JPPIPA 11(4) (2025)

Jurnal Penelitian Pendidikan IPA

http://jppipa.unram.ac.id/index.php/jppipa/index

Transformation of Science Learning with Android Applications: Improving Learning Outcomes and Student Activity Through "Marbel Sains SD 4-5"

Ponco Nur Hidayah[1*], Waris[1], Rina Sugiarti Dwi Gita[1]

[1]Departement of Educational Technology, Postgraduate, Universitas PGRI Argopuro Jember, Jember, Indonesia.

Received: December 12, 2024
Revised: February 07, 2025
Accepted: April 25, 2025
Published: April 30, 2025

Corresponding Author:
Ponco Nur Hidayah
ponconurh@gmail.com

DOI: 10.29303/jppipa.v11i4.10613

Abstract: This study evaluated how well the Android-based learning application "Marbel Sains SD 4-5" helps elementary school students learn science better. The study used a quasi-experimental design with a non-equivalent control group, involving 178 students selected from a pool of 3,650 students in 33 schools. Participants were divided into high-achieving and low-achieving groups, with each having a control group (conventional learning) and an intervention group (Marbel Sains), totaling 44 students in each group. The data collection tool consisted of a HOTS C4-level questionnaire designed to assess learning outcomes, along with an observation sheet rooted in the active learning model to evaluate student engagement. Due to the non-normal distribution of the data, the Friedman test for repeated measures and the Kruskal-Wallis test for group comparisons were used for analysis. The "Marbel Sains" application significantly improved learning activities and outcomes compared to the conventional method, highlighting its effectiveness as an interactive learning tool.

Keywords: Elementary school; Interactive learning; Learning activity; Learning outcomes; Marbel sains SD 4-5

Introduction

Indonesia's education sector is adopting Android-based learning media in schools, particularly following the Covid-19 pandemic. However, its implementation is not evenly distributed and still faces various challenges (Subroto et al., 2023). Android-based learning media are commonly used in urban schools in Indonesia, with applications like Ruangguru, Zenius, and Quipper. Several schools with good facilities have adopted an Android-based Learning Management System (LMS) for online learning (Verawati et al., 2023). On the other hand, schools in the regions, including remote or underprivileged areas, have not yet implemented technology-based learning. This is caused by poor infrastructure, untrained teachers, high usage costs, and other challenges (Widjayanti et al., 2024). Observations in several elementary schools in Umbulsari District, Jember Regency, reveal that many teachers still rely on dull teaching methods and materials. Educators often depend primarily on traditional lecture techniques and board writing in their teaching approach, occasionally incorporating question-and-answer sessions to enhance interaction. Teachers hesitate to use different learning media mainly due to incomplete facilities and infrastructure in schools. Teachers acknowledged they are not yet familiar with using technology in learning.

While Umbulsari District is recognized for its internet-friendly environment, essential facilities like projectors and LCD screens remain inaccessible due to their high costs. Education is a vital foundational need, profoundly influencing both individuals and society (Kusumawati et al., 2023). Education is important because it enhances cognitive skills, improves quality of

How to Cite:
Hidayah, P. N., Waris, & Gita, R. S. D. Transformation of Science Learning with Android Applications: Improving Learning Outcomes and Student Activity Through "Marbel Sains SD 4-5". *Jurnal Penelitian Pendidikan IPA*, *11*(4), 459-466. https://doi.org/10.29303/jppipa.v11i4.10613

life, reduces poverty and inequality, fosters societal progress, and helps create responsible citizens (Suyatno, 2023). The fourth paragraph of the 1945 Constitution states that education is a human right that every child should have access to freely (Marinda et al., 2023). The Ministry of Education, Culture, Research, and Technology states that quality education involves a relevant curriculum, qualified teachers, effective teaching methods, proper facilities, a supportive learning environment, ongoing assessments, and active parental and community involvement (Kemendikbudristek RI, 2021). In the digital age, most information and learning materials are accessible through social media and Android apps (Aeni et al., 2022). The Ministry of Education, Culture, Research, and Technology advises using accessible technology in all learning processes (Isaeni & Nugraha, 2022). Using technology in education enhances learning by making it more interactive and engaging, while also increasing access to resources (Lestari & Kurnia, 2023). Technology serves as a powerful learning medium that enhances the educational experience within the classroom (Husein, 2022).

