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ENHANCING STUDENTS' SCIENCE PROCESS SKILLS ON SOUND WAVES THROUGH LEARNING CYCLE 7E INTEGRATED WITH PHET

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Abstract

This study is prompted by the lack of science process skills among students in physics learning. Through the implementation of the Learning Cycle 7E integrated with PhET, this study aims to enhance students' science process skills on sound waves. A pre-experimental research design with one group pretest-posttest design was used, involving 30 students of grade XI in one of the high schools in Bandung. The instruments employed in this study comprise science process skills test, observation sheets on the implementation of learning model, and student response questionnaire. The paired sample t-test and N-Gain were used to assess the enhancement in students' science process skills. The findings revealed that the implementation of the Learning Cycle 7E integrated with PhET can enhance students' science process skills in the moderate category, with an N-gain score of 0.63. In addition, the paired sample t-test revealed significant differences in students' science process skills after engaging in classroom learning. The implementation of the Learning Cycle 7E integrated with PhET has shown the "very good" category, and received positive responses from students. This study has provided evidence that integrating the Learning Cycle 7E with PhET can improve students' science process skills on sound waves.

Keywords: Learning Cycle 7E Model; PhET Simulations; Science Process Skills

INTRODUCTION

The profile of high school graduates in the revised 2013 Curriculum illustrates the idea that education should not only generate graduates who have conceptual knowledge, but also have strong character, attitudinal competence, and relevant skills to face the challenges of the world (Melis, 2022). In addition to this, the revised 2013 curriculum aims to prepare Indonesian young people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to the life of society, nation, state, and world civilization which results in students being required to be more active in the learning process (Clarisa, Danawan, Muslim, & Wijaya, 2020; Dalilah, Rusnayati, & Kaniawati, 2023). In line with this, currently one of the important goals in education is to present science process skills and conceptual understanding among students (Putri, Koto, & Putri, 2018). Science process skills are the steps performed by students when they apply the scientific method in finding answers or solving problems (Ikhsanudin & Subali, 2023; Lederman et al., 2014). Science process skills are competencies that graduates should have, and schools have the responsibility to provide effective learning approaches to develop these competencies among students (Ningsih, 2019). According to Listiani & Kusuma, (2024) science process skills are important for the development of students for

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provision in developing science so that students get new knowledge that is already owned to the fullest.

Science process skills is a way of thinking in science to construct scientific knowledge as done by scientists (Putri et al., 2018). (AFIFATURRIZQI, 2012) revealed that science process skills stimulate students to be active in the learning process which involves various activities such as observing, making temporary answers, conducting experimental activities, analyzing data, making conclusions, and presenting the findings obtained. This is in line with Hariyanti, (2018) which states that students' science process skills are very important to develop in science learning because it can help students combine concepts obtained through investigation activities to produce appropriate evidence through data analysis activities.

According to an interview with a high school physics teacher in Bandung, the current learning process has not improved students' science process skills due to limited experimental equipment in the laboratory. Apart from that, the average final exam score in physics is less than satisfactory, as shown in Table 1.

Table 1. Average score of students' final exam in Physics subject

School Year	Minimum Completion Criteria	Average Final Exam Score	
		Cognitive	Psychomotor
2018/2019	75	76.50	76.00
2020/2021	76	77.40	77.00
2022/2023	76	77.80	77.30

Based on Table 1, the learning outcomes in psychomotor aspects of science process skills show that students are less trained due to a learning environment that does not support the development of psychomotor skills, such as a lack of facilities or laboratory equipment, which can limit students' ability to develop science process skills (Yulianto, 2018). As a result, it is possible to conclude that low student learning outcomes are due to a lack of training in science process skills in physics learning.

Several factors contribute to inadequate scientific process skills, including students' limited understanding of science concepts and a lack of laboratory equipment (Jack, 2013), books as the only source for learning (Igboegwu Ekene & Egbutu Rita, 2011), and learning activities that do not explore and practice students' science process skills Putri et al., 2018; Sukarno & Hamidah, (2013) stated that students' lack of proficiency in science process skills is caused by the limited availability of laboratory equipment and unsuitable for usage. This consequently restricts the opportunity to conduct experiments that can teach students' science process skills.

