Al-Ishlah: Journal of Education
Vol.15, 4 (December, 2023), pp. 5593-5603
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/alishlah.v15i4.4414

Transforming Education: A PBL Framework for Fostering Student Understanding and Communication Skills in the Face of Climate Change and Global Warming

Merry Novia[1], Asrizal*[2]

[1] Universitas Negeri Padang, Indonesia; mnovia722@gmail.com
[2] Universitas Negeri Padang, Indonesia; asrizal@fmipa.unp.ac.id

ARTICLE INFO

Keywords:

E-Student Worksheet;
Global warming;
PBL models

Article history:

Received 2023-07-08
Revised 2023-10-19
Accepted 2023-12-20

ABSTRACT

Learning in an independent curriculum involves independent conditions for fulfilling objectives, methods, materials, and learning evaluations for both teachers and students. The preliminary research students' conceptual understanding results and communication skills are still low. The solution to the problem is integrated Problem-Based Learning (PBL) model E-Student Worksheet (E-SWS) is the solution to this problem. This study aims to look at the effect of climate change E-SWS on global warming integrated with the PBL model to support the improvement of the process for conceptual understanding and skills for communicating with students. This research is included in the quasi-experimental research through the Posttest-Only control design. The research instrument for conceptual understanding is measured through a final test, and aspects of communication skills are measured through scientific work in the form of written ideas. Based on the data analysis of learning outcomes aspects of conceptual understanding and communication skills with successive averages of 88.19 and 80.20, the research work hypothesis is accepted. The research results implication is that teachers must construct students through integrated PBL models and E-SWS teaching materials. The research results reached the conclusion that student learning outcomes using the climate change E-SWS in integrated global warming PBL models were significantly higher than the teaching materials in schools.

Corresponding Author:
Asrizal
Department of Physics, FMIPA, Padang State University, Indonesia; asrizal@fmipa.unp.ac.id

1. INTRODUCTION

In the era of globalization, various skills must be mastered by students to achieve success. Students must have 21st century skills in order to survive in this age of information and knowledge. Students must be faced with many challenges and opportunities (Anggraini et al., 2021). 21st-century skills are the skills needed by someone to be successful in dealing with increasingly complex challenges, especially in order to be successful in life and career in the world of work (Redhana, 2019). Skills in the 21st century focus on all students so that they have skills in the hard skill or soft skill sector so they can be involved in the world of work and have the readiness to compete with competitors from other countries (Hudda et al., 2016; Idawati et al., 2022). Achieving the goals of 21st-century learning requires

broad knowledge, critical thinking, communication, collaboration, and the ability to innovate or be creative and literate.

The process of developing science and technology in the education world has created major new innovations in supporting the process of learning. Science and technology have developed drastically in various sectors, one of which is education. All forms of the process of learning can be conducted easily (Mulyani et al., 2021). The development of science and technology characterizes the 21st century and influences the global order of life. In this era, every activity in life cannot be separated from technology. To communicate, communication equipment is needed as a result of communication technology. In constructing a place to live, construction equipment and building materials are needed as a result of the construction technology (Aththibby, 2015). As well as many other activities in life, all of which are assisted by technology, especially in the world of education.

The use of information technology in learning needs to be encouraged to encourage students' conceptual understanding and skills. Technology in the process of learning always experiences growth in line with the times. In the realization of the process of learning in our daily lives, we often encounter the use of technological developments in the world of education (Jamun, 2018). Efforts to master good physics concepts refer to the process of presenting good information as well (Siswono, 2017). In line with the conceptual understanding, students must also have communication skills. Communication skills are reliable in channelling the contents of thoughts, ideas, knowledge, and new information they have to them through direct delivery, in writing, through symbols, pictures, graphics, and numbers (Siti, 2018; Rianingsih et al., 2019). Through the conceptual understanding and communication skills possessed, it is hoped that they can achieve the goals of education.

The practice of the process of learning in the independent curriculum must be able to ensure student-centred learning. Learning in the era of independent learning includes independent conditions for fulfilling objectives, methods, materials, and assessments of the process of learning for both teachers and students (Indarta et al., 2022). Through this effort, we can find out where the process of learning in the independent learning curriculum tends to provide direction to the needs of students, where previously the concept of the process of learning was still centered on the teacher. The teaching method focused on students is one of the teaching methods that must be implemented in the independent learning curriculum (Aprima et al., 2022). This student-centered learning method can be used as one of the teaching methods that are used at the same time in breakthrough independent learning curricula, especially in education in Indonesian field (Pertiwi et al., 2022; Jamilah et al., 2023).

