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The Use of Wokwi Learning Media Can Increase Science Learning Outcomes in Madrasah Ibtidaiyah Students

Penggunaan Media Pembelajaran Wokwi Dapat Meningkatkan Hasil Belajar IPA Pada Siswa Madrasah Ibtidaiyah

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ABSTRACT

This study aims to: (1) examine students' science learning outcomes before using Wokwi; (2) assessing learning outcomes after the use of the media; and (3) measuring the improvement of learning outcomes obtained. This study uses a quantitative method with *a pre-experimental design of one-group pretest-posttest* to measure changes in student learning outcomes after the use of Wokwi learning media. The research population is all students of class VI MIN 2 Majene for the 2025/2026 school year as many as 22 people, all of whom were used as samples with saturated sample techniques. Data was collected through learning outcome tests in the form of 20 multiple-choice questions that included aspects of knowledge, understanding, and application of concepts, given in the form of pretests and posttests. Data analysis was carried out with descriptive statistics to describe the average student achievement and N-gain calculation to determine the level of improvement in learning outcomes more measurably after the treatment was given. The results showed that (1) students' science learning outcomes before the use of Wokwi media were in the medium and high categories with an average of 58.45, which shows the limitations of their initial understanding. (2) After the implementation of Wokwi, the average score increased significantly to 82.73 with the distribution of the majority score in the high and very high categories, without any students in the medium or low categories. (3) The calculation of N-gain of 0.57 which is classified as moderate shows that 75% of students experienced moderate improvement, 20% high, and only 5% low. These findings prove that Wokwi media is effective in improving science learning outcomes while leveling student achievement, although further development is still needed through simulation variations and integration with collaborative and project-based learning methods.

Key words : Wokwi Learning Media, Science Learning Outcomes. Students of Madrasah Ibtidaiyah

ABSTRAK

Penelitian ini bertujuan untuk: (1) menelaah capaian belajar IPA siswa sebelum menggunakan Wokwi; (2) menilai hasil belajar setelah penggunaan media tersebut; dan (3) mengukur peningkatan hasil belajar yang diperoleh. Penelitian ini menggunakan metode kuantitatif dengan desain pra-eksperimen one-group pretest-posttest untuk mengukur perubahan hasil belajar siswa setelah penggunaan media pembelajaran Wokwi. Populasi penelitian adalah seluruh siswa kelas VI MIN 2 Majene tahun ajaran 2025/2026 sebanyak 22 orang, yang

semuanya dijadikan sampel dengan teknik sampel jenuh. Data dikumpulkan melalui tes hasil belajar berupa 20 soal pilihan ganda yang mencakup aspek pengetahuan, pemahaman, dan penerapan konsep, diberikan dalam bentuk pretest dan posttest. Analisis data dilakukan dengan statistik deskriptif untuk menggambarkan rata-rata capaian siswa serta perhitungan N-gain guna mengetahui tingkat peningkatan hasil belajar secara lebih terukur setelah perlakuan diberikan. Hasil penelitian menunjukkan bahwa (1) capaian belajar IPA siswa sebelum penggunaan media Wokwi berada pada kategori sedang dan tinggi dengan rata-rata 58,45, yang menunjukkan keterbatasan pemahaman awal mereka. (2) Setelah penerapan Wokwi, nilai rata-rata meningkat signifikan menjadi 82,73 dengan distribusi skor mayoritas pada kategori tinggi dan sangat tinggi, tanpa ada siswa yang berada pada kategori sedang maupun rendah. (3) Perhitungan N-gain sebesar 0,57 yang tergolong sedang menunjukkan bahwa 75% siswa mengalami peningkatan sedang, 20% tinggi, dan hanya 5% rendah. Temuan ini membuktikan bahwa media Wokwi efektif dalam meningkatkan hasil belajar IPA sekaligus meratakan capaian siswa, meskipun masih diperlukan pengembangan lebih lanjut melalui variasi simulasi dan integrasi dengan metode pembelajaran kolaboratif maupun berbasis proyek.

