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Comparison of Problem Based Learning and Realistic Mathematics Education to Improve Students Academic Performance

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Abstract: Comparison of problem based learning and realistic mathematics education to improve student academic performance. Objectives: The aim of this study was to see an increase in the academic performance of island students in Ambon City by applying the problem based learning (PBL) learning model and realistic mathematics education (RME). **Methods:** This research was in the form of a descriptive qualitative study with a case study approach and a sample of 116 students. **Findings:** There was a significant increase in student academic performance at each meeting and learning outcomes with PBL were higher than RME. **Conclusion:** The PBL model is more effective in increasing students' academic performance than RME because students were facilitated with online-based media in PBL when compared to RME, so that it can attract students' attention in learning and have a significant impact on student academic performance.

Keywords: Academic performance, problem-based learning, realistic mathematics education.

Abstrak: Perbandingan pembelajaran berbasis masalah dan pendidikan matematika realistik untuk meningkatan performa akademik siswa. Tujuan: *Adapun tujuan dalam penelitian ini adalah melihat peningkatan prestasi akademik siswa kepulauan di Kota Ambon dengan menerapkan model pembelajaran problem based learning (PBL) dan realistic mathematics education (RME).* ***Metode:*** *Penelitian ini berupa studi kualitatif deskriptif dengan pendekatan studi kasus dan sampel penelitian sebanyak 116 siswa.* ***Temuan:*** *Terjadi peningkatkan yang cukup signifikan untuk performa akademik siswa pada setiap pertemuan dan hasil belajar dengan PBL lebih tinggi bila dibandingkan dengan RME.* ***Kesimpulan:*** *Model PBl lebih efektif dalam meningkatan performa akademik siswa dibandingkan dengan RME, hal ini karena pada PBL siswa difasilitasi dengan media berbasis online bila dibandingkan dengan RME, sehingga dapat menarik perhatian siswa dalam belajar dan berdampak signifikan pada prestasi akademik siswa.*

Kata kunci: *Prestasi akademik, pembelajaran berbasis masalah, pendidikan matematika realistik.*

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INTRODUCTION

Living in an era that is completely open, it takes a superior generation to be able to give birth to new things that benefit many people. All of that must be supported by good academic performance. Academic performance is a series of portraits of cognition that are marked by the skills obtained from the results of the assessment process in achieving learning objectives. In addition, academic performance is always colored by changes in the structure of thinking after receiving and learning something. All this can be seen from the mental reconstruction that interacts with the existing environment (Okland, 2012). Academic performance starts from receiving sensory stimulus, storing information and processing it well in the brain to become information and when needed can solve problems.

At present, almost all countries in the world, one of which is Nigeria, implements academic regulations, starting from the elementary level up to tertiary level. To improve academic quality, each student is required to have good academic grades which are the main prerequisites for entering a higher level (Fakeye, 2010). During these decades, several countries such as the UK, USA, Australia, New Zealand and South Africa has changed the student-oriented learning paradigm. Curriculum orientation is more directed at students' academic skills (Rust, 2002). Some researchers and psychologists report that academic skills and achievement through IQ tests are good tools for predicting and being a determining factor for how successful an educated person can live in the present and future (Fakeye, 2002). Besides, academic skills are also as predictors in success, comfort, well-being and longevity (Marioni et al., 2016). The United States of America, which is one of the countries with the most advanced education, says that students' academic skills are greatly supported by the support of parents in providing motivation. In addition, in the Netherlands through the Ministry of Education and Culture, all schools require that all reading and numeracy skills be possessed by all students to encourage student academic performance (MECS, 2010).

Some facts explain that not all students have independence in their learning. This can be seen from the words and actions of the teacher who are considered by students to be rude, so it is very disturbing students' academic skills. In addition, many tasks given by the teacher to students so that it becomes a burden for students. The teachers assume that students must study continuously in order to be smart people. However, the assumption is not necessarily all true. Students need freedom to express and be creative. We can portray this from one of the countries in the world with the best education system, Finland. Elementary school students only go to school at the age of 7 years to prepare their children's mental. Learning process is 45 minutes per hour and given 15 minutes to rest, free of charge education and there is no superior school category so there are no discrimination for certain students. The quality of teachers is a priority where being a teacher must have a master's degree and the best graduates from world-renowned universities. In addition, the welfare of teachers is highly considered because all the abilities of teachers are devoted to school academics. The learning system is only 5 hours per day and the rest of the students create their own creativity and there is no national examination because the teacher is the only person who knows exactly students' academic skills (Bastos, 2017).

