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Comparison of Cognitive Learning Outcomes and Students' Science Process Skills Between Hands on Practicum and Virtual Laboratory Based on PhET Simulation Viewed from Students' Learning Style

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Abstract: This study aims to determine the comparison of direct practicum with virtual laboratory practicum based on phet simulation on geometric optics material in terms of learning style, cognitive learning outcomes, and student science process skills. The research was conducted at SMA Negeri 1 Belalau, West Lampung Regency, with a population of all XI IPA class students, a sample of XI IPA 2 class of 26 students and XI IPA 3 class of 27 students taken by purposive sampling technique. This study used a research design, namely factorial design. Data analysis techniques used were N-Gain test, normality test, homogeneity test, and Two Way Anova test. The results showed that there was no significant difference after the application of hands on practicum and virtual laboratory based on PhET Simulation on optical geometry material in terms of learning style, cognitive aspect learning outcomes, and student science process skills. Based on the results of the study, it can be concluded that learning methods with hands on practicum and virtual practicum patterns are able to accommodate different learning styles of students and train learning outcomes of cognitive aspects and learning outcomes of science process skills aspects of students.

Keywords: Cognitive learning outcomes; Hands on practicum; Learning style; Science process skills; Virtual practicum

Introduction

Currently, education is entering the 21st century transformation era. The era of 21st century education transformation is a flow of change where teachers and students both play an important role in learning activities (Zubaidah, 2020). The role of the teacher is not only as a transfer of knowledge or teacher as a teacher center, but the teacher as a mediator and active facilitator to develop the potential of students who exist in themselves. Teachers' knowledge, skills and experience can be integrated in creating effective and professional learning conditions to make it more varied, meaningful and fun.

Learning in the 21st century needs to be done according to student needs. Students who have kinesthetic learning styles need to learn by moving, working and touching. Students who have an auditory learning style need to be taught by listening, emphasizing all sounds and words that are created, created and remembered. Students who have a visual learning style need to be taught by neatly recording material, reading books that have text and images or through concept maps (Nurnaifah et al., 2022).

These diverse learning styles must also be accommodated with a variety of teaching methods, in this case meaning differentiated learning. Differentiated learning is a way or effort made by teachers to meet the needs and expectations of students. The problem in the field is that learning has not accommodated students' learning styles. Teachers teach students not maximally conceptualize differentiated learning and even teachers

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tend to not understand or ignore this concept. Learning is more dominant in teacher-centered (teacher centered), which in the latest educational concepts has begun to be abandoned, which should be based on students (student centered) (Alhafiz, 2022; Saparuddin et al., 2021).

Learning in the 21st century is a new challenge for teachers and students, including in physics. Physics is one of the branches of science. Physics is the result of human activities in the form of organized knowledge, ideas, and concepts about the surrounding nature obtained from a series of experiences through the scientific process. Physics lessons are not enough to just study the product but emphasize how the product is obtained, both as a scientific process and the development of students' scientific attitudes. For this reason, learning outcomes are not only limited to the cognitive domain, but also the psychomotor domain and the affective domain.

Psychomotor skills are very important to teach because from these skills, students will better know and understand what they have learned (Prihatiningtyas et al., 2013). In other words, students must have good skills, understanding and reasoning power towards a physics phenomenon. Physics learning should provide direct learning experiences through the use and development of process skills and scientific attitudes.

The physics learning process that takes place so far is still dominated by conventional learning models, namely with direct learning models with lecture methods. The main reason teachers still use conventional learning models is because of the limited physics laboratory equipment owned by schools, both in terms of quantity and quality. Experimental activities can not only be carried out in real laboratories, but can use virtual laboratories, supported by the characteristics of physics material itself which involves abstract processes and concepts that cannot be observed directly (Mackin et al., 2012; Sutarno et al., 2017).

The demand to improve science process skills and student learning outcomes naturally leads educators to consider how this can be implemented in the classroom. Science process skills can usually be explored from hands-on practicum activities. Seeing that not all schools allow hands on practicum, one solution is to use a virtual laboratory.

