ISSN (PRINT) : 2549-9955 ISSN (ONLINE): 2549-9963
JURNAL ILMIAH PENDIDIKAN FISIKA
https://ppjp.ulm.ac.id/journals/index.php/jipf/index

Effectiveness of Mechanical Waves Teaching Materials Using Direct Teaching to Improve Problem-Solving Skills of Students

Norma Norma, Sarah Miriam, Suyidno Suyidno*, and Dewi Dewantara
Pendidikan Fisika, FKIP, Universitas Lambung Mangkurat, Banjarmasin, Indonesia
*suyidno_pfis@ulm.ac.id

Abstract

One of the skills in physics learning is problem-solving skills. However, this skill is not sufficiently trained at school. Therefore, this study aims to analyze the effectiveness of mechanical wave teaching materials that apply direct teaching models to improve students' problem-solving skills. This is a quantitative descriptive research with one group pre-test post-test design on 28 class XI MIA 2 SMA Negeri 1 Alalak students. According to Heller, data collection was obtained through problem-solving tests using indicators of problem-solving skills: visualizing problems, describing problems, planning solutions, implementing solutions, and evaluating problems. The study results stated that the mechanical wave teaching materials effectively improved students' problem-solving problem-solving by producing a problem-solving test N-gain score of 0.83 with a high category. This also shows an increase in students' problem-solving skills. Thus, teaching materials for mechanical waves using the direct teaching method are effectively used in physics learning to improve students' problem-solving skills at school.

Keywords: direct teaching; mechanical waves; problem-solving skills

Received : 1 November 2023
Accepted : 4 May 2024
Published: 27 June 2024
DOI : https://doi.org/10.20527/jipf.v8i2.10705

How to cite: Norma, N., Miriam, S., Suyidno, S., & Dewantara, D. (2024). Effectiveness of mechanical waves teaching materials using direct teaching to improve problem-solving skills of students. *Jurnal Ilmiah Pendidikan Fisika*, *8*(2), 219-231.

INTRODUCTION

Education is a conscious and planned effort to create a learning atmosphere and learning process so that students actively develop their potential for religious spiritual strength, self-control, personality, intelligence, noble character, and skills needed by themselves, society, nation, and state. With the passage of time and the times that continue to develop, there are changes in behaviour.

Human behaviour changes over time. Similarly, it has also changed the development of the education system in the world and in Indonesia. The education system is a strategy or method used in the teaching and learning process to achieve goals. The goal is for students to actively develop the potential that exists within themselves (Mursid & Yulia, 2017). In addition, students can master various skills and prepare themselves to succeed (Wijaya *et al.*, 2016).

The development of education in the world cannot be separated from the development of the Industrial Revolution

that occurred in the world, which indirectly changed the economic order and also changed the educational landscape in a country. The Industrial Revolution started from (1) Industrial Revolution 1.0 occurred in the 18th century through the invention of the steam engine, allowing goods to be mass produced, (2) Industrial Revolution 2.0 occurred in the 19-20th century through the use of electricity which made production costs cheap, (3) Industrial Revolution 3.0 occurred around the 1970s through the use of computerization, and (4) Industrial Revolution 4.0 itself occurred around 2010 through engineering intelligence and the internet of things as the backbone of human and machine movement and connectivity.

One of the efforts that need to be made to face the challenges of the Industrial Revolution 4.0 is to improve the quality of teachers so that they are able to teach the material with an approach to the application of the use of information technology in the teaching and learning process if not it will be increasingly outdated and this will have an impact on the quality of graduates. This effort is made in order to prepare human resources who excel in global competence and are able to adapt to the existing era; whatever the technology, information develops so quickly and learning resources are so easily obtained; the role of the teacher as an educator cannot be replaced by technological advances able to adapt. An educator must utilize information technology to improve the quality of the teaching and learning process at every level of education (Mursid & Yulia, 2017). A teacher must be able to teach some of the skills needed to be empowered in teaching and learning activities, one of which is problem-solving skills (Laksana, 2021). Problem-solving cannot be separated from critical thinking skills because these skills are very important skills in solving problems (Zubaidah, 2017).

Problem-solving skills are skills where students must be able to understand how to solve a problem and apply the ability to select principles and concepts related to the problem(Ramadhanti *et al.,* 2020). These skills also derive solutions to a problem, choose actions to solve the problem and improve on previously learned skills (Asfar et al., 2019). However, Aji et al. (2017) argued that students' problem-solving skills are still low, especially in physics learning. This is because students prioritize concepts and ignore problem-solving skills. Meanwhile, problem-solving skills are needed to build new knowledge in physics learning.