Educational potraits in Indonesia especially in Ambon City, Maluku are inversely proportional. This can be seen that most students who come from villages want to continue their studies in the city. They think that the city have a better learning life. It would be interesting if a

student who has a simple family background had to struggle with education with limited textbooks as a learning resource. Besides, the students have to live with a family that takes up time so that it interferes the academic skills of students (Pianta & Hamre, 2009).

Currently the government has made various efforts to develop eastern Indonesia to become a decent and prosperous region. Ambon City as an agrarian city surrounded by small islands as the best education center in Maluku province feels challenged to produce students who are superior and has good achievement. Many activities that have been carried out include *Ambon pintar matematika*, English and early sports education. These activities are for the development of teacher and student skills to become better. The study results report that students' academic performance is still relatively low. This is evidenced by a series of critical and creative tests for learning science. The results showed that the average student was only able to get score 53, 41 (Leasa & Corebima, 2017) and for mathematics an average of 35.27 (Ratumanan, 2016).

In addition, other information tell us that learning currently still uses structuralist patterns, does not emphasize challenging things such as HOTS, problem solving, and student motivation, which are relatively very low. In addition to the learning patterns that are of concern, the assessment also requires that teachers do not tell authentic things, still assume that they will continue to go up to the next grade and graduate regardless of the circumstances, learning is a form of heavy work and certain subjects become a scourge for students such as mathematics (Ratumanan , 2016). Thus, the lack of student involvement in learning will interfere with student academic ability. Conversely, if students' involvement in the learning process is good, it will be positively correlated with various learning outcomes so that it leads to better academic skills (Lee, 2014).

Living in an all-round open era, many learning models have been offered in order to improve academic skills with learning centered on students. In this study, there are two constructive learning models, which are problem based learing (PBL) and realistic mathematics education (RME). Many studies have shown that these learning models have contributed greatly to improving student learning outcomes (Cotic & Zuljan, 2009; Damkhi & Pehlivan, 2018); Laurens et al., 2018); Leasa & Corebima 2017), stimulating thinking skills in solving problems and producing new solutions (Kantar, 2014). All learning models have different characteristics to improve students' academic skills, encourage students to think scientifically (Adulyasas & Rahman, 2014), find , develop work skills cooperatively and collaboratively (Mergendoller et al, 2006), train themselves to think critically, analytically, systematically, and logically to find alternative solutions to problem solving through empirical data exploration (Mantri, 2014).

A written report explaining the recommended learning model was implemented several hundred years ago. One such example, PBI, was implemented and introduced about 100 years ago in the laboratory world in which scientists in chemistry, biology and physics encourage students to apply concepts to answer science questions (Smith & Hall, 1902). Based on the explanation, this learning model is very suitable to be applied to concepts that emphasize understanding, skills and scientific thinking so as to enhance students' academic skills. Thus, the purpose of this study is to see an increase in the academic performance of island students in Ambon City by applying the problem based learning (PBL) and realistic mathematics education (RME) models.

METHOD

1) Research Design

This research was a descriptive qualitative study by case studies approach and using snow ball techniques to obtain more comprehensive data. This study was taken to find more detailed information related to student academic performance with the PBL and RME models. With a qualitative approach, it was expected to get more information and find practical solutions. This research was carried out per field of science involving five students including chemistry, physics, biology, mathematics and physical education to obtain learning data. Furthermore, the qualitative study used five undergraduate students who were already in semester 7 and understood the research methodology. The goal was that the data source obtained is better. The five prospective undergraduate students interviewed subject teachers in-depth. This research was carried out for 3 months with data collection, data analysis until reporting.

2) Samples

The sample in this study was 116 students that consisted of X class students of several high schools and students of one junior high school. Recommended high schools included PGRI 1 High School in Ambon, which tells the concept of chemistry, YPKPM Christian High School in Ambon represents the results of physics, Kartika XIII-1 High School in Ambon, which explains the concept of biology, and Junior High School 19 in Ambon, which tells about mathematics. This sample was designated for several specific reasons, among others, because the average school graduate came from outside Ambon City including the Tanimbar Islands, Southwest Maluku, Buru, Aru Islands, West Seram District, and Central Maluku. In addition, other students also live in mountainous areas such as the villages of Ema, Kilang, Hatalai, Hukurila, Kusu-kusu and Mount Nona. Students who entered this school were on average relatively low academic performance.