In fact, students' science process skills can be developed through experimental activities in the laboratory or investigative activities to find answers to a problem by formulating hypotheses, conducting experiments, analysing data, and drawing conclusions. In this study, experimental or practical activities were carried out using a virtual laboratory as an effort to overcome problems related to the lack of laboratory equipment at schools. A virtual laboratory is an application on a computer that allows students to conduct virtual experimental or practical activities. Virtual laboratory applications that are widely used are the Physics Education Technology (PhET) simulations. This application was developed since 2002 by Nobel Laureate Carl Wieman at the University of Colorado which is a media simulation of science material by utilizing computer technology (Sujanem, Suswandi, & Yasa, 2019), designed to be interactive and can improve students' science process skills (Muzana, Lubis, & Wirda, 2021).

The Learning Cycle 7E model is one of the learning models that can help students improve their science process skills (Novebrini, Salamah, Agustin, & Azmi, 2021). This learning model promotes student-centered activities, which allows students to actively engage in the learning process in the classroom. In addition, the Learning Cycle 7E model is a learning cycle model that actively involves students through 7 phases of learning.

The activities carried out in the Learning Cycle 7E model are as follows: a) Elicit Phase, this phase begins with basic questions related to the lesson to be learned by taking easy examples known to students such as phenomena in everyday life and related to the topic to be studied; b) Engagement Phase, this phase is used to focus students' attention, stimulate students' thinking skills and enhance students' interest and motivation towards the concepts to be taught; c) Exploration Phase, during this phase, students are given the opportunity to work in small groups, to observe data, record data, isolate variables, design and plan experiments, create graphs, interpret results, develop hypotheses and report their findings; d) Explanation Phase, at this stage students are introduced to new concepts, laws and theories so that students can conclude and explain the results of their findings at the Explore stage; e) Elaboration Stage, at this stage students are trained to be able to apply the new knowledge and concepts learned to new situations; f) Evaluation Stage, at this stage the teacher evaluates students' mastery of skills which can be done by giving a written test at the end of the lesson or an oral test during the learning process.; g) Extended stage, at this stage aims to think, search, find, and explain examples of the application of concepts that have been learned. This activity can even stimulate students to look for relationships between concepts and enable students to explain more complex phenomena.

Apart from that, this study focuses on eight aspects of science process skills proposed by (Rustaman, 2007) which are hypothesizing, applying ideas or concepts, observing, grouping, organizing experiments, interpreting, communicating, and predicting. Previous research demonstrated that the Learning Cycle model can improve students' science process skills (Khotimah, Utami, & Prihatiningtyas, 2018). This study seeks to analyse the improvement in students' science process skills after implementing Learning Cycle 7E integrated with PhET simulations on sound wave as well as students respond to this learning model

RESEARCH METHODS

The research method employed in this study was a quantitative, using a pre-experimental research design with one group pretest-posttest design. In this study, only the experimental class was used without a control class (comparison class) in which a pretest conducted before treatment and a posttest carried out after treatment. The treatment refers to the implementation of Learning Cycle 7E model assisted by PhET simulations. The treatment was given for 2 meetings (3 JP @45 minutes). Table 2 illustrates the one-group pretest and posttest design.

Table 2. One group pretest and posttest research design

Pre-test	Treatment	Post-test
O_1	X	O_2

with:

O1: pretest conducted before the implementation of Learning Cycle 7E model integrated with PhET simulations.

X: Treatment (the implementation of Learning Cycle 7E model integrated with PhET simulations).

O2: posttest conducted before the implementation of Learning Cycle 7E model integrated with PhET simulations.

This study involved 30 students of grade XI in one of the high schools in Bandung City. The participants comprised 12 males and 18 females with an age range of 15 - 17 years. The participants were taken from one of the grade XI classes that had not learned about the topic of sound waves.

