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Implementation of Project Based Learning in Mathematics Capita Selecta for Elementary School

Hanifah & Tria Utari*

Department of Mathematics Education, Universitas Bengkulu, Indonesia

Abstract: Mathematics Capita Selecta For Elementary School is a course that aims to produce students who are able to find solutions to problems that occur in learning mathematics in elementary schools. To achieve this, implementing the Project Based Learning (PjBL) model is the right choice, because PjBL is a student-centered learning model. This study aims to find out impact of the implementation of the Project Based Learning (PjBL) model which is applied to the Mathematics Capita Selecta for Elementary School course. The subjects in this study were 31 students of the Mathematics Education Study Program University of Bengkulu 2021/2022 who took the courses. Data collection method used is open-ended tests and surveys using questionnaire response. Research results show that students' learning outcome is at the value of 75 obtained from the t test using SPSS software, where obtained P-Value>0,05. Besides that, results research also shows that response student to learning is very good with percentage of 64.52% and good with percentage of 35.48%.

Keywords: project based learning, mathematics capita selecta , elementary school

Abstrak: *Matakuliah Mathematics Capita Selecta Matematika Jenjang Pendidikan Dasar merupakan matakuliah yang bertujuan menghasilkan mahasiswa yang mampu menemukan solusi terhadap permasalahan yang terjadi pada pembelajaran matematika di Sekolah Dasar. Untuk mewujudkan hal ini, penerapan Model Project Based Learning (PjBL) menjadi salah satu pilihan yang tepat, karena PjBL merupakan model pembelajaran yang terpusat pada mahasiswa. Penelitian ini bertujuan untuk mengetahui pengaruh implementasi Model Project Based Learning (PjBl) pada matakuliah Mathematics Capita Selecta MatematikaJenjang Pendidikan Dasar (JPD). Subjek sasaran dalam penelitian ini adalah mahasiswa Program Studi S1 Pendidikan Matematika FKIP UNIB TA 2021/2022 yang mengambil matakuliah Mathematics Capita Selecta Matematika Jenjang SD yang berjumlah 31 orang. Metode pengambilan data yang digunakan ialah tes menggunakan lembar tes open-ended dan survey menggunakan angket respon. Hasil penelitian menunjukkan bahwa hasil belajar mahasiswa berada diatas nilai 75 yang diperoleh dari uji t menggunakan software SPSS, dimana didapatkan P-Value>0,05. Selain itu, hasil penelitian juga menunjukkan bahwa respon mahasiswa terhadap pembelajaran sangat baik dengan persentase 64,52% dan baik dengan persentase 35,48%.*

Kata kunci: *project based learning, Mathematics Capita Selecta matematika, sekolah dasar.*

▪ INTRODUCTION

There are two important goals that must be achieved by a lecturer in teaching prospective teachers, namely so that they can transfer what they learn to their students in the future and so that they can facilitate final generation students to transfer what they learn in their future lives. (Howard, 2002). The Mathematics Kapita Selecta Course for Elementary Schools is a compulsory subject offered at the Mathematics Education Study Program at the University of Bengkulu with 3 credits. Compulsory competencies that must be achieved by students after taking this course are students must know the

Tria Utari
*Email: triautari@unib.ac.id

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problems in learning mathematics that occur in elementary schools. Students must be able to find solutions to solve problems.

Prior to the Covid 19 pandemic, the learning process for Mathematics at Mathematics Capita Selecta Elementary School was carried out in class by applying the Project Based Learning (PjBL) model. PjBL is believed to be able to realize course objectives as stated by Larmer, Mergendoller, & Boss (2015) that project-based learning is a powerful teaching method that motivates students, prepares students for college, career and citizenship, and helps students meet standards and do well on tests that ask students to demonstrate in-depth knowledge and thinking skills. Although there are disciplinary challenges to using PjBL (Rogers, Cross, Gresalfi, Trauth-Nare, & Buck, 2011) and it can be difficult for those who avoid the challenge to undergo PjBL (Meyer, Turner, & Spencer, 1997), Viro, Lehtonen, Joutsenlahti , and Tahvanainen (2020) found that the majority of teachers regard developing students' knowledge and understanding of mathematics and science, as well as 21st century skills as an important goal of PjBL in mathematics and science education. Condliffe (2017) found several studies in schools that implemented the PjBL approach had shown positive effects on students' engagement, motivation, and belief in their own abilities.

