Learning Project Based with the Help of an Android Smartphone on Trigonometry Comparison Material

Istadi[1], Herlina Hidayati[2], Astri Rakhmawati[3] , Anwar Muttaqien[4], Catherine M. Kursius[5]
[1,2,3,4,5]Program Studi Pendidikan Matematika FKIP Universitas Muhammadiyah Sampit

Abstract
The aim of this research is to describe the use of project-based learning with the help of Android smartphones in trigonometric ratio material in grade X SMAN 1 Kota Besi. This research method is descriptive qualitative. The subjects of this study were tenth grade students SMAN 1 Kota Besi. Based on the results of reflections and interviews, it shows that the use of android application in project-based learning, namely (1) makes learning easier for students to understand and learning is more interactive because students experience it for themselves, (2) learning becomes more interesting because they use their gadgets for learning and practicum, and (3) students are more creative because they have to make reports and make presentations in front of the class. Thus, the use of android application can support project-based learning on trigonometric ratio material at SMAN 1 Kota Besi both inside and outside the classroom and outside of school

Keywords: Pembelajaran Berbasis Proyek Android Trigonometri

INTRODUCTION

The development of digital technology, which is a tool with a computerized system, is growing rapidly at this time. The development of digital technology can be seen from the large number of people who use it, where the majority of students already have Android smartphones. This phenomenon requires teachers to be able to utilize this technology for the learning process. So, technology is more useful than just being used for browsing and accessing social media. Moreover, after the Covid-19 pandemic, digital platforms, especially smartphones, are very important for use in communication and social media [N. H. Sari]. In learning, the use of technology is very important, as we have now entered the industrial era 4.0 or what is known as the digital era. The technology used in learning, for example, making teaching materials using Geogebra software [S. Ramdhani]. There are many benefits to be gained from using technology in the digital era, including effectiveness and time efficiency in learning and supporting distance learning [G. F. Khairunnisa and Y. I. N. Ilmi] .

The implementation of an independent curriculum in educational units is required to implement innovative learning models. One of the recommended innovative learning models is project-based learning (PjBL). To help implement project-based learning, teacher creativity and innovation is needed in designing learning models. For example, in learning trigonometry which is related to geometry and algebra, it will feel difficult and less interesting if it is only done through textbooks. Using smartphones and androids will make students more interested in learning, if combined with conventional media, such as protractors and rulers. Smartphone android now is easy to get and can optimize learning, in addition smartphone android It can also support teacher competency standards and make learning effective [B. Cahyono and E. K. Nisa, Z. Aulia Ilma and T. Turmudi, N. Nurhayati, F. Zuhra, and O. P. Salehha, N. Bito and A. K. Masaong] .

According to Grant [M. M. Grant] project-based learning is a student-centered learning model for carrying out an in-depth investigation of a topic. Students constructively deepen their learning with a research-based approach to problems and questions that are meaningful, real and relevant. Meanwhile Goodman and Stivers [B. Goodman] defines project-based learning as a teaching approach that is built on learning activities and real tasks that provide challenges for students related to everyday life to be solved in groups.

According to the Buck Institute for Education [seaqil team] project-based learning is also relevant to high-level thinking skills (HOTS) in implementing scientific learning and 21st century skills known as 4C (Critical thinking, Collaboration, Creative, Communication) [E. E. Peters-burton]. Based on research results, project-based learning has an effect on learning achievement, conceptual understanding, high-level thinking abilities (HOTS), learning motivation, creative thinking abilities, and critical thinking abilities [L. Mutakinati, I. Anwari, and K. Yoshisuke, S. K. Ummah, A. Inam, and R. D. Azmi,A. W. Asmi, F. Rahmat, and M. Adnan, P. A. Facione]. Project-based learning also improves students' process skills and learning outcomes, and influences student learning in science education that uses a science approach (*science*), technology (*technology*), technique (*engineering*), art (*art*), and mathematics (*mathematics*) (STEAM) [H. Aprianty, A. Gani, and A. U. T, A. A. Chistyakov, S. P. Zhdanov, E. L. Avdeeva, E. A. Dyadichenko, M. L. Kunitsyna, and R. I. Yagudina, P. Lely, S. Prabawati, G. Ngurah, and S. Agustika]. Project-based learning can also improve students' mathematical representation abilities, mathematical communication abilities, explore computational thinking abilities, and improve students' mathematical reasoning abilities [N. A. Hrp and I. F. Rahma, N. K. Restu, S. Ruqoyyah, and A. Samsudin, R. D. Azmi and S. K. Ummah, Z. Abidin, A. C. Utomo, V. Pratiwi, and L. Farokhah] .