The instruments used in this study consisted of science process skills test used to assess students' science process skills through pretest and posttest. This instrument comprises 23 items that have gone through the process of expert judgment, validity test, reliability test, difficulty level, and differentiating power. Another instrument was an observation sheet for the implementation of the learning model which was used to determine the implementation of the learning model during the lessons. The observation sheet contains the stages of learning activities that need to be filled in by observers by giving a score of one if the activity stage is carried out and a score of zero if it is not carried out. In addition, a student response questionnaire was used to determine student responses to the implementation of the Learning Cycle 7E model assisted by PhET simulations. This questionnaire sheet contains positive responses and negative responses that need to be filled in by students after learning was complete, by ticking the Likert scale column.

The science process skills instrument that used in this study has been tested for validity which is divided into content validity conducted by experts and empirical validity by conducting science process skills instrument trials. Content validity was carried out by 3 experts with 2 lecturers and 1 physics teacher. The results of the validation conducted by experts are shown in Table 3 below.

Table 3. Results of Validation by Experts

	Average	**Conc.**
Science Process Skills	94.20%	Highly valid or can be used without revision

Based on table 3, it can be seen that the average value of the results of the three experts for the science process skills instrument is 94.2%, which means that the question instrument is in the very valid category or can be used without revision. As for the results of the empirical validity test are shown in Table 4 below.

Table 4. Results of the Validity Test of the Science Process Skills Instrument

Item Number	Validity			Level of Difficulty		Discrimination Power	
	r_{hitung}	r_{tabel}	Desc.	Index	Criteria	Index	Criteria
1	0.67	0.35	High	0.47	Medium	0.69	Good
2	0.62	0.35	High	0.59	Medium	0.69	Good
3	0.56	0.35	Medium	0.69	Medium	0.37	Medium
4	0.46	0.35	Medium	0.44	Medium	0.37	Medium
5	0.67	0.35	High	0.59	Medium	0.56	Good
6	0.43	0.35	Medium	0.62	Medium	0.25	Medium
7	0.42	0.35	Medium	0.50	Medium	0.25	Medium
8	0.75	0.35	High	0.41	Medium	0.56	Good
9	0.41	0.35	Medium	0.78	Easy	0.31	Medium
10	0.85	0.35	Very high	0.44	Medium	0.87	Very good
11	0.77	0.35	High	0.53	Medium	0.81	Very good
12	0.37	0.35	Low	0.69	Medium	0.25	Medium
13	0.55	0.35	Medium	0.53	Medium	0.44	Good
14	0.76	0.35	High	0.47	Medium	0.81	Very good
15	0.53	0.35	Medium	0.50	Medium	0.50	Good
16	0.41	0.35	Medium	0.72	Easy	0.29	Medium
17	0.48	0.35	Medium	0.25	Difficult	0.50	Good
18	0.42	0.35	Medium	0.53	Medium	0.29	Medium
19	0.54	0.35	Medium	0.69	Medium	0.25	Medium
20	0.56	0.35	Medium	0.62	Medium	0.37	Medium
21	0.50	0.35	Medium	0.41	Medium	0.44	Good
22	0.55	0.35	Medium	0.47	Medium	0.56	Good
23	0.43	0.35	Medium	0.84	Easy	0.31	Medium
Coefficient Reliability				0.97			
Criteria				Very high			

Based on Table 4, it can be seen that the results of validity test the science process skills instrument which was tested on 32 students before the study. The results showed that there was 1 question with very high validity, 6 questions with high validity, 15 questions with sufficient validity, and 1 question with low validity. As for the level of difficulty, there was 1 difficult question, 19 medium questions, and 3 easy questions. While in terms of differentiating power, there are 3 questions that fall into the very good category, 9 questions that fall into the good category, and 11 questions that fall into the low category. So it can be concluded that the science process skills instrument is valid with very high reliability and can be used in this study.

Data analysis used in this study includes prerequisite tests consisting of normality tests and homogeneity tests based on students' pretest and posttest results using IBM SPSS version 26 software. Normality testing illustrates that the samples were drawn from a normally distributed population (Kasmadi & Sunariah, 2014). The normality test has two criteria: (1) if the significance value (p) is > 0.05, the sample is from a normally distributed population, and (2) if the significance value (p) is < 0.05, the sample is not from a normally distributed population.

