Received : 23 August 2023
Revised : 29 November 2023
Accepted : 28 December 2023
Online : 31 December 2023
Published: 31 December 2023

DOI: doi.org/10.21009/1.09207

Profile of students' Physics Problem Solving Skills and Implementation PBL Model Assisted by 3D Digital Module to Improve Problem Solving Skills

Rachmadaniz Audrey Kinasih[1], Binar Kurnia Prahani[1,a)], Firmanul Catur Wibowo[2,b)], Bayram Costu[3,c)]

[1]*Universitas Negeri Surabaya, Surabaya, Indonesia*
[2]*Universitas Negeri Jakarta, Jakarta, Indonesia*
[3]*Yildiz Technical University, Turkiye*

✉: [a)]binarprahani@unesa.ac.id, [b)]fcwibowo@unj.ac.id, [c)]bayram.costu@deu.edu.tr

Abstract

The aim of this research is to analyze high school students' ability to solve physics problems as a consideration for implementing the PBL learning model assisted by Android-based 3D digital modules. The research method uses descriptive qualitative analysis techniques to find out information about a problem the facts face. The research was conducted at SMA Nahdlatul Ulama 1 Gresik with 160 students as respondents. Data obtained from research respondents were categorized into three groups, namely low (score 0-40), medium (score 41-70) and high (score 71-100). From the research results, there were 154 students in the low category, while there were 5 students in the medium category and 1 person in the high category. The conclusion is that students' ability to solve physics problems is still low and needs to be improved, so it is necessary to provide innovative learning models and media, one of which can be done by implementing PBL models and media in the form of Android-based 3D digital modules which will make students more interested in learning so that helps hone physics problem solving skills.

Keywords: elasticity, PBL, problem solving skills, 3D digital module

INTRODUCTION

Education is an activity carried out by someone consciously, deliberately, and with full responsibility to improve their capabilities. (Bahri 2021). According to Ki Hajar Dewantara, education occurs in schools, the family, and the community. This is what is called the Three Education Centers. Education is expected to improve the quality of Human Resources to face the demands of an increasingly advanced era. School is a formal institution that has clear rules and objectives. One is in terms of the curriculum the government has set. The curriculum is an essential tool to determine the success of an education. Improving the quality of education is also a demand for every school in the current era of globalization. The quality of education must be developed and improved again, focusing on teachers and curriculum and on innovation, technology, and learning models applied in the classroom.

So far, teaching and learning activities have centered more on the teacher or teacher-center. This is what will cause students to be less active in the learning process, and they are more concerned with the results than the learning process itself. So that learning will seem monotonous and boring. (Triyadi 2018) Students are not required to be active, ask questions and express their opinions. If the teacher

always applies this learning model, it will make it difficult for students to understand the material presented. Therefore, it is time for an innovative learning model that can help students be more active, quickly understand the material, and be able to apply it in everyday life.

One of the subjects that is considered difficult and rarely interested in by students is physics. This subject has always been a scourge for the students themselves. This then hinders their learning process (Aldila 2022). Physics is a branch of natural science (IPA) with broad meaning. In physics, many things are discussed, from knowledge, ideas, and concepts in the natural surroundings obtained from experience through a series of scientific processes. In everyday life, there are many physical events related to physics. Through physics, students can have direct experience to understand the natural world scientifically. This is because physics does include not only facts and concepts but also the learning process. According to Khusaeri, Herman and Gading (2022), learning physics can educate students to have superior knowledge and skills, practice formulating research according to scientific procedures, have honesty, discipline, and responsibility, and be able to work in groups, be able to think critically and be able to apply their knowledge in everyday life. According to Hutasoit et al. (2023), physics learning has so far focused on ideas only, not encouraging students' ability to solve physics problems and apply them in everyday life. Teachers usually only ask questions without including problems that can sharpen students to investigate existing problems, so that problem-solving abilities in learning are not trained.

In the 21st century, the development of science, especially the field of science and technology, is progressing and developing rapidly (Ayudha 2021). This is why the education unit system must also be demanded to progress. According to Lolanessa (2020), there are three categories of skills that students must possess in the 21st century, namely the first is how to think critically, creatively, and innovatively, being able to solve problems, make good decisions, and carry out learning. Second, students must also have communication skills and be able to work individually or in teams. Then, the third is being able to be responsible to oneself as a naturalized citizen of the nation and state.

One of the skills that students must possess is the ability to solve complex problems. This problem is a fact that takes place in human beings's lives. According to Aristiawan et al. (2022), problem solving abilities are very much needed in the world of work. So, at the high school it is hoped that students can improve problem solving skills, because they can think critically and have high curiosity, so the education unit system must help students to improve the quality of human resources in this country.

According to G. Polya, there are four indicators in problem-solving skills, namely: 1) analyzing problems, 2) planning problem-solving, 3) carrying out problem-solving plans, and 4) evaluating problem-solving (Jayadiningrat. MG et al. 2018). In the first indicator, students must understand the problems contained in the questions. Students then explore the principles of physics in problem design. In the case of the third indicator, students systematically solve tasks according to a predefined plan. Then in the last indicator, students can evaluate the problem-solving that has been done.