Android-based learning media refers to software or apps for Android devices like smartphones and tablets, aimed at enhancing the learning process (Hingide et al., 2021). "Marbel Sains SD 4-5" is an Android app that helps elementary school students learn natural science interactively and enjoyably (Barokah et al., 2023). This app is part of the "Marbel" educational series from Educa Studio, which focuses on creating educational apps for children. This application offers science materials for elementary school students in grades 4-5, covering topics like the universe, energy, ecosystems, and natural phenomena. "Marbel Sains SD 4-5" is designed to maintain student interest interactively, featuring interesting animations, images, and interactions. Furthermore, this application offers a range of engaging educational games that make learning science enjoyable and inspire students to embrace a more interactive approach to their studies. Interactive quizzes help students assess their understanding of the material, while a reward system adds motivation for learning science.

The "Marbel Science SD 4-5" app can serve as an effective learning tool to enhance science education (Barokah et al., 2023). This application enhances learning by using various media, like visual demos, simulations, and interactive quizzes, making it more dynamic and enjoyable. This application can also be used outside of class hours, providing flexibility for independent learning or additional assignments. Students can access materials anytime and anywhere according to their own needs and learning pace.

Android learning apps like "Marbel Science SD 4-5" can effectively enhance elementary students' understanding of science concepts (Barokah et al., 2023). The integration of animation and educational games significantly enhances the learning process, making complex scientific concepts more accessible and easier to grasp. This app offers practice questions and quizzes to help students prepare for exams and assignments (Yasin et al., 2023). Using Android-based learning media enhances learning outcomes, boosts student engagement and motivation, improves technology skills, facilitates easy access, and encourages collaboration and communication, along with better assessment and feedback. "Marbel Science SD 4-5" can be an effective tool for teachers in the learning process (Barokah et al., 2023). This application provides teachers with a visually engaging way to deliver learning materials, making lessons more dynamic and actively involving students. This application supports different learning methods like flipped classrooms and project-based learning, and includes a quiz feature for teachers to track each student's progress.

With its numerous advantages, the "Marbel Science SD 4-5" application can serve as a powerful tool to enhance the science learning experience in elementary schools. Learning outcomes are the results achieved by students after receiving instruction over a certain period of time (Sundari, 2023). Learning outcomes are often used as a reference in assessing the success of learning (Nawangsari et al., 2022). The factors that shape student learning outcomes can be effectively understood through the lens of Bloom's taxonomy, which highlights the significance of students' prior knowledge and their motivation to learn. A conducive learning environment, practical skills, constructive feedback, analytical skills, and student creativity also play an important role. Collaboration with peers and reflection skills in evaluating information further improve learning outcomes. In addition, the learning method used is also a factor that is no less important in influencing student learning outcomes.

So, it is important for teachers to design more effective learning activities to improve students' mastery of the material. Using the Android-based learning app "Marbel Science SD 4-5" can boost student activity during lessons. Activeness is a state where students can think critically, act, and solve problems (Gustiansyah et al., 2020). Student learning activeness is behavior or activity that occurs in themselves during the learning process (Busa, 2023). Activeness can be demonstrated through participation in assignments, problem-solving, seeking help from friends or teachers, engaging in group discussions, and presenting work results (Hasanah & Himami, 2021). Learning activeness is influenced by

stimuli, attention, motivation, learned responses, reinforcement, and the application and transfer of knowledge (Hasanah & Himami, 2021). So far, the learning outcomes and activeness of students in elementary schools, especially in science subjects, still show many shortcomings. Research by Nawangsari et al. (2022) indicates that student learning outcomes in the Umbulsari sub-district are low and below the minimum completion standards. The Android-based learning app "Marbel Science SD 4-5" aims to enhance student learning outcomes and engagement by providing features that promote interaction and participation in the learning process.

Method

This study employed a quasi-experimental design featuring a non-equivalent control group to evaluate the impact of the "Marbel Sains SD 4-5" learning application on elementary school students' engagement and academic performance. The study included 33 elementary schools with 3,650 students. Using G- Power 3.1.9.7, the sample size was set at 178 students, divided into four groups: high and low-achievement groups, each with a control group (conventional learning) and an intervention group (using "Marbel Sains SD 4-5"), totaling 44 students per group. The purposive sampling technique was used to select samples that were relevant to the research objectives. Data was collected through questionnaires based on the RPP and question grids for assessing learning outcomes at the HOTS C4 level. Student engagement was assessed with a validated observation sheet based on the active learning model. The analysis used the Friedman test for repeated measurements and the Kruskal-Wallis test for group differences since the data did not follow a normal distribution. This approach allowed for a comprehensive assessment of the effectiveness of each learning method on student learning outcomes and engagement.