While the homogeneity test is a statistical test procedure designed to show that two or more sample data sets come from a population having the same variant (Dalilah, et al., 2022). The homogeneity test used is the Barlett test with the following test criteria: (1) if the significance value (p) > 0.05, then the sample is from a homogeneous population; and (2) if the significance value (p) < 0.05, then the sample is not from a homogeneous population.
Following the prerequisite test, a t-test was conducted to determine the average difference between two paired or related samples. Hypothesis testing in this study used the Paired Sample T-test employing IBM SPSS software version 26. The proposed hypothesis for this paired sample t-test is as follows:

H0: There is no significant difference in students' science process skills before and after implementing the Learning Cycle 7E model integrated with PhET simulations;

Ha: There is significant difference in students' science process skills before and after implementing the Learning Cycle 7E model integrated with PhET simulations.
The basis for decision making is based on the significance value: (1) if the significance value > 0.05; then H0 is accepted; and (2) if the significance value ≤ 0.05; then H0 is rejected.
Another data analysis used was N-Gain score, to determine the improvement of students' science process skills after treatment. The formula used to calculate the N-Gain score is as follows.

$$G = \frac{Score\ posttest - Score\ pretest}{Score\ ideal - Score\ pretest}$$

with:

Ideal score is the highest score the N-Gain score data obtained was then interpreted based on the categories in Table 5.

Table 5. N-Gain score interpretation

N-Gain score	Interpretation
G < 0.7	High
0.3 ≤ G ≤ 0.7	Moderate
G < 0.3	Low

(Sundayana, 2014)

The implementation of learning model is analysed from the results of the observers' assessment during the learning process. The assessment given is processed with a percentage of implementation which is formulated as follows.

$$x = \frac{indicators\ that\ are\ implemented}{total\ indicators}$$

The classification of the implementation of the learning model is presented in Table 6.

Table 6. Classification of Learning Model Applicability

Learning Model Applicability (%)	Category
$87.60 < x \leq 100$	Very good
$62.60 < x \leq 87.60$	Good
$37.60 < x \leq 62.60$	Medium
$25.00 < x \leq 37.60$	Low
$0.00 \leq x \leq 25.00$	Very low

(Clarisa, et al., 2020)

Meanwhile, the student response questionnaire was given after the learning process or treatment was completed. In the student questionnaire there are positive statements and negative statements. Table 7 shows the interpretation of students' answers to positive and negative statements.

Table 7. Positive and Negative Statement Scores

Positive Statement Score	Answer
1	Strongly Disagree
2	Disagree
3	Agree
4	Strongly Agree
Negative Statement Score	**Answer**
1	Strongly Agree
2	Agree
3	Disagree
4	Strongly Disagree

The formula proposed by Damayanti & Gayatri (2019) is used to analyse student questionnaires as follows.

$$P = \frac{n}{N} \times 100\%$$

with:

P: percentage assessment of each statement (%)

n: number of scores obtained from each statement

N: total maximum score

The results of the total score of each statement of student responses regarding the implementation of the Learning Cycle 7E model assisted by PhET simulations are matched with the criteria as presented in Table 8.

Table 8. Student Response Interpretation

Rating Response (%)	Category
86 – 100	Very Positive
71 – 85	Positive
51 – 70	Less Positive
P < 50	Not Positive

(Khabibah, 2006)

RESULT AND DISCUSSION

In analysing the improvement of students' science process skills, the first test carried out is the normality test and homogeneity test. Normality test and homogeneity test were conducted through IBM SPSS 26 with Kolmogorov-Smirnov test. The test results can be seen in Table 9 and Table 10.

Table 9. Normality Test Results of Science Process Skills

Data	Sig.	Conclusion
Pretest	0.062	Normal
Posttest	0.060	Normal

Table 10. Homogeneity Test Results of Science Process Skills

Data	Sig.	Conclusion
Pretest	0.066	Homogeneous
Posttest	0.062	Homogeneous

According to Table 9, the normality test, both pre and posttest, shows a significant value (p) is > 0.05, indicating that all data is normally distributed. Meanwhile, in Table 8, the homogeneity test, both pre and posttest, shows a significant value (p) is > 0.05, indicating that the data is homogenous.

