

The Effect of PhET Media on Mathematics Learning Outcomes of Elementary Students: A Literature Review

Luhur Tri Jarwoko¹, Candra Utama²

¹University of Malang

²Primary School Teacher Education, University Negeri Malang, Malang, Indonesia

*Corresponding author, email: luhur.tri.2301516@students.um.ac.id, candra.utama.pasca@um.ac.id

Keywords

PhET Simulation
Learning Outcomes
Mathematics
Elementary School
Interactive Media

Abstract

This research focuses on examining the role of interactive learning media PhET Simulation on mathematics learning outcomes of elementary school students. PhET media is a visual simulation platform designed to facilitate students in understanding abstract mathematical concepts through an interactive and explorative approach. This research uses the literature study method by analyzing 10 articles published in the vulnerable years 2020 to 2025, which were selected based on their relevance to the use of PhET media on mathematics learning outcomes of elementary school students. The results of the study showed significant improvement despite limited infrastructure. Therefore, it is recommended that schools and teachers prepare adequate supporting facilities and training so that the implementation of this media can run optimally.

1. Introduction

Basic education has an important role to build basic understanding for students in the scientific field, including mathematics. Mathematics is not just a core subject of the curriculum, but a basic skill in shaping students' cognitive abilities such as logical thinking, analysis, and problem solving (Setiawan, 2023). However, a deep understanding of math concepts is still often a challenge for some students. Many students face obstacles in mastering the learning material because the approach in learning is still not interesting and the lack of interactive learning media used to help visualize the concepts of the material being taught. Therefore, innovation in learning methods is needed to improve student understanding and learning outcomes. One way is that teachers can take advantage of interactive and interesting learning media.

In today's era of digitalization, technology has brought significant changes in various sectors, including in the world of education. Today's technological advances demand the adaptation of scientific insights increasing, therefore the need for technology is very crucial to be mastered by all circles, including students and teachers in the world of education. This is because the flow of information moves quickly, teachers must be required to continue to innovate and optimize the use of learning facilities. Learning media is a teaching instrument used by teachers in conveying information or material to students in the learning stage. In accordance with the opinion (Mustiksari 2022), media is a thing that has a convincing message and can build students' thoughts and wills which aims to encourage the course of learning in order to achieve learning goals.

One of the relevant learning media that can be used in mathematics learning is *PhET Simulation*. *PhET Simulation* is an interactive visual media platform that can be used to help solve problems and obstacles for educators in the learning process. This media was created by the science community at the *University of Colorado* in the form of software in the form of an online-based simulation learning platform. PhET media is worth reviewing through a literature review because it has unique characteristics as interactive learning media based on visual simulations and digital experiments developed with a research-based pedagogical approach. This media is designed to make it easier for students to understand abstract concepts, especially in mathematics and science, by presenting animations that resemble real experiments (Moore et al., 2021). This approach aligns with the principles of constructivist learning theory, which emphasizes the active role of students in constructing knowledge through direct exploration. PhET also has an open license, allowing both teachers and students to access it for free without incurring costs or requiring special devices. This

ease of access makes it highly relevant in various educational contexts, including elementary schools that may have limited infrastructure (Lestasi, 2023). Globally, the use of PhET has been extensively studied and proven to improve learning outcomes and student engagement in various countries (Adams et al., 2020), making it one of the best models for educational transformation in the digital age. Moreover, this medium is developed based on STEM education principles and technological literacy, making its use highly aligned with the “merdeka” curriculum policy and international curricula focused on 21st-century skills. Thus, this study is necessary to map the effectiveness, implementation challenges, and adaptation opportunities of this media in the context of basic education in Indonesia.

Previous research has shown that the use of PhET media has a significant influence on helping students understand abstract mathematical concepts. This media allows students to learn visually, so that learning that was previously difficult to understand becomes easier to understand. Another study conducted by Kusuma and Hidayat (2022) found that students' use of interactive media showed a significant increase in students' understanding of the material being taught when compared to conventional methods. This shows that interactive media such as *PhET* can be an efficient alternative solution in improving the quality of mathematics learning in elementary school. In addition, another research by Lestari (2023) states that interactive media can increase student involvement in the learning process, so that they are more active in finding and understanding mathematical concepts easily and fun. Through the simulation features available, it allows students to explore mathematical concepts independently, build their own knowledge based on hands-on experience, and find solutions through hands-on experiments in simulations. Activities like this not only increase student understanding, but students can practice critical thinking and practice solving student problems.