Early observation by Sagita et al. (2018) and Izzati et al. (2020) shows that students still do not believe in the understanding of applying equations in solving problems because they have not received individual instructions on how to recognize, identify, describe, and solve the problem itself. This can also be seen from research conducted by Putri *et al*. (2019) where about 60.7% of all students have not been able to complete their critical thinking in solving problems or physics phenomena because they have not been explained how to solve their ideas and instead fixate on existing formula solutions.

Initial studies conducted by researchers in November at SMA Negeri 1 Alalak reinforced the results of previous research. In this initial study, researchers gave problems that students had to solve using the five stages of problem-solving skills: problem visualization, problem description, planning solutions, implementing solutions, and evaluating. These five stages of problem-solving skills are the five stages according to Heller et al. (1992), where the percentage of problem-solving skills is obtained, namely: 40.77% in visualizing the problem, 40.48% in describing the problem, 25.61% in planning the solution of the

problem, 15.45% in implementing the solution of a problem, and 3.57% in evaluating a problem from the total number of students in class XI MIA 2. The results of the initial study showed that students only wrote down the formula and entered the values they knew without further understanding the physical situation that occurred. In addition, students also do not carry out the evaluation stage or re-examination of the answers given, so it can be said that students' problem-solving skills need to be improved.

Based on the above problems, the researcher provides a solution, namely developing teaching materials using direct teaching models also known as direct teaching, in order to improve students' problem-solving skills. Of the several existing teaching models, the direct teaching model is the most suitable to be applied in physics learning because it can increase the activeness and criticality of students to solve problems related to their daily activities of students. In this learning, there is a need for boring innovation to be fun so that students can play an active role in learning and achieve maximum learning outcomes, especially in learning physics (Qalbi *et al.*, 2019). Students can channel their curiosity, making them more independent and skilful. Rosenshine (2008) in *Five Meanings of Direct Instruction* includes the advantages of direct teaching, namely direct teaching, where students receive direct teaching from educators which significantly exceeds students in the control group assessed by the development of experimental short answer tests, summary tests and evaluation tests (Herman & Suyidno, 2014)

The researchers also provide solutions to develop teaching materials that can improve students' problem-solving skills. If students are given a problem, they can use their skills to solve it, not only by memorizing but by solving a problem that can expand their thinking process. The experience or learning done later will provide opportunities for students to develop skills in solving a problem.

Students can explore the understanding of concepts and principles as well as various problems or certain phenomena, both problems that students often face in their daily lives, which can stimulate students' critical thinking skills. This is needed to solve a problem to obtain a quick and precise decision (Suma, 2006).

Researchers chose mechanical wave material to be developed in this study because the material is abstract. Because this material is abstract, it is difficult for students to understand (Jumadin et al., 2017).

A strong grasp of mechanical waves will greatly help students understand other physics topics, such as optics and quantum mechanics. The wave concept is also needed to understand spectroscopy and seismology, which shows how necessary it is to understand the topic of waves (Kameo et al., 2020).

Based on the background and problems mentioned, it is important to test the effectiveness of mechanical wave teaching materials using direct teaching to improve students' problem-solving skills in the era of 21st-century skills by reviewing the effectiveness of the teaching materials developed. This study aims to describe the effectiveness of teaching materials for mechanical waves using direct teaching to improve students' problem-solving skills in physics learning at school.

METHOD

The researchers used direct teaching materials to improve students' problem-solving skills in this study. The subject of this study was teaching materials consisting of lesson plans, teaching materials, student worksheets, and TPM on mechanical wave material. This research is quantitative descriptive

research with a one-group pre-test post-test design. The research sample was 28 class XI MIA 2 SMA Negeri 1 Alalak students in the 2022/2023 school year.

Table 1 Trial design *one-group pre-test post-test design*

Pre-test	***Treatment***	***Post-test***
O_1	X	O_2

The research data collection started from March to May 2023 and was carried out at SMA Negeri 1 Alalak located at Jl. Brig. H. Hasan Basri KM 11. Handil Bakti, Alalak District, Barito Kuala Regency, South Kalimantan Province. The researchers conducted research there because the school's principal and educators were willing to accept this research activity with open arms. In addition, based on the researcher's initial observation, it was found that the problem-solving skills of students in the school were low. This is also supported by an interview with one of the educators who stated that learning has only been centred on students so far. There has been no teaching material specially prepared to improve students' problem-solving skills, so innovation in the learning process is needed to be able to improve the problem-solving skills of students in the school.