3) Instrument

The instrument used in this study was in the form of observation sheets at six meetings that had been designed according to the needs and curriculum of the school. There were 10 test questions in the form of diagnostic test schools that have been validated by experts in their fields. Another instrument used for qualitative data collection was a structured interview instrument consisting of 10 questions that were more focused on students and teachers.

4) Data collection Ttechniques

Data collection techniques in the form of observation worksheets that had been made was based on the material taught during six meetings for subjects of chemistry, physics, biology, and mathematics. Each meeting was measured by students' learning attainment and academic skills. This phenomenon was rarely explored by teachers as evaluation material. Tests were also done at the beginning and at the end of the learning to measure student academic performance. Another orientation for getting data was in-depth interviews with teachers because they are the only person who knows about students' abilities.

5) Data Analysis

Data analysis used data interpretation, both descriptive and qualitative, to group data according to the research needs. Data analysis was done descriptively to see the development of students' academic performance during six meetings. Qualitative data in the form of interviews was to find out the academic performance of students who came from outside the city of Ambon.

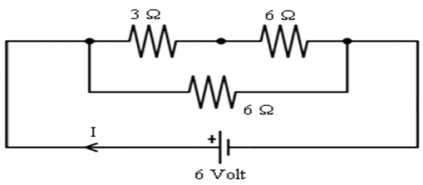
RESULT AND DISCUSSION

Table 1. Data of Students' Academic Performance in PBL and RME Models

Groups	Pre Test	Post Test	N-Gain
PBL + Experiment work sheet	40.00	85.00	0.66
PBL + Phet simulations	38.24	82.25	0.71
RME	47.28	78.44	0.50
PBL + blended learning	35.00	80.25	0.70

The findings prove that PBL + Phet simulations have the highest N-gain values when compared to other studies. Students feel helped by animation-based learning that reconstructs students' conceptual physics about abstract phenomena to become more tangible and concrete. The concept of dynamic electricity was still considered as a material that was quite difficult by students because students still have difficulty in designing combination circuit. Therefore, students need a good understanding of concepts about series and parallel circuits so that when conducting trials with phet simulations, it would produce a correct series. This was done by resolving a case. Based on a given case, it was still apparent that 25% of students were still experiencing misconceptions. The reasons of students' misconception are 1). Keep the concept that electricity flowing from a high place to a low place so that it would move up again like a cycle, so students prefered a new parallel path to complete in series, 2). Students were still having trouble using the formula well, 3) students are still having trouble with mathematical problems. Data shows that 75% of students were at the point of truth. This proves that students always pay attention to what was directed by the teacher. Besides, students trained themselves more with analytical questions that challenge their cognition. By providing continuous questions, students were more accustomed to solvie physics problems with various forms of sequence.

Table 2. Results of Student Answers on the Concept of Dynamic Electric combination Circuits

Question	Answer
Silas is one of the 10th grade students at YPKM Christian High School. He is currently instructed by the teacher to assemble a simple electrical circuit that has a value of R1 = 3 ohms, R2 = 6 ohms, R3 = 6 ohms and has a voltage of 6 volts. Calculate how much the replacement resistance and strong current flowing in the electrical circuit?. Look at the picture below 	Has a replacement resistance of 3.6 Ω and a strong electric current flowing at 1.67 A

In the learning process using PBL with experiment worksheets, phet simulations and blended learning, students have difficulty in solving concept questions, as evidenced in chemical learning such as experiment worksheets 01 about the effect of concentration. In question number 2 about the results of the experiment, students were asked to make graph of the relationship between concentration and time. Students feel confused to make graphs and tables. The experiment worksheets 02 told about the influence of temperature. The question number 1 explained why the reaction was faster at high temperatures. Both of these questions were considered difficult for students because the concept of students' chemistry was still relatively low so it did not illustrate the graph. This was according to several research reports that students still have difficulty in making a graph of the relationship between one concept with another concept. This can be seen from the 48, 99% difficulty of the term, 41, 32 difficulty of the concept, and 70.97% difficulty of the calculation (Yakina et al., 2017). At the third meeting and subsequently, it was found that students experienced a significant increase in learning. This was proven by 20 students who were at a very good level, as shown in Figure 1.