Solomon (2003) explains that PjBL is a learning model that provides opportunities for students to work in groups to solve challenging problems that are authentic, curriculum-based, and often interdisciplinary. In PjBL, students are divided into small groups consisting of 2-3 students per group. The process of collecting data to presenting the results of group work is done offline. One of the learning tools produced at that time was teaching aids. Each group that is presenting must demonstrate how to use the props in front of the class. At that time the presenter group became the teacher, while the other groups became students. The class atmosphere became very interesting, the students lowered their voices like students to the teacher, moreover what was being practiced was teaching aids for elementary schools. Both presenters and students all look happy, because teaching aids can facilitate the delivery of subject matter

. Kurniasih (2014) also stated the positive impact of the assignment of teaching aids, namely: "(1) increase students' motivation to learn to encourage their ability to do important work, and they need to be rewarded; (2) improve problem solving ability; (3) make students more active and successful in solving complex problems; (4) improve cooperation: (5) encourage students to develop and practice communication skills; (6) improve students' skills in managing resources; (7) provide learning and practical experiences for students in managing projects and making allocations of time and other resources such as equipment to complete assignments; (8) provide learning experiences that involve students in a complex manner and are designed to develop according to the real world; (9) involving students to learn to take information and show their knowledge, then implement it in the real world; (10) making the learning atmosphere fun, so that students and educators enjoy the learning process.

Roessingh and Chambers (2011) developed eight guiding principles in the PjBL model to support teacher candidates, namely instructors who need expertise in content areas and pedagogical competencies, introductory and flexible instructional design to students, central questioning or problem focus and providing a catalyst for learning, learning objectives teaching is explicit, learning tasks are authentic and engaging, instruction is mediated and integrated, promotes critical reflection and higher-order

thinking skills, assessment and monitoring of continuous learning. These eight things need to be considered in applying PjBL to prospective teachers.

Since the Covid 19 pandemic hit the world which required people to keep their distance from one another, the government issued a circular regarding the implementation of online education from home. This also affects the results of the implementation of the PjBL Model in the Mathematics Capita Selecta course. Initially the product was in the form of teaching aids, because learning was carried out online and teachers were required to provide learning material via video. Apart from teaching aids, learning videos are another product of implementing PjBL in Mathematics Capita Selecta courses, both at the Elementary and Secondary Education levels. Kokotsaki, Menzies & Wiggins (2016) states that there are many factors that influence the implementation of PBL, namely modern digital technology, high-quality group processes, the ability of teachers to effectively plan student learning and provide guidance and support, a balance between didactic instruction with in-depth inquiry methods and aligned assessment.

Another 21st century phenomenon is the shift in the need for Human Resources (HR), which shifts HR from low-level skills (handwork) to HR jobs with high creativity. Creativity is the only possibility for developing countries to develop so you as a 21st century learning teacher need to orient learning to produce students who have high creative power. This is achieved more quickly when students become active subjects in constructing learning experiences, practicing higher-order thinking (HOTS), and developing habit creation.

One of the significant influences of technology on 21st century learning is the ease of access or accessibility to digital learning resources to meet the various needs of students. 21st century learning components (Pujiriyanto, 2019) which increase their interaction with each other, namely: (1) instructor/teacher/mentor/facilitator activities, (2) online learning design, (3) data as a learning resource (big data), and (4) online learning strategies, and (5) student performance. The five components are clearly illustrated in Figure 1.

