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META ANALYSIS OF THE INFLUENCE OF PROBLEM BASED LEARNING MODELS IN HIGH SCHOOL PHYSICS STUDENTS ON STUDENT LEARNING OUTCOMES

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ABSTRACT

The purpose of this research was to determine the effect size of the use of problem-based learning models in five categories, namely class level, material, aspects of knowledge, aspect of critical thinking skills, and aspects of problem-solving skills. The method used in this research is meta-analysis. Data analyzed is secondary data obtained from the previous research. The sample of this research consists of 18 national articles and 2 international articles. The instrument used is the category code and the calculation of the size of the effect. Data analysis techniques in this study using the calculated effect size of each article. The results showed that the influence of the use of the problem-based learning model on the level of class X with an average of 1.22 in a category very high. Although, on the level of class XI with an average of 1.95 in the category of very high. Second, the influence of problem-based learning on the electric dynamic, motion, heat and temperature, and optical geometric was high. Moreover, Newton's Law is very high. Third, the influence of the problem-based learning model, on aspects of knowledge in the category of very high, aspects of critical thinking skills including high category, and aspects of skills problem solving belongs to the category of high.

Keywords : Meta-analysis, problem based learning, learning outcomes.

I. INTRODUCTION

Education is a national extension. Learning is expected to strengthen community activity and can increase the level of human expertise. Law no. 20 of 2003 relates to the national learning system. National learning has a goal. The target of national learning is to improve student skills so that students have a character who is obedient to God Almighty. Students who have strong faith and devotion to God Almighty, have amazing morals, are fit, knowledgeable, clever, thuggish, autonomous, then become a populist society and are responsible for everything they do. The goal of national education is expected to be able to produce human resources who can communicate, work productively, have life skills to determine work priorities, evaluate themselves, manage time and solve problems according to the skills needs of the 21st century. To produce a golden generation that can compete in the international community, education must be achieved. This education is an effort to prepare students for the 21st century [1]. One of the ways the government advances the world of education is to make changes to the curriculum until the 2013 curriculum is implemented.

The 2013 curriculum requires teachers to change their teaching habits. Learning that is usually teacher-centered must change the pattern to be student-centered. According to Permendikbud Number 22 of 2016, the learning process is held in an interactive, fun, challenging manner, motivates students to participate actively, and provides space to develop student creativity. The learning that is carried out should be able to prepare students for the 2nd century. The target of learning physics is not only aspects of knowledge but includes all aspects such as aspects of attitudes and skills. One of the efforts made to create quality physics learning is to empower all the potential of students in schools. The learning resources used must be able to support the achievement of all the required skills in the 2013 curriculum.

21st-century learning expects learning that can think critically. Critical thinking is a major factor in learning physics. Critical thinking needs habituation, done gradually and continuously. Critical thinking can be done by giving students problems that exist in the environment and then students can find solutions and solve these problems. Students can conclude with the correct physics concept [2].

However, problems were found in the research. This problem has been resolved by previous research. His research is the effect of problem-based learning models in high school physics subjects on student learning outcomes. The results of previous research were first that students' motivation was still lacking in learning physics. Students' interest in taking physics lessons is still low. The cause of the lack of student interest in physics lessons is monotonous physics learning, this is evidenced by 89.65% of students saying that they only take notes and do assignments, and 55.17% say that teachers only give assignments and other causes that make students' interest in learning Physics is the facilities and infrastructure in schools that are still very minimal in use [3].

The teacher is still the center of learning in the teaching and learning process in the classroom. Students tend not to be able to convey their opinions when they have problems with the teacher [4]. Problem-solving skills are still low. The skills that exist in students are still not being explored. One of them is problem-solving skills. To solve a problem in completing the steps students still do not understand and find it difficult [5]. The value of the child's attitudes, knowledge, and skills are classified as lacking. Physics learning still uses the lecture method. Learning like this includes students who are bored and do not understand physics material. Such conditions make student learning outcomes low. There are still many students who get relatively low scores [6].

Previous research still has limitations. As for the limitations of the previously analyzed research, namely, first, the previously analyzed research only determines the effect of the model. The two studies analyzed previously were limited to one level only. Third, the research analyzed previously had limitations on only one material. Fourth, the research analyzed has limitations on just one lesson. So that meta-analysis research becomes the reason for researchers to choose meta-analysis research.