According to Larmer et al. [J. Larmer, J. Mergendoller, S. Boss] project-based learning models always emphasize deep conceptual understanding and critical thinking when solving problems, developing and answering driving questions, and creating high-quality products. Meanwhile, general standards for learning mathematics highlight the ability to solve problems that arise in everyday life, society and the workplace according to those that occur in real projects. In trigonometry learning, the use of project-based learning is quite effective because students are exposed to a pleasant atmosphere to solve problems in everyday life [M. T. C. Gerhana, M. Mardiyana, and I. Pramudya].

The steps of the project-based learning model consist of three main stages, namely planning, implementation, and reporting. Details and technical details of the three main stages in the learning steps produce eight activities, including the following: (1) planning, consisting of five activities, namely determine topics, designing projects, and preparing project implementation schedules; (2) implementation, consisting of one activity, namely investigating and completing the project accompanied by teacher monitoring and consultation; and (3) reporting, consisting of two activities, namely testing results and assessing project results, and evaluating project results and learning activities [seaqil team].

RESEARCH METHOD

The approach used in this research is descriptive qualitative. Sampling in this research was purposeful sampling. Researchers collected data through interviews, student documents (reflections) and field observations/notes [Sugiyono]. The participants in this research were class X students in the even semester of the 2022/2023 academic year. The research uses several stages, namely (1) design instrument assist with research, (2) conducting research and (3) data analysis. The design stage includes making observation sheets and interview guidelines. Furthermore, the research was carried out for 6 weeks by following the project-based learning stages as shown in Table 1 below:

Vol. 9 No. 4 Desember 2024
p-ISSN: 2548-5555, e-ISSN: 2656-6745

Table 1. Stages of Project Based Learning

No	Stages of Project Based Learning	Description of Student Activities
1	Planning	Prepare equipment that will be used for practicum, such as protractor, ruler, geogebra application and digital compass. Prepare a schedule of activities that will be carried out in the classroom and outside the classroom/school
2	Implementation	Carrying out practicums in class/outside of class/outside of school Make practical reports
3	Reporting	Make a presentation Conduct reflection

Next, for data analysis, after the data is collected, data validation is carried out using technical triangulation, which checks the source, namely students, with different techniques. Data was obtained through student documents (reflections) then checked using interviews and observations/field notes. From the three techniques, the results obtained were the same data, then data reduction was carried out by removing unnecessary data, in this case data that was not in accordance with the project-based learning stages [J. W. Creswell].

RESEARCH RESULTS AND DISCUSSION

3.1 Project Planning

Activities in project-based learning are arranged in a schedule agreed upon by students and teachers. Previously, students were directed to determine topics and discussions. The topic in this activity is trigonometric comparisons and their applications. The agreed results of the project schedule can be shown in table 2 below:

Table 2. Activity Schedule

No	Time	Activity	Place
1	Week I of the Month September 2024	Determine topics, answer basic questions and create a schedule	in the classroom
2	Second Week of the Month September 2024	Practicum in class with a protractor and ruler assisted with geogebra.	in the classroom
3	Third week of the month September 2024	Making conclusions and practicing HOTS questions.	in the classroom
4	IV Week of the Month October 2024	Practicum in a school environment with a simple clinometer and digital compass.	outside class

5	Week I of the Month October 2024	Presentation and reflection.	in the classroom
6	Second Week of the Month October 2024	Practicum outside the school environment with a digital compass.	outside school

3.2. Project Implementation

a. Practicum in class

Based on the agreement between the teacher and students regarding the project schedule that has been made, the first step is to carry out practical work with a protractor and ruler to discover the concept of trigonometry comparisons with the help of LKPD with the stages carried out by students as in Table 3 below:

Table 3. Practicum Stages in Class

No	Corner	Practical Stages in the Classroom
1	30the	a. Draw a triangle with one angle of 30 with a protractor and set the lengths of the front sides as 5 cm and 10 cm. b. Measure with a ruler how long the hypotenuse is. c. Calculate using the Pythagorean Theorem the length of the side. d. uses the Geogebra application to prove accuracy in measurements.
2	45the	a. draws a triangle with one angle of 45 with an arc and set the lengths of the front sides as 5 cm and 10 cm. b. Measure with a ruler how long the side is. c. Calculate using the Pythagorean theorem the length of the hypotenuse. d. uses the Geogebra application to prove accuracy in measurements.
3	60the	a. Draw a triangle with one angle of 60 with an arc and set the lengths of the sides as 5 cm and 10 cm. b. Measure with a ruler how long the hypotenuse is. c. Calculate using the Pythagorean theorem the length of the front side. d. uses the Geogebra application to prove accuracy in measurements.

