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PHET Interactive Simulation Media Improves Students' Understanding of Mathematical Concepts in Integer Material

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ABSTRAK

Matematika merupakan ilmu dasar yang penting bagi manusia, tetapi pada kenyataannya banyak peserta didik yang tidak menyukai mata pelajaran tersebut dikarenakan mereka mengganggap matematika sulit, bersifat abstrak, dan membosankan. Hal ini dapat terjadi karena kurang efektifnya media pembelajaran yang digunakan oleh pendidik sehingga peserta didik kurang memahami konsep materi-materi matematika. Penelitian ini dilaksanakan dengan tujuan untuk mengetahui pengaruh penggunaan media PHET Interactive Simulation terhadap pemahaman konsep matematika peserta didik pada materi bilangan bulat. Penelitian ini tergolong kedalam jenis penelitian eskperimen, dengan populasi penelitian yakni seluruh siswa kelas IV. Penarikan sampel dalam penelitian dilakukan dengan teknik sampling jenuh, dengan jumlah sampel penelitian yakni 67 peserta didik yang terdiri dari dua kelas yaitu kelas kontrol dan kelas eksperimen. Pengumpulan data dalam penelitian dilakukan menggunakan metode tes, dengan instrument penelitian berupa tes pemahaman konsep matematika. Data yang diperoleh dalam penelitian kemudian dianalisis dengan analisis uji normalitas, uji homogenitas, dan uji hipotesis. Hasil penelitian ini menunjukkan ada pengaruh penggunaan media PHET Interactive Simulation terhadap pemahaman konsep matematika peserta didik. Disimpulkan bahwa ada pengaruh penggunaan media PHET Interactive Simulation dalam kemampuan pemahaman konsep matematika peserta didik.

ABSTRACT

Mathematics is a basic science important for humans, but in reality, many students prefer to avoid it because they think mathematics is difficult, abstract, and boring. It can happen because of the ineffectiveness of the learning media educators use, so students need help understanding the concept of mathematical materials. This research was conducted to know how PHET Interactive Simulation media affects students' understanding of mathematical concepts in integer material. This research belongs to the type of experimental research, with the research population being all fourth-grade students. Sampling in the study was carried out using a saturated sampling technique, with a total sample of 67 students consisting of two classes, namely the control and experimental classes. Data collection in the study was carried out using the test method, with the research instrument being a test of understanding mathematical concepts. The data obtained in the study were then analyzed by analyzing the normality test, homogeneity test, and hypothesis testing. This study's results indicate the effect of using PHET Interactive Simulation media on students' understanding of mathematical concepts. It was concluded that there was an effect of using PHET Interactive Simulation media on students' ability to understand mathematical concepts.

1. INTRODUCTION

Mathematics is a compulsory subject at every level of education, both elementary school, junior high school, high school, and even high school, because mathematics has an important role in human life, and mathematics is the basic science that underlies the development of science, other sciences and underlies the development of modern technology (Damayanti & Qohar, 2019; Mawaddah et al., 2021; Octavyanti & Wulandari, 2021; Sudiana et al., 2020). In mathematics, students must memorize existing formulas and understand the concepts presented (Dewi & Suniasih, 2022; Vikiantika et al., 2022). Concept understanding is defined as the ability of students to master a subject matter; students not only know or

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remember the material, but students can re-express the material in a simpler and easier-to-understand form (Aisyah & Sucahyo, 2022; Giriansyah et al., 2023; Septian et al., 2020). Students who have good conceptual understanding skills will be able to show indicators of conceptual understanding in tests, which consist of restating learned concepts, identifying examples and non-examples, applying concepts algorithmically, and presenting concepts in various forms of mathematical representation (Febriyani et al., 2022; Oktaviani & Anugrahi, 2019; Sengkey et al., 2023).

Almost all mathematics material requires understanding students' concepts and material on integer operations. The operations of addition and subtraction in integers are the most important things in mathematics. Studying integers requires concrete learning concepts, so students can imagine integers related to everyday life conditions using simulations or effective learning media (Arnandi et al., 2022; Haryanto & Dewi, 2019). In teaching and learning activities, learning media can act as a tool for educators in conveying teaching material to students in order to increase student learning motivation and also focus students during learning, make learning more meaningful, and so that learning is not boring (Arisandy et al., 2021; Suantiani & Wiarta, 2022; Tafonao, 2018). Therefore, educators are required to be creative and innovative in using learning media. Learning media can also function in accelerating the learning process. It implies that learning media lets students capture learning goals and materials more easily and quickly (Dewi & Suniasih, 2022; Guntur et al., 2023). It is further explained that learning media has an important role in supporting the quality of the teaching and learning process, where the media can make the learning process interesting and fun (Atmaja et al., 2021; Hasiru et al., 2021).