This shows that there is an imbalance between ideal conditions and previous research. With the imbalance between the ideal state and the previous research, it is necessary to have a solution that can overcome these problems. The solution to overcome these problems is to develop a learning model that can arouse and increase student motivation. Strong student enthusiasm will add to the level of student activity in the teaching and learning process in physics subjects. The teaching and learning process combined with giving problems is an effort so that students in the learning process do not feel bored and bored. For students to be more skilled in the learning process, the educational model combined with the problem is the right model. An educational model that has innovative advantages is a problem-based learning model [7]. To improve and develop students' thinking, be it the development of problem-solving abilities or scientific abilities, the problem-based learning model is the right model [8]. Studying physics lessons by relating it to existing phenomena around it so that it becomes real, and learning is more independent and autonomous [9]. Students who are given treatment by combining the learning model with the problem have better knowledge and performance than the class of students in the class whose learning process does not combine problems [10].

An educational model that has innovative advantages is a problem-based learning model [11]. To improve and develop students' thinking, both the development of problem-solving abilities and knowledge abilities, the problem-based learning model is the right model [12]. Studying physics lessons by relating it to existing phenomena around it so that it becomes real, and learning is more independent and autonomous [13]. Students who are treated by integrating the learning model with the problem have better knowledge and performance than the class of students in the class whose learning process does not combine problems [14].

This meta-analysis research is the right solution for select researchers. The reasons for the researchers chose this meta-analysis study for several reasons. First, see the consistency of the research results. Second, look at research that has a broader scope. Third, it is necessary to study the effect size. Fourth, look at the broader research conclusions.

This research is based on previous research. There are three reviews related to this study. The first review from [15] is related to the effect of problem-based learning models on the physics learning outcomes of students in class X SMAM 2 Prayat in the 2015/2016 academic year. The second review was carried out by [16] relating to the influence of problem-based learning models and enthusiasm for learning on student learning outcomes in class X SMA Sawasta SinarHusni. The third relevant research was conducted [17] which was related to the effect of problem-based learning models on the learning outcomes of students' knowledge of temperature and heat eleven X semester III at SMA Muhammadiyah 8 Kisaran, Indonesia.

The research to be carried out has the desired objectives. The objectives of this study are generally not the same as other types of clinical research. The purpose of the first study was to determine the effect size due to problem-based learning models in physics learning which was reviewed based on the class levels, namely class X and class XI. Second, to know the effect size of the combined problem learning model for physics subjects that are reviewed based on the material being taught, namely dynamic electric entities, motion, temperature and heat, Newton's laws, geometric optics, and fluid mechanics. The third is to know the effect size of the effect of the combined problem learning model for physics subjects in terms of student learning outcomes, namely knowledge, and skills.

II. METHOD

The research category is meta-analysis research to review research based on a quantitative approach. The secondary data used from the results of previous studies. This research consists of 20 articles in international and national journals. The articles were chosen based on problem-based learning model themed which was published in the last 10 years. The selected articles reviewed the improvement of students' knowledge and skills, studies in high school physics subjects, and used the experimental method.

Meta-analysis has several advantages when used as a research method. The advantage is that meta-analysis can combine some of the results of previous research quantitatively, provide a good overview between studies, and can minimize differences from the results of the study, very objective, and focuses on research data obtained from articles research, and quantitative and very easy to perform.

Meta-analysis often makes published results only significant, whereas insignificant results are not published. This method is averaging something so that the difference can be seen in the same way in this method. Meta-analysis is not suitable for samples with little data.

Meta-analysis research has several steps [18]. First, select and review the theme of the review to be summarized. Second, select and combine several assessments with predetermined themes. Third, calculates the effect size. Fourth, recognizes the heterogeneity of effects in the model. Fifth, analyze the moderator variables. Sixth, make conclusions from the results of the meta-analysis research.