This study aims to analyze the effectiveness of mechanical wave teaching materials using direct teaching to improve students' problem-solving skills where data collection is obtained from the results of problem-solving tests. The solution test uses indicators of problem-solving skills.

The indicators of problem-solving skills used here are, according to Heller where, there are five steps of problem-solving skills, namely visualizing problems, describing problems, planning solutions, implementing solutions, and evaluating problems (Heller et al., 1992)

Learning is carried out in 3 sub-topics of mechanical wave material, namely understanding waves, mechanical wave symptoms, and analyzing the magnitude and symptoms of waves. The three sub-subjects will be taught using a direct teaching model. The direct teaching model is one of the learning models that guide students in learning basic skills and gaining insights that educators will teach gradually (Asri et al., 2022). Feedback to students in teaching is a force which is an application of the behavioural theory of learning (Pratiwi, 2021).

Assessment of problem-solving skills is obtained from the results of the problem-solving test, which is calculated using the following equation (Mardapi, 2008).

$$N = \frac{S_{pd}}{S_m}\, x\, 100 \qquad \dots (1)$$

The average value of the problem-solving skills assessment was adjusted to the following categories.

Table 2 Problem-solving skills value interval

Interval Value	**Category**
$\underline{X} > 80{,}00$	Excellent
$60{,}00 < \underline{X} \leq 80{,}00$	Good
$40{,}00 < \underline{X} \leq 60{,}00$	Average
$20{,}00 < \underline{X} \leq 40{,}00$	Deficient
$\underline{X} \leq 20{,}00$	Unsatisfactory

(Widoyoko, 2009)

The level of improvement of students' problem-solving skills can be obtained using the normalized gain (N-gain) equation, where the N-gain value to be obtained will be adjusted to the category according to Hake (1998), namely high, 0.7 medium ≥ 0.3 and 0.3 low.

RESULTS AND DISCUSSION

This study aims to describe the effectiveness of teaching materials developed using direct teaching to improve students' problem-solving skills. Effectiveness comes from the word effective, which means having an influence or effect. While effectiveness means the success of a particular action (Thomas & Collier, 1997). Meanwhile, teaching materials are materials or subject matter arranged in a systematic

order, which teachers and students use in the learning process (McDonough *et al.*, 2013). The teaching materials developed here include lesson plans, student worksheets, teaching materials, and problem-solving tests. RPP is the smallest learning program unit that contains a delivery plan for a particular subject or unit of discussion to achieve one KAD (Expected Final Competency). A learning implementation plan, or RPP, is a series of activities to achieve a learning achievement. In other words, the lesson plan is a derivative of the RPS, which the teacher will use in every face-to-face learning. Learning or teaching is an effort to teach students. In another sense, teaching involves selecting, determining, and developing methods to achieve the desired teaching results. The stages of selecting, determining, and developing these methods are based on existing teaching conditions. In achieving learning objectives, several things need to be considered, such as how to organize learning, deliver learning content, and organize interactions between existing learning resources to function optimally (Sudrajat, 2018). A student worksheet is a type of learning tool that contains questions that are expected to increase students' understanding of what has been learned. The material is a study guide for students during teaching and learning activities which contains a cover, preface, instructions for use, concept map, and learning material, which is divided into three subchapters, summary, glossary along with sample problems and practice questions that contain indicators of problem-solving skills (Purnamasari *et al.*, 2016).

The teaching materials developed can be seen in Figure 1, 2, and 3.