This research uses the Quasi Experiment type. According to Indra (2021), experimental research is a study that identifies the causal relationship between independent variables and dependent variables, where the independent variable is controlled in such a way that the effect caused to the dependent variable can be known. The independent variables in this study are based learning application "Marbel Sains SD 4-5, while the dependent variables are motivation and learning achievement. The following is the experimental design that the researcher used.

Table 1. Nonequivalent pretest-posttest control group design

Group	Pretest	Treatment	Posttest
Experiment	O_1	X	O_2
Control	O_1	-	O_2

Source: (Indra, 2021)

Result and Discussion

Result

Table 2. Friedman test result

Sessions	Variable							
	High Achievement Group				Low Achievement Group			
	Learning Activity		Learning Outcome		Learning Activity		Learning Outcome	
	Marbel Sains	Conventional	Marbel Sains	Conventional	Marbel Sains	Conventional	Marbel Sains	Conventional
	Average rank		Average rank		Average rank		Average rank	
Pretest	1.05	5.66	1.09	5.75	1.03	5.50	1.06	5.34
Day 1	2.06	5.68	2.01	5.86	2.03	5.63	2.05	5.47
Day 2	2.98	5.55	2.97	4.77	3.01	5.80	2.99	4.83
Day 3	3.95	5.35	4.06	5.36	4.02	5.52	3.97	5.70
Day 4	5.00	5.64	5.02	5.39	4.94	5.35	5.05	4.93
Day 5	6.05	5.66	5.93	5.66	6.05	4.83	6.05	5.80
Day 6	6.93	5.15	7.02	5.28	6.99	5.91	6.95	6.25
Day 7	8.06	5.50	7.95	5.98	8.00	6.07	8.01	6.20
Day 8	8.99	5.49	9.01	5.47	8.97	5.65	9.01	5.09
Day 9	9.94	5.33	9.93	5.47	9.95	4.75	9.98	5.39
Chi-square	393.632	1.356	392.045	5.189	393.033	7.986	391.783	10.565
Df	9	9	9	9	9	9	9	9
P-value	0.000	0.998	0.000	0.818	0.000	0.536	0.000	0.307

The analysis indicates that the average rank of activity and learning outcomes in the high-achieving group using science marble increases from the first meeting to the ninth meeting, with chi-square test results of 393.632 and 392.045, respectively, and a p-value of 0.00, indicating a significant difference in learning activity levels between meetings. The low-achieving group also shows a significant increase in activity mean rank when using science marbles.