The data analysis technique to find the effect size value used in this study is the equation used is:

a. For a one-group test, the related sample is known if the mean and standard deviation of the pre-post test for one group is known. Then the effect size can be determined by the formula below:

$$ES = \frac{\bar{x}_{post} - \bar{x}_{pre}}{SD_{pre}} \qquad (1)$$

Informations :
ES = Effec size
Xpost = Average posttest
Xpre = Average pretest
SD = Standard deviation

b. To test the differences between the two sample groups that are related if it is known only the post-test data from the mean and standard deviation of the two sample groups. Then the effect size is determined by the formula below:

$$ES = \frac{\bar{x}_E - \bar{x}_C}{SD_C} \qquad (2)$$

Informations :
ES = Effec size
X_E = Average value of eksperimental group
X_C = Average value of control group
SD = Standard Deviation

c. To test the two groups the sample is related if the mean and standard deviation of the pre-post test of the two groups is known. Then the effect size is determined by the formula below:

$$ES = \frac{(\bar{x}_{post} - \bar{x}_{pre})_E - (\bar{x}_{post} - \bar{x}_{pre})_C}{\frac{SD_{preC} + SD_{preE} + SD_{postC}}{3}} \quad \text{..............(3)}$$

Informations :
ES = Effect size
X_{postE} = Average posttest eksperimental group
$X_{pre\ E}$ = Average pretest eksperimental group
X_{postC} = Average posttest control group

The following are categories of effect sizes according to Cohen's can be seen in Table 1 [19].

Table 1. Effect Size Criteria

No	ES	Category
1	$0 < ES \leq 0.2$	Low
2	$0.2 < ES \leq 0.8$	Moderate
3	$ES > 0.8$	High

III. RESULTS AND DISCUSSION

A. Result

Each journal has statistical parameters. The values of each statistical parameter for each journal can be seen in Table 2.

Table 2. Statistical Parameter Values

Journal Code (J)	The number of students		T_{hit}	Pra-test		
	n_e	n_c		X_c	X_e	SD_c
J01	-	-	-	30.93	27.74	10.88
J02	-	-	-	20.29	21.32	8.87
J03	-	-	-	-	-	-
J04	-	-	-	18.07	18.57	5.30
J05	32	31	2.77	-	-	-
J06	-	-	-	7.56	9.04	3.26
J07	-	-	-	9.00	8.70	3.16
J08	-	-	-	16.32	16.28	2.96
J09	-	-	-	35.52	33.88	9.10
J10	-	-	-	44.47	42.63	10.84
J11	-	-	-	34.43	29.71	9.29
J12	-	-	-	33.79	34.07	10.27
J13	35	35	3	-	-	-
J14	32	32	1.68	-	-	-
J15	-	-	-	11	11.36	3.15
J16	-	-	-	-	47.2	-
J17	-	-	-	28.58	30.36	5.57
J18	-	-	-	-	77.5	-
J19	26	28	3.52	-	-	-
J20	32	32	6.75	-	-	-

Journal Code (J)	Pos-test			
	X_C	X_E	SD_C	SD_E
J01	53.75	73.01	10.99	9.75
J02	42.29	53.24	17.33	16.87
J03	64.57	72.11	9.15	9.15

J04	69.00	78.57	8.64	11.17
J05	44.3	56.8	-	-
J06	13.12	15.12	2.74	3.1
J07	16.64	20.35	3.68	3.16
J08	20.29	20.54	2.97	2.94
J09	74.91	80.00	9.55	7.75
J10	54.23	75.42	9.14	9.87
J11	66.42	71.71	10.11	11.87
J12	53.89	62.87	7.53	10.01
J13	16	21	-	-
J14	69.09	74.9	-	-
J15	18.29	21.33	3.16	3.15
J16	-	69.8	-	1.54
J17	61.20	79.07	7.28	7.36
J18	-	85.3	-	2.7
J19	-	-	-	-
J20	-	-	-	-

The total number of articles which are under the research objectives is 20 articles. Articles analyzed were from 2010 to 2020. Articles in the past ten years that were selected for this meta-analysis were coded J1 through J20. Each journal is the variable to find effect sizes in terms of education level. subject matter. and learning outcomes.

The first result in this meta-analysis research is related to the influence of problem-based learning models in terms of class level. The average effect size value based on class level is obtained from the calculation of the effect size of each article. The average effect size in terms of the class level used from 20 articles can be seen in Table 3.

Table 3. The Influence of Problem Based Learning Model Based on Class Level

Grade level	Journal Code	Effec Size	Average ES	Category
X	J1	2.12	1.22	High
	J2	0.88		
	J3	0.82		
	J4	1.36		
	J5	0.69		
	J6	0.17		
	J10	2.27		
	J11	1.01		
	J12	0.96		
	J15	0.86		
	J17	1.35		
	J18	1.80		
	J20	1.67		
XI	J7	1.21	1.81	High
	J8	0.09		
	J9	0.70		
	J13	0.71		
	J14	0.42		
	J16	8.60		
	J19	0.95		

Table 3 illustrates the meta-analysis of the effects of the learning model combined with problems in physics learning on learning outcomes based on class level. The results describe that the combination of the problem-based learning model has a high effect for class X with an average value of 1.22. In class XI, the problem-based learning model has a very high effect on the results of student's practice in Physics subjects with a mean value of 1.81. This situation shows that the higher the class level. the effect of problem-based learning models for physics on student practice results is higher, and vice versa.