Learning Physics is a process of learning through the development of power in reasoning and analysis, which makes almost every problem related to nature understandable. In an effort to study physics, students are expected to not only understand the theories, ideas, and principles of physics but also how these physical phenomena can take place (Erlinawati et al., 2019). The principle of the physics process of learning is based on a scientific approach and prioritizes scientific techniques to develop something. The end result is not only in the form of objects but also focuses on an idea or scientific thought. Scientific procedures used to make items will form a scientific attitude (Sari et al., 2018). Physics learning is needed in everyday life to fulfill what humans need through problem-solving. To solve the problem, a relevant teaching model is needed which is popular with PBL also known as a problem-based teaching model (Nurlina et al., 2015; Kusumawati et al., 2022). The PBL model will make learning activities more enjoyable by supporting an increase in learning and student interaction, leading to a direct link to the process of mastering the material. Through student participation, students' conceptual understanding and communication skills will increase (Amalia et al., 2014).

The initial research results show the real conditions found in the field, real conditions related to the low use of technology in learning. From the results of the observation questionnaire, it was obtained that the average use of technology in learning was 68.42. Conceptual understanding and communication skills from students can be seen from the assessment instruments given in the form of essay questions and assignments in the form of written ideas. Judging from the data analysis results,

we can see that students' efforts to develop conceptual understanding and communication skills have an average of 52.96 and 50.52, respectively. Relevant to the research analysis results from (Rosmiati et al., 2020), the factors that influence the lack of understanding of physics concepts are due to the use of teaching models that are irrelevant to the material presented. Also the research analysis results from (Wahyu et al., 2018) that during learning, the interaction between the teacher and students or between students is still low; this indicates the low ability of student communication. The last real condition is related to the problem of learning materials and low student learning outcomes. Students' understanding of global warming is minimal; teachers and students need teaching worksheets on the global warming process of learning so that the process of learning is conducted more effectively and can support the improvement of students' skills (Harnani et al., 2015). Based on the findings, only 5% of the students could provide a complex and precise explanation of the greenhouse effect (Mariya et al., 2015). Based on the data analysis results, we can see that the midterm exam outcomes of learning by students have an average of 53.58. Based on the assessment results, it can be seen that the problems students have, namely, their learning outcomes still need to be improved so that they are better.

The difference between the ideal situation and the real situation in the field is the reason for the existence of problems that must be addressed by research. Efforts can be made to overcome the ongoing problems, namely using the climate change E-SWS on global warming integrated with the PBL model. Several studies have succeeded in using electronic teaching materials and PBL models to learn physics. Validating electronic worksheets in providing support for critical thinking skills that have a PBL orientation is conducted by (Wulandari et al., 2022). Developing an E-module teaching physics on a PBL basis for work and energy material for class X high school students conducted by (Wakiah et al., 2019). From several previous studies with similar or dissimilar models and teaching materials, each of which showed success, the researcher determined the use of integrated PBL model E-SWS teaching materials because they were in line with students' needs.

Research on physics worksheets for students has been conducted by several previous researchers (Ramadhani et al., 2021) analyzing the effect size of the influence of the use of worksheets on the outcomes of learning of students in the process of learning science and physics (Hakim et al., 2018) reviewed the effect of the CTL teaching model through the help of worksheets on the physics outcomes of learning of high school students. (Nurhaliza et al., 2019) see the effect of using the PBL model through the help of worksheets for force material and Newton's laws on the physics competence of class X students. There are at least three different things which are the most basic of the research conducted on previous research. First, this SWS is electronically based so it is cost-effective for students who use it. Second, this SWS is integrated with the PBL model in connecting teaching materials to real life in the world. Third, the material used in the research is global warming.

E-SWS has many uses when used in the process of learning. SWS can focus teaching activities and encourage student participation in the process of learning (Ni'mah et al., 2013; Awe et al., 2019). Students will be active in developing knowledge and improving learning abilities. The use of SWS in the process of learning can support an increase in students' knowledge and skills to develop (Asrizal et al., 2019). According to (Khabibah et al., 2018), SWS is used by teachers to encourage student participation in teaching activities. Through the use of SWS, students can have a more active role in changing the process of learning focused on the teacher into a process focused on students. SWS can be said to be able to support increasing student competence in the fields of attitudes, knowledge, and skills.

Teachers can make many efforts to address the problem. Teachers can use relevant teaching models in their classes. One of the teaching models is the PBL model. PBL is an innovation in learning caused by actually maximizing the ability to think of students through the process of working with systematic groups or teams, enabling students to deal with problems, carry out tests, and develop their thinking skills related to (Rusmono, 2012; Aji et al., 2019). The application of the PBL model includes five basic stages in the process of learning including 1) Orientation of students to problems, 2)

Organizing students in learning, 3) Providing guidance to investigate both individuals and groups, 4) Developing and presenting the work, 5) Perform analysis and assessment of the problem-solving process (Damayanti et al., 2018).