A virtual laboratory can be described as an interactive situation to simulate an experiment. Many virtual laboratories have been developed, one example that provides easy access is the PhET Simulations virtual laboratory (Puspita, 2020; Taufik et al., 2022). PhET stands for Physics Education Technology. PhET Simulations can be accessed freely, downloaded without payment and can be used without being connected to the internet if it has been downloaded (Subeki et al., 2022).

Based on research conducted by Arifudin (2021), the application of practicum with PhET virtual laboratory can increase the average score and the number of students who are complete in learning Physics at SMAN 1 Amuntai. The results of this study showed that the number of learning completeness in Direct Current Electricity increased by 30% (from 64% to 94%). In addition to the number of students who completed the learning increased, another thing that was found was the use of practicum with virtual laboratory will provide a learning experience that is very useful for learning the next physics concepts.

From the interview with the physics teacher at SMAN 1 Belalau, West Lampung Regency, during the learning process students tend to be passive so that the teacher plays a more dominant role in the learning process. The school also never uses learning media during the physics learning process, the teacher only uses lecture-based learning methods, read books, then practice questions. Students' science process skills and cognitive learning outcomes are still low because students are less directed in the development of science process skills, students only learn physics such as memorizing concepts and theories.

Based on the description above, it is very important to investigate whether the learning outcomes of cognitive aspects and science process skills of students with virtual practicum methods can match the hands on practicum method and find out how to practicum in accordance with students' learning styles. Research on the effectiveness of virtual practicum on student learning outcomes is essential to identify the benefits, limitations and potential for development. Thus, it will create a better, inclusive, educational approach that focuses on the individual needs of students in understanding science concepts. Therefore, the researcher intends to conduct research on hands on practicum and virtual practicum with geometry optics material to determine the comparison of cognitive learning outcomes and science process skills of students at SMAN 1 Belalau. The title of this research is "Comparison of Hands on Practicum with Virtual Laboratory Based on PhET Simulation of Geometric Optics Material in terms of Learning Style, Cognitive Learning Outcomes and Science Process Skills of Students".

Research like this has been carried out by previous researchers, namely research conducted by Arifudin (2021) with the title "Use of PhET Virtual Laboratory to Improve Physics Learning Outcomes of High School Students". In addition, research conducted by Arumningtyas et al. (2022) with the title "Application of Virtual Laboratory to Improve Students' Science Process Skills during Pandemic". The difference between this research and previous research is that previous researchers have not examined the relationship between student learning styles with practicum methods, student learning outcomes and science process skills.

Method

This research uses a quantitative approach. The design used in this research is factorial design which aims to see the interaction of the factors tried. The first factor is the practicum method, namely hands on practicum and virtual laboratory. The second factor is learning style, namely visual, audiotory, and kinesthetic learning styles. The research design can be seen in Table 1.

Table 1. Research Design

O_1	A_1	B_1	O_2
O_1	A_1	B_2	O_2
O_1	A_1	B_3	O_2
O_1	A_2	B_1	O_2
O_1	A_2	B_2	O_2
O_1	A_2	B_3	O_2

Description:

O_1 : Pretest in experimental class 1 and 2
O_2 : Posttest in experimental class 1 and 2
A_1 : Giving hands on practicum treatment to experimental class 1
A_2 : Giving virtual practicum treatment to experimental class 2
B_1 : Visual learning style
B_2 : Audiotory learning style
B_3 : Kinesthetic learning style

The population in this study were students of class XI majoring in IPA SMAN 1 Belalau. The samples used in this study were class XI IPA 2 and XI IPA 3 SMAN 1 Belalau. Of the two classes, one class was grouped into experimental class 1, namely class XI IPA 2 and another class as experimental class 2, namely class XI IPA 3. The sample was taken using purposive sampling technique, with the consideration that students in both classes had relatively the same daily test scores, UTS, and UAS.