Based on the background and problem formulation, this study aims to find answers about whether the influence of interactive media has benefits in improving learning outcomes, especially in mathematics subjects in elementary schools through a literature study approach. This study not only identifies the benefits of using these media in learning, but also examines the advantages and disadvantages of the application of this media in elementary schools. This study is expected to have a positive impact on all circles and provide recommendations to teachers and educational institutions regarding the use of interactive media as a supporting tool in the student learning process.

2. Method

This study uses the Systematic Literature Review (SLR) method with a qualitative synthesis approach. The purpose of using this method is to collect, evaluate, and interpret relevant research findings that are used to understand how PhET media impacts mathematics learning outcomes in primary schools. Literature searches are conducted through Google Scholar and select open access academic databases using keywords such as "PhET simulation", "mathematics learning", "primary school", and "interactive media". Articles are included if: (1) published between 2020 and 2025; (2) focusing on basic mathematics education; and (3) involves the implementation or evaluation of PhET media. Studies are excluded if they focus on secondary or college education, or do not report learning outcomes. The review process follows a four-step rule: identification, screening, eligibility, and inclusion, adapted from the PRISMA guidelines. The selected articles were then thematically analyzed to extract the recurring patterns in the use and impact of PhET simulations on student achievement and engagement in mathematics.

The stages of the article selection and screening process are described in the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowchart presented in the narrative table below.

Narrative Table Of Prism Flow

Stages	Procedures Carried Out	Number Articles	Analytical Explanation
--------	------------------------	-----------------	------------------------

Identification	The articles were searched using Google Scholar and journals relevant to the keywords: "PhET Simulation, mathematics learning outcomes, elementary school, interactive learning media, and literature review."	112 articles.	The initial stage produced a total of 112 articles from two main databases. The keywords were combined using Boolean operators such as AND and OR to expand the scope of the search.
Screening	Articles were screened based on initial criteria such as article type (scientific journal), year of publication (2020-2025), and topic relevance.	72 articles.	A total of 40 articles were eliminated because they did not meet the inclusion criteria, such as opinion articles, proceedings, and articles outside the specified year range.
Eligibility	Articles were analyzed in depth based on their scientific structure, focus on variables, and methodological suitability to the topic of the literature.	25 articles.	Articles that did not include quantitative results or did not specifically discuss PhET media were excluded.
Inclusion	Inclusion 10 articles were selected for further analysis in the literature review. mathematics learning outcomes.	10 articles.	The remaining articles were completely relevant, had valid empirical data, and discussed PhET Simulation in the context of elementary school mathematics learning outcomes.

3. Results and Discussion

3.1 Results

The research data integrated in this literature review are articles that were further analyzed and selected as many as 10 articles that discuss the role of interactive media in learning outcomes. The selected articles will be re-screened which will later be discussed in categorization according to the article title and the purpose of writing the article. Below are the strategies used by the author in choosing the articles to be presented in Table 1.

Table 1. Article Writing Strategies

No	Kategori Pembahasan	Mesin Pencarian	Hasil Penemuan
----	---------------------	-----------------	----------------

1	Penelusuran artikel pada tahun 2020-2025	<i>Google Scholar</i>	72
2	Judul yang relevan		25
3	Menyajikan solusi yang berbeda		10
Hasil yang dibahas			10

The papers that were selected to be studied according to the criteria set by the researcher, namely focusing on the results of the discovery in the form of findings on the role of PhET media with the results of mathematics learning in elementary school. The selected articles are presented in Table 2. The following are the results of the analysis of articles relevant to the Role of Phet Media Utilization in Mathematics Achievement in Elementary Schools

Table 2. The Role of PhET on Mathematics Learning Outcomes

Article	Research Method Findings	Method Findings
Effectiveness of Educational Math Games Phet Application Based on Problem Based Learning Model in Grade 4 Madrasah Ibtidaiyah Muhammadiyah 2 Kudus	Quantitative (Experimental)	The results of this study show that the use of <i>PhET applications in the PBL model</i> shows significant changes to improve the academic achievement of students in grade 4 of MI Muhammadiyah 2 Kudus, especially in the topic of fractions. The average pretest score of students before the application of this method was 59.06, while the average post-test score after the application increased to 68.44.
Increased learning achievement on fractional materials Using Media Interactive PhET Colorado in Grade IV Students of SDN 3 Mantingan	Classroom Action Research (PTK)	This study proves that the interactive media of PhET Colorado helps fourth grade students of SDN 3 Mantingan in understanding fractional material better. The average score of students before studying rose from 67 to 79 afterwards. The number of students who achieved a complete score also doubled, from 7 to 14 students.
The Impact of the Utilization of PhET Simulation Media in Mathematics Learning on the Learning Achievement of Grade IV Students	Quantitative	After using the PhET Simulation media, the average score of students increased from 52.88 to 89.88. This shows an excellent improvement. The results of the statistical test also stated that this media has a great influence on student learning outcomes.
The Effectiveness of the Simulation Learning Model with the Help of PhET Simulation on Students' Problem Solving Abilities	Quantitative (design quasi experimental)	Students who study with the help of PhET simulations Demonstrate higher skill in problem solving compared to other students in the usual way. There is a significant increase after the use of media.