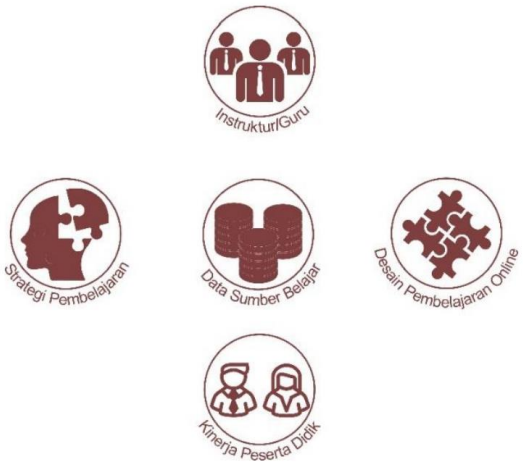


Figure 1. The main components of 21st century learning

Computer Science Technology (ICT) facilities need to be utilized as fully as possible to support mathematics learning activities. ICT must be mastered both for learning resources, learning media, as well as a means of communication and collaboration. The use of ICT is expected to increase abstraction in learning mathematics. The current condition is that there are still many teachers who have not utilized ICT as a medium for learning mathematics. This is because not all schools have adequate ICT facilities or there are still many teachers who have not mastered ICT, especially computers and the internet (Suyono, 2012).

Technology is very suitable for PjBL because according to Beckett, & Slater (2018) what has been done in project-based language teaching in general and in projects that focus on the use of technology shows that participating in projects can build decision-making skills, foster independence while increasing work skills. cooperative, challenge students' creativity, cultivate creative thinking skills, and improve problem solving skills. This is in line with the statement of Boss & Krauss (2022) that PjBL supported by contemporary technology is a particular strategy to overturn the traditional classroom.

Based on the learning experience cone in Figure 2 (Pujiriyanto, 2019), if the learning is designed by the lecturer in such a way that students make their own learning tools to solve mathematics learning problems at school, then students will be at the highest level. and will remember this event for a lifetime, where students actively construct their own way of teaching material at school, how to make learning aids. How learning tools are applied to other students' friends.

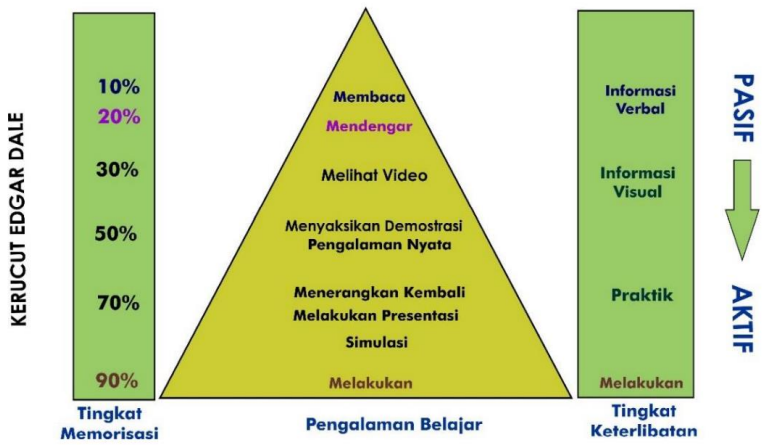


Figure 2. Learning experience cone

Over time, where generally learning is still carried out online by utilizing social media, learning platforms and video conferencing and others, as well as the availability of computer application programs for various purposes on the internet, PjBL products in the Mathematics Capita Selecta course of course made by students. increase. The demands of prospective teachers in the 21st century also make students try to learn from anywhere, anytime, and with anyone. This of course will also affect the results of the implementation of the PjBL Model in the Mathematics Capita Selecta course at the Basic Education level. Based on the above, it can be stated that the formulation of the

problem in this research is how to apply the Project Based Learning (PjBL) Model in the Mathematics Capita Selecta Elementary School (JSD) course as a provision for students to face the 21st Century. To see how PjBL effects on affective and cognitive outcomes, we used questionnaires for affective outcomes (i.e. perceptions of PjBL benefits and perceptions of PjBL experiences) and tests for cognitive outcomes (i.e. knowledge and cognitive strategies) as recommended by Guo, Saab, Pos, & Admiral (2020).