Figure 1 Cover and concept map of teaching material

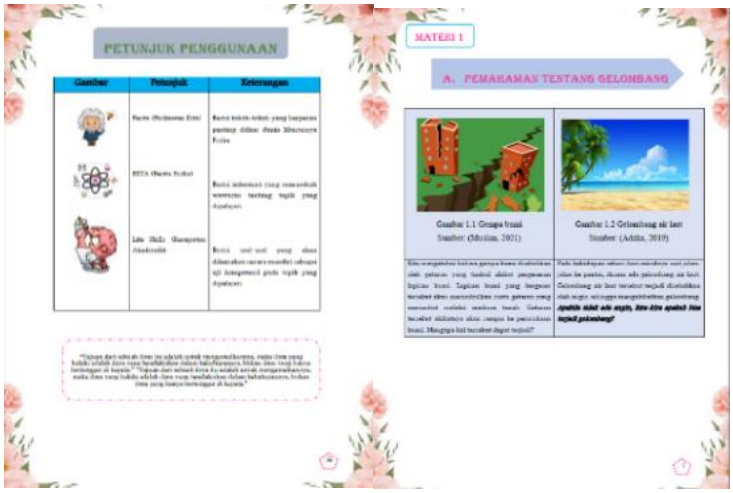

Figure 2 Instructions for use and learning material 1

Figure 3 Sample problems contain indicators of problem-solving skills

Teaching materials on mechanical wave material using direct teaching to improve students' problem-solving skills developed by researchers have been validated by validators and simulated with fellow students (Mulhayatiah *et al.*, 2019). After that, a trial was conducted for students in class XI MIA 2 SMA Negeri 1 Alalak, taking into account the effectiveness of these teaching materials, where effectiveness is an educational standard that can be seen from the achievement of these learning objectives derived from tests given to students or called problem-solving tests (Rohmawati, 2015).

Researchers conducting this study used a problem-solving test because physics is a science classified as the most basic physical knowledge. It is related to the basic principles of the universe. Therefore, learning physics requires direct contact with what is desired.

Direct experience or observation with the five senses makes it easier for students to learn. These experiences will develop students' ability to gradually understand the abstract concepts of physics, think logically, and even make

generalizations. States that physics learning should facilitate students' building their knowledge and thinking skills. Thinking skills develop because physics students find many problems that allow them to think.

Students will use these thinking skills to solve physics problems. Thus, physics learning should help students acquire these skills. However, in reality, learning physics does not help students improve their thinking skills (Dasilva *et al.*, 2019).

To solve existing problems, researchers take action steps related to the problem-solving process. The steps or steps that students must go through in solving existing problems are five stages, namely (1) visualizing the problem, (2) describing the problem in a physics description, (3) planning a solution, (4) implementing the plan, and (5) checking and evaluating *(Apriyani et al.*, 2019).

The tests to be given amounted to five essay questions and were calculated using the average N-gain score formula in the form of *pre-test* and *post-test* (Asfar & Nur, 2018). The results can be shown in Table 3.

Table 3 Problem-solving skills analysis results (*pre-test*)

Indicators	*Pre-test*	
	Average	**Category**
Visualize	14.05	Unsatisfactory
Describe	39.29	Deficient
Plan	7.97	Unsatisfactory
Implement	5.79	Unsatisfactory
Evaluate	1.79	Unsatisfactory

Based on Table 3 where, when students take the first test before the teacher provides a teaching aid or guideline that will be used using Heller's problem-solving stages, it can be seen that the resulting category is, on average, not good, so it can be concluded that students' problem-solving skills are still low. This is also seen from several studies conducted by previous researchers who found that students' problem-solving skills were low (Abdollahi *et al.*, 2015).

Table 4 Problem-solving skills analysis results (*post-test*)

Indicators	*Post-test*	
	Average	**Category**
Visualize	90.60	Excellent
Describe	97.14	Excellent
Plan	85.10	Excellent
Implement	83.59	Excellent
Evaluate	69.29	Good

Based on Table 4, there are stages of students' problem-solving skills after being given treatment; visualizing the problem meets the excellent category. The stages of describing, planning and implementing solutions are categorized as very good and evaluating the problem meets the good category. Based on the table above, it can be seen that learning with mechanical wave teaching materials with direct teaching models is effectively used to improve students' problem-solving skills.

According to Heller, the stages that students must go through in solving the problem-solving test are the sof problem-solving skills Heller, namely visualizing problems, describing problems, planning solutions, implementing solutions, and evaluating problems. The test step is a pre-test question distributed to students before learning activities are conducted to obtain the results of their problem-solving skills. This can be seen in Table 3, the results of the problem-solving skills *pre-test* analysis of students.

The results of the *pre-test* conducted by students on average were categorized as not good because at the time of the pre-test, some of the students could not visualize the problem, describe the problem, plan a solution, implement a solution, and evaluate a problem. After learning using teaching materials using the direct teaching model, an increase in students' problem-solving skills is obtained as in Table 4 of the *post-test* section, where an increase is obtained in each indicator of problem-solving skills.

