguru: Jurnal Karya Ilmiah Guru* **8** 569–76

[26] Inayah S, Safitri Y, Andriani N, Anindita M, Mardhotillah B, Multahadah C and Karmanto B 2025 *STATISTIKA NON*

[27] Khairunnisa, Sari F F, Anggelena M, Agustika D and Nursa'adah E 2022 Penggunaan Effect Size Sebagai Mediasi Dalam Koreksi Efek Suatu Penelitian *Jurnal Pendidikan Matematika: Judika Education* **5** 138–51