In learning physics, innovation is needed so that learning becomes active, practical, fun, and not dull. Various innovative learning models can be used to improve the quality of education and student learning outcomes. One of these learning models is problem-based learning or problem-based learning. Problem-Based Learning (PBL) can create active learning activities for students. PBL is a learning model that engages students to solve problems with the scientific method stage. According to Yuliani (2021), through learning the PBL model, students can practice on their own and not only material knowledge. This is because the problems given to students are problems that really happen in the environment around them.

The current millennial generation is very dependent on technology. Thus, learning must also utilize this technology by the times. Utilizing technology as a learning medium will make learning more fun so that students will be more interested and have a high curiosity and motivate students to do learning. According to Jannah et al. (2022), android-based digital modules are very suitable to be used as a physics learning medium to help students solve problems. Digital modules are one of the learning media that teachers can use to teach in the classroom (Carlina et al. 2021). That way, problem-solving abilities can be trained to meet the demands of the 21st century. In addition, digital modules based on Android have advantages such as being efficient and practical. They can be done anywhere and anytime because these modules will later be downloaded via PlayStore. From the explanation above, the aim of this research is to analyze the physics problem solving skills of high school students for consideration

of the implementation of the PBL learning model assisted by Android-based 3D digital modules on the topic of elasticity. It is hoped that this PBL learning model assisted by digital modules can improve high school students' physics problem solving skills.

METHODS

This study uses analytical techniques in the form of descriptive qualitative. This is because researchers analyze by describing the data that has been obtained from a subject under study so that conclusions can be drawn (Nababa 2022). This study does not test hypotheses but finds out information from a problem faced by the facts. The data obtained from research respondents will be categorized into three groups: low, medium, and high. The results might be used as material for consideration of models and learning environments that improve high school students' problem solving abilities.

The research was done in a private school in Gresik Regency which consisted of 6 classes; each class had 35 students. Thus, the number of subjects in this study was 210 students. The instruments used to obtain data are (1) problem-based essay questions consisting of 4 indicators: analyzing problems, planning to problem-solve, carrying out problem-solving plans, and evaluating problem-solving (Jayadiningrat. MG et al. 2018). (2) Student response questionnaires, (3) student interviews, (4) teacher interviews. All instruments used in this research have been validated by experts. The essay questions given to students have been validated by 3 validators and have been revised according to suggestions. The selection of essay questions is based on real problems that they can encounter in everyday life. Questionnaires and interviews given to students and teachers aim to discover how the conditions of learning facts exist in class, the effectiveness of learning models and media used in class, and the atmosphere and motivation of students in studying physics which can influence students' problem solving skills. The analytical method used is descriptive qualitative. Researchers can find out the situations according to the facts on the problem-solving abilities possessed by using students at the high school through test results, questionnaires, and interviews with teachers. The following are the research stages used in FIGURE 1.

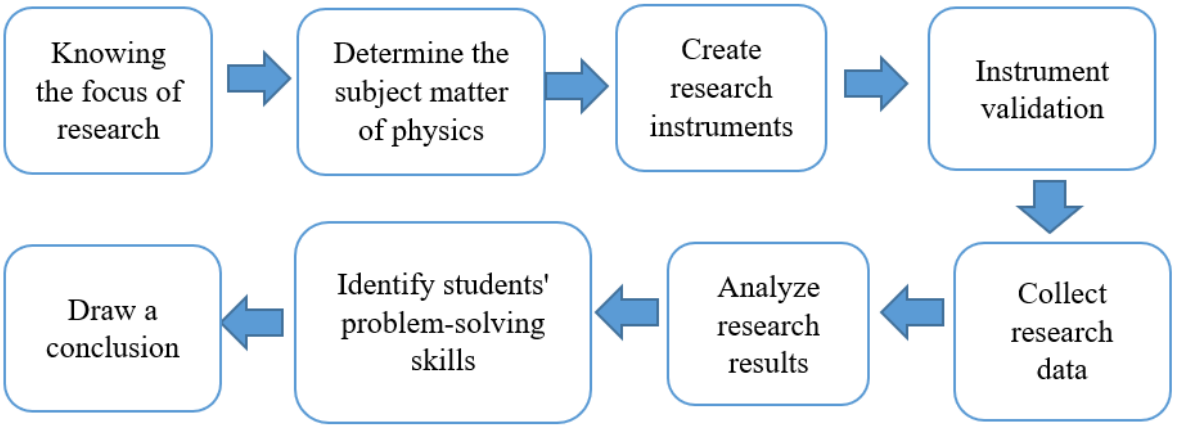

FIGURE 1. Research Methods

RESULTS AND DISCUSSION

The potential of students to clear up a physics problem is, of direction, different. This is because they have their solution to solve the problem. In this study, students were given five questions on Elasticity and Hooke's Law to determine the level of their problem-solving abilities. Of the five questions, students are required to work on the questions according to the instructions and fulfill four indicators of problem-solving ability, namely (1) analyzing problems (2) planning problem-solving (3) carrying out problem-solving plans (4) and evaluating problem-solving. Then, the effects of students' physics problem-solving skills are obtained, as shown within the graph below.