The stage of visualizing the problem has increased, where the average

category is very good. This is because students already know that in physics learning, to understand the question better, they must be able to identify what is known about the question. Some students are also able to describe it well, but there are also some students who do not draw and go straight to the next problem-solving stage. So an increase in other problem-solving stages is obtained in a very good category.

The stage of describing problems in physics problems, the results of the post-test improvement are obtained in a very good category. This is because almost all students can identify what variables are known and what variables are asked in this problem. Table 4 of the results of the problem-solving skills analysis of students *post-test* shows this.

The solution's planning stage also increased, with an average of very good category; this is because most students have been able to plan which formula will be used in carrying out the next stage, even though in the processing stage, there are still those who forget / even pass the formula that has been determined. At the stage of implementing problem-solving solutions in Table 4, the *post-test* section also increased; namely, the average category was very good even though one question was categorized as good.

The last stage, namely, evaluating the problem, obtained an increase in the good category. This is because students usually do not use evaluation/ conclusions when answering the questions given. Students will usually immediately collect the answers they get without evaluating whether the answer is correct or not, so overall, at the evaluation stage, the category is good.

Tables 3 and 4 show the conclusion that the average value of the stages of problem-solving skills on the post-test results has increased after treatment. The lowest *pre-test* score was 0.00, and the highest was 18.00. The lowest *post-test* score was 65.50, and the highest was 99.00. These results can be seen in the following Figure 5, 6, 7, 8, and 9.

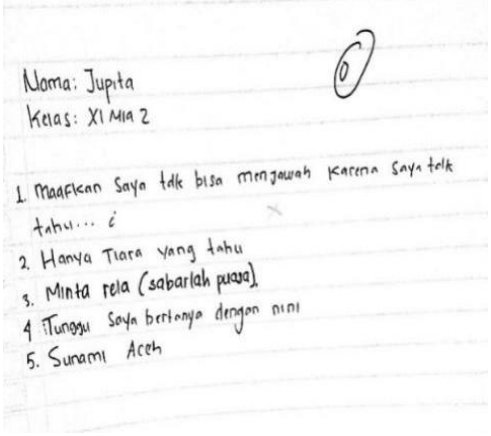

Figure 5 Lowest *pre-test* result

Figure 6 Highest *pre-test* result

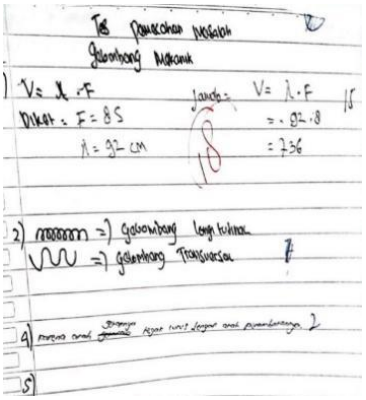

Figure 7 Lower *post-test* result

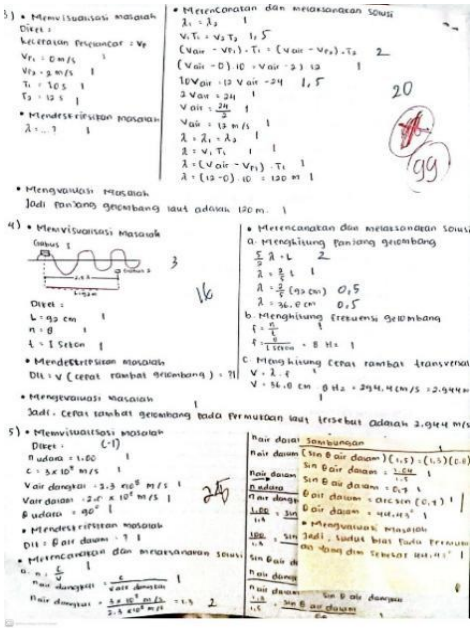

Figure 8 Highest *pre-test* result section 1

Figure 9 Highest *post-test* result section 2

These results indicate that using this mechanical wave teaching material can improve student learning outcomes, especially their problem-solving skills(Rifansyah & Mastuang, 2017). Problem-solving is very important to use in everyday life because it can solve problems for students (Sari *et al.*, 2019).