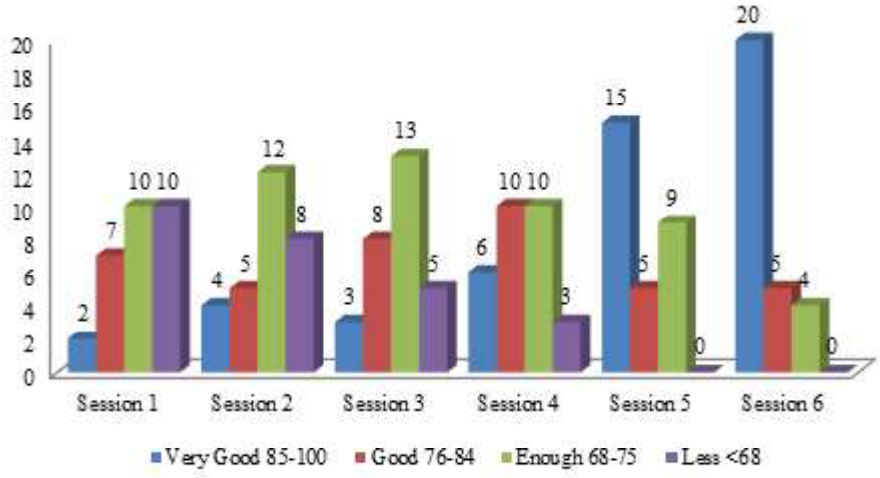


Figure 1. Academic performance in the field of chemistry studies

Learning with PBL by applying Experiment Worksheet, phet simulations and blended learning in learning was very helpful and provides opportunities for students to explore what was not yet known. In the implementation of learning, students were required to be actively involved in following the learning process. The initial step of learning activities was carried out by inviting students to understand the situation proposed by both the teacher and students by orienting towards authentic problems related to the material to be learned. At each meeting, there was an increase in students' academic skills in chemistry, physics and biology classes.

This was because PBL encouraged students' cognition to understand material in greater depth so that students not only got basic knowledge, but could also feel how they used knowledge to solve real-world problems. In addition, the PBL model aims to improve student performance to work in teams to collaborate so that their ability can be coordinated to access information and turn it into appropriate knowledge (Rotgans et al., 2011). PBL empowers critical thinking skills

and directly relates to real problems that are real faced (Yew & Goh, 2016). This model was based on constructivist that reconstruct student knowledge in a better direction (Inel & Balim, 2010). In each meeting, students were given the opportunity to build the meaning of learning. Therefore, the class was set up with a learning environment that stimulated students' critical problem solving. The teacher in learning had a role as a facilitator to help students find new meaning in learning. PBL does not facilitate students to memorize, but constructs their own knowledge by producing an open exchange of ideas (Loyens et al, 2015).

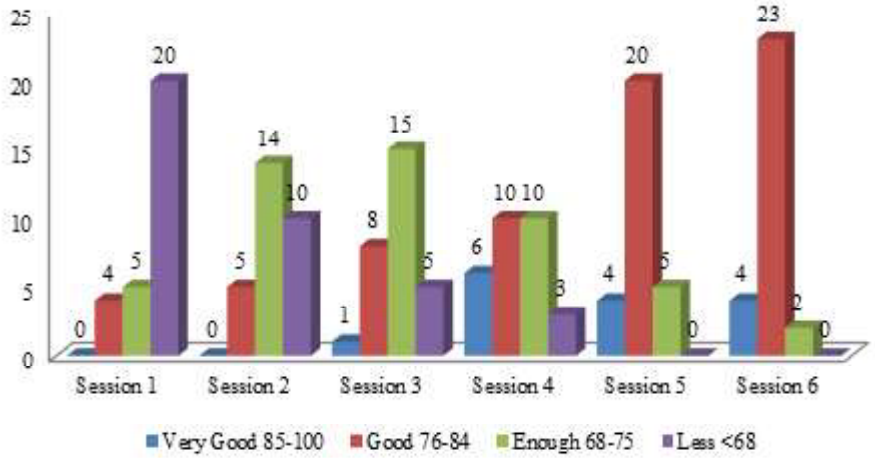


Figure 2. Academic performance in the field of physics studies

In learning physics, the teacher developed learning media using Phet simulations. This program trained students to make their own electrical circuits based on the theory being taught. At the first and second meeting, students still find it difficult to make electrical circuits by using phet simulation. However, students experience increased learning at the next meeting. By using Phet simulations, students developed concepts scientifically without using real materials. It can be seen from the learning activities that students were so enthusiastic about this media beause they can increase creativity in designing electrical circuits in series, parallel or combination. Furthermore, the simulated particle flow can be seen well. This makes students' scientific arguments stronger. The results of students' performance in assembling a simple electrical circuit are shown in Figure 3. This proves that students were skilled in assembling tools properly.