Real-world conditions illustrate that the use of ICT is still less effective in learning. Furthermore, the student's conceptual understanding and communication skills was quite low, and the outcomes of learning of students who were reviewed through midterm exam were also relatively low. When this problem is left unchecked, it will have an impact on 21st-century skills, where students are expected to have the ability to conceptual understanding and the skills to communicate. Through the implementation of integrated E-SWS, the PBL model can support the improvement of students' conceptual understanding and communication skills as well as being an appropriate innovation that is conducted, especially in physics learning, which has a lot to do with the universe. Students can develop their knowledge of natural phenomena, which will greatly assist them in observing and also in understanding the symptoms or concepts that take place so that their conceptual understanding and communication skills can increase. Based on the research conducted, students' conceptual understanding and communication skills can be increased. Based on the research conducted, students' conceptual understanding and communication skills can be increased. Based on the research conducted by Rizal et al. (2019), to facilitate students' independent learning about global warming so that students can become people who encourage change and strive to protect and protect nature, teaching materials are needed in the form of E-SWS. Based on the problems described, the research aims to determine the effect of climate change E-SWS on global warming integrated PBL models on students' conceptual understanding and communication skills?. So, this research focuses on determining the effect of climate change E-SWS on global warming integrated PBL models on students' conceptual understanding and communication skills.

2. METHODS

This research is a quasi-experimental type through the Posttest-Only Control Design research design. There were two classes in this research design, each of which was randomly selected. The group for experimental used the E-SWS on climate change on global warming combined with the PBL approach, but the group for control used teaching materials provided by the school. The treatment effects are X1 and X2. The population is an item or subject that is generalized through the special attributes and characteristics that the researcher uses to study it. The population in this study is all class X students of Senior High School at Padang for the 2022/2023 academic year. The sample is a component of the number and characteristics that the population has (Sugiyono, 2017). Through the use of the random sampling technique, the sample class in this study was achieved, namely class X.7, which became the group for control, and X.8, which became the experimental group.

The variables in this study include the dependent variable, independent variable, and control variable. In this study, the dependent variable included the students' conceptual understanding and communication skills achieved after carrying out the final test and written ideas made by students. The independent variable, namely Action in the form of a process of learning through the use of climate change E-SWS on global warming, is integrated with the PBL model which is presented to students in group for experimental. As a control variable, namely all things that can give effect to students' conceptual understanding and communication skills. The type of data in this study is primary data collected through learning achievement tests and written ideas made by students who conducted an action in the sample class.

The research was conducted in 3 processes, including stages to prepare, implement, and complete. For the initial stage, the preparation of teaching materials, test questions, analysis of questions, and initial tests of conceptual understanding and communication skills were conducted. The questions that were tested had a total of 40 questions, through objective forms as well as initial tests of conceptual understanding and communication skills in the form of essay questions and written ideas

made by students. After testing and analyzing the questions, 20 questions that were suitable for use as the final test were obtained. The second stage is conducted by the process of learning activities. The process of final test testing and processing of final test data as well as data in observing is conducted in the final stage.

The instruments used in this study were written tests to assess conceptual understanding and scientific papers for assessing communication skills. The tests used are in the form of objective questions and written ideas that match the objectives of the learning process. Analysis of the data in the study was conducted with the aim of testing the truth of the hypotheses that were conducted in the study. Hypothesis testing is used to analyze the correctness of the data from the research results, namely through the two average difference tests or t-tests. before carrying out the t-test previously conducted testing and homogeneity.

Normality testing is conducted with the aim of obtaining normal distribution information from the population. To carry out the normality test, the Liliefors test is used (Sundayana, 2015). In reviewing the homogeneity variance of the two homogeneity tests were conducted. In carrying out the homogeneity test, the F-test is used. However, hypothesis testing has the goal of establishing acceptance of the hypothesis. This hypothesis is made in the form of a statistical hypothesis through one-party testing. When the data processing results are achieved both classes have normally distributed values and have a homogeneous variance. So, to test the hypothesis used a t-test. However, when both classes have normally distributed values and have non-homogeneous variances, the hypothesis testing uses the t-test.