▪ METHOD

Participants

The population in this study were all undergraduate Mathematics Education students at Bengkulu University. The sample for this research was students from batch 2020. This sample was selected using a purposive sampling technique on the grounds that students from batch 2020 were taking the Mathematics Capita Selecta course at the time this research was to be conducted. The sample is class A which uses a project-based learning model with a total of 31 students.

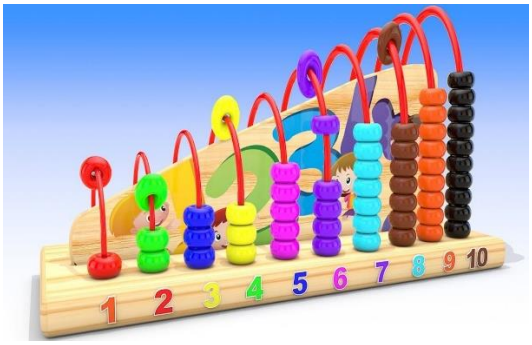
Research Design and Procedures

This study was a quasi-experimental study in the form of a one group post test design. This means that there is only one class in this study. Research procedure carried out with the stages of determining the time for research implementation, namely February 4 to June 10 2022. Then, determining research class samples, compiling learning achievement test questions and response questionnaires, validating test questions and response questionnaires that will be used in research to validators to test the validity of the questions , conducting test questions and response questionnaires, analyzing test results data to find out which questions and questionnaires are appropriate for use, carrying out learning activities using the PjBL learning model, conducting post-tests in research classes, analyzing data and determining the results of hypothesis testing, drawing conclusions and compiling research reports.

Instruments

Data collection techniques used in this study consisted of two, namely: non-test and test. The non-test technique is in the form of distributing response questionnaire sheets. The data collection technique uses a test, namely an open description test which aims to measure the effectiveness of the PjBL Model in the Mathematics Capita Selecta course. To measure student learning outcomes, a description test was used which consisted of two questions for each indicator which the researcher developed himself, namely being able to explain number material in grade 1 elementary school using teaching aids and being able to explain statistical material in grade 6 elementary school using teaching aids. Validity test results logically with the Aiken index shows that the average score is 0.89 which means the number is very valid to use (Retnawati, 2016). The details of the questions can be seen in table 1.

Table 1. Final exam sheet

Props	Assignment
A. Perhatikanlah gambar Alat Peraga Matematika Kelas 1 SD berikut ini: 	Perhatikanlah Gambar 1. Alat Peraga Matematika Kelas 1 SD Buatlah Percakapan antara saudara sebagai Guru dan Siswa di Kelas I SD, dimana Guru sedang menggunakan gambar 1 sebagai alat peraga pembelajaran matematika dalam: A.1. Mengenalkan Angka A.2. Mengenalkan Penjumlahan dan A.3. Mengenalkan Pengurangan
B. Perhatikanlah gambar Alat Peraga Berhitung Kelas 6 SD berikut ini. 	Buatlah percakapan antara saudara sebagai guru dan siswa di kelas 6 SD dengan menggunakan gambar 2 sebagai alat peraga pembelajaran matematika materi Statistika.

To measure student responses, a response questionnaire was used. There are 20 question items used in the questionnaire. The indicators used were adapted from Sugiyono (2011), which included indicators of interest, benefits and understanding. Indicators of interest were developed into 8 question items, indicators of benefits were developed into 11 question items, indicators of understanding were developed into 1 question item. The results of the logical validity test with the Aiken index show that the average score is 0.96, which means that the questionnaire is very valid to use (Retnawati, 2016). The results of the instrument reliability test showed that Cronbach's Alpha = 0.907 where this value is more than the r table, namely 0.355. This means that the questionnaire is reliable for use in research.