In the *post-test* of students who exceeded minimum completeness criteria, they were able to describe the problem so that students could determine the appropriate equation or formula and have been able to apply the formula to obtain the correct results. Furthermore, students have been able to conclude the answers obtained. Students who score above the minimum completeness criteria look more active and often ask questions during learning, so the *post-test* scores obtained are also higher than those of students who look passive during learning. According to Slameto in Iswadi & Herwani (2021), the achievement of learning objectives depends on students' learning process.

Based on the statement of Nurwulandari et al. (2019), students who are accustomed to practising solving problems will have an impact on students to be responsive and creative in solving their problems, not only physics problems but problems related to the needs in everyday life. Some students who are passive in learning are also influenced by learning in the month of Ramadan; because of the effects of hunger and thirst, students make less effort to understand what is conveyed by the educator, so the educator must be more patient and repeat which things/ material that students do not understand at the time of learning. The results of the analysis of the solution test will be calculated using the *N-gain* formula, which obtained the following results.

Table 5 Average results

Pre-test	***Post-test***	***Pre-test***	***Post-test***
Category	**Value**	**Category**	**Value**
7.88	Unsatisfactory	7.88	Unsatisfactory

Table 6 *N-gain* test result

N-gain	
<g>	**Category**
0.83	Highest

Table 5 shows that the average pre-test score is still not good, which means that students ' problem-solving skills are still low. Then, the average value of the post-test has increased to a very good category; by comparing the *pre-test* and *post-test* scores, it can be seen that students' problem-solving skills have increased. This is reinforced by Table 6, where the average *N-gain* score is 0.83 with a high category. Thus, the developed mechanical wave teaching materials can be said to be effectively used for the learning process. In this study, the *N-gain* score results obtained were in the high category; this can be interpreted as the level of effectiveness has a high or very effective category. This is in line with the opinion of Rohmawati (2015) and Swan (2003), who state that effectiveness is the level of success of the learning process objectives using the product that has been developed.

Based on the research data on the results of the problem-solving test, it can be seen that there is an increase in the value of students before and after learning using the developed mechanical wave teaching materials, so it can be said that this teaching material is effective and feasible to use to improve students' problem-solving skills at school. This can be seen from the results of research from researchers and supported by research by Ulandari *et al*. (2019), which meets the effective category because students have been able to answer the questions that have been given and experience an increase in students' problem-solving skills after using the teaching materials provided by the researcher.

This research also shows that mechanical wave teaching materials are one way that teachers can provide learning to students with a direct teaching model.

The difference between this research and previous research is that the researcher uses the test subjects as students of class XI MIA 2 SMA Negeri 1 Alalak in the 2022/2023 school year, totalling 28 students, where these participants are students when researchers do teaching practice.

This study uses a direct teaching model to improve problem-solving skills, which can be seen from the effectiveness of teaching materials provided by researchers to students. The focus of this research is to see the effectiveness of the teaching materials themselves from the tests that will be given by researchers where the tests use stages from Heller so that the results of the teaching materials have an effective category to improve students' problem-solving skills.

The weakness of this research is that the problem only uses the application (C3) and analysis (C4) stages, while for problem-solving skills itself, it can use questions consisting of C2-C6, but because it adapts to the ability of students, researchers only use C3 and C4 in the solution test. In addition, the learning was carried out during the fasting month, when there were time cuts so that there were time constraints that caused the work on the practice questions at each meeting to be continued independently at home.

CONCLUSIONS

The results of the effectiveness of teaching materials in students' problem-solving tests where the category is obtained with a very good average. These results can also be viewed from the average N-gain value, where 0.83 is obtained in the high category. This shows that the teaching materials that have been developed are effective and feasible to use in physics learning at school. Further research when using the direct teaching model to improve problem-solving skills,

researchers review and pay more attention to time so that later learning is not rushed and students get thorough guidance when solving problems that contain indicators of problem-solving skills.

REFERENCES

Abdollahi, A., Talib, M. A., Yaacob, S. N., & Ismail, Z. (2015). Problem-solving skills appraisal mediates hardiness and suicidal iideation among malaysian undergraduate students. *PloS One*, *10*(4), e0122222.

Aji, S. D., Hudha, M. N., & Rismawati, A. Y. (2017). Pengembangan Modul Pembelajaran Fisika Berbasis Problema Based Learning untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika. *SEJ (Science Education Journal)*, *1*(1), 36–51.