Table 3. Post Hoc test in high achieving group

	Learning Activity						Learning Outcomes				
Meeting-meeting	Test Statistic	Std. Error	Standard Test Statistic	Sig	Adj. Sig	Meeting-meeting	Test Statistic	Std. Error	Standard Test Statistic	Sig	Adj. Sig
Pretest-3	-2.909	0.645	-4.507	0.000	0.000	Pretest-3	-2.966	0.645	-4.595	0.000	0.000
Pretest-4	-3.955	0.645	-6.126	0.000	0.000	Pretest-4	-3.932	0.645	-6.091	0.000	0.000
Pretest-5	-5.000	0.645	-7.746	0.000	0.000	Pretest-5	-4.841	0.645	-7.500	0.000	0.000
Pretest-6	-5.886	0.645	-9.119	0.000	0.000	Pretest-6	-5.932	0.645	-9.190	0.000	0.000
Pretest-7	-7.011	0.645	-10.862	0.000	0.000	Pretest-7	-6.864	0.645	-10.633	0.000	0.000
Pretest-8	-7.943	0.645	-12.306	0.000	0.000	Pretest-8	-7.920	0.645	-12.270	0.000	0.000
Pretest-9	-8.898	0.645	-13.784	0.000	0.000	Pretest-9	-8.841	0.645	-13.696	0.000	0.000
1-4	-2.943	0.645	-4.560	0.000	0.000	1-4	-3.011	0.645	-4.665	0.000	0.000
1-5	-3.989	0.645	-6.179	0.000	0.000	1-5	-3.920	0.645	-6.074	0.000	0.000
1-6	-4.875	0.645	-7.552	0.000	0.000	1-6	-5.011	0.645	-7.764	0.000	0.000
1-7	-6.000	0.645	-9.295	0.000	0.000	1-7	-5.943	0.645	-9.207	0.000	0.000
1-8	-6.932	0.645	-10.739	0.000	0.000	1-8	-7.000	0.645	-10.844	0.000	0.000
1-9	-7.886	0.645	-12.218	0.000	0.000	1-9	-7.920	0.645	-12.270	0.000	0.000
2-5	-3.068	0.645	-4.753	0.000	0.000	2-5	-2.966	0.645	-4.595	0.000	0.000
2-6	-3.955	0.645	-6.126	0.000	0.000	2-6	-4.057	0.645	-6.285	0.000	0.000
2-7	-5.080	0.645	-7.869	0.000	0.000	2-7	-4.989	0.645	-73728	0.000	0.000
2-8	-6.011	0.645	-9.313	0.000	0.000	2-8	-6.045	0.645	-9.366	0.000	0.000
2-9	-6.966	0.645	-10.792	0.000	0.000	2-9	-6.966	0.645	-10.792	0.000	0.000
3-6	-2.977	0.645	-4.162	0.000	0.000	3-6	-2.966	0.645	-4.595	0.000	0.000
3-7	-4.102	0.645	-6.355	0.000	0.000	3-7	-3.898	0.645	-6.038	0.000	0.000
3-8	-5.034	0.645	-7.799	0.000	0.000	3-8	-4.955	0.645	-7.676	0.000	0.000
3-9	-5.989	0.645	-9.278	0.000	0.000	3-9	-5.875	0.645	-9.102	0.000	0.000
4-7	-3.057	0.645	-4.736	0.000	0.000	4-7	-2.932	0.645	-4.542	0.000	0.000
4-8	-3.989	0.645	-6.179	0.000	0.000	4-8	-3.989	0.645	-6.179	0.000	0.000
4-9	-4.943	0.645	-7.658	0.000	0.000	4-9	-4.909	0.645	-7.605	0.000	0.000
5-8	-2.943	0.645	-4.560	0.000	0.000	5-8	-3.080	0.645	-4.771	0.000	0.000
5-9	-3.898	0.645	-6.038	0.000	0.000	5-9	-4.000	0.645	-6.197	0.000	0.000
6-9	-3.011	0.645	-4.665	0.000	0.000	6-9	-2.909	0.645	-4.507	0.000	0.000

Table 4. Post Hoc test in low achieving group

	Learning Activity						Learning outcomes				
Meeting-meeting	Test Statistic	Std. Error	Standard Test Statistic	Sig	Adj. Sig	Meeting-meeting	Test Statistic	Std. Error	Standard Test Statistic	Sig	Adj. Sig
Pretest-3	-2.989	0.645	-4.630	0.000	0.000	Pretest-3	-2.909	0.645	-4.507	0.000	0.000
Pretest-4	-3.909	0.645	-6.056	0.000	0.000	Pretest-4	-3.989	0.645	-6.179	0.000	0.000
Pretest-5	-5.011	0.645	-7.764	0.000	0.000	Pretest-5	-4.989	0.645	-7.728	0.000	0.000
Pretest-6	-5.955	0.645	-9.225	0.000	0.000	Pretest-6	-5.989	0.645	-9.137	0.000	0.000
Pretest-7	-6.966	0.645	-10.792	0.000	0.000	Pretest-7	-6.955	0.645	-10.774	0.000	0.000
Pretest-8	-7.932	0.645	-12.288	0.000	0.000	Pretest-8	-7.955	0.645	-12.323	0.000	0.000
Pretest-9	-8.920	0.645	-13.820	0.000	0.000	Pretest-9	-8.818	0.645	-13.661	0.000	0.000
1-4	-2.909	0.645	-4.507	0.000	0.000	1-4	-3.000	0.645	-4.648	0.000	0.000
1-5	-4.011	0.645	-6.214	0.000	0.000	1-5	-4.000	0.645	-6.197	0.000	0.000
1-6	-4.955	0.645	-7.676	0.000	0.000	1-6	-4.909	0.645	-7.605	0.000	0.000
1-7	-5.966	0.645	-9.242	0.000	0.000	1-7	-5.966	0.645	-9.242	0.000	0.000
1-8	-6.932	0.645	-10.739	0.000	0.000	1-8	-6.966	0.645	-10.792	0.000	0.000
1-9	-7.920	0.645	-12.270	0.000	0.000	1-9	-7.830	0.645	-12.129	0.000	0.000
2-5	-3.034	0.645	-4.700	0.000	0.000	2-5	-3.057	0.645	-4.736	0.000	0.000