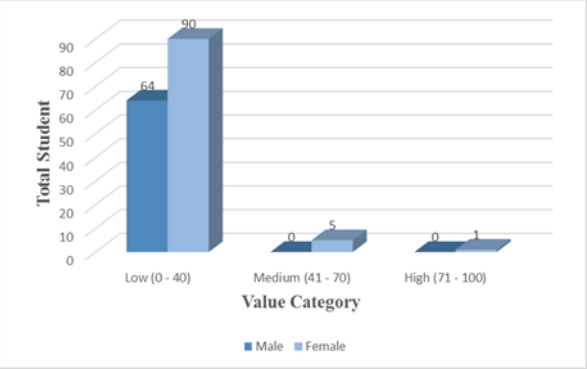

FIGURE 2. The connection among value categories and the quantity of students

Students who get scores in the range of 0-40 are included in the low category, while the value range of 41-70 is in the medium category, and the range of values 71-100 is included in the high category. One question has a score of 25 with the following details; understanding the problem has a score of 5, planning problem-solving has a score of 5, executing the problem-solving plan has a score of 10, and evaluating the problem-solving plan has a score of 5. Out of 160 students at SMA Nahdlatul Ulama 1 Gresik, the scores are mainly in the low category. This shows that the skills of students to solve a problem is relatively low and unable to solve the problem. Even so, medium category has 5 students and high category has 1 student.

From the results of this study, students still find it challenging to solve a physics problem, especially with the four indicators. Students need to get used to working on HOTS (High Order Thinking Skills) questions to make the results more optimal. The following results are from the average students' understanding score in each problem-solving ability indicator.

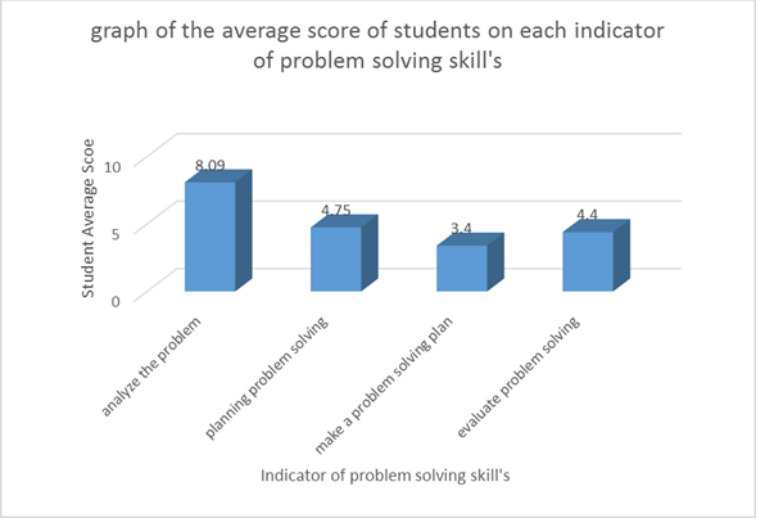

FIGURE 3. Students average scores for each indicator

FIGURE 3 shows that students are more likely to experience difficulties in working on indicators and carrying out problem-solving plans. Students more easily understand physics problems but need help finding solutions to solving the problem. Following are the results of the analysis of student responses in each problem-solving indicator:

1. Analyze problems. In this indicator, students are asked to analyze a problem contained in the problem.

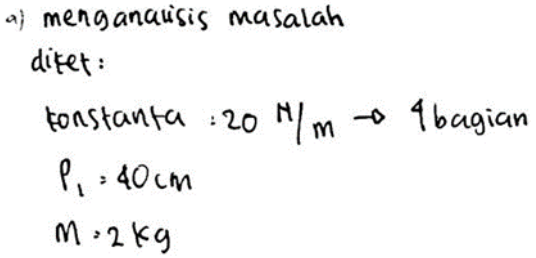

FIGURE 4. Student answers on indicators of analyzing problems

FIGURE 4 shows that students are used to working on questions using the "known, asked, and answered" system, so that students are considered less in a position analyze a problem contained in the problem.

2. Plan problem-solving. In this indicator, students are asked to find or plan the right solution and determine what physics principles will be used.

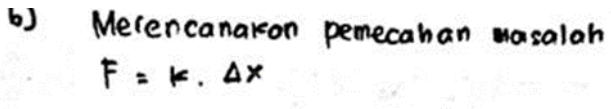

FIGURE 5. Student answers on indicators of planning problem solving

From FIGURE 5, students tend to determine the final formula without involving the stages in solving existing problems.

3. Do a problem-solving plan. In this indicator, students are asked to solve a problem in the problem by applying formula that has been determined in the second indicator.

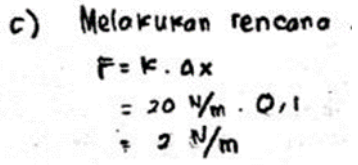

FIGURE 6. Student answers on indicators of carrying out a problem-solving plan

From FIGURE 6, shows that students only calculate using the formula they know but still need to determine the formula appropriate to the existing problem.

4. Evaluate problem-solving. In this indicator, students are predicted in order to evaluate the results of solving the problems they have done. Thus, it can be seen how confident they are with their own answers.

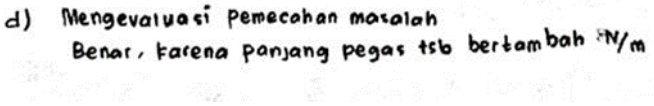

FIGURE 7. Student answers on indicators evaluating problem solving

From FIGURE 7, students can evaluate the problem-solving they have done, but the reasons given need to be revised.