The prerequisite test results have shown that the data is normally distributed and homogeneous. The next step is to test the correlation or relationship between the pretest and posttest scores of students' science process skills using paired sample correlation. The results of the paired sample correlation test are presented in Table 11.

Table 11. Results of paired samples correlations test

Data	Correlation	Sig.	Conc.
Pretest Posttest	0.228	0.226	No relation

Based on the results of the paired samples correlation test shown in Table 11, it can be seen that the correlation coefficient value is 0.228 with a significance value of 0.226. Because the significance value greater than 0.05, indicating that there is no relationship between the pretest and the posttest data.

The next step is to test the hypothesis, namely whether there is a significant difference in students' science process skills before and after implementing the Learning Cycle 7E model integrated with PhET simulations. Since the data is normally distributed and homogeneous, hypothesis testing is carried out using a parametric test, namely the paired sample t-test. The hypothesis proposed in this study is as mentioned previously.

The results of the paired t-test are presented in Table 12.

Table 12. Paired Sample T-Test Results

Data	Sig.	Conc.
Pretest Posttest	0.000	H_0 rejected

Based on the results of the paired sample t-test shown in Table 12, the significance result is 0.000. It can be concluded that H0 is rejected or in other words there is significant difference in students' science process skills before and after implementing the Learning Cycle 7E model assisted by PhET simulations.

The following analysis investigates the improvement in students' science process skills before and after treatment. This analysis was performed by calculating the normalized N-gain (g) score based on pretest and posttest scores. The results of the N-gain scores for students' science process skills are presented in Table 13.

Table 13. N-Gain Score of Students' Science Process Skills

Average score	Category

Pretest	Posttest	N-Gain	
32.93	75.47	0,63	Moderate

Table 13 shows that the N-gain score on the student science process skills is 0.63, which falls into the moderate category.

This result indicates that there is an increase in students' science process skills after implementing the Learning Cycle 7E model assisted by PhET simulations. In conclusion, the Learning Cycle 7E learning model, along with PhET simulations, can help students enhance their science process skills.

Student responses to the implementation of the Learning Cycle 7E model assisted by PhET simulations were collected through a questionnaire, consisting of a total of 14 statement items, with 7 positive statement items and 7 negative statement items. The recapitulation results of the average student response assessment scores are presented in Table 14.

Table 14. Average Student Response Assessment Score

Average Assessment Percentage (%)	Category
75.30	Positive

Based on Table 14, the average score of students' responses to the Learning Cycle 7E model assisted by PhET simulations is included in the positive category, with an average assessment percentage of 75.30%.

The implementation of the Learning Cycle 7E which is integrated with the PhET simulations in lessons 1 and 2 is included in the very good category, this is due to the fact that the implementation of Learning Cycle 7E model consists of 7 structured and systematic stages. Moreover, the use of the PhET simulations in learning will make it easier for students to practice their science process skills.

Students begin learning with preliminary activities consisting of orientation, apperception, motivation and reference. In the motivation section, students are given a stimulus in the form of a video regarding examples of the application of sound waves in life, at this stage students are trained to be able to observe phenomena and are expected to raise questions about why this can happen. In the core activities, students carry out learning activities according to the syntax of the Learning Cycle 7E model, namely elicit, engagement, exploration, explanation, extension, evaluation, and elaboration.

At the elicit stage, students are given a stimulus in the form of an animation of the vibrating cellphone phenomenon. In the animation, there is a cellphone placed on a table with the condition of the cellphone with vibration mode only but when there is a notification the cellphone can make a sound. After that, students are given the question "why does the cellphone still sound when the cellphone mode vibrates?" Furthermore, students are guided by the teacher to formulate problems from the stimulus given.

At the engagement stage, students are given stimulation or briefing material delivered by the teacher in the form of images or video through PPT. Furthermore, the teacher divides students into 6 groups, each group consisting of 5 students. From these activities, students are trained to use one of the science process skills aspects, namely observing.