Kata Kunci **:** *Media Pembelajaran Wokwi, Hasil Belajar IPA. Siswa Madrasah Ibtidaiyah*

INRODUCTION

Natural Sciences (IPA) at the elementary education level plays an important role as the basis for the formation of students' knowledge, skills, and scientific attitudes (Iskandar & Kusmayanti, 2018). Science learning is not only aimed at mastering concepts, but also provides experience in critical thinking, finding solutions, and training the investigation process (Kelana & Wardani, 2021). In order for learning to be more meaningful, an approach that is in accordance with technological developments and educational innovations is needed. (Rahmawati & Nurachadija, 2023)

Science learning at the elementary education level has a strategic role in shaping students' initial understanding of natural phenomena and scientific thinking skills, but in practice it still faces various challenges (Abdullah et al., 2025). Many students experience difficulties because science material is often presented abstractly and theoretically without adequate media or direct experience, so learning tends to be memorized rather than conceptual understanding (Ramadhani & Amelia, 2025). In addition, the limitations of laboratory facilities, the lack of variety of teaching methods, and the dominance of conventional approaches make students less actively involved in the learning process (Ratno et al., 2024). This has an impact on low interest, motivation, and learning achievement of science at the elementary level. Therefore, it is necessary to innovate learning that is contextual, interactive, and utilizes digital media or simple simulations, so that students not only understand concepts cognitively, but also are able to relate them to daily life and foster scientific attitudes from an early age.

In practice, science learning at the Elementary education level still faces obstacles. Teachers often use conventional methods that are centered on lectures, limited learning media, and digital technology has not been utilized optimally (Fauziyah et al., 2025). This

condition has an impact on low motivation as well as student learning outcomes. Initial observations at MIN 2 Majene show that the average achievement of science students in Class VI is still in the medium category, so a new strategy is needed that can improve the quality of learning.

One potential medium is Wokwi, a web-based simulator originally used to visualize microcontrollers such as the Arduino and ESP32 (Qirom et al., 2024). In science learning, this media can be modified to show various scientific phenomena, simple experiments, and basic electrical concepts that are difficult to understand just by reading books (Fahmi & Kurniawan, 2025).

The main advantage of Wokwi is that it can present simulations similar to real practices without the need for expensive laboratory equipment (Wahyudi & Sabara, 2022). Teachers can design virtual experiments that resemble activities in the lab (Ngaga et al., 2024). This is in line with the concept of virtual laboratories which are now widely used to overcome the limitations of school facilities (Qirom et al., 2024). In addition, Wokwi supports project-based learning and problem-based learning (Laila et al., 2025), in line with the Independent Curriculum which emphasizes students' creativity and independence.

Research conducted by Taroreh, (2024) also shows that interactive digital media improves understanding of scientific concepts, especially abstract ones. With simulation-based learning experiences, students find it easier to relate science material to real-life contexts (Parisu et al., 2025). Therefore, Wokwi is expected to be able to become an effective innovation to improve science learning outcomes in elementary schools, especially in materials that require analytical skills.

Science learning in Class VI MIN 2 Majene takes place in the context of students who are in the final stages of elementary education, where they are required to master scientific thinking skills while preparing themselves for the next level of education. The real conditions in the classroom show that most students have a high curiosity about the natural phenomena around them, but often the limitations of facilities such as laboratories, learning media, and teaching aids make the learning process more centered on the teacher's explanation than on direct experimental activities. This has an impact on the lack of optimal development of science process skills, such as observing, classifying, or testing hypotheses. In addition, the variation in the level of understanding of students is also quite diverse; there are students who quickly grasp science concepts, but there are also those who still have difficulty understanding abstract material without the help of concrete media. On the other hand, teachers continue to try to use contextual learning strategies, for example by associating science materials with the environment around Majene which is rich in natural phenomena, so that students can more easily relate theory to daily experiences. Thus, the science learning situation in class VI MIN 2 Majene reflects the great potential in building students' science literacy, but still requires

more intensive support of facilities, methods, and mentoring so that learning outcomes can be achieved optimally.