Student Questionnaire Results

Student questionnaires were used to find students' responses in working on physics problem-solving questions, the difficulties they faced, the learning methods used by the teacher, and their responses regarding Android-based 3D modules. This questionnaire contains ten questions related to problem-

solving indicators and also learning activities in the classroom. Responses from this questionnaire were in the form of STS (Strongly Disagree), TS (Disagree), S (Agree), and SS (Strongly Agree). The following are the results of a questionnaire filled out by 160 students in Table below.

TABLE 1. Student Questionnaire Results on Physics Problem Solving Ability and Learning Activities in the Classroom

No	Statement	Response			
		STS	**TS**	**S**	**SS**
1.	Physics subject is very boring	5.6 % (9)	46.9 % (75)	45 % (72)	2.5 % (4)
2.	I find it difficult to solve a problem related to physics	3.1 % (5)	12.5 % (20)	68.8 % (110)	15.6 % (25)
3.	Elastic material is essential in everyday life	1.9 % (3)	11.9 % (19)	69.4 % (111)	16.9 % (27)
4.	I prefer memorizing formulas rather than understanding their physical meaning	11.3 % (18)	32.5 % (52)	47.5 % (76)	8.8 % (14)
5.	Teachers prefer to teach conventionally through the lecture method	5 % (8)	36.3 % (58)	48.1 % (77)	10.6 % (17)
6.	I am comfortable learning with the method used by the current teacher	5 % (8)	14.4 % (23)	68.1 % (109)	12.5 % (20)
7.	I prefer self-study with the help of books rather than teachers	18.1% (29)	58.1 % (93)	20.6 % (33)	3.1 % (5)
8.	I prefer physics learning to be done online *rather* than face to face	37.5 % (60)	52.5 % (84)	8.1 % (13)	1.9 % (3)
9.	I am interested in learning elastic material physics using an Android-based 3D module	6.3 % (10)	20.6 % (33)	44.4 % (71)	28.7 % (46)
10.	In my opinion, the 3D module is very efficient in helping my understanding of elastic materials	3.8 % (6)	11.9 % (19)	54.4 % (87)	30 % (48)

Based on the results of the questionnaires completed by students, it can be seen that (1) Physics is very dull, but some students say that Physics is not boring. This is because the teacher influences mastery in the classroom and can attract students' attention, (2) Students find it challenging to solve physics problems, (3) Elasticity material is essential in everyday life, (4) Students are more likely to memorize formulas than understand its physical meaning, (5) the teacher applies the learning model conventional teacher-centered methods, (6) students still feel comfortable with the current learning model, this may be because students do not understand what can make them feel familiar with the material (7) Students prefer learning that is directly guided by the teacher, (8) Students prefer offline physics learning because they can directly ask about the difficulties they face, (9) Students are very interested in learning elasticity material physics using 3D modules based on Android, (10) 3D modules are very efficient in helping students' understanding of elasticity material.

Teacher Interview Results

Based totally on the outcomes of interviews with three physics situation teachers at SMA Nahdlatul Ulama 1 Gresik, it was found that students' interest in physics tends to be low because they think that physics is a complex subject. The obstacle student’s face is that they tend to memorize formulas rather than understand their physical meaning. This is what causes their reasoning power to be relatively low, and they need more training in analyzing questions, so they are less able to understand or interpret the words in the questions (low literacy). The physics learning model currently applied is more teacher-centered because students are more interested in learning if accompanied by their teacher. However, this will make students lazy to learn to solve problems. The lack of practice questions is caused by limited time, and when given assignments, students complain. The physics teacher says students' problem-solving skills must be trained and improved. Android-based 3D E-Modules are considered very useful as physics learning media. The teacher said that the advantages of this android-based module are that it is more effective, easy to access at any time, and the use of visual technology is very efficient for the z generation, who never get off their cell phones.

Relevant Research

As previously explained, this study aimed to analyze physics problem-solving skills in high school students to consider implementing the PBL learning model assisted by 3D digital modules based on Android on the subject of elasticity. Based on previous research states that the Problem-Based Learning model can affect problem-solving abilities in students (Asiyah et al. 2021). However, learning will be more interesting if balanced with learning media that can arouse students' interest in studying physics. For example, learning media assisted by 3D digital books can help students solve problems quickly. This is because the media is flexible and easily accessible at any time (Prahani et al. 2022). Thus, the effectiveness of learning media is also essential in increasing students' interest in learning physics. The following are the results of an analysis of previous research taken from several articles ranging from 2018 to 2022 in TABLE 2.