The reality shows that media use in learning mathematics is still relatively low. The low intensity of media use then impacts the low enthusiasm of student learning in teaching and learning mathematics (Anggraini, 2021; Hasbullah et al., 2020). Many students in Indonesia think that learning mathematics is difficult. The Program for International Student Assessment (PISA) under the Organization for Economic Cooperation and Development (OECD), which was conducted in 65 countries around the world in 2012, based on the results of its survey, stated that the mathematical ability of students in Indonesia was ranked lower with a score of 375 or less than 1%. Indonesian students who have good abilities in Mathematics (Aditya, 2018; Vikiantika et al., 2022). In the concept of integers and integer arithmetic operations, many students cannot distinguish the "+" and "-" signs as types of integers and integer arithmetic operations. However, not all schools have complete learning facilities to support the process of students understanding mathematical concepts. The results of observations made at SDN Jati Murni II show that many students at SDN Jati Murni II complain that they need help understanding the concepts of learning mathematics, especially in integer material, due to limited learning facilities and boring learning activities. Students cannot carry out direct simulations and practicals that educators commonly use to make explaining the concept of learning material easier. Therefore, we need interactive learning media based on direct simulations that can be used both for online and offline learning.

One of the media that can be used to improve students' understanding of mathematical concepts is the PHET interactive simulation media. PHET interactive simulation is an interactive learning medium from the University of Colorado in the form of a website that provides physics, biology, chemistry, and mathematics learning simulations, which can be accessed free of charge for the benefit of classroom learning or can be used for individual learning purposes (Arinda et al., 2019; Puspitasari et al., 2022). PHET simulation media emphasizes the relationship between real phenomena and computer simulations. It presents them in physical conceptual models that are easy for students to understand in understanding the concepts of teaching materials (Arisandy et al., 2021; Oktaviana et al., 2020). Using PHET Simulation, students will actively participate in the thought process and conclude (Subhan, 2021; Sukamto, 2022). This PHET Interactive Simulation can also be very useful for schools that do not have a complete laboratory. Educators and students can do free simulations on the PHET Interactive Simulation website (Laksono et al., 2023; Rahayu & Sartika, 2020; Roosyanti, 2022). The material presented in the PHET Interactive Simulation media is also very complete, for example, the material on integers.

Several studies that have been carried out previously revealed that educational game media using software construct two assisted by PHET simulation is practical and effective for increasing students' creative thinking abilities (Arisandy et al., 2021). Further research revealed that the PHET Simulation learning media significantly affected students' physics learning outcomes (Puspitasari et al., 2022). The results of other studies revealed that the electronic learning module assisted by the developed PHET simulation was in the very valid category (Oktaviana et al., 2020). Based on some of these studies' results, PHET simulation positively influences student learning outcomes. In previous studies, no studies specifically discussed the effect of PHET interactive simulation media on students' understanding of mathematical concepts in integer material. So, this research is focused on this study to know the effect of using PHET Interactive Simulation media on students' understanding of mathematical concepts in integer material.

2. METHOD

This research belongs to the type of experimental quantitative research. This research was initiated by providing treatment during learning in one of the classes using the PHET Interactive Simulation media with six meetings. Then, at the end of the meeting, a post-test question was given related to students' understanding of the concept. The population in this study were all students in class FOUR at SDN Jati Murni II Bekasi City, which consisted of 2 classes with a total of 67 students. The sampling technique in this study used a saturated sampling technique in which the samples were taken from all population members. The sample in this study consisted of 2 classes totaling 67 students, where there were two classes, namely class IV-A (control class with conventional media) and class IV-B (experimental class with PHET Interactive Simulation media). The experimental class (IV-B) consisted of 33 students, and the control class (IV-A) consisted of 34 students. The variables used in this study are independent variables (PHET Interactive Simulation media) and independent variables (understanding of mathematical concepts). The research design is a post-test-only control design.