Based on the conditions of science learning in class VI MIN 2 Majene, the use of Wokwi-based learning media is very important to support the improvement of student learning outcomes. The limitations of laboratory facilities and teaching aids that have made learning more theoretical can be overcome by presenting Wokwi as a digital simulation media that allows students to conduct virtual experiments interactively. Through Wokwi, students can visualize abstract science concepts, such as electrical circuits, energy, or the working mechanism of a system, so that it is easier to understand and not just stop at the teacher's verbal explanation. It also provides students with the opportunity to practice science process skills, such as observing, designing, and testing hypotheses, even without physical laboratory facilities. In addition, learning with Wokwi can increase students' motivation to learn because it provides a learning experience that is contextual, fun, and close to the digital world that is familiar to them. Thus, the integration of Wokwi media in science learning is expected to be able to bridge the gap between the limitations of facilities and the demands of mastering scientific competence, as well as contributing to improving science literacy and learning outcomes of Class VI students of MIN 2 Majene.

Based on the explanation above, this study aims to: (1) examine students' science learning outcomes before using Wokwi; (2) assessing learning outcomes after the use of the media; and (3) measuring the improvement of learning outcomes obtained. This research is expected to contribute to the development of science learning strategies at the Elementary Education level as well as become a practical reference for teachers in the use of technology-based media.

METHOD

This study uses a quantitative method with a pre-experimental design of the one-group pretest-posttest design (Adnan & Latief, 2020). The selection of this design was based on the purpose of the research to measure the extent to which there were changes in student learning outcomes after being treated in the form of the use of Wokwi based learning media. This design allows researchers to compare student learning outcomes before (pretest) and after (posttest) learning with the media, so that the effectiveness of the treatment provided can be known. The research population is all students of class VI MIN 2 Majene for the 2025/2026 school year which totals 22 people. Samples were taken using the saturated sample technique, so that the entire population was used as a research sample.

Data collection in this study was carried out through a learning outcome test. The test is arranged in the form of 20 multiple-choice objective questions, which are designed to measure three important aspects in science learning, namely knowledge, understanding, and application of concepts. The pretest is given before the learning process begins to measure

the student's initial ability, while the posttest is given after the treatment is completed to determine the improvement in learning outcomes. Thus, this data collection technique is directly related to the research objective of evaluating changes in student learning outcomes.

The data obtained was analyzed using two statistical approaches, namely descriptive statistics and N-gain calculations. Descriptive statistics are used to describe the average score of the pretest and posttest, so that an overview of student achievement can be seen (Putri et al., 2021). Meanwhile, the N-gain calculation is used to determine the rate of improvement in student learning outcomes in a more measurable manner (Sukarelawan et al., 2024). The N-gain formula allows researchers to assess how much improvement students achieve after the use of Wokwi media in science learning with the formula

$$N - gain = \frac{(Skor\ Posttest - Skor\ Pretest)}{(Skor\ Maksimum - Skor\ Pretest)}$$

Information:

- Height: g > 0.7
- Medium: 0.3 ≤ g ≤ 0.7
- Low: g < 0.3

RESULTS AND DISCUSSION

This research is a field study that aims to obtain empirical data on students' science learning outcomes after participating in learning with innovative media. Data was collected through pre-learning and post-learning tests in the classes that were used as research subjects.

The main focus of the research lies in the analysis of improving science learning outcomes, especially on natural disaster mitigation materials. The learning media used is Wokwi, which is a digital simulation application that can help students understand science concepts through visualization and virtual experimentation.

The research design chosen was Pre-Experimental Design with a One Group Pretest-Posttest pattern. This design emphasizes on comparing students' learning outcomes before and after being treated. The treatment in question is in the form of a learning process by utilizing Wokwi media directly in the classroom.

The research instrument used to measure student learning outcomes is a description test. This test is designed to measure the extent to which students understand natural disaster mitigation material both before and after the use of Wokwi media. Thus, this study seeks to provide a clear picture of the effectiveness of Wokwi learning media in improving understanding of science concepts in Class VI students of MIN 2 Majene for the 2025/2026 Academic Year.