TABLE 2. Research Related of the ranging 2019 – 2022

Author (Year)	Sample Characteristics	Findings
Asiyah, A, Topano, A & Walid, A. (2021)	The subjects of this study were 2 classes at SMA Negeri 10 Bengkulu City	The use of the PBL model has a significant effect on improving student learning outcomes.
Prahani, BK, Rizki, IA, Citra, NF, Alhusni, HZ, & Wibowo, FC (2022)	The sample in this study were 2 grade 11 consisting of 65 students at SMA Negeri 2 Bangkalan	The PBL learning model assisted by 3D digital books is very valid and reliable for students.
Nasution, SWR, & Siregar, LH (2022)	The research sample was 63 students from 2 class X SMA.	The PBL model is effective enough to be applied to physics subjects and can improve physics learning outcomes for students.
Aulia, IM (2022)	The research subjects comprised of 2 class X SMA Negeri 1 Empang totaling 53 students.	The PBL Learning Model influences students' problem-solving abilities.
Asuri, AR, Suherman, A and Darman, DR (2021)	The research subjects were 65 students consisting of 2 class X SMA Al Husna.	The PBL learning model assisted by mind mapping has an effect on improving student problem-solving.
Beautiful Dewi Permata Sari (2021)	The research subjects were all students of class XII MIPA 1 SMA Negeri 2 Tanjung Jabung Timur	The PBL model can make students skilled in solving a physics problem so that it can improve students' understanding of physics material.
Aulia, IM (2022)	The research sample consisted of 27 students from the experimental class and 26 students from the control class in class X SMA Negeri 1 Empang.	The significant level value of 5% is 2.007, which positively increases students' problem-solving abilities.
Nanda Wijayanti (2022)	The research sample consisted of 2 classes totaling 62 SMA Negeri 17 Surabaya students.	The PBL model can encourage and facilitate students in understanding concepts and linking them with authentic problems so that students have no difficulty in making conclusions based on the material and knowledge they have acquired.
Sitinjak, L & Banurea, JS (2022).	The research subjects were 136 students of class 2021 at the Sibolga Fisheries College.	The PBL learning model using macro flash affects problem-solving skills.
Sunaryo, A, Kushermawati, A & Delina, M (2020)	The research subjects were students at MAN 12 Jakarta.	E-module is an instrument or learning media appropriate for the physics learning process because it can improve students' ability to think at a higher level and improve problem-solving skills.
Ayudha, CFH & Setyarsih, W (2021)	Type of library research with bibliometric analysis of 21 articles.	The PBL learning model can train students' problem-solving skills.
Noviatika, R, Guawan, Rokhmat, J (2019)	The research subjects consisted of 31 students from the experimental class and 27 students from the control class, class X MIPA in Mataram.	A significant level of 5% of mobile pocketbooks affects students' problem-solving abilities, as evidenced by the N-gain test.
Heldianty, Y, Tampubolon, T (2020)	The research sample consisted of 30 control class students and 30 experimental class students in class X Semester 2 SMAN 1 Batang Quiz.	Problem-based learning models can improve students' cognitive learning outcomes in physics subject matter of work and energy.

Author (Year)	Sample Characteristics	Findings
Putri, GE, Festiyed (2019)	Using the 2013 curriculum in MIPA classes using e-books	Digital book media can visually support students' learning styles to improve learning outcomes in physics subjects.
Juliani, H., Setiawan, I & Putri, DH (2021)	The research sample consisted of 2 classes taken by purposive sampling technique at SMAN 1 Bengkulu Tengah.	The PBL learning model assisted by crocodile physics media influences students' mastery of physics concepts because it is based on constructivism in building their knowledge.
Putri, DAH, Fauziah, N & Wati, WW (2022)	Analyze the effect size value in each journal, consisting of 1 international journal and 19 national journals from the last five years.	The effect size value on problem-solving is 1.6, so it is stated that this model affects students' problem-solving abilities in physics subjects.
Lestari, SA, Supriadi, B & Harijanto, Adi (2022)	The research sample of class XI IPA at MA Negeri 2 Jember.	The PBL model using PhET simulation media improves students' physics problem-solving abilities and scientific thinking processes.
Firmansyah, F, Sukarno, S & Kafrita, N (2022)	The research sample was taken from a purposive sampling technique at SMA Negeri 11 Muaro Jambi.	The PBL learning model affects students' physics problem-solving abilities with an increase of 88%.
Alatas, F (2022)	The research sample comprised 64 students in class XI MIPA at MAN 14 Jakarta.	The average value of N-gain in the experimental class is 0.71, and in the control class is 0.47.
Mahardhika, K (2022)	The research sample was from class X IPA 3 experimental class, while the control class was from class X IPA 4 at SMA Plus PGRI Cibinong.	Module media can improve students' physics problem-solving abilities with a value of 0.008.

CONCLUSION

From the research that has been done, the ability of students to solve a physics problem is relatively low. 160 students evidence this; as many as 154 students are in the low category, medium category has 5 students, and high category has 1 student. The reason is that students must be used to solving problems with indicators of existing problem-solving abilities. Further, students also need help to solve questions “HOTS” High Order Thinking Skills. So, it is essential to provide learning innovations to improve students' problem-solving abilities, such as the application of the PBL model and also learning media in the form of 3D digital modules, because, from the results of the questionnaire given, students are interested in these learning models and media. Through digital modules, it can help improve students' problem solving abilities because of the advantages of this media by utilizing existing technology. For further research, it is recommended to use the PBL model with the help of 3D digital modules in order to improve students' problem solving abilities, especially in physics subjects.

ACKNOWLEDGMENT

Thanks to the supervisor because always guides the author in writing this article. Thank you also to SMA Nahdlatul Ulama 1 Gresik for permitting me to conduct research and to the physics teacher as well as all students grade XI who participated in assisting in the preparation of the article.

REFERENCES

Agustia, FS & Fauzi, A 2020, ‘Efektivitas E-Modul Fisika Sma Terintegrasi Materi Kebakaran Berbasis Model Problem Based Learning’, *Jurnal Penelitian Pembelajaran Fisika*, vol. 6, no. 1.