Data collection in this study was carried out using the test method, with a research instrument in the form of 5 essay questions using integer material. Before testing the hypothesis from the data, the researcher tested the data using a prerequisite test consisting of a validity test, reliability test, normality test, and homogeneity test. After testing the prerequisites of the hypothesis, namely the normality and homogeneity tests, a hypothesis test can be carried out using an independent two-sample t-test to determine whether or not PHET Interactive Simulation media affects students' understanding of mathematical concepts.

3. RESULT AND DISCUSSION

Result

The data used in this study came from data on students' ability to understand mathematical concepts in integer material. The data were obtained from the experimental class using PHET Interactive Simulation media, while the control class used learning with conventional media. Data on the ability to understand mathematical concepts is obtained through test results (post-test) in the control and experimental classes. The test was conducted to measure the level of understanding of students' mathematical concepts. Based on the post-test results of the control and experimental classes, it was found that in the experimental class learning using the PHET Interactive Simulation media, it was found that the lowest score was 44 and the highest was 84, with a class average value of 63.75. Meanwhile, in the control class, the lowest score was 32, and the highest was 60, with an average control class score of 45.64. Research data on the control and experimental classes can be seen in Table 1, and Table 2.

Table 1. Data on Students' Understanding of Mathematical Concepts

Class	Data	Mean	Min	Max
Experiment	33	63,75	44	86
Control	34	45,64	32	60

Table 2. Frequency Distribution Table of Experimental Class Post-Test Scores

No.	Score	Median	Real Limits	Frequency		
				Absolute	Cumulative	Relative (%)
1	44 – 50	47	43,5 – 50,5	5	5	15%
2	51 – 57	54	50,5 – 57,5	5	10	15%
3	58 – 64	61	57,5 – 64,5	9	19	27%
4	65 – 71	68	64,5 – 71,5	3	22	9%
5	72 – 78	75	71,5 – 78,5	6	28	18%
6	79 – 85	82	78,5 – 85,5	5	33	15%

Table 3. Frequency Distribution of Control Class Post-Test Score

No.	Score	Median	Real-Limits	Frequency		
				Absolute	Cumulative	Relative (%)
1	32 – 36	34	31,5 – 35,5	8	8	24%
2	37 – 41	39	36,5 – 41,5	5	13	15%
3	42 – 46	44	41,5 – 46,5	6	19	18%
4	47 – 51	49	46,5 – 51,5	4	23	12%

No.	Score	Median	Real-Limits	Frequency		
				Absolute	Cumulative	Relative (%)
5	52 – 56	54	51,5 – 56,5	6	29	18%
6	57 – 61	59	56,5 – 61,5	5	34	15%

Based on the frequency distribution table for understanding the mathematical concepts of the experimental class, it can be seen that the integer material in the experimental class has the highest absolute frequency in the range of values 58-64 with a relative frequency of 27%. At the same time, the value with the smallest absolute frequency lies in the range of values 65-71, with a relative frequency of 9%. Furthermore, based on the frequency distribution table for understanding the mathematical concept of integer material in the control class, it can be concluded that the highest absolute frequency is in the range of values 32-36 with a relative frequency of 24%. At the same time, the value that has the smallest absolute frequency lies in the range of values 47-51 with a relative frequency of 12%. A histogram graph can be made from the frequency distribution table, as shown in Figure 1, and Figure 2.

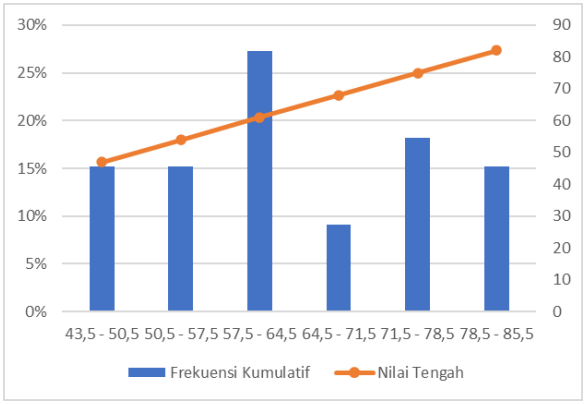

Figure 1. Frequency Distribution of Post-Test Scores for Experimental Class Students