Learning Activity						Learning outcomes					
Meeting-meeting	Test Statistic	Std. Error	Standard Test Statistic	Sig	Adj. Sig	Meeting-meeting	Test Statistic	Std. Error	Standard Test Statistic	Sig	Adj. Sig
2-6	-3.977	0.645	-6.162	0.000	0.000	2-6	-3.966	0.645	-6.144	0.000	0.000
2-7	-4.989	0.645	-7.728	0.000	0.000	2-7	-5.023	0.645	-7.781	0.000	0.000
2-8	-5.955	0.645	-9.225	0.000	0.000	2-8	-6.023	0.645	-9.330	0.000	0.000
2-9	-6.643	0.645	-10.756	0.000	0.000	2-9	-6.886	0.645	-10.668	0.000	0.000
3-6	-2.966	0.645	-4.595	0.000	0.000	3-6	-2.989	0.645	-4.630	0.000	0.000
3-7	-3.977	0.645	-6.162	0.000	0.000	3-7	-4.045	0.645	-6.267	0.000	0.000
3-8	-4.943	0.645	-7.658	0.000	0.000	3-8	-5.045	0.645	-7.816	0.000	0.000
3-9	-5.932	0.645	-9.190	0.000	0.000	3-9	-5.909	0.645	-9.154	0.000	0.000
4-7	-3.057	0.645	-4.736	0.000	0.000	4-7	-2.966	0.645	-4.595	0.000	0.000
4-8	-4.023	0.645	-6.232	0.000	0.000	4-8	-3.966	0.645	-6.144	0.000	0.000
4-9	-5.011	0.645	-7.764	0.000	0.000	4-9	-4.830	0.645	-7.482	0.000	0.000
5-8	-2.920	0.645	-4.524	0.000	0.000	5-8	-2.966	0.645	-4.595	0.000	0.000
5-9	-3.909	0.645	-6.056	0.000	0.000	5-9	-3.830	0.645	-5.933	0.000	0.000
6-9	-2.966	0.645	-4.595	0.000	0.000	6-9	-2.920	0.645	-4.524	0.000	0.000

The post hoc test results in Table 3 and 4 showed significant differences between meetings, particularly between the pretest and the next session, highlighting a gradual improvement in learning activity and outcomes. All significant values at p 0.05 indicate that each meeting led to meaningful changes, particularly in the group using the Android-based Marbel Science learning media.

Table 5. Kruskal-Wallis test result

Meeting	Learning Activity			Learning Outcomes		
	Chi-square	Df	Asymp. sig	Chi-square	Df	Asymp. sig
Pretest	102.194	3	0.000	82.439	3	0.000
Day 1	98.363	3	0.000	82.942	3	0.000
Day 2	95.885	3	0.000	82.765	3	0.000
Day 3	99.613	3	0.000	84.626	3	0.000
Day 4	123.003	3	0.000	109.379	3	0.000
Day 5	130.460	3	0.000	117.117	3	0.000
Day 6	134.468	3	0.000	122.165	3	0.000
Day 7	137.595	3	0.000	136.354	3	0.000
Day 8	140.191	3	0.000	141.251	3	0.000
Day 9	141.411	3	0.000	139.337	3	0.000

The test indicates a notable difference in activity and learning outcomes between the "Marbel Sains SD 4-5" group and the standard learning group, as evidenced by significant chi-square values in each session. The use of the Android-based learning app "Marbel Sains Sd 4-5" consistently boosts student activity and learning results compared to traditional methods.

Discussion

The study found that the Android-based learning tool "Marbel Science 4-5 SD" significantly boosts student activity and performance, regardless of achievement level, with a p-value of 0.000. This study's key scientific discovery reveals that exploration-based learning tools, like "Marbel Science 4-5 SD," can substantially enhance student engagement in the learning process. "Marbel Science 4-5 SD" creates an interactive learning environment where students can experiment directly with materials, following the constructivist principle that knowledge is formed through active engagement with the surroundings (Piaget, 1970). The rise in activity is due to the engaging nature of learning, which stimulates student participation (Sharma et al., 2020). Engagement theory suggests that students become more involved in learning when they find the material relevant and have the freedom to explore (Kearsley & Shneiderman, 1998). "Marbel Sains 4-5 SD" offers an engaging experience that sparks curiosity and encourages students to participate more than traditional teacher-centered methods. The drive to boost student engagement in exploratory learning can be understood through intrinsic motivation theory (Deci & Ryan, 1985). Students are more motivated when they see meaning and relevance in what they're learning and can explore the material freely. Technology-based interactive learning media, like "Marbel Sains 4-5 SD," offers a distinctive and engaging experience that significantly boosts students' intrinsic motivation (Mustaqim &

Mahamad, 2023). This motivation stems from students' natural curiosity to solve problems and understand concepts, leading to increased engagement in learning (Wijnia & Baars, 2021). Leitão et al. (2022) found that educational games can effectively maintain student motivation and engagement. This study supports the idea that exploration-based learning is important for keeping students motivated throughout different learning sessions.