Table 1. Description of Student Science Learning Outcome Score

Statistics	Statistical Score	
	Pretest	***Posttest***
Number of Students	20	20
Standard Deviation	6,12	5,87
Highest Score	72	92
Lowest Score	45	75
Range	27	17
Average Score	58,45	82,73
Minimum Ideal Score	0	0
Maximum Ideal Score	100	100

Based on the results of data analysis in Table 1, it can be seen that there is an increase in the achievement of science learning outcomes of Class VI students of MIN 2 Majene after the implementation of Wokwi-based learning media. The average pretest score of 58.45 increased to 82.73 in the posttest, with a difference of 24.28 points. This increase was also seen in the lowest and highest scores of students, where the lowest score increased from 45 to 75, while the highest score increased from 72 to 92. This shows that the application of Wokwi media is able to encourage an overall improvement in learning outcomes for almost all students.

According to (Nurmadiah, 2016), learning media is an important means that functions to channel messages and stimulate students' thoughts, feelings, attention, and interest in learning activities. The increase in learning outcome scores in this study is in line with this opinion, where the use of simulation-based media such as Wokwi is able to visualize abstract science concepts such as electrical circuits and energy making it easier for students to understand.

Furthermore, Mayer, (2024) in Multimedia Learning Theory emphasizes that learning that combines text, images, and interactive simulations can improve concept understanding because students use dual cognitive channels (verbal and visual) in processing information. Wokwi as a digital-based simulation media provides concrete visual representations, thus helping students in connecting theoretical concepts with real phenomena. This may explain why the average posttest score is much higher than the pretest score.

In addition, the results of this study support the findings of Shahzad & Nadeem, (2021) who stated that interactive learning media can create a more meaningful learning atmosphere by actively involving students. In the context of this research, the use of Wokwi allows students to explore, try simulations, and directly observe the results of each digital experiment they conduct, thereby strengthening their understanding of science concepts.

In terms of grade achievement, the increase in the lowest score from 45 to 75 shows that Wokwi media is effective not only for high-ability students, but also helps students who previously had low abilities to achieve better results. This is in line with the opinion of Dakhi, (2020) that one of the characteristics of learning success is the increase in student learning achievement evenly.

The score of science learning outcomes for students in Class VI MIN 2 Majene pretest of students' science learning outcomes is shown in the following table.

Table 2. Distribution of Pretest Scores for Students' Science Learning Outcomes

No	Score Range	Category	Number of students
1	70 – 100	Very High	0
2	55 – 69	High	7
3	40 – 45	Keep	9
4	25 – 39	Low	4
5	0 – 24	Very Low	0
	Sum		20