Apriyani, R., Ramalis, T. R., & Suwarma, I. R. (2019). Analyzing Students' Problem solving abilities of direct current electricity in stem-based learning. *Journal of Science Learning*, *2*(3), 85–91.

Arikunto, S. (2010). *Metode Penelitian*. *Jakarta: Bumi Aksara*.

Asfar, A. M. I. T., Asfar, A. M. I. A., & Halamury, M. F. (2019). Teori behaviorisme (Theory of behaviorism). *February*, 1–32.

Asfar, A. M. I. T., & Nur, S. (2018). *Model pembelajaran problem posing & solving: meningkatkan kemampuan pemecahan masalah*. CV Jejak (Jejak Publisher).

Asri, Y. N., Alti, R. M., Rizqi, V., Rismawati, E., Gatriyani, N. P., Amarulloh, R. R., Astuti, F., Utomo, S., Nurhuda, T., & Rahmiati, S. (2022). *Model-model pembelajaran*. Haura Utama.

Dasilva, B. E., Ardiyati, T. K., Suparno, Sukardiyono, Eveline, E., Utami, T., & Ferty, Z. N. (2019). Development of android-based interactive physics mobile learning media (IPMLM) with scaffolding learning approach to improve hots of high school students. *Journal for the Education of Gifted Young Scientists*, *7*(3), 659–681. https://doi.org/10.17478/jegys.610377

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics*, *66*(1), 64-74.

Heller, P., Keith, R., & Anderson, S. (1992). Teaching problem solving through cooperative grouping. Part 1: Group versus individual problem solving. *American Association of Physics Teachers*, *60*(7), 627–636.

Herman, M. W., & Suyidno, S. (2014). Pengajaran langsung dengan metode problem solving. *Jurnal Ilmiah Pendidikan Fisika*, *2*(2), 141–150.

Iswadi, I., & Herwani, H. (2021). Metode active learning upaya peningkatan keaktifan dan hasil belajar siswa di era pademi covid-19: Active learning method efforts to improve student activity and learning outcomes in the covid-19 pandemic era. *Chalim Journal of Teaching and Learning (CJoTL)*, *1*(1), 35–44.

Izzati, A. U., Arifuddin, M., Suyidno, S., & Misbah, M. (2020). Pengembangan perangkat pengajaran langsung untuk melatihkan keterampilan pemecahan masalah peserta didik SMA. *Jurnal Inovasi Dan Pembelajaran Fisika*, *7*(2), 190–199.

Jumadin, L., Hidayat, A., & Sutopo, S. (2017). Perlunya pembelajaran modelling pada materi gelombang. *Pendidikan: Teori, Penelitian, Dan Pengembangan*, *2*(3), 325–330.

Kameo, W., Handayanto, S. K., & Taufiq, A. (2020). Eksplorasi penguasaan konsep gelombang mekanik mahasiswa pendidikan Fisika tahun pertama semester genap Universitas Nusa Cendana Kupang.

Jurnal Riset Pendidikan Fisika, *5*(1), 46–52.

Laksana, S. D. (2021). Pentingnya pendidikan karakter dalam menghadapi teknologi pendidikan abad 21. *Jurnal Teknologi Pembelajaran*, *1*(01), 14–22.

Mardapi, D. (2008). *Teknik penyusunan instrumen tes dan nontes*. Yogyakarta: Mitra Cendikia Press.

McDonough, J., Shaw, C., & Masuhara, H. (2013). *Materials and Methods in ELT: A Teacher's Guide* (Vol. 2). John Wiley & Sons.

Mulhayatiah, D., Purwanti, P., Setya, W., Suhendi, H. Y., Kariadinata, R., & Hartini, S. (2019). The impact of digital learning module in improving students' problem-solving skills. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *8*(1), 11–22.

Mursid, R., & Yulia, E. (2017). *Pengembangan Pembelajaran dalam Teknologi Pendidikan di Era RI 4.0*. In *Prosiding Seminar Nasional Teknologi Pendidikan Peran Teknologi Pendidikan Dalam Mengembangkan Dan Meningkatkan Keprofesionalan Pendidik Di Era Revolusi Industri*, 4, 35-42.

Nurwulandari, N., Alam, Y., & Ajeng, R. S. (2019). Pengaruh kemampuan pemecahan masalah terhadap pembelajaran fisika pada materi hukum archimedes. *Jurnal Pendidikan Riset Dan Konseptual*, *3*(4), 218–223.