In addition to enhanced engagement, research reveals that learning outcomes significantly improve for student groups utilizing Android-based educational tools, such as "Marbel Science 4-5 SD." This happens because this learning media allows students to apply science concepts directly and strengthen their understanding. According to Bloom's taxonomy, students can develop analytical, application, and evaluation skills by connecting theory to real-world practice (Mahmudi et al., 2022). This aligns with the theory of contextual learning, which suggests that students grasp concepts better when they are taught through real-life applications. "Marbel Science 4-5 SD" helps students better understand and retain concepts compared to traditional learning (Baker & Ziegler, 2012).

The trend of gradual improvement in learning outcomes at each meeting reflects the long-term effects of practical application-based learning. This increase indicates that each meeting enhances students' understanding rather than just repeating material, aligning with the concept of spiral learning that focuses on gradual understanding development. This trend supports the theory of learning transfer, as students engaged in challenging activities can better connect new knowledge with their past learning experiences (Sheldon et al., 2023). Students familiar with exploratory methods like "Marbel Science 4-5 SD" will be better equipped to apply new concepts to complex situations in the future.

A comparison with related research, particularly the study conducted by Kartini (2021), demonstrates that interactive media has a substantial impact on enhancing student learning outcomes. Students who learn through interactive methods achieve higher learning outcomes on tests compared to conventional methods (Goode et al., 2022). Other studies using interactive methods like simulations or problem-based projects demonstrate that experiential approaches are generally effective for science learning (Holieva, 2022; Novitasari & Subekti, 2024). Comparing this study's results with others highlights the unique contribution of "Marbel Sains 4-5 SD," showcasing the benefits of an exploration-based approach to science learning that enhances student engagement and improves learning outcomes. The study shows that interactive methods like "Marbel Sains 4-5 SD" enhance student engagement and learning results. These findings support the importance of student-centered and experience-based teaching to optimize the learning process. The results suggest that similar methods could be used in other schools to enhance learning, particularly in subjects like science that demand a deep understanding of concepts.

Conclusion

The findings of this research demonstrate that utilizing the Android-based learning application "Marbel Sains SD 4-5" markedly enhances student engagement and academic performance in science subjects. Interactive media provides students with active learning experiences that promote exploration and critical thinking, aligning with constructivist principles. Chi-square test results of 393.632 and 392.045, respectively, and a p-value of 0.00, indicating a significant difference in learning activity levels between meetings These findings indicate that digital learning tools have a beneficial impact on students. Digital learning tools have a positive impact on student achievement, particularly in improving cognitive skills, student participation, and intrinsic motivation to learn.

Acknowledgments
All author would like to thank to all parties who has supported this research.

Author Contributions
P.N.H.: conceptualized the research, research procedures, analyzed the data and wrote the article; W. and R.S.D.G.: supervised the writing of the article, reviewed and validated the research instruments used.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

Reference

Aeni, A. N., Fachrina, A. Z., Nursyafitri, A. A., & Putri, T. A. (2022). Pengembangan Website Carrd sebagai Sarana Dakwah untuk Meningkatkan Akhlakul Karimah bagi Siswa SMP Kelas VIII. *Al-Tsiqoh: Jurnal Ekonomi dan Dakwah Islam*, *7*(1), 1–17. https://doi.org/10.31538/altsiq.v7i1.2208

Baker, D. J., & Ziegler, M. M. (2012). *Contextual Teaching and Learning: Empowering Students to Connect Concepts to Real World Situations*. SAGE Publisher.

Barokah, A., Fitriyani, F., Sriastuti, S. D., & Irsyad, M. (2023). The Influence of Marble Science'S Audio-Visual Media: Human Anatomy on Elementary

School Students' Learning Interest. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *12*(1), 126. https://doi.org/10.33578/jpfkip.v12i1.9339

Busa, E. N. (2023). Faktor yang Mempengaruhi Kurangnya Keaktifan Peserta Didik dalam Kegiatan Pembelajaran di Kelas. *Inovasi*, *2*(2). Retrieved from https://ejurnal.stie-trianandra.ac.id/index.php/inovasi/article/view/764

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. Plenum Press.