The second result is related to the effect of the combination of a problem-based learning model in terms of the learning material. The average effect size value in terms of the learning material used from 20 articles can be seen in Table 4.

Table 4. The Influence of Problem Based Learning Models in terms of Learning Materials

Theory	The amount of research	Effec Size	Average effect size	Category
Dynamic electricity	2	J1= 2.12 J12= 0.96	1.54	High
Motion	1	J2=0.88	0.88	High
Heat and temperature	3	J4= 1.36 J5= 0.69 J16= 8.60	3.55	High
Newtons' law	2	J7=1.21 J15= 0.86	2.07	High
Optic geometric	1	J11=1.01	1.01	High
Fluida mechanics	1	J19= 0.95	0.95	High

From the data in Table 4, it is described that the results of the meta-analysis of the effects of problem-based learning models based on the material found that in the material of dynamic electricity, motion, temperature and heat, Newton's laws, geometric optics have a very high effect with different effect sizes. Fluid mechanics material has a high effect with an average value of 0.95. It was concluded that the measuring effect of the effect of problem-based learning models on physics subjects in terms of the material used gave different effects.

Table 4 describes that the effects of problem-based learning models based on the material showed that in the material of dynamic electricity, motion, temperature, and heat, Newton's laws, geometric optics have a very high effect with different effect sizes. Fluid mechanics material has a high effect with an average value of 0.95. In conclusion, the measuring effect of the effect of problem-based learning models on physics subjects in terms of the material used gave different effects. The results of the analysis related to the effect of problem-based learning models on the aspects of knowledge can be seen in Figure 1.

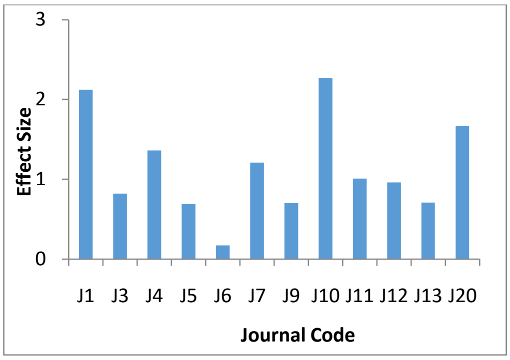

Fig. 1. Effect size of Problem Based Learning Model on Knowledge Aspects

Figure 1 illustrates that the effect size of the problem-based learning model based on the aspects of knowledge in each journal. In that journal, the lowest effect size was found in the sixth journal (J6) with an average value of 0.17. While the highest effect size was found in the tenth journal (J10) with an average value of 2.27. Each journal has a positive effect. This shows that the upgrading model combined with problems in physics effectively makes student learning outcomes increase in the knowledge aspect. The results of the analysis related to the effect of problem-based learning models on the skills aspects of knowledge can be seen in Table 5.

Table 5. The Effect of Problem Based Learning Model on the Skills Aspect

No	Skills	Code	ES	Category
1	Critical thinking skills	J2	0.88	High
		J8	0.09	Low
		J14	0.42	Moderate
		J20	1.67	High
2	Problem solving skills	J15	0.86	High
		J16	8.60	High
		J17	1.35	High
		J18	1.80	High
		J19	0.95	High

From the data in Table 5 it can be described that the results of the meta-analysis of the effects of the learning model combine problems on learning outcomes for aspects of skills in the domain of knowledge. Skills consisting of critical thinking skills and problem solving skills. Each skill has a different effect. Critical thinking skills consisting of 4 articles each in a different category. The problem solving skill consists of 5 articles each in a different category.

B. Discussion

The results of this study were carried out in three categories, namely the effect of problem-based learning models based on class levels (X and XI), the effects of problem-based learning models based on the material used (dynamic electricity, motion, temperature and heat, Newton's laws, and geometric optics). It is the effect of the problem-based learning model in terms of learning outcomes. The results of this study indicate that the use of problem-based learning models for physical learning subjects can add to the learning outcomes of high school students.