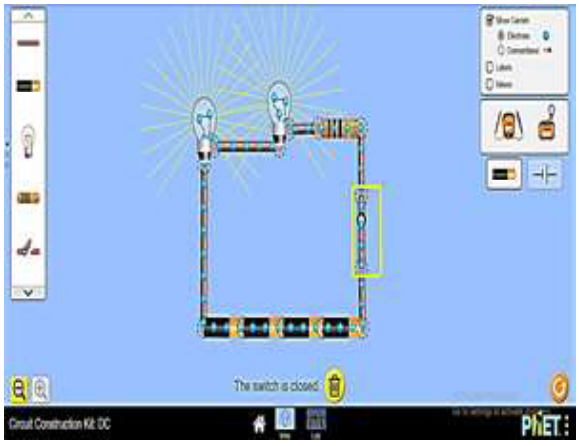


Figure 3. Learning physics by making electrical circuits with the Phet Simulations program

Student learning activities in learning biology can be shown in Figure 4. Learning was more oriented on local local wisdom to train students to be able to produce a product that could be used as a business. Currently, Tempe was mostly produced from soybeans, but students were trained to produce Tempe from green beans and kidney beans in this activity because there are many local farmers who grow a lot of these plants in Maluku, especially Southwestern Maluku, Tanimbar Islands and Buru Island,. Therefore, the harvest can be used as processed without having to spend money to buy. Likewise, students were taught how dry cloves when formed like a boat have an attractive appearance and high quality that attracts the attention of consumers because cloves bear fruit every season with tens of tons of produce. All available material given to students, was opened online. The media used to display the material was schoology.

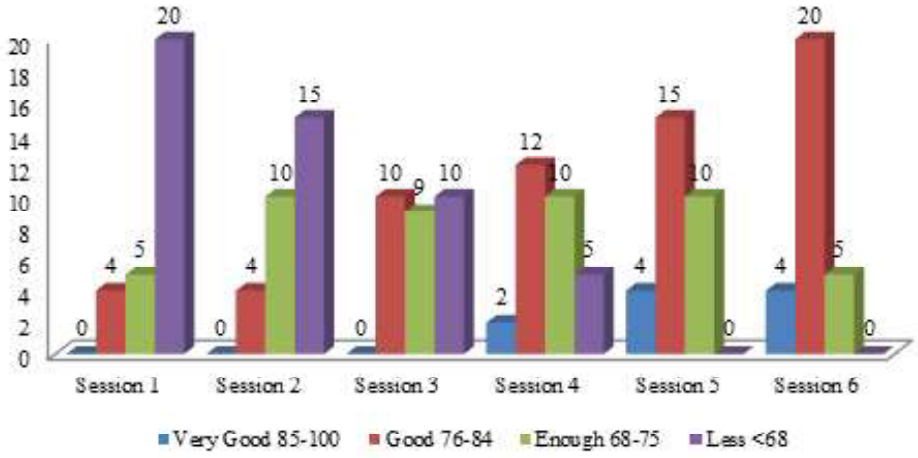


Figure 4. Academic performance in the field of biology studies

Academic performance in learning mathematics was shown with the highest value of 78.44 and the lowest of 47.28. Based on the results of the study, it appears that the RME made students more interested in learning, both individually and in groups to find solutions and find their own ways to solve problems. Although there were some students who have difficulty in solving problems, but this could be overcome by the teacher by providing solutions in the form of directions and explanations on how to solve formal problems.