3. FINDINGS AND DISCUSSION

The data obtained are student outcomes of learning in the cognitive field from 36 students in the experimental group and 35 students in the control group. The averages achieved in the experimental group and the control group in terms of conceptual understanding were 88.19 and 78.85, respectively. And the averages achieved in the group for experimental and group for control in the aspect of communication skills were 80.20 and 72.61 respectively. Data analysis was conducted through sequential stages, starting with a review of the difference in values of the experimental group and the control group, testing for normality, homogeneity, and hypotheses.

3.1. Research Physics Aspect Conceptual Understanding Result

Data from the evaluation of students' Physics competence in the aspect of conceptual understanding was obtained through a final test in the form of objective questions with a total of 20 questions. This test was presented to both sample classes at the end of the research activity. Viewed through the calculation processresults with statistics, the average value($\bar{x}$), standard deviation (S), variance (S^2), significant level (α), Lmaximum, Fcount, and tcount are obtained. The descriptive parametric statistical value of group for experimental and group for control can be observed in Table 1.

Table 1. Statistical Value Data Experiment group and Control Group

No.	Statistical Value	Experiment	Control
1.	The number of students	36	35
2.	Average	88.19	78.85
3.	Standard Deviation	10.29	15.58
4.	Variance	105.93	242.77
5.	Significant Level	0.05	
6.	Normality test	0.1252 (Normal)	a.1215 rmal)
7.	Homogeneity Test	0.1252(Homogeneous)	
8.	t-test	2.98	

Table 1 shows where the students' Conceptual Understanding tests results were group for experimental superior to the group for control. The value of Lmax in each sample class is lower than the value of the Ltable and the value of Fcount in each sample class is lower than that of Ft. This shows that the two sample classes have a normal distribution and homogeneous variance for all competencies. Based on the analysis that has been conducted, the hypothesis results are achieved by $t_{count} > t_{table}$, which makes the working hypothesis accepted for a significance level of 0.05. This shows that the outcomes of learning by students in the aspect of Conceptual Understanding using E-SWS climate change in integrated global warming PBL models are significantly superior to the outcomes of learning by students who use teaching materials available at school.

3.2. Physics Research Results Aspects of Communication Skills

Competency assessment data on student physics in the aspect of communication skills is obtained from written ideas made by students during the process of learning activities taking place. According to (Medriati et al., 2020) There are three indicators of communication skills, namely systematics or format, use of language, and the complexity of content and content order. Data on students' physics competency assessment on the aspect of communication skills for all indicators from the group for experimental and the group for control can be seen in Figure 1.

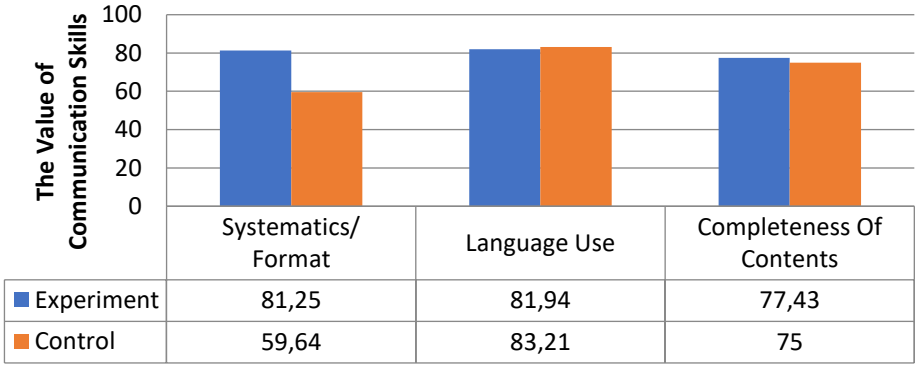

Figure 1. Competency Scores Of Students Communication Skills For Each Observed Indicator

Figure 1 shows the physics competency scores of the students in the aspect of communication skills in the group for experimental are superior to the scores of students in the group for control. The highest competency value for the aspect of communication skills is found in the systematic/format indicator with a percentage of 81.25 at group for experimental but in the group for control, namely 59.64. The lowest communication skills competency is found in the content completeness indicator. Percentage of

completeness of student content group for experimental 77.43 while the group for control 75. Aspects of communication skills can be improved through implementing students' real-world problems in the process of learning.

Based on the calculation processresults through statistics, the average value ($\bar{x}$), standard deviation (S), variance (S^2), significant level (α), Lmaximum, Fcount, and tcount. With skills in communicating both orally and in writing, students can make presentations on what has been taught to them. Descriptive parametric statistical value of group for experimental and group for control can be seen in Table 2. This analysis aims to see the value of students' physics competence in the aspect of communication skills.