The first result that was achieved was the problem-blended learning model for physics learning in terms of the class level aspect which gave a very high influence on the level of class X and class XI. The use of a problem-blended learning model for physics learning has a good effect on both classes, namely in class X and XI. This means that the problem-based learning model in physics learning is effectively used in high school education. This high average effect size has implications for children's cognitive development. This is supported by [20] who explained that the cognitive development of children at the age of fifteen and children. begin to understand the abstraction of concepts. This is what causes student learning outcomes to be higher because they have passed the basic education level and junior high school education level and can think to the adult level.

The second result that was achieved was the influence of problem-based learning models in physics subjects seen in the material aspect which gave a very high influence on the Dynamic Electricity material. Matter temperature and heat, and Newton's laws exert a very high impact. Meanwhile, motion material and optical geometry give a high influence. This condition means that the use of a mixed-problem learning model distributes different effects on student learning outcomes. Meeting students by solving problems will affect the students. Students become more active in the course of learning. What makes students more active is one reason because of the problem-based learning model [21]. The problem raised is real, and the problem must invite students' curiosity so that students will be motivated to find a solution or seek answers to the problem [22]

The third result achieved in this study is the effect of problem-based learning models in physics subjects in terms of learning outcomes. The mixed learning model for physics subjects has a very high influence on the aspect of knowledge. The learning model that combines problems in the field of physics is appropriate to use to increase student learning outcomes [23]. This situation is in line with [24] who said that critical thinking skills, motivation, and student learning outcomes are interrelated and can have a good effect using problem-based learning models.

The next research result that was achieved was the effect of problem-based learning models in physics learning from the aspects of skills in the realm of knowledge. Nine articles contain different skills, namely critical thinking skills, and problem-solving skills. Learning models combined with problems for the field of physics studies have a high influence on critical thinking skills. The problem-based learning model in physics subjects has a very high effect. Problem-solving, critical thinking, knowledge, increased student activity can be helped by using a learning-based model [25].

IV. CONCLUSION

Based on the studies that have been analyzed, conclusions can be drawn from this research. The conclusions in this study are firstly the use of a problem-mixed learning model for physics subjects has a good effect on class X using an effect size of 1.22 can be included in the high category, for class XI with an effect size of 1.95 can be included in the category. high. The second use of the combined problem learning model for physics subjects has a significant effect on dynamic electricity, motion, temperature and heat, Newton's laws, and geometric optics. The third use of problem-based learning models in physics subjects in terms of the learning outcomes aspect gives a significant effect which is included in the high category, the aspect of critical thinking skills has a meaningful influence which is included in the high category, the aspect of problem-solving skills has a significant effect who belong to the very high group.

REFERENCES

[1] Y. D. Amalia, *The Effect of the Implementation of Problem-Based Learning-Oriented Worksheets on the Physics Competence of Class X Students of SMA Negeri 1 Gunung Talang.* Doctoral dissertation, Padang State University. 2014

[2] Y.D. Anggreni, Festiyed, and Asrizal, "Meta-analysis of the influence of project based learning learning model on critical thinking ability of high school students," *Pillar of Physics Education*, vol. 12 (4), 2019.

[3] S. Junaidi, Asrizal, and Zulhendri, "The influence of textbooks with comprehensive intelligence in problem based learning models on competence in problem based learning models on the physics competencies of students in class xsma negeri 9 padang," *Pillar of Physics Education*, vol. 9, 2017.

[4] R. Artiwi, Asrizal, Desnita, and D. Yenni, "The effect of physics enrichment e-book accompanied by news and facts assignments on critical and creative thinking skills of class x students of sma negeri 12 padang," *Pillar of Physics Education*, vol 12, 2020.

[5] A.S. Argaw, B.B. Haile, B. T. Ayalew, and S.G. Kuma, "The effect of problem based learning (pbl) instruction on students' motivation and problem solving skills of physics," *Eurasia Journal of Mathematics, Science and Technology Education*, vol.13 (3), pp. 857-871, 2016.

[6] A. Aziz, J. Rokhmat, and K. Kosim, "The influence of problem based learning model with experimental method on physics learning outcomes of class x students of sman 1 gunungsari, west lombok regency, 2014/2015 academic year," *Journal of Physics and Technology Education,* vol.1 (3), pp. 200-204, 2017.