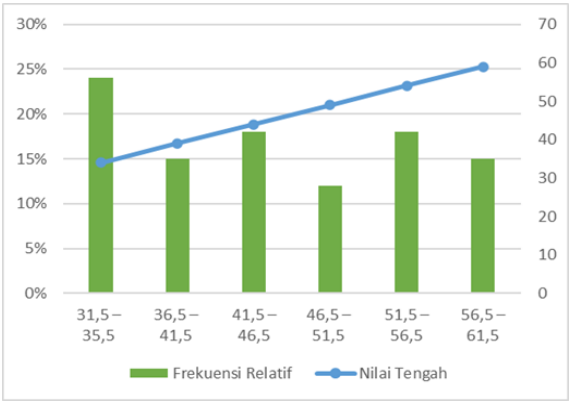

Figure 2. Frequency distribution of Post-Test Scores for Understanding Mathematical Concepts in the Control Class

Based on the histogram and polygon graphs in Figure 1, it can be determined that the highest frequency is at the real limit, namely 57.5 – 64.5 with a middle value of 61 and the lowest frequency is at the real limit of 64.5 – 71.5 with a middle value of 68 While the data in Figure 2 shows that the highest frequency is at the real limit, namely 31.5 – 35.5 with a median value of 34 and the lowest frequency is at a real limit of 46.5 – 51.5 with a median value of 49.

The normality test was carried out with Liliefors, and it was found that the significance value/Ltable with a value of α:0.05 in the experimental class and control class was greater than the arithmetic/Lcount statistics obtained from the experimental and control classes. So, it can be concluded that the test data for students' understanding of mathematical concepts in the experimental and control classes were normally distributed. The results of the calculation of the normality test can be seen in Table 3.

Table 3. Normality Test (*Liliefors*)

Class	L_{hitung}	df	L_{tabel}	Description
Experiment (PHET *Interactive Simulation*)	0,098	32	0,155	Normal
Control (Media Konvensional)	0,129	33	0,152	Normal

Furthermore, the results of calculating the homogeneity test using Fisher's test from the experimental class and control class obtained the variant in the experimental class, namely 149.93, and the variant in the control class, namely 84.47. Then, the Fcount is obtained, which is 1.774, smaller than the Ftable using α:0.05 with a value of 1.793. So, it was concluded that the samples in this study had the same variance or were homogeneous. After carrying out the prerequisite tests for normality and homogeneity, the hypothesis test was calculated using the t-test of two independent samples. In testing this hypothesis, the result is that the tcount value is 6.86 > ttable with a value of α = 0.05, which is 1.99. Therefore, H0, which reads that there is no influence of PHET Interactive Simulation media on students' understanding of mathematical concepts, is rejected, and H1, which reads that there is an influence of PHET Interactive Simulation media on students' understanding of mathematical concepts, is accepted. The experimental class

learning using PHET Interactive Simulation media has an average score of 63.75, higher than the control class learning using conventional media with an average score of 45.64. The results of calculating the hypothesis test using the t-test can be seen in Table 4.

Table 4. Hypothesis Test (T-Test)

	Experiment Class	Control Class
Mean	63.75	45.64
Variance	149.93	84.47
Observations	33.00	34.00
Pooled Variance	116.70	
Hypothesized Mean Difference	0.00	
df	65.00	
t Stat (t_{hitung})	6.86	
P(T<=t) one-tail	1.53	
t Critical one-tail	1.66	
P(T<=t) two-tail	3.06	
t Critical two-tail	1.99	

Based on the hypothesis test, it can be concluded that the PHET Interactive Simulation media improves students' ability to understand mathematical concepts in integer material, especially in fourth-grade students at SDN Jati Murni II, Bekasi City.

Discussion

Based on the results of the data analysis that has been carried out, the PHET Interactive Simulation media has effectiveness in increasing students' understanding of concepts. The PHET Interactive Simulation media can connect mathematical concepts with real-life contexts. PHET Interactive Simulation media was developed by emphasizing the relationship between real-life phenomena and the science that underlies them and trying to create physical conceptual models that are easy for students to understand so that students can learn interactively, like a game where students can learn. pleasantly (Fitriyati & Prastowo, 2022; Prihatin et al., 2022). In its use, the PHET Interactive Simulation media has several advantages, such as being able to connect concepts and real phenomena that occur and providing a visual picture of phenomena that are difficult for students to observe directly, can be used anywhere and anytime, the website used is free and easy to obtain, contains various animations so that it attracts the attention of students and makes learning not boring, and can connect material that is abstract with everyday life so that students can easily understand the concept of the material being taught (Arinda et al., 2019; Puspitasari et al., 2022; Subhan, 2021; Sukamto, 2022).