There is a significant difference, due to differences in the treatment of the learning steps and the process of delivering the material. The application of RME gave more opportunities for students to actively participate in learning that was understanding contextual problems, discussing answers, solving problems, and concluding. Students were given the freedom to think and discuss together, exchange opinions according to their own ideas in finding concepts and building their own knowledge. Thus, students could actively and freely come up with ideas to solve the perimeter problems and areas of rectangles and squares given by the teacher in their own way. Then students were invited to draw conclusions from what had been obtained. This was indicated by the academic skills of students with RME increasing at each meeting, as shown in Figure 5 below.

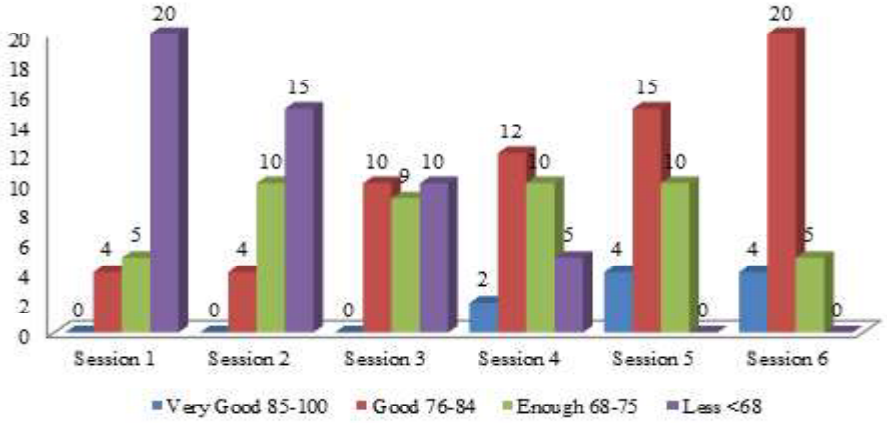


Figure 5. Academic performance in the field of mathematics studies

The results show that learning with RME has an N-gain value of 0.50 when compared to PBL. This proves that material characteristics are one of the main factors that hinder students' academic performance. Another thing is that students are still contaminated with the perception that mathematics is one of the difficult and boring subjects because it requires students to do calculations. Many students had more rote-based learning. The analysis of academic skills was low when compared to PBL so that learning with RME was still oriented toward visual media that were not moving and media with many features that made students more interested and did not feel bored in learning. The results of student answers related to RME for geometry materials can be shown in Table 3. Students could answer the problem well with simple questions that occur in everyday life.

Other results inform that students from outside Ambon Island have experienced an increase in good academic skills. They showed a significant increase in each meeting because the city has adequate facilities when compared to the state of education in the original school. It was also supported by technology and information that was so fast that can be accessed via the internet. In addition, students who had good academics from Ambon can share their knowledge with students from other regions. Teachers in the city tend to direct models of constructive learning and

Table 3. Student Answer Results for Plane Geometry Topics

	Questions	Students' answers
1.	Uncle Sam has an aquarium with an area of 200 dm^2 and a width of 10 dm. Therefore, what is the length and perimeter of the aquarium owned by Uncle Sam?	$L_{board} = p_{board} \times l_{board}$ $200 = p_{board} \times 10$ $P_{board} = 200 / 10$ $P_{board} = 20$ $K_{board} = 2(p + l)$ $= 2(20 + 10)$ $= 2(30)$ $= 60$ So, the length and circumference of Uncle Sam's board are 20 dm and 60 dm
2.	A square floor with a side length of 6 m will be installed with 30 x 30 cm square tiles. How many tiles are needed to cover the floor?	$L_{floor} = S_{floor} \times S_{floor}$ $= 600 \times 600$ $= 360.000$ $L_{tile} = S_{tile} \times S_{tile}$ $= 30 \times 30$ $= 900$ $H_{tile} = L_{floor} / L_{tile}$ $= 360.000 / 900$ $= 400$ So the number of tiles needed for the floor is 400 pieces.
3.	Mr. Semy, a contractor, plans to buy land in an area. Price per square meter of land is sold Rp. 200,000. If the land to be purchased is square, 25 x 25 meters long. How much money should Pak Joko provide to buy the land.	$L_{land} = S_{land} \times S_{land}$ $= 25 \times 25$ $= 625$ $J_{money} = L_{land} \times H_{land}$ $= 625 \times 200.000$ $= 125.000.000$ So the amount of money that must be provided by Mr. Joko to buy land is Rp 125,000,000

adequate media. Thus, it can be said that the existing factors can affect student learning. In addition, the average teacher in urban areas often follows developments in technology and information that support learning to improve teacher professionalism. The results of the interview with one of the teachers are as follows.