[7] Rusman, "Problem based learning, curriculum and educational technology, university of education and educational technology, " *Edutech Year* , Vol. 1 (2), 2014.

[8] M. Ali, and M. Pasaribu, "The influence of problem based learning model on physics learning outcomes in class xi sma negeri 5 palu," *Tadulako Online Journal of Physics Education*, vol. 1 (2), pp. 39-43, 2013.

[8] H. Ismoyo, "Effect of problem-based learning on improvement physics achievement and critical thinking of senior high school student." *Journal of Baltic Science Education*, vol. 16 (5), 2017.

[9] I. Bilgin, E. Şenocak, and M. Sözbilir, "The effects of problem-based learning instruction on university students' performance of conceptual and quantitative problems in gas concepts," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 5 (2), pp. 153-164, 2009.

[10] E. Kurniawan, "The effect of problem based learning model on critical thinking ability of class xi ipa students of sma negeri 3 takalar," *Journal of Physics Education, Muhammadiyah University of Makassar*, vol. 2 (5), 128, 2017.

[11] S. Rahayu, and R. Juliani, R. "The influence of problem based learning model on learning outcomes and student activities on dynamic electricity subjects for class x semester ii at sma muhammadiyah 8 kisaran 2014/2015 academic year," *Physics Learning Innovation*, vol. 4 (1), 2015.

[12] S.A. Rahmat, M. Pasaribu, and I.W. Darmadi, "The effect of problem-based learning on students' critical thinking skills on motion material in class x sma negeri 6 sigi," *Journal of Physics Education Tadulako Online*, vol. 4 (3), pp. 16-21, 2016.

[13] I. Ramadani, "The effect of problem based learning (pbl) implementation on students' critical thinking skills in learning physics class xi at sma 5 padang," *Pillar Of Physics Education*, vol. 4 (2), 2014.

[14] D. Derlina, and M.I. Sihotang, "The influence of problem-based learning models on student learning outcomes in the subject matter of optical geometry class x sma st. yoseph medan," *Proceedings of SEMIRATA*, vol.1 (1), 2013.

[15] N. Apriani, S. Ayub, and H. Hikmawati, "The effect of problem-based learning models on the learning outcomes of students in class x SMA 2 Praya in the academic year 2015/2016," *Journal of Pijar MIPA*, vol.11 (2), 2016.

[17] A.N. Sari, *The Influence of Problem Based Learning Model on Students' Cognitive Learning Outcomes of Temperature and Heat Material in Class X Semester II at SMA Muhammadiyah 8 Kisaran Tp 2014/2015,* Doctoral dissertation, UNIMED, 2015.

[18] J. DeCoster, Meta-analysis notes, 2004

[19] D. Demirel, D. Miray, "Effect of problem based learning on attidude a meta analysis study," *Eurasia Journal Of Mathematics, Science & Education*, 293a, 2016.

[20] A. Ekasari, M. Diantoro, P. Parno, "Increasing the problem solving ability of sman 1 gondang students on heat material with problem based learning," *Journal of Education: Theory, Research, and Development*, vol. 3(5), pp. 588-597, 2018.

[21] M.A. Fahrunnisa, "*The effect of problem-based learning models on physical learning motivation and learning outcomes in class xi students of sman13 makassar*," Physics Education Study Program, Makassar State University Postgraduate Program, Indonesia, 1-5, 2017.

[22] A. Pabenteng, H. Fihrin, and H.M. Ali, "The influence of problem based learning model with creative design on physics learning outcomes in class x students of sma negeri 7 palu," *Journal of Physics Education,* vol. 6 (3), pp. 35-39, 2018.

[23] S.A. Pratiwi, J. Rokhmat, and S. Sutrio, "The influence of problem based learning model with experimental method on physics learning outcomes of class xi mipa students of sma negeri 1 gerung," *Scientific Journal of the educational professional*, vol. 3 (1), 2018.

[24] H.S. Sinulingga, (2016). "The effect of problem based learning models and study motivation on student learning outcomes in class x sma private vocational school, sinar husni," *Physics Education*, Vol. 5 (1) pp. 32-37, 2016.

[25] S.N. Hidayah, N.M. Pujani, and R. Sujanem, R. "Implementation of problem based learning model to improve learning activities and physics problem solving ability of class x mipa 2 students of man buleleng academic year 2017/2018," *Journal of Physics Education,* vol. 8 (1), 42-52, 2018.