Goode, E., Nieuwoudt, J. E., & Roche, T. (2022). Does Online Engagement Matter? The Impact of Interactive Learning Modules and Synchronous Class Attendance on Student Achievement in an Immersive Delivery Model. *Australasian Journal of Educational Technology*, *38*(4), 76–94. https://doi.org/10.14742/ajet.7929

Gustiansyah, K., Sholihah, N. M., & Sobri, W. (2020). Pentingnya Penyusunan RPP untuk Meningkatkan Keaktifan Siswa dalam Belajar Mengajar di Kelas. *Darotuna: Jurnal of Administrative Science*, *1*(2), 81–94. https://doi.org/10.54471/idarotuna.v1i2.10

Hasanah, Z., & Himami, A. S. (2021). Model Pembelajaran Kooperatif dalam Menumbuhkan Keaktifan Belajar Siswa. *Irsyaduna: Jurnal Studi Kemahasiswaan*, *1*(1), 1–13. https://doi.org/10.54437/irsyaduna.v1i1.236

Hingide, M. N., Mewengkang, A., & Munaiseche, C. P. C. (2021). Pengembangan Media Pembelajaran Berbasis Multimedia Interaktif Platform Android pada Mata Pelajaran PPKN SMK. *EduTIK: Jurnal Pendidikan Teknologi Informasi dan Komunikasi*, *1*(5), 557-566. http://dx.doi.org/10.53682/edutik.v1i5.2922

Holieva, M. (2022). Project Approach to Learning: Experience in Different Countries. *Scientific Journal of Polonia University*, *53*(4), 26-34. https://doi.org/10.23856/5303

Husein, W. M. (2022). Upaya Guru dalam Meningkatkan Kualitas Pembelajaran Melalui Penerapan Teknologi Informasi di MI Miftahul Ulum Bago Pasirian. *Jurnal Petisi*, *3*(1), 20-28. http://dx.doi.org/10.36232/jurnalpetisi.v3i1.1800

Indra, I. M. (2021). *Experimental Research Design*. Klaten: CV Tahta Media Group.

Isaeni, N., & Nugraha, A. (2022). *Teknologi dalam Transformasi Pembelajaran Kurikulum Merdeka*. Retrieved from Direktorat Guru Pendidikan Dasar. https://gurudikdas.kemdikbud.go.id/news/teknologi-dalam-transformasi-pembelajaran-kurikulum-merdeka

Kartini, K. (2021). Analisis Pembelajaran Online Anak Usia Dini Masa Pandemi COVID -19 Kota dan Perdalaman. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *6*(2), 809–818. https://doi.org/10.31004/obsesi.v6i2.880

Kearsley, K. A., & Shneiderman, B. (1998). *Engagement Theory: A Framework for Technology-Based Teaching and Learning*. Educational Technology.

Kemendikbudristek RI. (2021). *Mendikbudristek: Guru Profesional dan Sejahtera Kunci Pendidikan Berkualitas*. Retrieved from https://www.kemdikbud.go.id/main/blog/2021/07/mendikbudristek-guru-profesional-dan-sejahtera-kunci-pendidikan-berkualitas

Kusumawati, I., Lestari, N. C., Sihombing, C., Purnawanti, F., Soemarsono, D. W. P., Kamadi, L., Latuheru, R. V., & Hanafi, S. (2023). *Pengantar Pendidikan* (3rd ed.). Batam: CV Rey Media Grafika.

Leitão, R., Maguire, M., Turner, S., & Guimarães, L. (2022). A Systematic Evaluation of Game Elements Effects on Students' Motivation. *Education and Information Technologies*, *27*(1), 1081–1103. https://doi.org/10.1007/s10639-021-10651-8

Lestari, D. I., & Kurnia, H. (2023). Implementasi Model Pembelajaran Inovatif untuk Meningkatkan Kompetensi Profesional Guru di Era Digital. *JPG: Jurnal Pendidikan Guru*, *4*(3), 205–222. https://doi.org/10.32832/jpg.v4i3.14252

Mahmudi, I., Athoillah, M. Z., Wicaksono, E. B., & Kusuma, A. R. (2022). Taksonomi Hasil Belajar Menurut Benyamin S. Bloom. *Jurnal Multidisiplin Madani*, *2*(9), 3507–3514. https://doi.org/10.55927/mudima.v2i9.1132