In this study, the data collection technique used was a test. Giving pretests to all students in experimental class 1 and experimental class 2, namely before learning activities are carried out. Giving posttests to all students in experimental class 1 and experimental class 2, namely after learning. The research instruments used by the author in this study were learning style questionnaire sheets, cognitive aspect learning outcomes test instruments, and science process skills test instruments.

The data obtained in this study is the data from the pretest and posttest results, then the data is analyzed using N-gain to determine the difference in pretest and posttest in experimental class 1 and experimental class 2. The N-Gain test formula is:

$$\text{Normalized Gain (g)} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}} \quad (1)$$

The results of the calculation of the normalized gain are then interpreted based on Table 2.

Table 2. N-Gain Index Interpretation Category

N-Gain Percentage (%)	Category
71 – 100	High
31 – 70	Medium
0 – 30	Low

To test the hypothesis in this study, researchers used several tests, namely normality test, homogeneity test, and two-way anova test. The two-way anova analysis design can be seen in

Table 3. Two Way Anova Analysis Design

Learning Outcomes	Practicum Pattern		Average (R_1)
	Hands on Practicum	Virtual Laboratory	
Visual	A_{11}	A_{21}	A_{11}+ A_{21}
Audiotory	B_{12}	B_{22}	B_{12}+ B_{22}
Kinesthetic	C_{13}	C_{23}	C_{13}+ C_{23}
Average (R_2)	A_{11}+ B_{12} + C_{13}	A_{21}+ B_{22} + C_{23}	$\sum R_1 + \sum R_2$

Information:

A_{11} : Average visual learning outcomes with hands on practicum pattern
B_{12} : Average audiotory learning outcomes with hands on practicum pattern
C_{13} : Average kinesthetic learning outcomes with hands on practicum pattern
A_{21} : Average visual learning outcomes with virtual laboratory practicum pattern
B_{22} : Average audiotory learning outcomes with virtual laboratory practicum pattern
C_{23} : Average kinesthetic learning outcomes with virtual laboratory practicum pattern

Result and Discussion

The Two Way Anova test was conducted to compare the differences in the average learning outcomes of cognitive aspects and learning outcomes of KPS aspects in samples given hands on practicum treatment and virtual practicum by reviewing student learning styles. The results of the Two Way Anova test are shown in Table 4 and Table 5.

Based on Table 4, the significance value of the treatment given, namely the practicum pattern in the form of hands on practicum and virtual laboratory, is greater than 0.05, then H_0 is accepted and H_1 is rejected, meaning that there is no difference in learning outcomes in the cognitive aspects of students using hands on practicum methods and virtual laboratories based on PhET Simulation on optical geometry material. The significance value of learning style is greater than 0.05, then H_0 is accepted and H_1 is rejected. This means that there is no difference in student learning outcomes in the cognitive domain of geometric optics material due to differences in learning styles. The significance value of treatment * learning style is greater than 0.05, then H_0 is accepted and H_1 is rejected. This means that there is no interaction between hands on practicum and virtual laboratory with learning style seen from the learning outcomes of the cognitive domain on geometry optics material.

Table 4. Two Way Anova Test of Cognitive Aspect Learning Outcomes

Measured subject	Sig.
Treatment	.343
Learning_Style	.061
Treatment* Learning_Style	.351

Tabel 5. Two Way Anova Test Learning Outcomes Aspects of Science Process Skills

Measured subject	Sig.
Treatment	.972
Learning_Style	.788
Treatment* Learning_Style	.656

Based on Table 5, the significance value of the treatment given, namely the practicum pattern in the form of hands on practicum and virtual laboratory is greater than 0.05, then H_0 is accepted and H_1 is rejected, meaning that there is no difference in learning outcomes in the KPS aspect of students using hands on practicum methods and virtual laboratories based on PhET Simulation on geometric optics material. The significance value of learning style is greater than 0.05, then H_0 is accepted and H_1 is rejected. This means that there is no difference in student learning outcomes in the aspect of science process skills in geometry optics material due to differences in learning styles. The significance value of treatment * learning style is greater than 0.05, then H_0 is accepted and H_1 is rejected. This means that there is no interaction between hands on practicum and virtual laboratory with learning style seen from the learning outcomes of science process skills aspects of geometry optics material.