Ambon	:	*What happens if learning in school is more lecture based?*
Maluku	:	*Students will feel bored in learning*
Ambon	:	*What do you fell when using the learning model in learning?*
Maluku	:	*Classroom learning is more directed so that it encourages students' academic skills. This is evidenced by the results obtained that are more improved.*

In accordance with the results of interviews with several students, they provided information that the situation in their area was so alarming. Their area are still in an isolated and far away from technological and information developments. Students must walk tens of kilometers from the residence to the school. Supporting facilities in the form of textbooks were still minimal. In addition, learning did not go well because of lack of teachers. Changes in student learning performance shown by the results of the interview as follows.

Ambon	:	*Why did you come to Ambon City for school?*
Buru	:	*We believe that we will get a lot of things if we study in Ambon City.*
Tanimbarr	:	*We have limited learning facilities and infrastructure at Tanimbar and,especialy the internet*
SBB	:	*Even though we are close to the capital city but it is still limited by the ocean and the island. Coastal teachers are very fast in accessing information when compared to teachers in the mountains*
Ambon	:	*What do you fell when studying in Ambon?*
Masohi	:	*We obtained many things because there were so many bookstore centers where we could buy some books and we can access the internet faster*
Ambon	:	*Do learning carried out with PBL and RME can improve your academic skills?*
MBD	:	*We feel a great change, where academic skills such as physics, chemistry, biology and mathematics are becoming more improved*

Some research reports that academic performance is greatly influenced by a person's social, psychological, economic, environmental and personality conditions. If all of this is well fulfilled, a student feels comfortable in his study (Ali et al., 2009). Another report also explained that parents in the USA were very concerned about quality and facilities when entering their children to go from elementary school to tertiary level. They consider that adequate facilities greatly support children's academic skills and intelligence (Cheryan et al., 2014).

■ CONCLUSION

Based on the results of existing studies, it can be concluded that the PBL Model is more effective in increasing student academic performance compared to RME because students were facilitated with online-based media in PBL when compared to RME. Therefore, it can attract students' attention in learning and have a significant impact on student academic performance. Thus, PBL and RME can be recommended to improve student academic performance. Suggestions for further research are to follow the development of students' academic

performance while in high school, college and the world of work. The implications of this research are as a reflection material for teachers and schools in applying learning models that are oriented to students' academic performance.

REFERENCES

Adulyasas, L., & Rahman, S. A. (2014). Lesson study incorporating phase-based instruction using geometer's sketchpad and its effects on thai students' geometric thinking. *International Journal for Lesson and Learning Studies*, *3*(3), 252-271.

Ali, N., Ali, S., Mokhtar, N., & Salamat, A. S. A. (2009). The factors influencing students' performance at Universiti Teknologi Mara Kedah, Malaysia, *Management Science and Engineering*, *3*(4), 81-90

Bastos, R. M. B. (2017). The surprising success of the finnish educational system in a global scenario of commodified education. *Revista Brasileira de Educacao*, *22*(70), 802-825.

Cheryan, S., Ziegler, S. A., Plaut, V. C., & Meltzoff, A. M. (2014). Designing classrooms to maximize student achievement. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 4-14.

Cotic, M., & Zuljan, M. V. (2009). Problem-based instruction in mathematics and its impact on the cognitive results of the students and on affective motivational aspects. *Educational Studies*,*35*(3), 297-310.

Damkhi, M., & Pehlivan, H. (2018). Determining the results of tournament games using complete graphs generation. *Computational and Applied Mathematics*, *37*(5), 6198-6211.

Fakeye D. O. (2002). Effect of componential and rhetorical strategies on students'achievement in essay writing Ph.D Thesis, Unpublished. Ibadan: University of Ibadan.

Fakeye, D. O. (2010). Students' personal variables as correlates of academic achievement in english as a second language in nigeria. *Journal of Social Sciences*, *22*(3), 205-211.

Inel, D., & Balim, A. G. (2010). The effects of using problem-based learning in science and technology teaching upon students' academic achievement and levels of structuring concepts. *Asia-Pacific Forum on Science Learning and Teaching*, *11*(2), 1-23.

Kantar, L. (2014). Incorporation of constructivist assumptions into problem-based instruction: a literature review. *Nurse Education In Practice*, *14*(3), 233-241.

Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M. (2018). How does realistic mathematics education (rme) improve students' mathematics cognitive achievement?. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(2), 569-578.

Leasa, M. and Corebima, D. A. (2017). The effect of numbered heads together (NHT) cooperative learning model on the cognitive achievement of students with different academic ability. *IOP Conf Series: Journal of Physics*, *795*, 2-9.

Lease, M., & Corebima, A. D. (2017). The effect of numbered heads together (nht) cooperative learning models on the cognitive achievement of students with different academic ability. *Journal of Physics: Conference Series*,795, 1-9.

Lee, S. (2014). An Exploration of Learning Environmental Factors Affecting Student

Cognitive Engagement: Implications For Instructional Design Research. *Educational Technology International*, *15*(2), 143-170.

Loyens, S. M. M., Jones, S. H., Mikkers, J., & van Gog, T. (2015). Problem-based learning as a facilitator of conceptual change. *Learning and Instruction*, *38*, 34-42.

Mantri, A. 2014. Working towards a scalable model of problem-based learning instruction in undergraduate engineering education. *European Journal of Engineering Education*, *39*(3), 282-299.

Marioni, R. E., Ritchie, S. J., Joshi, P. K., Hagenaars, S. P., Okbay, A., Fischer, K.,... Deary, I. J. (2016). genetic variants linked to education predict longevity. proceedings of the National Academy of Sciences of the United States of America, *113*, 13366-13371.

Mergendoller, J. R., Maxwell, N. L., & Bellisimo, Y. (2006). The effectiveness of problem-based instruction: a comparative study of instructional methods and student characteristics. *Interdisciplinary Journal of Problem-Based Learning*, *1*(2), 49-69.

Ministry Of Education And Culture - Finland. Education in Finland. Finland Education in a nutshell. 2017. Disponível em: <http://oph.fi/download/146428_Finnish_Education_in_a_Nutshell.pdf>. Acesso em: 22 jun. 2017.

Ministry of Education, Culture and Science. 2010. Scholen voor Morgen [Schooling for Tomorrow]. The Hague: Ministry of Education, Culture and Science.

Okland, G. M. (2012). Determinants of learning outcome for students at high school in norway: a constructivist approach. *Scandinavian Journal of Educational Research*, *56*(2), 119-138.

Pianta, R., and B. Hamre. 2009. Conceptualization, measurement, and improvement of classroom processes: standardized observation can leverage capacity. *Educational Researcher*,*38*(2), 109-119.

Pomerantz, E. M., Moorman, E. A., & Litwack, S. D. (2007). The how, whom, and why of parents' involvement in children's academic lives: more is not always better. *Review of Educational Research*, *77*, 373-410.

Ratumanan, G. T. (2016). Motivasi siswa dalam pembelajaran matematika. Di sampaikan dalam seminar nasional pendidikan matematika 2016 pengembangan penelitian pendidikan matematika untuk mendukung peningkatan kualitas pembelajaran matematika [Student motivation in learning mathematics. Delivered in the 2016 national mathematics education seminar development of mathematics education research to support the improvement of the quality of mathematics learning]. Hal 6-13.

Rotgans, J. I., O'Grady, G., & Alwis, W. A. M. (2011). Introduction: studies on the learning process in the one-day, one-problem approach to problem-based learning. *Advances in Health Sciences Education*, *16*,443-448.

Rust, C. (2002). The impact of assessment on student learning how can the research literature practically help to inform the development of departmental assessment strategies and learner-centred assessment practices?, *Active Learning in Higher Education*, *3*(2), 145-158.

Smith, A., & Hall, E. (1902). Th e teaching of chemistry and physics in the secondary school. New York: Longmans, Green.

West. General Self-Concept, Self-Concept of Academic Ability and School Achievement: Implications for "Causes" of Self-Concept.

Yakina., Kurniati, T., & Fadhilah, R. (2017). analisis kesulitan belajar siswa pada mata pelajaran kimia kelas X di SMA Negeri 1 Sungai Ambawang [analysis of student learning difficulties in class X chemistry subjects at Senior High School 1 Sungai Ambawang]. *Ar-Razi Jurnal Ilmiah*, *5*(2), 287-297.

Yew, E. H. J., & Goh, K. (2016). Problem-based learning: an overview of its process and impact on learning. *Health Professions Education*, *2*(2), 75-79.