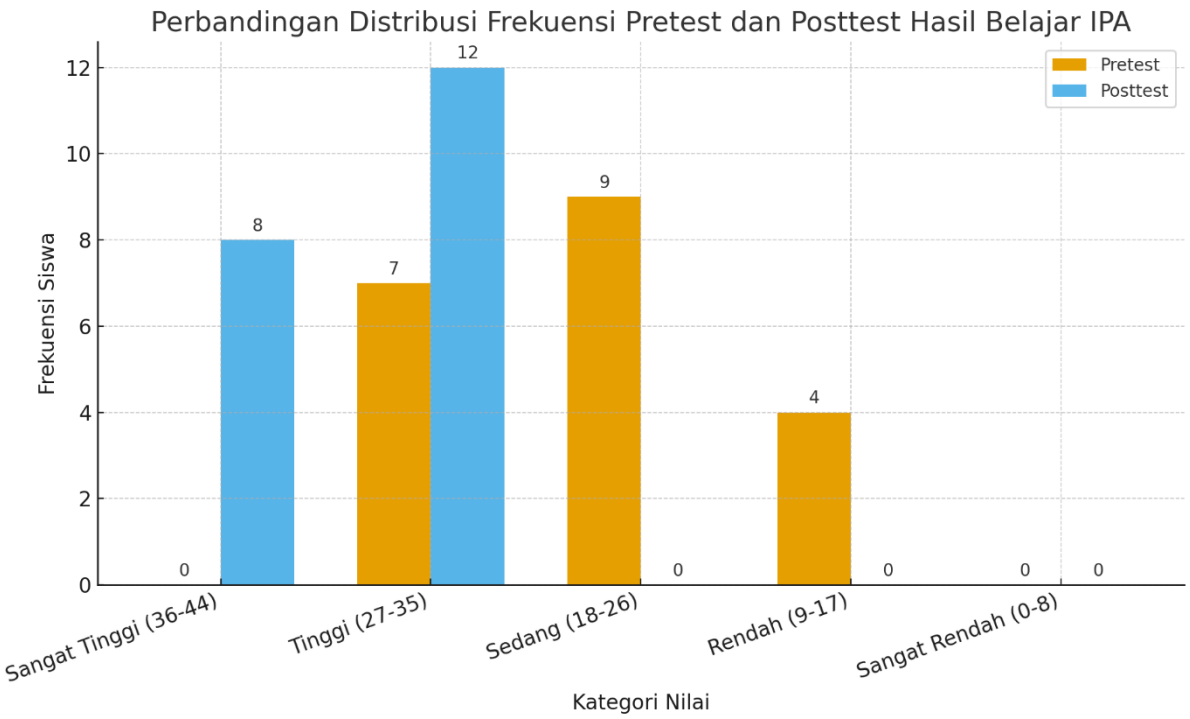
Meanwhile, the science learning outcomes scores of students in Class VI MIN 2 Majene *posttest* are shown in the following table:

Table 3. Posttest Score Distribution of Science Learning Outcomes for Students

No	Score Range	Category	Number of Students
1	85 – 100	Very High	8
2	70 – 84	High	12
3	55 – 69	Keep	0
4	40 – 54	Low	0
5	0 – 39	Very Low	0
	Sum		20

The comparison data of the frequency distribution table at the time of pretest and posttest is shown in the following graph image:

Figure 1. Pretest and Posttest Frequency Distribution



The results showed that there was a significant difference in score distribution between pretest and posttest achievements. On the pretest, most students were in the medium (9 students) and *high* (7 students) categories, while none of the students reached the very high category. This indicates that before being given treatment, students' initial ability to understand science concepts is still limited. However, after being given Wokwi media-based learning, the distribution of posttest scores experienced a very striking change, where 8 students were in the *very high* category and 12 students were in the *high* category. There are no more students who are in the *medium* or below categories.

These findings show that Wokwi media plays an effective role in improving science learning outcomes. According to Wulandari et al., (2023), learning media serves to clarify the presentation of messages so that they are not too verbal and are able to foster students' motivation and interest in learning. This is reflected in the improvement of learning outcomes, where the use of Wokwi based on digital simulations is able to make abstract science concepts more concrete and easy to understand.

Furthermore, Dale, (1946) through the Cone of Experience explained that learning experiences that involve more senses, especially visual and kinesthetic, will be more meaningful for students. Wokwi, which features simulations of electrical circuits and natural phenomena, provides students with the opportunity to learn through direct experience (learning by doing), so that they can understand science concepts not only theoretically, but also applicatively.

Mayer, (2024) through the theory of Multimedia Learning emphasizes that interactive multimedia-based learning is able to improve learning outcomes because it involves multiple cognitive processes. In this study, Wokwi combines text, visuals, and interactive simulations, so that students can process information through verbal and visual channels simultaneously. This process strengthens the understanding of complex concepts, thus having an impact on improving posttest scores.

In addition to improving learning outcomes, the results of the study also show an increase in students' motivation and concentration in participating in learning. This is in line with the opinion of Hampel & Pleines, (2013), that interactive media can foster active student involvement, create a more interesting learning atmosphere, and encourage the achievement of meaningful learning.