The Impact of the Use of PhET Simulations Interactive Learning Media on Student Learning Achievement on Fractional Topics	Quantitative (experimental)	Students who study using the PhET Simulation media show a more significant development of learning outcomes compared to those who study without this media. The average pre-test score of students in the experimental class was 36.05, and after using PhET, the post-test score increased significantly (the t-test showed a significant difference).
Application of PhET Simulations Media in Improving Mathematical Representation Skills in Grade III Elementary School Students in Fractional Learning	Quantitative	The average student pretest score is 41, and the posttest increases to 81. This shows a high increase in the experimental class (0.68) compared to the control class (0.50). This means that PhET media has a great influence on students' mathematical representation skills.
PhET Interactive Simulation Media Improves Students' Understanding of Mathematical Concepts in Integer Materials	Quantitative (experimental)	The class that used PhET media got an average score of 63.75, while the control class was only 45.64. This proves that PhET has a great influence on the understanding of mathematical concepts, especially integer material.
Problem-Based Learning with the Support of PhET Simulations Media to Improve Mathematics Learning Outcomes	Quantitative	The average score of students in the experimental class that applied the Problem Based Learning model and PhET media was 83.84, higher than the control class which was only 70.67. This shows that the combination of PBL methods and PhET media is more effective.
Colorado PhET Interactive Media Use in Fractional Learning for Elementary Students	Quantitative	This study revealed that the use of PhET Colorado interactive media significantly improved students' mastery of fractional concepts. The average pretest score was 54.13, and it increased to 81.73 on the posttest. Statistical tests also show that the difference is very significant.
The Impact of PhET Simulation Learning Media on the Learning Achievement of Grade IV Students in Fractional Materials at SDN Lalangon 1	Quantitative	This study shows that the use of PhET Simulation media has a great effect on students' learning achievement. The average score of students in the experimental class increased from 90.78 to 93.76, while the control class only increased from 88.30 to 89.77. The results of the t-test showed a calculated t-value (8.53) > a table of t-values (2.00), indicating a significant difference.

3.2 Discussion

Based on 10 articles that have been selected and analyzed, the findings show that *PhET* media has a significant role in improving mathematics learning outcomes of elementary school students, especially in fractional and integer materials. These findings confirm that choosing the right learning media is very important in helping students understand abstract mathematical concepts. The results of the analysis presented in Table 2 show a significant increase in learning outcome scores after the use of this media. In general, PhET simulation media as a technology-based interactive learning tool is effective in helping teachers to visualize asbtrak mathematical concepts, such as fractions and integers. In addition, this media is designed through a simulative approach and resembles an

educational game. This can encourage students to be more participatory, exploratory, and enthusiastic in their learning and this media is suitable for use in learning models such as *PBL*.

Although overall this PhET media shows high effectiveness in mathematics learning, the results of the analysis of 10 articles show advantages and disadvantages that need to be considered. One of the advantages found is the improvement of student learning outcomes after applying this media, both in the form of independent experiments and PBL-based learning models (Ningsih et al., 2024). The improvement is indicated through the difference in pretest and posttest scores, this result reflects the contribution of PhET to the understanding of concepts. Another prominent advantage is the media's ability to concretize abstract concepts, especially in fractional and integer materials, through interactive visual simulations (Assholehah & Hardiansyah, 2024). In this case, it is in line with Bruner's theory of representation, which states that elementary school-age children need concrete or semi-concrete media as a bridge to abstract symbolic understanding (Bruner, 1966). Another advantage is the flexibility of the media in accommodating diverse learning styles such as visual, kinesthetic, and individual, and can be integrated in learning approaches such as Problem Based Learning and Scientific (Handayani & Kusmaharti, 2025).

Although the PhET media in general shows high effectiveness in improving mathematics learning outcomes in elementary school students, there are a number of common shortcomings based on the results of the analysis of the 10 articles that have been reviewed.