In the learning process, namely Inquiry Labs, students conduct practicum in accordance with the experimental steps in the practicum guide, can be seen in Figure 1 and Figure 2. Figure 1 shows the activities of students in experimental class 1 doing hands on practicum, while Figure 2 shows the activities of students in experimental class 1 doing virtual practicum. During the practicum students also collect data obtained based on the results of the practicum and written in the observation table in the practicum guide. In the implementation of practicum, both experimental class 2 and experimental class 1 students were very enthusiastic about participating in practicum activities.

Figure 1. Students doing hands on practicum

Figure 2. Students performing virtual practicum

In the Real-World Application phase. After students carry out the practicum and collect experimental data, students analyze the experimental data and answer the questions in the practicum guide. At this stage, students are able to solve problems and answer questions in the practicum guide, shown in Figure 3.

Figure 3. Students analyzing experiment results and answering questions on the practicum guide

In the Inquiry Labs phase, the learning outcomes indicators of cognitive aspects are applying and analyzing, while in the Real World Application phase, the learning outcomes indicators of cognitive aspects are evaluating. The Inquiry Labs and Real World Application phases are trained in experimental class 1 using hands on practicum and experimental class 2 using a virtual laboratory, so that the learning outcomes of the cognitive aspects of experimental class 1 and experimental class 2 students increase and there are no differences after the application of hands on practicum with virtual laboratories on geometric optics material in terms of learning outcomes of students' cognitive aspects. These results are supported by research by Yunita et al. (2021), which found that learning with the practicum method can improve students' physics learning outcomes. Another study, namely by Martanti et al. (2021), which states that the virtual practicum-based physics learning method using PhET simulation has an effect on students' cognitive learning outcomes.

In addition to learning outcomes in cognitive aspects, the study showed that there was no significant difference after the application of hands on and virtual laboratory practicum on geometry optics material in terms of learning outcomes in the KPS aspect of students. This can be seen from the average value of N-Gain and the two-way anova test conducted. In the learning process of the Discovery Learning phase, students are guided to identify phenomena around their lives related to the reflection of light in flat mirrors, concave mirrors, and convex mirrors. In this study, the phenomenon of reflecting in a decorative mirror, rearview mirror, and spoon is presented. Based on this phenomenon, students are guided to observe the nature of the shadows formed by flat mirrors, concave mirrors, and convex mirrors. At this stage students are able to observe the nature of shadows well, it can be seen in the students' answers shown in Figure 4.

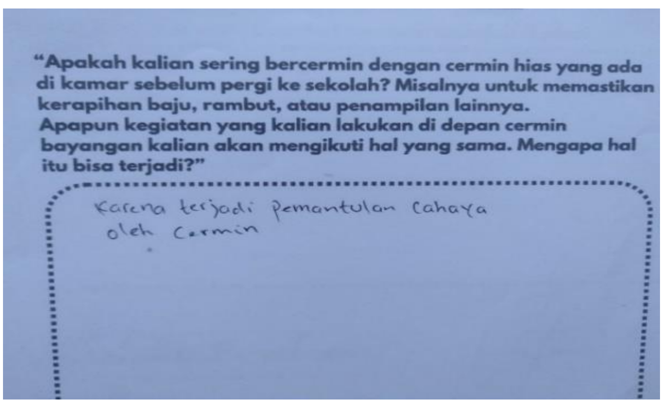

Figure 4. Students' answers on the practicum guide

In the second phase, Interactive Demonstration, students identify the problem formulation related to the experiment to be carried out, which is related to the nature of the shadow, the location of the shadow, and the path of the special ray in the event of light reflection on the mirror. At this stage, students must be guided so that the problem formulation is not too broad. After that, students make a provisional answer or hypothesis for solving the problem formulation. At this stage, students can analyze the problem formulation and make hypotheses as shown in Figure 5.