Alam, S 2019, ‘Higher Order Thinking Skills (Hots): Kemampuan Memecahkan Masalah, Berpikir Kritis Dan Kreatif Dalam Pendidikan Seni Untuk Menghadapi Revolusi Industri 4.0 Pada Era Society 5.0’, *In Prosiding Seminar Nasional Pascasarjana (Prosnampas)*, vol. 2, no. 1, pp. 790-797.

Alatas, F 2022, ‘Pengaruh Model Problem Based Learning (Pbl) Terhadap Kemampuan Pemecahan Masalah Peserta Didik Pada Materi Gelombang Bunyi’, *Bachelor's Thesis*, Jakarta: Fitk Uin Syarif Hidayatullah Jakarta.

Anggriani, L 2019, 'Pengembangan Modul Fisika Berbasis Higher Order Thinking Skills (Hots) Dengan Menggunakan 3d Pageflip Professional', *Doctoral Dissertation,* Uin Raden Intan Lampung.

Aripin, WA, Sahidu, H & Makhrus, M 2021, 'Efektivitas Perangkat Pembelajaran Fisika Berbasis Model Problem Based Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah Dan Kemampuan Berpikir Kritis Peserta Didik', *Jurnal Penelitian Dan Pembelajaran Fisika Indonesia,* vol. 3, no. 1.

Arisanti, D 2021, 'Penerapan Model Problem Based Learning (Pbl) Untuk Meningkatkan Kemampuan Dalam Pemecahan Masalah Fisika', *Edupsycouns: Journal Of Education, Psychology And Counseling,* vol. 3, no. 2, pp. 49-56.

Aristiawan, A 2022, 'Profil Kemampuan Pemecahan Masalah Fisika Siswa Sma Menggunakan Soal Essay', *Jurnal Tadris Ipa Indonesia,* vol. 2, no. 1, pp. 45-55.

Asiyah, A, Topano, A & Walid, A 2021, 'Pengaruh Problem Based Learning (Pbl) Terhadap Kemampuan Pemecahan Masalah Dan Hasil Belajar Kognitif Siswa Sma Negeri 10 Kota Bengkulu', *Edukatif: Jurnal Ilmu Pendidikan,* vol. 3, no. 3, pp. 717-727.

Asuri, AR, Suherman, A & Darman, DR 2021, 'Penerapan Model Problem Based Learning (Pbl) Berbantu Mind Mapping Dalam Pembelajaran Fisika Untuk Meningkatkan Kemampuan Pemecahan Masalah Pada Materi Usaha Dan Energi', *Jurnal Penelitian Pembelajaran Fisika,* vol. 12, no. 1, pp. 22-28.

Aulia, IM 2022, 'Pengaruh Model Pembelajaran Berbasis Masalah Terhadap Kemampuan Pemecahan Masalah Fisika Peserta Didik Pada Materi Usaha Dan Energi', *Jurnal Pendidikan Fisika Dan Teknologi,* vol. 8, pp. 52-57.

Ayudha, CFH & Setyarsih, W 2021, 'Studi Literatur: Analisis Praktik Pembelajaran Fisika Di Sma Untuk Melatih Keterampilan Pemecahan Masalah', *Jurnal Pendidikan Fisika Undiksha,* vol. 11, no. 1, pp.16-28.

Ayumniyya, L & Setyarsih, W 2021, 'Profil Kemampuan Berpikir Tingkat Tinggi Siswa Sma Dalam Pemecahan Masalah Pada Materi Hukum Newton', *Ipf: Inovasi Pendidikan Fisika,* vol. 10, no. 1, pp. 50-58.

Azmi, N, Asrizal, A & Mufit, F 2021, 'Meta Analisis: Pengaruh Model Problem Based Learning Terhadap Motivasi Belajar Dan Keterampilan Proses Sains Fisika Siswa Sma', *Orbita: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika,* vol. 7, no. 2, pp. 291-298.

Bahri, S 2021, 'Penerapan Model Problem Based Learning Terhadap Kemampuan Kognitif Pada Materi Fisika Siswa Kelas Vii Smp', *Jurnal Sains Dan Pendidikan Fisika,* vol. 17, no. 3, pp. 178-184.

Chairul Anwar 2014, 'Hakikat Manusia Dalam Pendidikan: Sebuah Tinjauan Filosofis', Yogyakarta: Suka Press.

Citra, KA, Nehru, N, Pujaningsih, FB & Riantoni, C 2021, 'Keterampilan Pemecahan Masalah Siswa Pada Materi Listrik Arus Searah Di Masa Pembelajaran Jarak Jauh', *Jurnal Pendidikan Fisika Dan Teknologi,* vol. 7, no. 2, pp. 75-79.

Desnita, D 2021, 'Meta Analisis Pengaruh Model Pembelajaran Problem Based Learning (Pbl) Terhadap Hasil Belajar Fisika', *Jurnal Pendidikan Fisika Undiksha,* vol. 11, no. 2, pp. 11-18.

Diansah, I 2018, 'Efektivitas Modul Elektronik Fisika Berbasis Model Pembelajaran Self Directed Learning (Sdl) Terhadap Pemahaman Konsep Fluida Dinamik', *Doctoral Dissertation,* Uin Raden Intan Lampung.