Pratiwi, I. (2021). *IPA untuk pendidikan guru sekolah dasar (Vol. 1)*. Umsu press.

Pribadi, B. A. (2016). *Desain dan pengembangan program pelatihan berbasis kompetensi implementasi model ADDIE*. Kencana.

Purnamasari, P., Annur, S., & M., A. S. (2016). Pengembangan bahan ajar melalui model pembelajaran REACT pada materi elastisitas. *Berkala Ilmiah Pendidikan Fisika*, *4*(3), 209.

Putri, C. S., Sesunan, F., & Wahyudi, I. (2019). Pengaruh penerapan model pembelajaran creative problem solving untuk meningkatkan kemampuan berpikir kreatif dalam pemecahan masalah Fisika pada siswa SMA. *Jurnal Pendidikan Fisika*, *7*(2), 149–155.

Raharjo, S. (2019). *Cara uji paired sample T-Test dan interpretasi dengan SPSS. SPSS Indonesia, olah data statistik dengan SPSS*.

Ramadhanti, Mastuang, & Mahardika, A. I. (2020). Pengembangan bahan ajar fisika topik elastisitas menggunakan model pengajaran langsung untuk melatihkan kemampuan pemecahan masalah peserta didik. *Jurnal Ilmiah Pendidikan Fisika 4*(2), 65–75.

Rifansyah, M., & Mastuang, M. (2017). Pengembangan perangkat pembelajaran IPA pada pokok bahasan tata surya. *Berkala Ilmiah Pendidikan Fisika*, *5*(3), 286–296.

Rohmawati, A. (2015). Efektivitas pembelajaran. *Jurnal Pendidikan Usia Dini*, *9*(1), 15–32.

Rosenshine, B. (2008). Five meanings of direct instruction. *Center on Innovation & Improvement, Lincoln*, 1–10.

Sagita, I., Medriati, R., & Purwanto, A. (2018). Penerapan creative problema solving model untuk meningkatkan kemampuan pemecahan masalah fisika siswa kelas xi mia 4 man 2 kota bengkulu. *Jurnal Kumparan Fisika*, *1*(3), 1–6.

Sari, N. M., Yaniawati, P., & Kartasasmita, B. G. (2019). The effect of different ways in presenting teaching materials on students' mathematical problem solving abilities. *International Journal of Instruction*, *12*(4), 495–512.

Setyosari, P. (2016). *Metode penelitian pendidikan & pengembangan*. Prenada Media.

Sugiyono, D. (2010). Metode penelitian kuantitatif dan R&D. *Bandung: Alfabeta*, 26–33.

Sugiyono, D. (2013). *Metode penelitian pendidikan pendekatan kuantitatif, kualitatif dan R&D*.

Suma, K. (2006). Pengaruh struktur kelompok dan tipe masalah terhadap kinerja pemecahan masalah siswa. *Jurnal Pendidikan Dan Pengajaran*, *39*(1), 1–13.

Sudrajat, Y. (2018). Techniques writing lesson plan (RPP). *International Journal Of Education, Information Technology, and Others*, *1*(1), 107–115.

Swan, K. (2003). Learning effectiveness online: What the research tells us. *Elements of Quality Online Education, Practice and Direction*, *4*(1), 13–47.

Tegeh, I. M., Jampel, I. N., & Pudjawan, K. (2015). *Pengembangan buku ajar model penelitian pengembangan dengan model ADDIE*.

Thomas, W. P., & Collier, V. (1997). *School effectiveness for language minority students. NCBE Resource Collection Series, No. 9*.

Ulandari, L., Amry, Z., & Saragih, S. (2019). Development of learning materials based on realistic mathematics education approach to improve students' mathematical problem solving ability and self-efficacy. *International Electronic Journal of Mathematics Education*, *14*(2), 375–383.

Wijaya, E. Y., Sudjimat, D. A., & Nyoto, A. (2016). Transformasi pendidikan abad 21 sebagai tuntutan pengembangan sumber daya manusia di era global. *Prosiding Seminar Nasional Pendidikan Matematika*, *1*(26), 263–278.

Widoyoko, E. P. (2009). Evaluasi program pembelajaran. *Yogyakarta: Pustaka Pelajar*, 203.

Zubaidah, S. (2017). Keterampilan abad ke-21: keterampilan yang diajarkan melalui pembelajaran. *Seminar Nasional Pendidikan*. 1-17.