In terms of equal distribution of achievements, the absence of students in the medium, low, *or* very low categories in the posttest results shows that the use of Wokwi not only increases the achievement of high-ability students, but also helps low-ability students to achieve the expected competency standards. Dakhi, (2020) emphasized that learning success can be measured by improving student learning outcomes as a whole, not just partially.

Thus, based on the results of the distribution of pretest and posttest scores and the views of experts, it can be concluded that the use of Wokwi learning media in science learning has proven to be effective in improving student learning outcomes. This media not only increases the average score, but also increases the equal distribution of learning outcomes, motivation, and the overall quality of the learning process.

To measure student learning outcomes before and after treatment, the N-gain test was used. To calculate N-gain on students' science learning outcomes before and after can be seen in Table 4 below.

Table 4. Distribution and Percentage of Normalized Student Gain Score

Gain Value Range 〈g〉	**Category**	**Number of Students**	**Percentage (%)**	**Average N-Gain**
(g) < 0.3	Low	1	5	0,57
0.3 ≤ (g) <0.7	Keep	15	75	
(g) ≥0.7	High	4	20	
Sum		20	100	

The results of the N-gain calculation showed that the average improvement in student learning outcomes was at a score of 0.57, which was included in the medium *category*. The distribution of N-gain scores showed that most students (75%) were in the medium *category*, 20% were in the high *category*, and only 5% were still in the low category. These findings show that the application of Wokwi-based learning media is generally effective in improving

the learning outcomes of science students in Class VI MIN 2 Majene, although there is still room for further development

According to Triyono et al., (2024), the N-gain score is one of the right indicators to measure the effectiveness of learning interventions in improving learning outcomes. The average N-gain score of 0.57 in this study showed that the effectiveness of learning was at a moderate level, which means that Wokwi media succeeded in improving students' understanding of science concepts, although the improvement was not optimal for all students.

In line with that, Joyce & Weil, (1972) assert that the effectiveness of learning is not only determined by the use of media, but also by the variety of teaching strategies that support students' active engagement. This is relevant to the research findings that improving learning outcomes can be further improved through the integration of Wokwi media with other learning models, such as project-based learning or collaborative learning.

Mayer, (2024) through the theory of Multimedia Learning explains that the combination of text, visuals, and interactive simulations can strengthen the understanding of complex concepts. However, he also emphasized the importance of managing students' cognitive load so as not to overdo it. Therefore, in further development, teachers need to expand the variety of Wokwi simulations gradually and contextually, so that students can build a deep understanding without feeling overwhelmed.

In addition, according to Vygotsky in Doolittle, (1995) with the concept of Zone of Proximal Development (ZPD), effective learning emphasizes collaboration between students and peers and teachers. The integration of Wokwi media with collaborative activities, such as group discussions or joint projects, will provide greater opportunities for students to exchange knowledge and strengthen their understanding of science concepts.

Thus, even though the average N-gain score is in the medium category, the results of this study confirm that innovative learning media such as Wokwi has great potential to improve science learning outcomes in Madrasah. In the future, the effectiveness of this media can be improved through the development of simulation variations, the application of project-based learning models, and increased collaborative student engagement. This is in accordance with the opinion of Kpolovie et al., (2014) that good learning is learning that not only improves academic achievement, but also shapes students' attitudes, skills, and learning independence.

CONCLUSION

Based on the results of the research and discussion that has been described, it can be concluded that several things are as follows:

1. The achievement of learning science before the use of Wokwi media showed that most students were in the medium and high categories, with an average pretest score of 58.45. This indicates that students' initial ability to understand science material, especially on the

topic of natural disaster mitigation, is still relatively limited and has not reached the very high category.

2. The learning outcomes after the use of Wokwi media have increased significantly. The average posttest score rose to 82.73 with the score distribution showing the majority of students were in the high and very high categories. There are no students in the medium or low categories, thus showing a better equitable distribution of learning outcomes.
3. The increase in students' science learning outcomes can be seen from the results of the N-gain calculation with an average of 0.57 which is in the medium category. As many as 75% of students experienced an increase in the medium category, 20% in the high category, and only 5% in the low category. This proves that Wokwi-based learning media is effective in improving science learning outcomes, although there is still room for further development, for example by expanding the variety of simulations and integrating them with project-based or collaborative learning methods.