At the exploration stage, students learn to determine the experimental variables. The teacher explained the definitions of independent variables, dependent variables, and controlled variables. Furthermore, students formulate hypotheses by looking at the relationship between quantities from the phenomena and PhET demonstrations displayed. Students determine the variables and experimental procedures with teacher guidance from the identification of the problem given. When conducting experiments using PhET simulations, students make mistakes in carrying out experimental procedures, namely in the step of changing the value of the amplitude (independent variable). In the practicum, students did not change the amplitude value, but changed the frequency value. Therefore, the teacher guided students to understand more about the application of the independent variable in the experiment and told them the mistakes made by students. From these activities students are trained to use the science process skills aspects of classifying, interpreting, predicting, hypothesizing, planning experiments.

At the explanation stage, students conduct experiments using the PhET simulations according to the experimental procedure and record the data obtained. Furthermore, students process observation data with their group members. From these activities, students are trained to use the science process skills aspects of observing, interpreting, predicting, applying concepts and communicating.

At the elaborate stage, students exchange ideas with other groups to develop concepts that they already have so that they can answer questions on data analysis. Students analyse data by determining the relationship of quantities in the observation data in a table and making conclusions. The science process skills trained at this stage are applying concepts and communicating.

At the evaluation stage, students representative from each group presented their findings and then other groups were invited to respond to the results of their friends' exposure. Furthermore, the teacher verifies the conclusions and adds information that has not been obtained by students. The science process skills trained at this stage are the communication aspects.

In the closing activity, the teacher provides reinforcement by explaining again about the material that has been learned, giving appreciation to students who have completed the learning well, giving directions for the next meeting and closing the lesson by praying and saying greetings.

The results obtained are in accordance with research conducted by (Andani, 2024) which shows that the Learning Cycle 7E model using a virtual laboratory can improve science process skills. (Haryadi & Pujiastuti, 2020) also stated that learning using PhET simulations is 37% better than conventional learning because it emphasizes the relationship between real-life phenomena and the underlying knowledge and can improve students' science process skills. he learning cycle 7E learning model which contains 7 important stages in the learning process can improve students' science process skills.

CONCLUSION

This study suggests that the implementation of the Learning Cycle 7E model integrated with PhET simulations on sound wave is classified as "very good" category. The paired sample t-test has revealed a significant difference between students' science process skills before and after implementing the Learning Cycle 7E model. The improvement in students' process skills is categorized as moderate, with an N-gain score of 0.63. Furthermore, students offered positive responses to the model learning they had experienced, with an assessment percentage of 75.30%. According to the findings of this study, implementing the Learning Cycle 7E model assisted by PhET simulations can help students enhance their science process skills.

BIBLIOGRAFI

afifaturrizqi, Vivi Noviyani. (2012). Penerapan Model Learning Cycle Pada Pokok Bahasan

Pencemaran Dan Perubahan Lingkungan Untuk Meningkatka N Keterampilan Proses Sains Siswa MAN 2 CIREBON. *Skripsi. Institut Agama Islam Negeri (IAIN) Syekh Nurjati Cirebon*.

Andani, Sola Gratia Wurry. (2024). *Ketahanan Rasa Malu Perempuan Jawa Korban Body Shaming*.

Clarisa, Gabriela, Danawan, Agus, Muslim, Muslim, & Wijaya, Agus Fany Chandra. (2020). Penerapan Flipped Classroom dalam Konteks ESD untuk Meningkatkan Kemampuan Kognitif dan Membangun Sustainability Awareness Siswa. *Journal of Natural Science and Integration*, *3*(1), 13–25.

Dalilah, Kania, Rusnayati, Heni, & Kaniawati, Ida. (2023). Pemanfaatan Komik Berbasis Brain Based Learning Sebagai Sumber Belajar Mandiri Pada Materi Hukum Kepler Untuk Meningkatkan Pemahaman Konsep. *Journal of Teaching and Learning Physics*, *8*(2), 81–88.

Hariyanti, Merli. (2018). *Pengaruh Model Pembelajaran Learning Cycle Tipe 7E Terhadap Keterampilan Proses Sains (KPS) Pada Materi Organisasi Tingkat Jaringan Peserta Didik Kelas XI IPA Di SMA Gajah Mada Bandar Lampung*. UIN Raden Intan Lampung.