Table 2. Statistical Value Data Experiment group and Group for control

No.	Statistical Value	Experiment		Control
1.	The number of students	36		35
2.	Average	80.20		78.85
3.	Standard Deviation	10.69		15.58
4.	Variance	114.45		242.77
5.	significant level		0.05	
6.	Normality test	0.1465 (Normal)		0.1215 (Normal)
7.	Homogeneity Test		2.3702 (Inhomogeneous)	
8.	t'-test		3.55	

From Table 2 an explanation can be given where the assessment of students' communication skills results are experimental group superior to will group for control. The value of Lmax in each sample class is smaller than the price of the Lmax and the value of Fcount in each sample class is superior to that of Ft. This shows that the two sample classes have non-homogeneous distribution and variance in all competencies. Based on the analysis that has been conducted, the hypothesis results are achieved by $t_{count} > t_{table}$, so the working hypothesis is accepted at a significant level of 0.05. This shows where student outcomes of learning are in aspects of communication skills using E-SWS climate change in the integrated global warming PBL model is significantly superior to the outcomes of learning by students who use teaching materials available in schools. This means that there is an influence of E-SWS climate change on global warming integrated PBL model on students' physics communication skills.

3.3 Discussion

On learning global warming in groups for experimental and control both used the PBL model. PBL is one of the teaching models used in developing students' mindsets and making students more active. Similar things are shown in Nurdyansyah et al. (2016), who provide a teaching model defined as a collection of learning resources and methods that work together to produce and support the improvement of student learning outcomes. The problem-based process of learning is a learning style that describes various real-world situations in students' daily lives to arouse their interest in learning (RI, 2014). Students carry out the independent construction of new knowledge and skills when these students take part in teaching. In the group for experimental use of E-SWS climate change in global warming is integrated with the PBL model while in the group for control, teaching materials are used in schools.

SWS can be a complementary tool in the process of learning that can be used in combination with other models or methods that support the competence of students (Yuliani et al., 2015). Learning by using E-SWS climate change in global warming integrated PBL models can attract students' interest in learning. This is because E-SWS climate change in the integrated global warming PBL model contains prerequisite orientation or knowledge, information, pictures, and exercises. This is in accordance with the opinion of Rerung (2017), who provides a statement that the application of the PBL model can support an increase in cognitive outcomes of learning. The PBL model can also support the increase in psychomotor outcomes of learning. In line with the opinion of Mara (2019) which states statement where the average student outcomes of learning and all aspects of affective assessment, skills, and student learning activities increase using the PBL model can support an increase in student outcomes of learning. In this case, students observe and analyze the content of E-SWS climate change on global warming integrated PBL models to answer questions that can provide encouragement for students to improve their conceptual understanding and communication skills.

Based on the influence obtained from the application of E-SWS climate change on global warming integrated PBL models will understanding of students' concepts and communication skills, so it can be suggested to teachers to use E-SWS climate change on global warming integrated PBL models during learning. So that it is easier for students to construct the knowledge they have and students become more active. This result is in line with the other studies' results which provide statements where the E-SWS and PBL models have an influence on outcomes of the learning (Anori et al., 2013), the implementation of the PBL model can support an increase in student outcomes of learning (Jenah et al., 2022), the use of guided inquiry-based experimental worksheets can support an increase in student outcomes of learning (Maida et al., 2019). Students are expected to read more and get used to analyzing existing problems when solving problems so that it is easier to find solutions to problems.

This research is focused on reviewing the influence of students' conceptual understanding and communication skills with a product, namely electronic teaching materials. Electronic teaching materials that are integrated with the PBL model in supporting the improvement of students' conceptual understanding and communication skills are the objectives of this study. Teaching materials in the form of E-SWS provide encouragement to students to explore, expand, and explain teaching materials to support an increase in students' conceptual understanding and communication skills. The research results imply that teachers must provide learning motivation and guide and direct students in constructing or building students' conceptual understanding and communication skills through E-SWS and integrating PBL models. The E-SWS made is limited by teaching materials developed using ICT in learning, and this research is limited to class X global warming material.

4. CONCLUSION

Based on the research and discussion results, two conclusions were reached. First students' physics scores in learning using E-SWS climate change on global warming integrated PBL model on aspects of conceptual understanding and aspects of communication skills respectively 88.19 and 80.20. Second, the implementation of climate change E-SWS on global warming integrated with the PBL model has a significant effect on students' conceptual understanding and communication skills in class X Senior Hight School at Padang at a significant level of 0.05. Based on the results of the analysis, it can be concluded that the use of climate change E-SWS in integrated global warming PBL models can support an increase in student outcomes of learning in the physics process of learning in aspects of conceptual understanding and communication skills. The use of E-SWS and the PBL model should be used repeatedly so that students are accustomed to learning with electronic teaching materials and the PBL model. In addition, teachers must also use study time as efficiently as possible. The limitation of this research is that it only developed global warming material and was only tested in one school. Future researchers can develop other physics materials with a wider school sample.