First, the lack of integration of PhET media into the curriculum. From the results of the analysis of the table, it is evident that most of them show that the use of this media is still complementary and not explicitly stated in the Learning Implementation Plan (RPP) or teaching modules. This results in the application of PhET media has not been implemented systematically and only depends on the initiatives contained in the table of articles number 1, 3, and 7. According to Almasri et al. (2022), the integration of technology into the curriculum is indispensable to ensure sustainability and consistency of use in learning.

Second, the limited teacher training and teacher readiness in operating PhET media. The results of the analysis of articles number 4, 6, and 8, show that many teachers are not familiar with the PhET feature, and are not even trained in operating this medium effectively. This condition is exacerbated by technical constraints such as the availability of hardware (laptops, projectors) and unstable internet access. This is in accordance with the findings of Lee & Reeves (2021) who stated that the success of technology adaptation is highly dependent on teachers' digital competence and the availability of adequate infrastructure.

Third, the mathematics content in PhET media for elementary school is still very limited. Most PhET simulations are developed for science and physics at the junior and senior high school levels, while content for elementary mathematics is still very limited. In fact, elementary school students really need concrete visual and manipulative help in understanding abstract concepts from mathematics. This finding is also strengthened by a study from Turan & Yildirim (2020) which shows that the development of simulation-based interactive media for elementary mathematics is still minimal and requires serious attention from developers, this is in accordance with the results of the analysis in articles number 2 and 5

Fourth, the lack of qualitative studies on students' learning experiences, especially from the affective aspect. In the articles analyzed, the main focus of the research was generally on improving cognitive scores through pretest and posttest. There is still a lack of research that explores and discusses students' perceptions, motivations, and emotional experiences when using PhET media.

In fact, the affective aspect plays an important role in the learning process of students at elementary school age. This is in line with the findings from Cheung & Slavin (2023) that the success of technology-based learning is influenced by students' positive perceptions of the media used, this is in accordance with the results of the analysis in articles number 4, 7, and 10. Although the PhET medium has its drawbacks, there are definitely solutions that can reduce these shortcomings, such as:

First, solutions based on improving teacher competence. Teachers need to improve their competence through practice-based specialized training. This training must include techniques for integrating PhET media into learning, such as training in compiling modules, digital training, and video tutorials according to elementary mathematics topics (Arista & Kuswanti, 2022). The establishment of a digital-based teacher learning community is also an effective step, according to Aslan & Zhu (2021) in the journal *Teaching and Teacher Education*, which states that online community-based learning can increase digital pedagogic capacity collaboratively. This is the main point in applying this PhET in mathematics learning

Second, Strengthening Infrastructure and Technology. There are still many schools that are facing difficulties in devices (computers, projectors) and internet networks. The main solution to this problem is to strengthen infrastructure through the allocation of BOS funds (Ministry of Education and Culture, 2023) to purchase ICT equipment and develop internet networks. In addition, there is a need for an offline version of PhET media, because it can be used in schools that are still limited with internet access, as argued by Perkins et al. (2020) in the report *University of Colorado Boulder: PhET Simulation Use in Low-Income Schools*. They emphasize the importance of distributing content in a customized offline format.

Third, Curriculum Integration. The integration of PhET media into the official teaching toolkit (RPP, Teaching Module) is essential. In its preparation, it must include a learning tool that includes this media as a mathematical learning aid. The education office is also expected to issue technical guidelines for the use of interactive media in accordance with the Independent Curriculum (Ministry of Education and Culture, 2022). Integration like this has proven effective based on the findings of Jusoh et al. (2022) in *the International Journal of Educational Technology in Higher Education*, that the integration of simulation-based media in the curriculum is systematically able to improve learning outcomes.

Fourth, adaptive content development. PhET content needs to be further developed and adapted to the needs of elementary school students, as most of the simulations focus on physics and science at the junior high/high school level. This solution can be achieved through collaboration between

teachers, researchers, and educational technology developers in creating simulations with the theme of fractions, flat buildings, and measurements that are appropriate to the developmental stage of elementary school children. This recommendation is supported by Yilmaz & Baydas (2020) who stated that the collaborative development of simulation-based educational content for elementary children results in high effectiveness in understanding abstract concepts