Marinda, A. D., Erwandi, R., & Mandasari, N. (2023). Pengembangan Media Pembelajaran Ensiklopedia pada Mata Pelajaran IPA Kelas 5 SDN 58 Kota Lubuklinggau. *Journal of Education and Instruction*, *6*(2), 727–735. https://doi.org/10.31539/joeai.v6i2.5934

Mustaqim, M. F., & Mahamad, A. K. Bin. (2023). Development of Interactive Web-Based Learning Media with the Discovery Learning Model to Increase Student Learning Motivation in Object Oriented Programming XI Vocational High Schools. *Letters in Information Technology Education (LITE)*, *6*(1), 22. https://doi.org/10.17977/um010v6i12023p22-26

Nawangsari, A., Susanti, M. M. I., & Rustamti, M. I. (2022). Meningkatkan Keaktifan dan Hasil Belajar IPS Kelas IV SD Negeri Brengosan 2 Menggunakan Project Based Learning. *Jurnal Pendidikan dan Konseling (JPDK)*, *4*(4), 1232–1239. https://doi.org/10.31004/jpdk.v4i4.5443

Novitasari, C., & Subekti, H. (2024). Developing a Mutually Cooperative Attitude and Science Process Skills Through Experiential Learning. *Jurnal Pijar*

MIPA, *19*(1), 1–5. https://doi.org/10.29303/jpm.v19i1.6167

Piaget, J. (1970). Piaget's Theory (G. Gellerier & J. Langer, Trans.). In P.H. Mussen (Ed.), *Carmichael's Manual of Child Psychology* (3rd Edition, Vol. 1). New York: Wiley.

Sharma, K., Leftheriotis, I., & Giannakos, M. (2020). Utilizing Interactive Surfaces to Enhance Learning, Collaboration and Engagement: Insights from Learners' Gaze and Speech. *Sensors (Switzerland)*, *20*(7). https://doi.org/10.3390/s20071964

Sheldon, S., Fan, C., Uner, I., & Young, M. (2023). Learning Strategy Impacts Medical Diagnostic Reasoning in Early Learners. *Cognitive Research: Principles and Implications*, *8*(1). https://doi.org/10.1186/s41235-023-00472-3

Subroto, D. E., Supriandi, S., Wirawan, R., & Rukmana, A. Y. (2023). Implementasi Teknologi dalam Pembelajaran di Era Digital : Tantangan dan Peluang bagi Dunia Pendidikan di Indonesia. *Jurnal Pendidikan West Science*, *1*(7), 473-480. https://doi.org/10.58812/jpdws.v1i07.542

Sundari, T. A. (2023). *Pengaruh Pemanfaatan Sumber Belajar dan Kemandirian Belajar Terhadap Hasil Belajar Ekonomi Siswa Kelas XI IPA SMAIT Nurul 'Ilmi Jambi* (Undergraduate Thesis). Universitas Jambi. Retrieved from https://repository.unja.ac.id/48952/

Suyatno, S. (2023). *Dasar-Dasar Pendidikan* (1st ed.). Jakarta: PT Bumi Aksara.

Verawati, U. J., Alifa, Y. D. N., Millah, Z., & Nissa, Z. K. (2023). Implementasi Pembelajaran E-Learning Sebagai Transformasi Pendidikan di Era Digital. *Social Science Academic*, *1*(2), 221–228. https://doi.org/10.37680/ssa.v1i2.3532

Widjayanti, R. P., Muhimmah, H. A., & Istiqfaroh, N. (2024). Pengaruh Kurikulum di Jepang dan di Indonesia Terhadap Kualitas Pendidikan. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *3*(2), 7506-7543. https://doi.org/10.23969/jp.v9i2.15876

Wijnia, L., & Baars, M. (2021). The Role of Motivational Profiles in Learning Problem-Solving and Self-Assessment Skills with Video Modeling Examples. *Instructional Science*, *49*(1). https://doi.org/10.1007/s11251-020-09531-4

Yasin, M., Kelrey, F., Ghony, A., Syaiful, S., Karuru, P., Pertiwi, A., Abadi, A., Ardiansyaj, W., Kabanga', T., & Aryanti, N. (2023). *Media Pembelajaran Inovatif (Menerapkan Media Pembelajaran Kreatif untuk Menyongsong Pendidikan di Era Society 5.0)* (1st ed.). Jambi: PT. Sonpedia Publishing Indonesia.