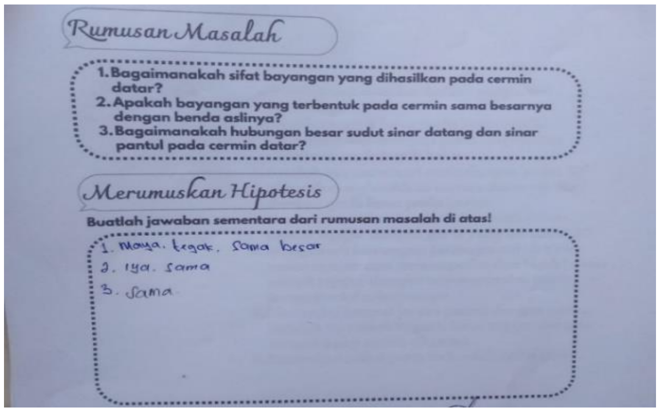

Figure 5. Students' answers on the practicum guide

Next is the Inquiry Lesson phase. At this stage, students in experimental 2 and control classes recognize and prepare tools and materials to conduct a practicum on light reflection in mirrors. Students observe the observation table and analyze the fixed variables and variables that will be changed during the practicum. The last phase is the Hypothetical Inquiry phase, students make conclusions according to the experiments that have been carried out. Students are able to analyze the nature of shadows, the location of shadows, and are able to describe the course of special rays in the event of light reflection by a mirror. This can be seen in Figure 6.

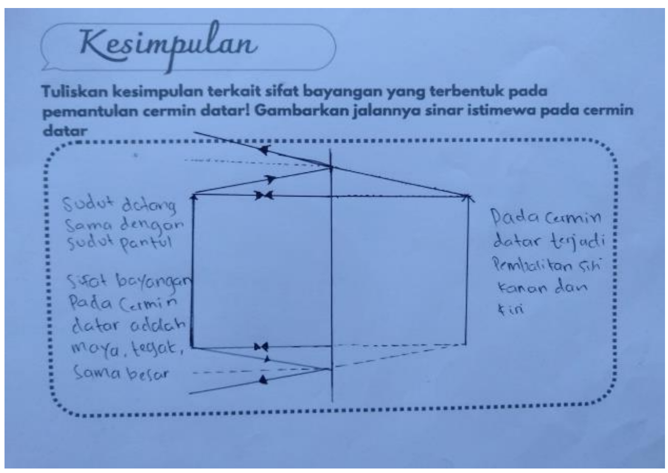

Figure 6. Students' answers on the practicum guide

Students' involvement in each phase of the learning process provides a stimulus to train the learning outcomes of cognitive aspects or learning outcomes of KPS aspects. In the Discovery Learning phase, the learning outcome indicators of the KPS aspects that are trained are observing, where students observe the nature of the shadows formed by flat mirrors, concave mirrors, and convex mirrors. In the Interactive Demonstration phase, the learning outcome indicators of the KPS aspects that are trained are formulating problems and formulating hypotheses related to the experiments to be carried out.

The Inquiry Lesson phase trains the learning outcome indicators of the KPS aspect, namely predicting, students predict the fixed variables and variables that can be changed in the experiment. In the Inquiry Labs phase, the learning outcome indicators of the KPS aspects are grouping, communicating, planning experiments, and using tools and materials. The Real-World Application phase trains the learning outcome indicators of the KPS aspect of interpreting. The Hypothetical Inquiry phase trains the learning outcome indicators of the KPS aspect of applying concepts.

These six learning phases are applied with different practicum patterns, in experimental class 1 with hands on practicum and experimental class 2 with virtual laboratory. However, the learning phase is carried out with the same stages so that the learning outcomes of the KPS aspects of experimental class 1 and experimental class 2 increase and there are no differences after the application of hands on practicum with virtual laboratories on geometric optics material in terms of learning outcomes of students' KPS aspects. The results of this study are supported by research conducted by Fitriani et al. (2021), students' science process skills with practicum methods show that the level of students' science process skills is classified at a very good level. In addition, research conducted by Defianti et al. (2021) showed an increase in the science process skills of prospective physics teacher students when doing practicum using a virtual laboratory.