Thus, this study emphasizes that the use of Wokwi learning media in science learning in class VI MIN 2 Majene can be an effective strategy to improve student learning outcomes, both in terms of academic achievement and the quality of the overall learning process.

REFFERENCES

Abdullah, G., Arifin, I. N., Sianu, L., Suleman, A. R., & Doe, R. (2025). *Pembelajaran IPA Di Sekolah Dasar*. PT. Sonpedia Publishing Indonesia.

Adnan, G., & Latief, M. A. (2020). *Metode Penelitian Pendidikan Penelitian Kuantitatif, Penelitian Kualitatif, Penelitian Tindakan Kelas*. Erhaka Utama.

Dakhi, A. S. (2020). Peningkatan Hasil Belajar Siswa. *Jurnal Education and Development*, *8*(2), 468. https://www.neliti.com/id/publications/561738/peningkatan-hasil-belajar-siswa#cite

Dale, E. (1946). The Cone Of Experience. *Audio-Visual Methods in Teaching*, *1*, 37–51.

Doolittle, P. E. (1995). *Understanding Cooperative Learning through Vygotsky's Zone of Proximal Development.*

Fahmi, A., & Kurniawan, I. (2025). Studi Kinerja Transmisi Data Menggunakan ESP32 dan Raspberry Pi Pico Berbasis Simulasi Wokwi. *JOURNAL ZETROEM*, *7*(1), 80–87. https://doi.org/10.36526/ztr.v7i1.5102

Fauziyah, Z., Azzahra, S. F., Azka, H., Putri, A. A., Arya, N. W., & Rif'iyati, D. (2025). Pemanfaatan Inovasi Digital PHET Sebagai Media Belajar Interaktif Siswa Pada Pembelajaran IPA Di SD/MI. *Prosiding SEMAI: Seminar Nasional PGMI*, *3*, 89–104. https://proceeding.uingusdur.ac.id/index.php/semai/article/view/2845.

Hampel, R., & Pleines, C. (2013). Fostering Student Interaction And Engagement In A Virtual Learning Environment: An Investigation Into Activity Design And Implementation. *Calico Journal*, *30*(3), 342–370. https://eric.ed.gov/?id=EJ1027978.

Iskandar, R., & Kusmayanti, I. (2018). Pendekatan Science Technology Society: IPA di Sekolah Dasar. *Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *2*(02). https://doi.org/10.31326/jipgsd.v2i02.129.

Joyce, B., & Weil, M. (1972). *Conceptual Complexity, Teaching Style and Models of Teaching.*

Kelana, J. B., & Wardani, D. S. (2021). *Model Pembelajaran IPA SD*. Cirebon: Edutrimedia Indonesia.

Kpolovie, P. J., Joe, A. I., & Okoto, T. (2014). Academic Achievement Prediction: Role of Interest In Learning And Attitude Towards School. *International Journal of Humanities Social Sciences and Education (IJHSSE)*, *1*(11), 73–100. 10.12691/education-6-10-3.

Laila, I., Armynah, B., & Arifin, A. (2025). Pelatihan Penggunaan Simulator Wokwi Untuk Meningkatkan Pemahaman Konsep Fisika Berbasis STEM. *Jurnal Abdi Insani*, *12*(7), 3396–3407. https://doi.org/10.29303/abdiinsani.v12i7.2685.

Mayer, R. E. (2024). The Past, Present, And Future Of The Cognitive Theory Of Multimedia Learning. *Educational Psychology Review*, *36*(1), 8. 10.1007/s10648-023-09842-1.

Ngaga, E., Siki, Y. C. H., Manehat, D. J., Bria, Y. P., & Nani, P. A. (2024). Pengenalan Dan Pelatihan Pemrograman Dasar Iot Dengan Simulasi Wokwi Bagi Siswa Tkj Smkn Noemuti. *Jurnal Abdimas Bina Bangsa*, *5*(2), 1823–1831. https://doi.org/10.46306/jabb.v5i2.1450.