Firmansyah, F, Sukarno, S & Kafrita, N 2022, 'Pengaruh Model Pembelajaran Problem Based Learning (Pbl) Terhadap Kemampuan Pemecahan Masalah Fisika Siswa Sma Negeri 11 Muaro Jambi', *Doctoral Dissertation,* Uin Sulthan Thaha Saifuddin Jambi.

Handayani, MF 2019, 'Efek Model Pembelajaran Problem Based Learning Berbantuan Edmodo Terhadap Kemandirian Belajar Siswa Pada Materi Fluida Statis Kelas Xi Semester I Sman 1 Binjai Tp 2019/2020', *Doctoral Dissertation*, Unimed.

Heldianty, Y & Tampubolon, T 2019, 'The Effect Of The Problem Based Learning (Pbl) Model With Polya Techniques On Students'cognitive Learning Outcomes In Basic Business And Energy Materials In Class X Semester Ii Senior High School 1 Batang Kuis', *Iser (Indonesian Science Education Research)*, vol. 2, no. 1.

Hutasoit, RY, Sitompul, CME, Perangin-Angin, A & Susanto, I 2023, 'Pengaruh Model Pembelajaran Cooperative Learning Berbantuan Media Phet Terhadap Kemampuan Pemecahan Masalah Fisika Pada Materi Vektor Dikelas X Semester I Sma Swasta Etislandia Medan Tahun Ajaran 2021/2022', *Jurnal Penelitian Fisikawan*, vol. 6, no. 1, pp. 15-24.

Iskandar, AM, Nurfadiah, D, Yuli, WI 2021, 'Meta-Analisis Pengaruh Model Pembelajaran Problem Based Learning Terhadap Kemampuan Berpikir Kritis Siswa', *Jurnal Pendidikan Fisika Dan Teknologi (Jpft)*, vol. 7, no. 1.

Juliani, H, Setiawan, I & Putri, DH 2021, 'Pengaruh Model Pembelajaran Problem Based Learning Berbantuan Media Crocodile Physic Terhadap Penguasaan Konsep Fisika Materi Usaha Dan Energi Di Sman 1 Bengkulu Tengah', *Jurnal Kumparan Fisika*, vol. 4, no. 2, pp. 85-92.

Jumanta Hamdayana 2014, 'Model Dan Metode Pembelajaran Kreatif Dan Berkarakter', Bogor: Ghalia Indonesia.

Kholidah, A, Savitri, EN 2022, 'Pengaruh Interactive E-Module Berbasis Masalah Terhadap Minat Belajar Dan Kemampuan Pemecahan Masalah Peserta Didik', *Procedding Seminar Nasional Ipa XII*.

Khusaeri, A 2022, 'Peningkatan Keaktifan Dan Hasil Belajar Peserta Didik Dalam Proses Pembelajaran Fisika Materi Fluida Dinamis Dengan Model Pembelajaran Berbasis Masalah (Problem Based Learning)', *Global Journal Science Ipa*, vol. 1, no. 1, pp. 31-37.

Kusumo, MA, 2019, 'Pengembangan Modul Interaktif Berbasis Android Pada Materi Fluida Dinamis Sebagai Media Untuk Meningkatkan Hasil Belajar Fisika Sma/Ma Kelas XI'.

Lestari, SA, Supriadi, B & Harijanto, A 2022, 'Pengaruh Model Pembelajaran Problem Based Learning Disertai Phet Simulation Terhadap Keterampilan Proses Sains Dan Kemampuan Pemecahan Masalah Fisika Di Sma Pokok Bahasan Suhu Dan Kalor', *Jurnal Pembelajaran Fisika*, vol. 11, no. 1, pp. 34-40.

Mahardika, K 2022, 'Pengaruh Modul Berbasis Problem Possing Dan Konvensional Berbantuan Mind Mapping Terhadap Kemampuan Pemecahan Masalah Dan Self Regulated Learning Peserta Didik Pada Materi Usaha Dan Energi', *Bachelor's Thesis*, Jakarta: Fitk Uin Syarif Hidayatullah Jakarta.

Mukhaiyar 2020, 'Efektivitas Model Pembelajaran Problem Based Learning Pada Mata Pelajaran Dasar Listrik Dan Elektronika Di Kelas X Smk Negeri 1 Bukittinggi*', Journal Of Multidicsiplinary Research And Development.*

Mulyani, S, Efendi, R & Ramalis, TR 2021, 'Karakterisasi Tes Keterampilan Pemecahan Masalah Fisika Berdasarkan Teori Respon Butir', *Jurnal Pendidikan Dan Ilmu Fisika*, vol. 1, no. 1, pp. 1-14.

Nababan, ST & Putri, DH 2022, 'Analisis Kebutuhan E-Lkpd Terhadap Pembelajaran Fisika Di Masa Pandemi Covid-19', *Jipfri (Jurnal Inovasi Pendidikan Fisika Dan Riset Ilmiah)*, vol. 6, no. 1, pp. 32-40.

Nasution, SWR, Siregar, LH & Nasution, USZ 2022, 'Pengaruh Model Problem Based Learning (Pbl) Terhadap Hasil Belajar Fisika Materi Hukum Newton', *Jurnal Physedu (Physics Education)*, vol. 4, no. 1, pp. 20-20.