Based on the results of the study, there was no significant difference in student learning outcomes in the cognitive domain due to differences in learning styles. This study also found that there was no significant difference in student learning outcomes in the KPS aspect due to differences in learning styles. This can be proven in the results of the two-way anova test.

The application of hands on practicum and virtual laboratory can accommodate various learning styles of students. Students with visual learning styles who have dominant characteristics can learn to use the sense of sight in the learning process in hands on practicum learn by looking at pictures on LKPD, looking directly at practicum tools, reading, writing, understanding well the position, shape, numbers, and remembering what they see. In virtual practicum, students with visual learning styles can learn by looking at pictures on the LKPD, looking at pictures on the PhET Simulation, reading, writing, remembering the shapes and numbers they see. Students with audiotory learning styles who have dominant characteristics can learn using the sense of hearing in hands on practicum and virtual practicum learn through what they listen to, both from the teacher and the opinions of their colleagues in the learning process. Students with kinesthetic learning styles who have dominant characteristics can learn with physical activity, in hands on practicum students can move, touch, and do hands-on practicum with the tools provided so that they can more easily understand learning. In virtual practicum students can also move, touch, and do practicum with PhET Simulation-based virtual laboratory which has complete features and can match learning outcomes using hands on practicum. The results of this study are not in line with research conducted by Hasanah et al. (2018), where this study found that learning style has a dominant effect on the learning outcomes of grade XI students.

The results showed that there was no interaction between hands on practicum and virtual laboratory with learning style in terms of cognitive learning outcomes. In addition, there is no interaction between hands on practicum and virtual laboratory with learning style seen from the learning outcomes of KPS aspects. The results showed that there was no significant difference after the application of hands on practicum and virtual laboratory based on PhET Simulation on geometry optics material in terms of learning style, learning outcomes of cognitive aspects, and students' science process skills also strengthened the result that there was no interaction between hands on practicum and virtual laboratory with learning style in terms of learning outcomes of cognitive aspects and students' KPS.

In the application of hands on practicum and virtual laboratory methods, students are fully involved in the learning process. Students conduct experiments, collect data, analyze data, and solve problems, so that learning will make students apply theory and understand the material more complexly. This is in line with Tiranda (2020), who states that physics learning based on proof and testing from theoretical to practical phenomena will make physics concepts understandable, so that the development of student behavior, knowledge, and skills can be improved properly.

The difference between this research and previous research is that previous researchers have not examined the relationship between students' learning styles with practicum, learning outcomes of students' cognitive aspects and students' science process skills. Previous researchers only examined the relationship between practicum and learning outcomes in cognitive aspects, the relationship between practicum and learning outcomes in KPS aspects, and the relationship between learning styles and learning outcomes in cognitive aspects. Research conducted by Ovez et al. (2016) examined the effect of compatibility between learning styles and teacher teaching methods on student learning achievement among 700 students and 31 teachers. The results of this study reveal that there is a close relationship between teacher teaching methods, student learning styles and student achievement, student achievement increases when teaching is done based on student learning styles. A different study was conducted by Chetty et al. (2019), the results of this study showed that teaching style has a significant influence on learning styles and student academic achievement.

The advantage of this study is that researchers reviewed students' learning styles, where in the application of differentiated learning teachers must accommodate different learning styles of students to get maximum learning results. The results showed that there was no significant difference after the application of hands on practicum and virtual laboratory based on PhET Simulation on geometry optics material in terms of learning style, learning outcomes of cognitive aspects, and science process skills of students can be a reference that the use of hands on practicum and virtual laboratory methods can accommodate various learning styles of students.

In this study, the obstacle faced by researchers is that students still have to be guided to do practicum, both hands on practicum and virtual practicum. This happens because students have never done hands-on or virtual practicum with teachers at school so that students do not understand the function and how to use practicum tools correctly. Nevertheless, the learning method with hands on practicum and virtual practicum patterns is able to accommodate different learning styles of students and train the learning outcomes of cognitive aspects and learning outcomes of students' science process skills aspects.