In this activity students will carry out practical work with a protractor and ruler to discover the concept of trigonometric ratios. This practicum is based on constructivist learning where students deepen the material by investigating the topic at hand. This simple practicum will lead them to practice critical thinking, for example students analyze and evaluate what they learn, as well as reflect [P. A. Facione]. Apart from that, students collaborate with other students by helping each other for those who don't understand, think creatively to create maximum results, and foster communication between students. This is in accordance with the scientific learning model and 21st century skills [E. E. Peters-burton].

Students carry out practical work using a protractor and ruler manually to discover the concept of trigonometric ratios. In the next activity, students used the Geogebra application to get better accuracy than what they did manually using a protractor and ruler. The students' practicum results are shown in Figure 1 below:

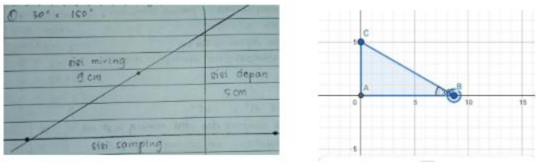

Figure 1. Illustration of Trigonometric Comparisons

Before practical activities outside the classroom/school, students must already understand the concept of trigonometric comparisons. They were asked to make a conclusion about the concept of trigonometric comparisons by making comparisons of the values of the sides of a triangle (side side, front side, hypotenuse). So, it helps achieve learning, understanding concepts, and also higher-level thinking (HOTS). Making simple conclusions will also help students' mathematical communication skills, with students learning to express their mathematical ideas. The results of students' activities in making simple conclusions in defining trigonometric ratios are shown below:

$$\frac{front\ side}{hypotenuse} = \frac{5}{10} = \frac{10}{20} = 0.5(sinus30)$$

$$\frac{side\ side}{hypotenuse} = \frac{5}{10} = \frac{10}{20} = 0.5(Cosinus60)$$

b. Practicum outside the classroom

In activities outside of class, students apply applications of trigonometric comparisons outside of class. The objects they chose were buildings in the school environment with the help of a simple clinometer and digital compass. Then the results of the observations are made into a report for presentation. From this activity students are trained to think at a higher level (HOTS) in accordance with proficiency 21st century known as 4C (Critical thinking, Collaboration, Creative, Communication).

Figure 2. Results of observations and practicum outside the classroom

c. Practicum Outside School

For activities outside of school, this is an option for students who are good at reporting and presenting. They do this by exploiting the surrounding environment or the potential of the region they have. In this activity the potential chosen is the Mentaya River. Students make observations on the river bank using a modified digital compass to estimate the width of the Mentaya River. Meanwhile, to find out or estimate the actual distance, you can use the Google Maps application by entering the coordinate values for the position of the point where the observation is made. This activity will train students to utilize simple navigation tools available on Android gadgets or smartphones. The results of students' activities outside of school in the practicum measuring the width of the Mentaya River are shown in Figure 3 below:

Figure 3. Results of Observations and Practicum Outside School

3.3. Project Report

At the report stage students make presentations in front class. They explain the results of observations in the form of simple presentations and calculation results from the objects they previously measured. Reports are made in groups consisting of: (1) the name of the group and its tasks; (2) observation results; (3) illustration of the object being measured; (4) calculation of observed objects; (5) draw conclusions; and (6) documentary evidence of activities. In this activity, students' mathematical representation abilities can be seen in how students create illustrations of the objects they observe. Then computational thinking skills can also be seen in using the Google Maps application to create illustrations of measured objects. This is also needed in the application of STEAM to project-based learning, so that the combination of science and technology in learning can be realized and become meaningful and motivating [P. Lely, S. Prabawati, G. Ngurah, and S. Agustika]. Next, the object being measured is simply illustrated on the report sheet by simply painting. Results of student illustrations manual and with the help of Google Maps is shown in Figure 4 below:

Figure 4. Illustration of objects observed manually and the Google Maps application

After making a presentation in front of the class, the next stage of project-based learning is reflection where students are asked to fill in a learning reflection sheet. The reflection results show that using Android smartphones in project-based learning helps students in learning compared to just using textbooks or eBooks from the internet.

CONCLUSION

Based on the results of reflections and interviews, it shows that the use of Android smartphones in project-based learning is (1) making learning easier for students to understand and learning more interactive because students experience it themselves, (2) learning becomes more interesting because they use their gadgets for learning and practicum, and (3) students are more creative because they have to make reports and make presentations in front of the class. In this way, the use of Android applications can support project-based learning on trigonometry material at SMA Negeri 1 Kota Besi both in the classroom and outside the classroom.

ACKNOWLEDGEMENT

We would like to express our deepest gratitude to the principal, teachers and all components of SMAN 1 Kota Besi who have become partners in this research activity. Besides that, Thank You LP2M has also provided moral and material support so that this research activity can be carried out well and smoothly. Then thank you also to all parties who have made this activity a success, especially the students of SMAN 1 Kota Besi who were involved in this activity.

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