Noviatika, R, Gunawan, G & Rokhmat, J 2019, 'Pengaruh Model Pembelajaran Berbasis Masalah Berbantuan Mobile Pocket Book Fisika Terhadap Kemampuan Pemecahan Masalah Peserta Didik', *Jurnal Pendidikan Fisika Dan Teknologi*, vol. 5, no. 2, pp. 240-246.

Prahani, BK, Rizki, IA, Citra, NF, Alhusni, HZ & Wibowo, FC 2022, 'Implementation Of Online Problem-Based Learning Assisted By Digital Book With 3d Animations To Improve Student's Physics Problem-Solving Skills In Magnetic Field Subject', *Journal Of Technology And Science Education*, vol. 12, no. 2, pp. 379-396.

Puspitasari, AD 2019, 'Penerapan Media Pembelajaran Fisika Menggunakan Modul Cetak Dan Modul Elektronik Pada Siswa SMA', *Jpf (Jurnal Pendidikan Fisika)*, Universitas Islam Negeri Alauddin Makassar, vol. 7, no. 1, pp. 17-25.

Putri, DAH, Fauziah, N & Wati, WW 2022, 'Analisis Effect Size Pengaruh Model Problem Based Learning Terhadap Keterampilan Berpikir Kritis Dan Pemecahan Masalah Dalam Pembelajaran Sains', *Orbita: Jurnal Kajian, Inovasi Dan Aplikasi Pendidikan Fisika*, vol. 8, no. 2, pp. 205-211.

Putri, GE, Festiyed 2019, 'Analisis Karakteristik Peserta Didik Dalam Pembelajaran Fisika Untuk Pengembangan Buku Digital (E-Book) Fisika Sma Berbasis Model Discovery Learning', *Jurnal Penelitian Pembelajaran Fisika*, vol. 5, no. 2.

Rahmana, F, Susilawati, S & Kosim, K 2021, 'Efektivitas Perangkat Pembelajaran Fisika Berbasis Masalah Berbantuan Video Untuk Meningkatkan Kemampuan Pemecahan Masalah Peserta Didik Pada Materi Elastisitas', *Jurnal Penelitian Pendidikan Ipa*, vol. 7, pp. 326-330.

Rerung, N, Sinon, IL & Widyaningsih, SW 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*, vol. 6, no. 1, pp. 47-55.

Sari, IDP 2021, 'Respon Siswa Terhadap Pembelajaran Fisika Menggunakan Model Pembelajaran Pbl (Problem Based Learning) Di Sman 2 Tanjung Jabung Timur', Universitas Jambi.

Sari, IP, Nanto, D & Putri, AA 2022, 'Pengaruh Hasil Belajar Pendidikan Fisika Siswa Menggunakan Teknik Meta-Analisis Dengan Model Pbl (Problem Based Learning),' *Jurnal Mentari: Manajemen, Pendidikan Dan Teknologi Informasi*, vol. 1, no. 1, pp. 20-28.

Sitinjak, L & Banurea, JS 2022, 'Analisis Interaksi Model Pembelajaran Problem Based Learning Dan Berpikir Kritis Terhadap Pemecahan Masalah', *Jurnal Pendidikan Fisika*, vol. 11, no. 1, pp. 61-66.

Sitompul 2022, 'Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Keterampilan Berfikir Kritis Peserta Didik Pada Materi Getaran Dan Gelombang Di Kelas VIII Smp Negeri 1 Tukka', Universitas Hkbp Nommensen.

Sunaryo, S, Kushermawati, A & Delina, M 2020, 'E-Modules On Problem Based Learning To Improve Students' Higher Order Thinking Skills (Hots)', *International Journal Of Innovation, Creativity And Change*, vol. 11, no. 1, pp. 444-457.

Suyidno, Surya, H, Titin, S 2021, 'Pembelajaran Kreatif Berbasis Otonomi', Lambung Mangkurat, University Press.

Uastra, I, Suarni, N & Dharma, K 2019, 'The Effect Of Problem Based Learning Model On Elementary School Student's Science Higher Order Thinking Skills And Learning Autonomy', Iop Conf. Series: Journal Of Physics, pp. 1-7.

Wijayanti, N, Jatmiko, B 2022, 'Pembelajaran Virtual Fisika Dengan Model *Problem Based* Learning Untuk Meningkatkan *Higher Order Thinking Skills* Siswa Sma', *Brilliant: Jurnal Riset Dan Konseptual*, vol. 7, no, 1.

Wisic, MI & Makiyah, YS 2021, 'Efektivitas Modul Pembelajaran Berbasis Problem Based Learning Terhadap Kemampuuan Pemecahan Masalah Siswa Pada Materi Dinamika Rotasi', *Orbita: Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, vol. 7, no. 1, pp. 229-232.

Wulandari, S 2021, 'Studi Literatur Penggunaan Pbl Berbasis Video Untuk Meningkatkan Kemampuan Pemecahan Masalah', *Jpf (Jurnal Pendidikan Fisika) Universitas Islam Negeri Alauddin Makassar*, vol. 9, no. 1, pp. 7-17.

Yolanda, Y 2021, 'Pengembangan E-Modul Listrik Statis Berbasis Kontekstual Sebagai Sumber Belajar Fisika', *Jurnal Luminous: Riset Ilmiah Pendidikan Fisika*, vol. 2, no. 1, pp. 40-56.