Conclusion

Based on research that has been conducted at SMAN 1 Belalau West Lampung Regency in class XI IPA 2 and XI IPA 3 even semester of the 2022/2023 school year, it can be concluded that there are no differences in learning outcomes in cognitive aspects and KPS of students who use hands on practicum methods and virtual laboratory based on PhET Simulation on geometric optics material, there are no differences in student learning outcomes in the cognitive domain and KPS of geometric optics material due to differences in learning styles, and there is no interaction between hands on practicum methods and virtual laboratory with learning styles in terms of learning outcomes.

Author Contributions

Cerli Anjarsari collected, analyzed, interpreted data, and wrote the draft article. Agus Suyatna collected and analyzed relevant literature reviews. Viyanti wrote the discussion section and revised the article.

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Conflicts of Interests

No Conflicts of interest.

References

Alhafiz, N. (2022). Analisis Profil Gaya Belajar Siswa Untuk Pembelajaran Berdiferensiasi Di Smp Negeri 23 Pekanbaru. *J-ABDI: Jurnal Pengabdian Kepada Masyarakat*, *1*(8), 1913–1922. https://doi.org/10.53625/jabdi.v1i8.946

Arifudin, M. (2021). Penggunaan Laboratorium Virtual Phet untuk Meningkatkan Hasil Belajar Fisika Siswa SMA. *JIRA: Jurnal Inovasi Dan Riset Akademik*, *2*(6), 906–916. https://doi.org/10.47387/jira.v2i6.174

Arumningtyas, N., Budiyanto, M., & Purnomo, A. R. (2022). Penerapan Virtual Laboratory untuk Meningkatkan Keterampilan Proses Sains Siswa di Masa Pandemi. *Pensa E-Jurnal:Pendidikan Sains*, *10*(2), 246–252. Retrieved from https://ejournal.unesa.ac.id/index.php/pensa

Chetty, N. D. S., Handayani, L., Sahabudin, N. A., Ali, Z., Hamzah, N., Rahman, N. S. A., & Kasim, S. (2019). Learning styles and teaching styles determine students' academic performances. *International Journal of Evaluation and Research in Education*, *8*(4), 610–615. https://doi.org/10.11591/ijere.v8i3. 20345

Defianti, A., Hamdani, D., & Syarkowi, A. (2021). Penerapan Metode Praktikum Virtual Berbasis Simulasi Phet Berbantuan Guided-Inquiry Module Untuk Meningkatkan Pengetahuan Konten Fisika. *Jurnal Pendidikan Fisika Undiksha*, *11*(1), 47. https://doi.org/10.23887/jjpf.v11i1.33288

Fitriani, R., Maryani, S., Chen, D., Aldila, F. T., Br.Ginting, A. A., Sehab, N. H., & Wulandari, M. (2021). Mendeskripsikan Keterampilan Proses Sains Siswa melalui Kegiatan Praktikum Viskositas di SMAN 1 Muaro Jambi. *PENDIPA Journal of Science Education*, *5*(2), 173–179. https://doi.org/10.33369/pendipa.5.2.173-179

Hasanah, I., Kantun, S., & Djaja, S. (2018). Pengaruh Gaya Belajar Terhadap Hasil Belajar Siswa Kelas Xi Jurusan Akuntansi Pada Kompetensi Dasar Jurnal Khusus Di Smk Negeri 1 Jember Semester Genap Tahun Ajaran 2017/2018. *Jurnal Pendidikan Ekonomi: Jurnal Ilmiah Ilmu Pendidikan, Ilmu Ekonomi, Dan Ilmu Sosial*, *12*(2), 277–282. Retrieved from https://jurnal.unej.ac.id/index.php/JPE/article/view/8572

Mackin, K. J., Cook-Smith, N., Illari, L., Marshall, J., & Sadler, P. (2012). The effectiveness of rotating tank experiments in teaching undergraduate courses in atmospheres, Oceans, and climate sciences. *Journal of Geoscience Education*, *60*(1), 67–82. https://doi.org/10.5408/10-194.1