Acknowledgements: The researcher would like to thank Drs. Barlius, MM. as the head of the Education Office of West Sumatra Province who has given permission to conduct research. On the other hand, the researcher would also like to thank Drs. H. Syamsul Bahri, M.Pd.I as head of SMA Negeri 1 Padang who gave permission to carry out research at SMA Negeri 1 Padang. Thanks also go to Mrs. Liza Marnalista, S.Pd., M.Pd., as well as students of class X.7 and X.8 who are willing to become research samples to obtain data on the effect of using climate change E-SWS on global warming integrated with the PBL model. Thank you also to the ladies and gentlemen of the UNP physics lecturers who have shared their knowledge, as well as Ms. Sherly who gave directions in writing this article. Final,

REFERENCES

Aji, Pandhu W. W., & Sulandjari, S. (2019). Pengaruh Penerapan Moel Pembelajaran Problem Based Learning (PBL) tehadap Hasil Belajar Kompetensi Dasar Menganalisis Bahan Makanan dari Unggas dan Hasil Olahannya Pada Siswa Kelas X SMKN 1 Buduran Sidoarjo. *E-Jurnal Tata Boga*, *8*(1), 177–185.

Amalia, Y. D., Asrizal, & Kamus, Z. (2014). Pengaruh Penerapan LKS Berorientasi Pembelajaran Berbasisi Maslah Terhadap Kompetensi Siswa Kelas X SMA Negeri 1 Gunung Talang. *Pillar of Phyisics Education*, *4*(3), 17–24.

Anggraini, W., & Hudaidah. (2021). Reformasi Pendidikan Menghadapi Tantangan Abad 21. *Journal on Education*, *3*(3), 208–215.

Anori, S., & Putra, A. (2013). Pengaruh Penggunaan Buku Ajar Elektronik Dalam Model Pembelajaran Langsung Terhadap Hasil Belajar Siswa Kelas X SMAN 1 Lubuk Alung. *1*(April), 104–111.

Aprima, D., & Sari, S. (2022). Analisis Penerapan Pembelajaran Berdiferensiasi Dalam Implementasi Kurikulum Merdeka Pada Pelajaran Matematika SD. *Cendikia : Media Jurnal Ilmiah Pendidikan*, *13*(1), 95–101.

Asrizal., Amran, A., Ananda, A., & Festiyed. (2019). Effect of Science Student Workshett of Motion in Dail Life in Adaptive Contextual Teaching Model on Academic Achievement of Students. *Journal of Physics: Conference Series*, 1185(1),1–9.

Aththibby, A. R. (2015). Pengembangan Media Pembelajaran Fisika Berbasis Animasi Flash Topik Bahasan Usaha Dan Energi. *Jurnal Pendidikan Fisika*, *3*(2),25-33.

Awe, E. Y., & Ende, M. I. (2019). Pengembangan Lembar Kerja Siswa Elektronik Bermuatan Multimedia Untuk Meningkatkan Kemampuan Kognitif Siswa Pada Tema Daerah Tempat Tinggalku Pada Siswa Kelas IV SDI Rutosoro Di Kabupaten Ngada. *Jurnal DIDIKA: Wahana Ilmiah Pendidikan Dasar*, *5*(2), 48–61.

Damayanti, R., & Afriansyah, E. A. (2018). Perbandingan Kemampuan Representasi Matematis Siswa antara Contextual Teaching and Learning dan Problem Based Learning. *JIPM (Jurnal Ilmiah Pendidikan Matematika)*, *7*(1), 30–39.

Erlinawati, C. E., Bektiarso, S., & Maryani. (2019). Model Pembelajaran Project Based Learning Berbasis Stem Pada Pembelajaran Fisika. *Seminar Nasional Pendidikan Fisika*, *4*(1), 1–4.

Hakim, S., Wahyuddi, N. V. (2018). Pengaruh Model Pembelajaran Contextual Teaching and Learning (CTL) Berbantuan LKS terhadap Hasil Belajar Fisika Siswa SMA Attohiriyah Bodak. *Lensa: Jurnal Kependidikan Fisika*, *6*(1), 1–7.

Harnani, S., & Suyatna, A. (2015). Lks Pemanasan Global Bervisi Sets Berorientasi Kontruktivistik Untuk Meningkatkan Kemampuan Berpikir Kritis. *Prosiding Seminar Nasional Fisika*, *IV*, 179–184.