Haryadi, Rudi, & Pujiastuti, Heni. (2020). PhET simulation software-based learning to improve science process skills. *Journal of Physics: Conference Series*, *1521*(2), 22017. IOP Publishing.

Igboegwu Ekene, N., & Egbutu Rita, N. (2011). Effects of co-operative learning strategy and demonstration method on acquisition of science process skills by chemistry students of different levels of scientific literacy. *Journal of Research and Development*, *3*(1), 137.

Ikhsanudin, Ikhsanudin, & Subali, Bambang. (2023). Measuring the divergent thinking ability in biology science process skills of elementary school students based on tutoring activities. *Edu Sains: Jurnal Pendidikan Sains Dan Matematika*, *11*(1), 92.

Khotimah, Nur, Utami, Citra, & Prihatiningtyas, Nindy Citroresmi. (2018). Penerapan Model Learning Cycle 7E Untuk Meningkatkan Kemampuan Literasi Matematis Siswa Kelas VIII Pada Materi Prisma. *JPMI (Jurnal Pendidikan Matematika Indonesia)*, *3*(1), 15–20.

Lederman, Judith S., Lederman, Norman G., Bartos, Stephen A., Bartels, Selina L., Meyer, Allison Antink, & Schwartz, Renee S. (2014). Meaningful assessment of learners' understandings about scientific inquiry—The views about scientific inquiry (VASI) questionnaire. *Journal of Research in Science Teaching*, *51*(1), 65–83.

Listiani, Listiani, & Kusuma, Arief Ertha. (2024). A Study of Students' Science Process Skills at A National–Plus Middle School in Tarakan. *Berkala Ilmiah Pendidikan Fisika*, *12*(1), 36–48.

Melis, Sintia Indriani. (2022). *Konstruksi Dan Analisis Tes Keterampilan Proses Sains Materi Elastisitas Dan Hukum Hooke Menggunakan Teori Respon Butir*. Universitas Pendidikan Indonesia.

Muzana, Syarifah Rahmiza, Lubis, Silvi Puspa Widya, & Wirda, Wirda. (2021). Penggunaan simulasi phet terhadap efektifitas belajar IPA. *Jurnal Dedikasi Pendidikan*, *5*(1), 227–236.

Ningsih, Vika Ayu Ratna. (2019). *Pengaruh Model Pembelajaran Learning Cycle 7E Terhadap Pemahaman Konsep dan Sikap Sosial Peserta Didik Kelas X di SMA Negeri 2 Natar Lampung Selatan*. UIN Raden Intan Lampung.

Novebrini, Sintya, Salamah, Ummi, Agustin, Silvia, & Azmi, Nurul. (2021). Penggunaan LKPD Berbasis Model Discovery Learning Berbantuan Simulasi PhET untuk Meningkatkan Pengetahuan dan Keterampilan Proses Sains Siswa Kelas VIII SMPN 14 Padang. *Jurnal Penelitian Pembelajaran Fisika*, *7*(2), 179–188.

Putri, Enna Marti Eka, Koto, Irwan, & Putri, Desy Hanisa. (2018). Peningkatan keterampilan proses sains dan penguasaan konsep gelombang cahaya dengan penerapan model inkuiri berbantuan simulasi phet di kelas xi mipa e sman 2 kota bengkulu. *Jurnal Kumparan Fisika*, *1*(2 Agustus), 46–52.

Rustaman, Nuryani. (2007). Keterampilan Proses Sains. *Bandung: UPI*.

Sujanem, Rai, Suswandi, Iwan, & Yasa, Putu. (2019). Pemanfaatan Media Pembelajaran Fisika Berbasis Android Bagi Guru-Guru Fisika SMA. *International Journal of Community Service Learning*, *3*(4), 279–289.

Sukarno, S., & Hamidah, Ida. (2013). The profile of science process skill (SPS) student at secondary high school (case study in Jambi). *International Journal of Scientific Engineering and Research (IJSER)*, *1*(1), 79–83.