Martanti, N., Malika, E. R., & Setyaningsih, A. (2021). Pengaruh Penerapan Metode Pembelajaran Berbasis Eksperimen Virtual Menggunakan Simulasi PhET Terhadap Hasil Belajar Kognitif Siswa Kelas XI SMA Negeri 2 Karangangar Tahun Ajaran 2020/2021. *KONSTELASI: Konvergensi Teknologi Dan Sistem Informasi*, *1*(1), 83–92. https://doi.org/10.24002/konstelasi.v1i1.4315

Nurnaifah, I. I., Akhfar, M., & Nursyam. (2022). Pengaruh Gaya Belajar terhadap Hasil Belajar Fisika Siswa. *Al-Irsyad Journal of Physics Education*, *1*(2), 86–94. https://doi.org/10.58917/ijpe.v1i2.19

Övez, F. T. D., & Uyangör, S. M. (2016). The Effect of the Match between the Learning and Teaching Styles of Secondary School Mathematics Teachers on Students' Achievement. *Journal of Education and Practice*, *7*(29), 125–132. https://doi.org/10.7176/jep/7-29-4

Prihatiningtyas, S., Prastowo, T., & Jatmiko, B. (2013). Imlementasi simulasi phet dan kit sederhana untuk mengajarkan keterampilan psikomotor siswa pada pokok bahasan alat optik. *Jurnal Pendidikan IPA Indonesia*, *2*(1), 18–22. https://doi.org/10.15294/jpii.v2i1.2505

Puspita, I. (2020). PhET Aplication Program: Strategi Penguatan Pemahaman Pembelajaran Jarak Jauh pada Materi Radiasi Benda Hitam melalui Percobaan Berbantu Lab Virtual dan Media Sosial. *Jurnal Pendidikan Madrasah*, *5*(1), 57–68. https://doi.org/10.14421/jpm.2020.51-07

Saparuddin, S., Lestari, U., & Suarsini, E. (2021). Persepsi dan Kebutuhan Mahasiswa Calon Guru Biologi terhadap Media Pembelajaran Bioteknologi. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *6*(5), 720. https://doi.org/10.17977/jptpp.v6i5.14782

Subeki, R. S., Astriani, D., & Qosyim, A. (2022). Media Simulasi PhET Berbasis Inkuiri Terbimbing Materi Getaran dan Gelombang Terhadap Peningkatan Keterampilan Proses Sains Peserta Didik. *Pensa E-Jurnal : Pendidikan Sains*, *10*(1), 75–80. Retrieved from https://ejournal.unesa.ac.id/index.php/pensa/article/view/41459/37610

Sutarno, S., Setiawan, A., Suhandi, A., Kaniawati, I., & Putri, D. H. (2017). Keterampilan Pemecahan Masalah Mahasiswa Dalam Pembelajaran Bandul Fisis Menggunakan Model Problem Solving Virtual Laboratory. *Jurnal Pendidikan Fisika Dan Teknologi*, *3*(2), 164–172. https://doi.org/10.29303/jpft.v3i2.396

Taufik, A., Wardani, D., & Rosdiana, L. (2022). Efektivitas Simulasi PhET dengan Model Inkuiri Terbimbing untuk Meningkatkan Keterampilan Proses Sains Siswa SMP pada Materi Listrik Dinamis. *Pensa E-Jurnal : Pendidikan Sains*, *10*(2), 221–226. Retrieved from https://ejournal.unesa.ac.id/index.php/pensa

Yunita, H., Sesunan, F., Maulina, H., & Suana, W. (2021). Pembelajaran Blended Learning dengan Metode Praktikum untuk Meningkatkan Hasil Belajar Fisika Siswa SMK. *Physics Education Research Journal*, *3*(2), 133–140. https://doi.org/10.21580/perj.2021.3.2.8606

Zubaidah, S. (2020). Keterampilan Abad Ke-21: Keterampilan yang Diajarkan Melalui Pembelajaran. *Seminar Nasional Pendidikan*, *2*(2), 1–17. Retrieved from https://rb.gy/ctz851