Idawati., Laksono, P. J., & Fatimatuzzahra. (2022). Active, Creative, Effective and Fun Learning with Character in 21st Century Skills. *AL-ISHLAH: Jurnal Pendidikan*, *14*(3), 3667–3678.

Indarta, Y., Jalinus, N., Waskito, W., Samala, A. D., Riyanda, A. R., & Adi, N. H. (2022). Relevansi Kurikulum Merdeka Belajar dengan Model Pembelajaran Abad 21 dalam Perkembangan Era Society 5.0. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(2), 3011–3024.

Jamilah, I., Murti, R. C., & Khotijah, I. (2023). Analysis of Teacher Readiness in Welcoming the" Merdeka Belajar" Policy. *AL-ISHLAH: Jurnal Pendidikan,15*(1), 769–776.

Jamun, Y. M. (2018). Dampak Teknologi Terhadap Pendidikan. *Jurnal Pendidikan Dan Kebudayaan Missio*, *10*(1), 1–136.

Jenah, R., Wahdah, N., & Syar, N. I. (2022). Implementasi Model Problem Based Learning Secara Daring Pada Pembelajaran Matematika Untuk Meningkatkan Hasil Belajar Siswa. *Jurnal Eksakta Pendidikan (Jep)*, *6*(2), 178–184.

Khabibah, N., Jalmo, T., & Suyatna, A. (2018). The Use of Inquiry-Based Student Worksheet to Instills Science Generic Skill of Students. *International Journal of Research Granthaalayah*, *6*(6), 131–138.

Kusumawati, I. T., Soebagyo, J., & Nuriadin, I. (2022). Studi Kepustakaan Kemampuan Berpikir Kritis Dengan Penerapan Model PBL Pada Pendekatan Teori Konstruktivisme. *Jurnal Mathematic Education*, *5*(1), 13–18.

Maida, M. C., Bayharti, B., & Andromeda, A. (2019). Pengaruh Penggunaan Lembar Kerja Siswa (LKS) Eksperimen Laju Reaksi Berbasis Inkuiri Terbimbing Terhadap Hasil Belajar Siswa Kelas XI MIA SMAN 4 Padang. *Jurnal Eksakta Pendidikan (Jep)*, *3*(1), 75.

Mara, N. (2019). Pengaruh Model Pembelajaran Berbasis Masalah (Problem Based Learning) Terhadap Hasil Belajar Siswa Pada Materi Pokok Fluida Statis Di Kelas X Mia Semester Ii Sma Negeri 2 Tarutung T.P 2016/2017. *Jurnal Inovasi Pembelajaran Fisika (INPAFI)*, *7*.

Mariya, L., & Suyatna, A. (2015). Lembar Kegiatan Siswa Model Learning Cycle 7E Materi Pemanasan Global Untuk Meningkatkan Keterampilan Berpikir Kritis Siswa. *Prosiding Seminar Nasional Fisika*, *4(3)*, 81–86.

Medriati, R., & Risdianto, E. (2020). Penerapan Pendekatan Student Centered Learning (Scl) Untuk Meningkatkan Keterampilan Berpikir Kreatif Dan Komunikatif Mahasiswa Pendidikan Fisika Semester Iii Universitas Bengkulu. *Jurnal Kumparan Fisika*, *3*(1), 67–74.

Mulyani, F., & Haliza, N. (2021). Research & Learning in Faculty of Education Analisis Perkembangan Ilmu Pengetahuan dan Teknologi (Iptek) Dalam Pendidikan. *Jurnal Pendidikan Dan Konseling*, *3*(1), 101–109.

Ni'mah, L. H., Saptorini, & Stephani, D. P. (2013). Pengembangan LKS IPA Terpadu Berbasis Permainan Edukatif Tema Gerak Tumbuhan dan Faktor yang Mempengaruhi Untuk Siswa SMP. *Unnes Science Education Journal*, *2*(1), 149–156.

Nurdyansyah & Eni, F. F. (2016). *Inovasi Model Pembelajaran Sesuai Kurikulum 2013*. Nizamia Learning Center.

Nurhaliza, P., Yurnetti., Festiyed, & Letmi. (2019). Pengaruh Penerapan Model Pembelajaran Problem Based Learning (PBL) Berbantuan LKS Pada Materi Gaya Dan Hukum Newton Terhadap Kompetensi Fisika Siswa Kelas X MAN 1 Kerinci. *Pillar of Physics Education*, *12*(4), 721–728.

Nurlina, N., Nurhayati, N., & Arafah, K. (2015). Penerapan Pembelajaran Berbasis Masalah Terhadap Hasil Belajar Fisika Peserta Didik Kelas X Sma Negeri 2 Majene. *Jurnal Sains Dan Pendidikan Fisika (JSPF)*, *11*(3), 245–250.