Nurmadiah, N. (2016). Media Pendidikan. *Al-Afkar: Manajemen Pendidikan Islam*, *5*(1). https://doi.org/10.28944/afkar.v5i1.109.

Parisu, C. Z. L., Sisi, L., & Juwairiyah, A. (2025). Pengembangan Literasi Sains Pada Siswa Sekolah Dasar Melalui Pembelajaran IPA. *Jurnal Pendidikan Multidisiplin*, *1*(1), 11–19. https://doi.org/10.54297/jpmd.v1i1.880.

Putri, R. I. I., Araiku, J., & Sari, N. (2021). *Statistik Deskriptif*. Bening Media Publishing.

Qirom, Q., Albab, U., & Wikaningtyas, R. (2024). *Belajar Mandiri Pemrograman Arduino dengan Wokwi Simulator*. PT. Sonpedia Publishing Indonesia.

Rahmawati, S., & Nurachadija, K. (2023). Inovasi Pendidikan Dalam Meningkatkan Strategi Mutu Pendidikan. *BERSATU: Jurnal Pendidikan Bhinneka Tunggal Ika*, *1*(5), 1–12. https://doi.org/10.51903/bersatu.v1i5.303.

Ramadhani, A., & Amelia, F. R. (2025). Kendala dan Tantangan Pembelajaran IPA di UPT SD Negeri 064995 Kota Medan dalam Implementasi Kurikulum Merdeka. *Jurnal Penelitian Ilmu Pendidikan Indonesia*, *4*(2), 1150–1155. https://doi.org/10.31004/jpion.v4i2.547.

Ratno, S., Amelia, F. R., Siagian, A. N., Dongoran, I. K., Utami, J., Pandiangan, L. L., Nasution, R. K., Simanjuntak, R. P. B., & Amelia, V. Q. (2024). Analisis problematika proses pembelajaran IPA pada siswa kelas VI SDN 060912 Medan Denai. *JURNAL HUKUM PENDIDIKANMOTIVASI Dan Bahasa Harapan*, *2*(2).

https://doi.org/10.51878/knowledge.v5i2.6026.

Shahzad, M., & Nadeem, M. A. (2021). Developing Learning Environment Using Interactive Multimedia. *Pakistan Journal Of Distance And Online Learning*, *7*(1), 93–106. https://eric.ed.gov/?id=EJ1321263.

Sukarelawan, M. I., Indratno, T. K., & Ayu, S. M. (2024). *N-gain vs stacking*.

Taroreh, L. H. J. (2024). Efektivitas Media Pembelajaran Interaktif Berbasis Teknologi Dalam Meningkatkan Pemahaman Konsep IPA. *Jurnal Ilmu Pendidikan Guru Sekolah Dasar Dan Usia Dini*, *1*(1), 26–31. https://doi.org/10.70134/pedasud.v1i1.198.

Triyono, A., Nuary, R. H., Permatasari, N., Yuni, Y., & Wibowo, T. (2024). The Level Of Effectiveness Of Tps And Conventional Methods Judging From Students' Geometry Learning Results Using The N-Gain Test. *AlphaMath: Journal of Mathematics Education*, 142–156. 10.30595/alphamath.v10i1.21530

Wahyudi, W., & Sabara, E. (2022). Desain Dan Implementasi Media Pembelajaran Mikrokontroler Berbasis Hybrid Learning Menggunakan Wokwi Simulation. *Jurnal Media Elektrik*, *19*(3), 186–193. 10.26858/metrik.v19i3.37177.

Wulandari, A. P., Salsabila, A. A., Cahyani, K., Nurazizah, T. S., & Ulfiah, Z. (2023). Pentingnya Media Pembelajaran Dalam Proses Belajar Mengajar. *Journal on Education*, *5*(2), 3928–3936. https://doi.org/10.31004/joe.v5i2.1074.