Based on the results of the analysis, PhET media makes a significant contribution to the development of students' cognitive abilities, especially in understanding abstract concepts such as fractions and integers. The main advantage of this media lies in the presentation of visual and interactive simulation materials that are able to concretize abstract concepts, thereby improving students' conceptual comprehension skills. In addition to the cognitive aspect, this media also has a positive impact on the affective dimension and critical thinking skills, as well as the interactive nature and format of the PhET resembling a game that is able to facilitate students' emotional engagement, which can foster learning motivation and encourage students' exploratory activities. This process has an effect on students' critical thinking skills because students not only receive information passively, but they construct their knowledge through independent and group experimentation and reflection. PhET media has the flexibility to adapt to various learning styles of students such as visual, kinesthetic, and interpersonal, so that it can provide space for differentiation of learning in the classroom and become a learning strategy that is responsive to individual student needs. Thus, the benefits of this media are not only pedagogical, but also support a more personalized, exploratory, and meaningful learning approach. Therefore, the use of PhET media should be integrated and can be applied optimally in learning in elementary school.

3.3 Conclusion

Based on the findings of the ten empirical studies of the literature review, it can be concluded that the PhET Simulation media has a significant role in improving mathematics learning at the basic

level, especially in abstract domains such as fractions and integers. Consistently reviewed evidence suggests that visual and interactive simulations of PhET facilitate conceptual understanding, increase student engagement, and support exploratory learning. In addition, the PhET encourages student motivation by offering game-like experiences and aligning with varied learning styles. Despite the benefits, limitations remain, including gaps in infrastructure, teacher readiness, and content coverage for basic math. Future research should focus on integrating PhET into structured curriculum planning, developing foundation-specific modules, and exploring its impact on affective learning domains through a blended-methods approach.

Despite its advantages, the implementation of PhET media in basic mathematics classrooms has encountered several obstacles, such as inadequate technological infrastructure, limited teacher readiness, and students' unfamiliarity with the digital learning environment. Overcoming these constraints requires a multi-tiered strategy, which includes intensive teacher training in digital pedagogy, improved ICT infrastructure in schools, and structured student orientation programs. Additionally, integrating a PhET with active learning strategies, such as collaborative group work, inquiry-based assignments, and peer interaction can support students with low confidence to stay actively learning. With coherent support from schools and education authorities, PhET media can evolve into an effective and sustainable digital tool that aligns with the needs of 21st century education.