Pertiwi, A. D., Nurfatimah, S. A., & Hasna, S. (2022). Menerapkan Metode Pembelajaran Berorientasi Student Centered Menuju Masa Transisi Kurikulum Merdeka. *Jurnal Pendidikan Tambusai*, *6*(2), 8839–8848.

Ramadhani, D. P., Asrizal., &Festiyed. (2021). Analisis Effect Size Pengaruh Penerapan LKS Terhadap Hasil Belajar Siswa pada Pembelajaran IPA dan Fisika Pendahuluan. *Jurnal IPA Dan Pembelajaran IPA*, *5*(1), 77–89.

Redhana, I. W. (2019). Mengembangkan Keterampilan Abad Ke-21 Dalam Pembelajaran Kimia. *Jurnal Inovasi Pendidikan Kimia*, *13*(1).

Rerung, N. (2017). Penerapan Model Pembelajaran Problem Based Learning (PBL) Untuk Meningkatkan Hasil Belajar Peserta Didik SMA Pada Materi Usaha dan Energi. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *6*.

RI, M. P. dan K. (2014). *Lampiran Menteri Pendidikan dan Kebudayaan RI Nomor 59 tahun 2014 tentang Kurikulum 2013 Sekolah Menengah Atas/ Madarasah Aliyah*.

Rianingsih, D., Mawardi., & Wardani, K. W. (2019). Penerapan Model Pembelajaran Tps (Think Pair Share) Dalam Rangka Meningkatkan Keterampilan Komunikasi Siswa Kelas 3. *NATURALISTIC : Jurnal Kajian Penelitian Pendidikan Dan Pembelajaran*, *3*(2), 339–346.

Rizal, A., Akhlis, I., & Sarwi, S. (2019). Pengembangan Media Pembelajaran Scrapbook untuk Meningkatkan Pemahaman Materi. *Unnes Physic Education Journal*, *8*(3), 220–227.

Rosmiati, R., Hikmawati, H., & Harjono, A. (2020). Pengaruh Model Discovery Learning Terhadap Penguasaan Konsep Fisika Peserta Didik Kelas Xi Man 1 Lombok Barat. *Jurnal Ilmiah Profesi Pendidikan*, *5*(1), 29–34.

Rusmono. (2012). Startegi Pembelajaran dengan Problem Based Learning itu perlu: Untuk Meningkatkan Profesionalisme Guru. Ghalia Indonesia.

Sari, N., Sunarno, W., & Sarwanto, S. (2018). Analisis Motivasi Belajar Siswa Dalam Pembelajaran Fisika Sekolah Menengah Atas. *Jurnal Pendidikan Dan Kebudayaan*, *3*(1), 17–32.

Siswono, H. (2017). Analisis Pengaruh Keterampilan Proses Sains Terhadap Penguasaan Konsep Fisika Siswa. *Momentum: Physics Education Journal*, *1*(2), 83–90.

Sugiyono. (2017). *Metode Penelitian Kombinasi*. Alfabeta.

Sundayana, R. (2015). Statistika Penelitian Pendidikan (2nd ed.). Alfabeta.

Wahyu, I., Lewa, L., Susanto, H., & Marwoto, P. (2018). Implementasi Model Pembelajaran Inkuiri Terbimbing pada Kemampuan Pemecahan Masalah Fisika dan Kemampuan Komunikasi Siswa SMP. *UPEJ Unnes Physics Education Journal*, *7*(2), 44–51.

Wakiah, W. N., Ruhiat, Y., & Utami, I. S. (2019). Pengembangan E-Modul Pembelajaran Fisika Berbasis Problem Based Learning (PBL) Pada Materi Usaha dan Energi untuk Siswa SMA Kelas X. *Jurnal Prosiding Seminar Nasional Pendidikan Fisika Untirta*, *2*(1), 131–136.

Wulandari, K., & Cintamulya, I. (2022). Validitas LKS Elektronik dalam Mendukung Keterampilan Berpikir Kritis yang Berorientasi Problem Based Learning. *Jurnal Pendidikan Biologi*, *7*(1), 159–172.

Yuliani, K.,& Saragih, S. (2015). The Development of Learning Devices Based Guided Discovery Model to Improve Understanding Concept and Critical Thinking Mathematically Ability of Students at Islamic Junior High School of Medan. *Journal of Education and Practice*, *6*(24), 116–128.

Siti, Z. (2018). *Mengenal 4C: Learning and Innovation Skills untuk Menghadapi Era Revolusi Industri 4.0*. 1–18.