The characteristics possessed by PHET Interactive Simulation media are very much needed in learning mathematics. It is because mathematics material tends to contain various abstract concepts that are difficult for students to understand, so through the PHET Interactive Simulation media, these abstract concepts can be concretized through the presentation of learning animations (Anggraini, 2021; Hasbullah et al., 2020). Learning media that can concretize abstract concepts is very much needed by elementary school students. This is because elementary school students are in the concrete operational phase, where, at this stage, they have started to use logical thoughts by applying logic to physical objects (Arnandi et al., 2022; Haryanto & Dewi, 2019). In the process of understanding mathematical concepts, media is needed by students at the elementary school level in order to strengthen the foundation for learning mathematics (Febriyani et al., 2022; Oktaviani & Anugrahi, 2019; Sengkey et al., 2023). Besides strengthening the foundation of children's learning, PHET Simulation will involve students actively in the thought process and conclude (Subhan, 2021; Sukamto, 2022). This PHET Interactive Simulation can also be very useful for schools that do not have a complete laboratory. Educators and students can do free simulations on the PHET Interactive Simulation website (Laksono et al., 2023; Rahayu & Sartika, 2020; Roosyanti, 2022).

The results obtained in this study are in line with the results of previous research, which also revealed that the educational game media using the software construct two assisted by PHET simulation was stated to be practical and effective for increasing students' creative thinking abilities (Arisandy et al., 2021). Further research revealed that the PHET Simulation learning media significantly affected students' physics learning outcomes (Puspitasari et al., 2022). The results of other studies revealed that the electronic learning module assisted by the developed PHET simulation was in the very valid category (Oktaviana et al., 2020). Based on the results of this study, PHET simulation has a positive influence on student learning outcomes.

4. CONCLUSION

Based on the data analysis and discussion of research results, PHET Interactive Simulation media influences students' understanding of mathematical concepts in integer material. These results can be seen from the average post-test final score of the experimental class, which is higher than that of the control class. That way, this media can be an alternative to helping students understand mathematical concepts in integer material.

5. REFERENCES

Aditya, P. T. (2018). Pengembangan Media Pembelajaran Matematika Berbasis Web Pada Materi Lingkaran Bagi Siswa Kelas VIII. *Jurnal Matematika Statistika Dan Komputasi*, *15*(1), 64. https://doi.org/10.20956/jmsk.v15i1.4425.

Aisyah, D. D., & Sucahyo, I. (2022). Pengembangan Media Pembelajaran E-Book Berbasis Mobile Learning Dan Pendekatan Inkuiri Pada Materi Gelombang Untuk Meningkatkan Pemahaman Konsep Siswa. *Jurnal Inovasi Pendidikan Fisika*, *11*(3). https://doi.org/10.26740/ipf.v11n3.p23-31.

Anggraini, V. (2021). Stimulasi Kecerdasan Logika Matematika Melalui Media Animasi Lagu Berbasis Tematik Pada Masa Pandemic Covid-19 Di Kota Bukit Tinggi. *Pedagogi : Jurnal Anak Usia Dini Dan Pendidikan Anak Usia Dini*, *7*(1), 106. https://doi.org/10.30651/pedagogi.v7i1.7258.

Arinda, Y., Wilujeng, İ., & Kuswanto, H. (2019). The Application Group Investigation (GI) Learning Model assisted Phet to Facilitate Student Scientific Work Skills. *International Journal of Educational Research Review*, *4*(2), 254–261. https://doi.org/10.24331/ijere.518069.

Arisandy, D., Marzal, J., & Maison, M. (2021). Pengembangan Game Edukasi Menggunakan Software Construct 2 Berbantuan Phet Simulation Berorientasi pada Kemampuan Berpikir Kreatif Siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(3), 3038–3052. https://doi.org/10.31004/cendekia.v5i3.993.

Arnandi, F., Siregar, N., & Fitriawan, D. (2022). Media Pembelajaran Matematika Menggunakan Smart Apps Creator pada Materi Bilangan Bulat di Sekolah Dasar. *Plusminus: Jurnal Pendidikan Matematika*, *2*(3). https://doi.org/10.31980/plusminus.v2i3.2194.