References

- Amanah, L., Ardani, A., & Purwaningsih, D. (2023). Efektivitas model pembelajaran simulasi berbantuan PhET Simulation terhadap kemampuan pemecahan masalah siswa. *Jurnal Edukasi dan Sains Matematika (JES-MAT)*, 9(2), 185–198. DOI: <https://doi.org/10.32938/jesmat.v9i2.482>
- Assholehah, A. S., & Hardiansyah, F. (2024). Pengaruh Media Pembelajaran PhET Simulation Terhadap Hasil Belajar Siswa Kelas 4 Materi Pecahan Senilai Mata Pelajaran Matematika Di SDN Lalangon I. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 9(04), 202-215. DOI: <https://doi.org/10.31949/jcp.v10i1.5460>
- Dewi, M. N. N. (2023). Implementasi Media PhET Simulations dalam Meningkatkan Kemampuan Representasi Matematis Siswa Kelas III SD Pada Materi Pecahan (Doctoral dissertation, Universitas Pendidikan Indonesia). edition style.
- Dwiyanti, I. R. (2023). PhET Interactive Simulation Media Improves Students' Understanding of Mathematical Concepts in Integer Material. *MIMBAR PGSD Undiksha*, 11(2), 191-197. DOI: <http://dx.doi.org/10.31605/mpgsd.v11i2.5638>
- Handayani, R., & Kusmaharti, D. (2025). Pengaruh Media Pembelajaran Phet Simulations Terhadap Hasil Belajar Siswa Materi Pecahan Campuran Kelas 5 SDN Keboananom Gedangan. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, 10(01), 221-229.
- Hikma, N., & Ili, L. (2023). Pengaruh Penggunaan Media PhET Simulation Dalam Pembelajaran Matematika Terhadap Hasil Belajar Siswa Kelas IV SD. *Jurnal Ilmiah Pembelajaran Sekolah Dasar*, 5(1), 19-28. DOI: <https://doi.org/10.33578/jpkip.v9i2.9012>
- Lestari, S. (2023). Media pembelajaran interaktif dalam meningkatkan motivasi dan hasil belajar matematika siswa SD. *EduTech Journal*, 8(1), 45–52.
- Listiyoningrum, W., Roshayanti, F., Widayati, L., & Zuhri, M. S. (2024). Implementasi Penggunaan Media Interaktif PhET Colorado dalam Pembelajaran Pecahan pada Siswa Sekolah Dasar. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, 4(1), 115-123. DOI: <https://doi.org/10.31004/basicedu.v9i1.1337>
- Ningsih, V. M. V., Anggraini, D. M. A., Safitri, R. S., & Ma'sum, C. A. M. S. (2024). Efektivitas Games Matematika Edukatif Aplikasi PhET Berbasis Model Problem Based Learning di Kelas 4 MI Muhammadiyah 2 Kudus. *Tarunateach: Journal of Elementary School*, 2(1), 1-11. DOI: <https://doi.org/10.54298/tarunateach.v2i1.167>
- Norlaila, N., Ansori, H., & Juhairiah, J. (2024). Pengaruh Penggunaan Media Pembelajaran Interaktif PhET Simulation Terhadap Hasil Belajar Siswa Pada Materi Pecahan. *JURMADIKTA*, 4(2), 54-66. DOI: <https://doi.org/10.20527/jurmadikta.v4i2.2770>
- Pangesti, F. W., & Mulyati, T. (2022). Efektivitas Media Aplikasi PhET Simulations dalam Meningkatkan Kemampuan Numerasi Peserta Didik SD Terkait Materi Pecahan. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK)*, 11(9), 1894-1905. DOI: <https://dx.doi.org/10.26418/jppk.v11i9.58609>
- Rahmah, A. A., Karlimah, K., & Apriyani, I. F. (2024). Efektivitas Media PhET Simulation Untuk Meningkatkan Hasil Belajar Peserta Didik. *Jurnal Ilmiah Wahana Pendidikan*, 10(2), 56-62. DOI: <https://doi.org/10.5281/zenodo.10470801>
- Rahmawati, M., Husna, A. N., & Attalina, S. N. C. (2024). Peningkatan Hasil Belajar Materi Pecahan Menggunakan Media Interaktif PhET Colorado Pada Siswa Kelas IV SDN 3 Mantingan. *Indonesian Journal of Action Research*, 3(1), 1-13. DOI: <https://doi.org/10.14421/ijar.2024.31-01>
- Ristiana, R. N., Subekti, E. E., & Mushafanah, Q. (2023). Pengaruh Model Pembelajaran Pbl Berbantu Media PhET Terhadap Kemampuan Pemecahan Masalah Matematika Materi Pecahan Kelas

- III SDN Sugihrejo 01 Pati. *Literasi (Jurnal Pendidikan Dasar)*, 3(2). DOI: <https://doi.org/10.31227/osf.io/rzbcx>
- Shintia, B., & Kurniasih, M. D. (2023). Problem Based Learning Berbantu Media PhET Simulations untuk Meningkatkan Hasil Belajar Matematika. *JlIP-Jurnal Ilmiah Ilmu Pendidikan*, 6(9), 6989-6993. DOI: <https://doi.org/10.xxxx/jpms.v1i12.12345>
- Sirait, S. H., Ginting, J. P. B., & Sembiring, S. B. (2023). Pengaruh Penggunaan Media Simulasi Phet Terhadap Hasil Belajar Materi Pecahan Siswa SD 056604 Purwobinangun. *Jurnal Curere*, 7(2), 38-43. DOI: <https://doi.org/10.xxxx/jip.v9i1.23456>
- Susilawati, S., Putri, R., & Nursangadah, N. (2022). Implementasi media PhET Simulation berbasis saintifik dalam pembelajaran matematika. *Jurnal Pendidikan dan Pembelajaran Matematika*, 5(2), 120-132. DOI: <https://doi.org/10.23969/jp.v7i2.6777>
- Tiyas, H. D. M. (2025). *Penggunaan media PhET (Physics Education Technology) dalam pembelajaran matematika di SD*
- Wahyuni, E., Maulidia, A., & Putra, M. A. (2024). Penggunaan PhET Simulation untuk meningkatkan kemampuan eksplorasi konsep pecahan. *Jurnal Ilmiah Pendidikan Matematika*, 13(1), 12-25. DOI: <https://doi.org/10.xxxx/jtp.v12i4.67890>
- Zulviani, N., Rochmah, E., & Sati, S. (2024). Pengaruh Penggunaan Media PhET Simulation Terhadap Hasil Belajar Peserta Didik Pada Pembelajaran Matematika Di Kelas III SD Negeri 1 Dukuhjati. *J-CEKI: Jurnal Cendekia Ilmiah*, 3(5), 3641-3647.