Atmaja, I. K., Sukendra, K., & Widana. (2021). Pengembangan Bahan Ajar Digital Matematika SMA Kelas X Berorientasi HOTS. *Widyadari*, *22*(2), 459–468. https://doi.org/10.5281/zenodo.5550368.

Damayanti, P. A., & Qohar, A. (2019). Pengembangan Media Pembelajaran Matematika Interaktif Berbasis Powerpoint pada Materi Kerucut. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *10*(2), 119–124. https://doi.org/10.15294/kreano.v10i2.16814.

Dewi, P. D. P., & Suniasih, W. (2022). Media Video Pembelajaran Matematika Berbasis Etnomatematika pada Muatan Materi Pengenalan Bangun Datar. *Jurnal Edutech Undiksha*, *10*(1), 156–166. https://doi.org/10.23887/jeu.v10i1.44775.

Febriyani, A., Hakim, A. R., & Nadun, N. (2022). Peran Disposisi Matematis terhadap Kemampuan Pemahaman Konsep Matematika. *Plusminus: Jurnal Pendidikan Matematika*, *2*(1), 87–100. https://doi.org/10.31980/plusminus.v2i1.1546.

Fitriyati, I., & Prastowo, A. (2022). Pembelajaran Daring Menggunakan Phet Simulations Untuk Meningkatkan Keaktifan Dan Hasil Belajar Siswa Madrasah Ibtidaiyah. *Al-Madrasah: Jurnal Pendidikan Madrasah Ibtidaiyah*, *6*(4), 1041. https://doi.org/10.35931/am.v6i4.1120.

Giriansyah, F. E., Pujiastuti, H., & Ihsanudin, I. (2023). Kemampuan Pemahaman Matematis Siswa Berdasarkan Teori Skemp Ditinjau dari Gaya Belajar. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(1), 751–765. https://doi.org/10.31004/cendekia.v7i1.1515.

Guntur, M., Sahronih, S., & Ismuwardani, Z. (2023). Pengembangan Komik Sebagai Media Belajar Matematika di Sekolah Dasar. *Jurnal Kajian Pendidikan Dasar*, *8*(1). https://journal.unismuh.ac.id/index.php/jkpd /article/view/9685/5629.

Haryanto, H., & Dewi, S. R. (2019). Pengembangan multimedia interaktif penjumlahan pada bilangan bulat untuk siswa kelas IV sekolah dasar. *Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran*, *9*(1), 9. https://doi.org/10.25273/pe.v9i1.3059.

Hasbullah, Karim, A., & Savitri, D. (2020). Pengembangan Media Pembelajaran Matematika Berbasis Android Di Kelas 4 Sekolah Dasar. *Jurnal Lebesgue : Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika*, *1*(2), 63–75. https://doi.org/10.46306/lb.v1i2.17.

Hasiru, D., Badu, S. Q., & Uno, H. B. (2021). Media-Media Pembelajaran Efektif dalam Membantu Pembelajaran Matematika Jarak Jauh. *Jambura Journal of Mathematics Education*, *2*(2), 59–69. https://doi.org/10.34312/jmathedu.v2i2.10587.

Laksono, P., Wicaksono, A., & Habisukan, U. H. (2023). Pendampingan Pemanfaatan Simulasi PhET Sebagai Media Interaktif Virtual Laboratorium Di Mts Tarbiyatussibyan. *Jurnal Anugerah*, *4*(2), 179–192.

https://doi.org/10.31629/anugerah.v4i2.4843.
Mawaddah, A., Wardah, A., Hidayat, M. T., Amin, S. M., & Hartatik, S. (2021). Pengaruh Penggunaan Media Pembelajaran Quizizz terhadap Hasil Belajar Siswa pada Mata Pelajaran Matematika melalui Daring di Sekolah Dasar. *Jurnal Basicedu*, *5*(5), 3109–3116. https://doi.org/10.31004/basicedu.v5i5.1288.
Octavyanti, N. P. L., & Wulandari, I. G. A. A. (2021). Pengembangan Video Pembelajaran Berbasis Pendekatan Kontekstual Pada Mata Pelajaran Matematika Kelas IV SD. *Jurnal Edutech Undiksha*, *9*(1). https://doi.org/10.23887/jeu.v9i1.32223.
Oktaviana, M., Putri, D. H., & Risdianto, E. (2020). Pengembangan Modul Elektronik Berbantuan Simulasi PHET Pada Pokok Bahasan Gerak Harmonik Sederhana Di SMA. *Jurnal Kumparan Fisika*, *3*(2), 131–140. https://doi.org/10.33369/jkf.3.2.131-140.
Oktaviani, F. K., & Anugrahi, I. (2019). Pengaruh Metode Discovery Learning terhadap Pemahaman Konsep Operasi Hitung Siswa kelas V B dan C di SDN Neglasari. *Jurnal Basicedu*, *3*(2), 1. https://jbasic.org/index.php/basicedu/index.
Prihatin, I., Firdaus, M., Oktaviana, D., & Susiaty, U. D. (2022). Peningkatan Kemampuan Penalaran Matematis Siswa Dengan E-Modul Logika Matematika Berbasis PHET Simulation. *SAP (Susunan Artikel Pendidikan)*, *7*(2), 252. https://doi.org/10.30998/sap.v7i2.14071.
Puspitasari, L., Subiki, S., & Supriadi, B. (2022). Pengaruh Media Phet Simulation Terhadap Motivasi Dan Hasil Belajar Fisika Siswa Smk. *Jurnal Pendidikan Fisika*, *11*(2), 89. https://doi.org/10.24114/jpf.v11i2.37682.
Rahayu, C. D., & Sartika, S. B. (2020). Students Learning Motivation and Concepts Understanding of Science through the Use of PhET Interactive Simulations. *SEJ (Science Education Journal)*, *4*(1), 63–76. https://doi.org/10.21070/sej.v4i1.750.
Roosyanti, A. (2022). PhET Interactive Simulation As A Virtual Laboratory For Science Learning In Elementary School During The Covid-19 Pandemic. *Auladuna: Jurnal Pendidikan Dasar Islam*, *9*(2), 121–135. https://doi.org/10.24252/auladuna.v9i2a1.2022.
Sengkey, D. J., Deniyanti Sampoerno, P., & Aziz, T. A. (2023). Kemampuan Pemahaman Konsep Matematis: Sebuah Kajian Literatur. *Griya Journal of Mathematics Education and Application*, *3*(1), 67–75. https://doi.org/10.29303/griya.v3i1.265.
Septian, A., Agustina, D., & Maghfirah, D. (2020). Model Pembelajaran Kooperatif Tipe Student Teams Achievement Division (STAD) untuk Meningkatkan Pemahaman Konsep Matematika. *Mathema: Jurnal Pendidikan Matematika*, *2*(2), 10. https://doi.org/10.33365/jm.v2i2.652.
Suantiani, N. M. A., & Wiarta, I. W. (2022). Video Pembelajaran Berbasis Pendekatan Kontekstual Pada Muatan Matematika. *Jurnal Penelitian Dan Pengembangan Pendidikan*, *6*(1), 64–71. https://doi.org/10.23887/jppp.v6i1.45455.
Subhan, A. (2021). Penggunaan Model Pembelajaran Aktif Tipe Card sort Dengan Simulasi PhET Pada Materi Lensa Untuk Meningkatkan Sikap Ilmiah Siswa. *Jurnal Penelitian Pembelajaran Fisika*, *12*(2), 143–150. https://doi.org/10.26877/jp2f.v12i2.8325.
Sudiana, R., Putra, E. A., & Pamungkas, A. S. (2020). Pengembangan Smartphone Learning Management System (S-LMS) Sebagai Media Pembelajaran Matematika di SMA. *Jurnal Matematika Kreatif-Inovatif*, *11*(1), 36–45. https://doi.org/10.15294/kreano.v11i1.21014.
Sukamto, T. (2022). Pemanfaatan Media Phet Simulation Pada Pembelajaran Fisika Dengan Pendekatan Contextual Teaching and Learning. *Jurnal Educatio*, *8*(2), 649–654. https://doi.org/10.31949/educatio.v8i2.2327.
Tafonao, T. (2018). Peranan Media Pembelajaran Dalam Meningkatkan Minat Belajar Mahasiswa. *Jurnal Komunikasi Pendidikan*, *2*(2), 103. https://doi.org/10.32585/jkp.v2i2.113.
Vikiantika, A., Primasatya, N., & Erwati, Y. (2022). Peningkatan Hasil Belajar Siswa Sekolah Penggerak pada Mata Pelajaran Matematika Melalui Media Pembelajaran Berbasis Flipbook. *Jurnal Basicedu*, *6*(2), 2002–2013. https://doi.org/10.31004/basicedu.v6i2.2328.