Data Analysis

Analysis prerequisite tests, namely the normality test and homogeneity test were carried out using SPSS 22 software, as well as hypothesis testing. Hypothesis testing is used to test whether there is an influence of project-based learning models on student learning outcomes. Thus, the hypothesis is formulated as follows:

H_0: $\mu \leq 75$, average student learning outcomes are not more than 75

H_1: $\mu > 75$, the average student learning outcomes is more than 75

Questionnaire responses were analyzed by calculating the average score for each aspect. The average score for each aspect obtained was translated into qualitative data using Widyoko's assessment criteria (2009: 238):

Table 2. Response questionnaire assessment criteria

Range	Criteria
$\bar{x} > M_i + 1.8Sbi$	Excellent
$M_i + 0.6\,Sbi < \bar{x} \leq M_i + 1.8Sbi$	Good
$M_i - 0.6Sbi < \bar{x} \leq M_i + 0.6\,Sbi$	Fair
$M_i - 1.8Sbi < \bar{x} \leq M_i - 0.6\,Sbi$	Bad
$\bar{x} \leq M_i - 1.8Sbi$	Very Bad

Notes: Mi and Sbi are ideal average score and standard deviation.

▪ RESULT AND DISSCUSSION

The research results were obtained from open ended tests in the form of problem solving questions in learning mathematics in elementary schools. After obtaining the data from the test results, then the data is tested for normality. The results showed that student learning outcomes were normally distributed in data obtained from the Kolmogorov-Smirnov test using SPSS software, where p > 0.05. Then a t-test was carried out to see the effect of the PjBL model on student learning outcomes. The results showed that student learning outcomes above the value of 75 were obtained from the t test using the SPSS software, where a P-Value of 0.000 was obtained > 0.05.

The description above shows that there is an effect of implementing PjBL on learning outcomes. This is supported by previous research in which Cervantes, Hemmer, and Kouzekanani (2015) examined the impact of project-based learning on achievement of minority students: implications for school redesign and the results indicated that the PjBL group performed at higher levels of achievement than non-PBL students. Although there is research that is somewhat different, namely the results of research by Hixson, Ravitz, & Whisman (2012) which shows students who are taught with PjBL are no different from students who are taught by teachers or teachers who do not use PjBL. who have not received extensive training, but these results still produce good results related to PjBL. Previous research also concluded that there was an influence of PjBL on various aspects, for example Fini, Awadallah, Parast, and Abu-Lebdeh (2018) explained that implementing interventions significantly increases high-level cognitive skills, self-efficacy, teamwork, and communication skills. Belagra & Draoui (2018) see from a motivational perspective that the integration of tutorials with a project-based approach is likely to increase students' motivation to learn and master power electronics subjects. In line with Holmes and Hwang (2016) who stated that PBL students are more intrinsically motivated, show much higher critical thinking skills, and value peer learning.

In addition to the open-ended test, students are also given a response questionnaire. The data obtained shows that students' responses to learning are very good with a percentage of 64.52% and good with a percentage of 35.48%. According to students, they learn to find problems in the field, find the best solutions, write scientifically and develop learning media, both digital and non-digital. These results

indicate that there is an effect of implementing PjBL on student responses. This is supported by previous research by Al-Busaidi and Al-Seyabi (2021) regarding the implementation of PjBL in teacher education programs which revealed that student responses were positive. Students enjoyed the project and agreed that it helped them acquire many course design principles, as well as a number of academic skills.

After checking student answers, the results were obtained: For question No A. It turned out that 100% of students could use the visual aids in Figure 1 to introduce numbers 1 – 10 to students. Only 25% of students were able to make conversation scenarios between teachers and students in very interesting and complete categories. There are 75% of students who are able to make scenarios with interesting or complete qualities. Figure 3 below is an example of a very interesting and complete answer from a student.

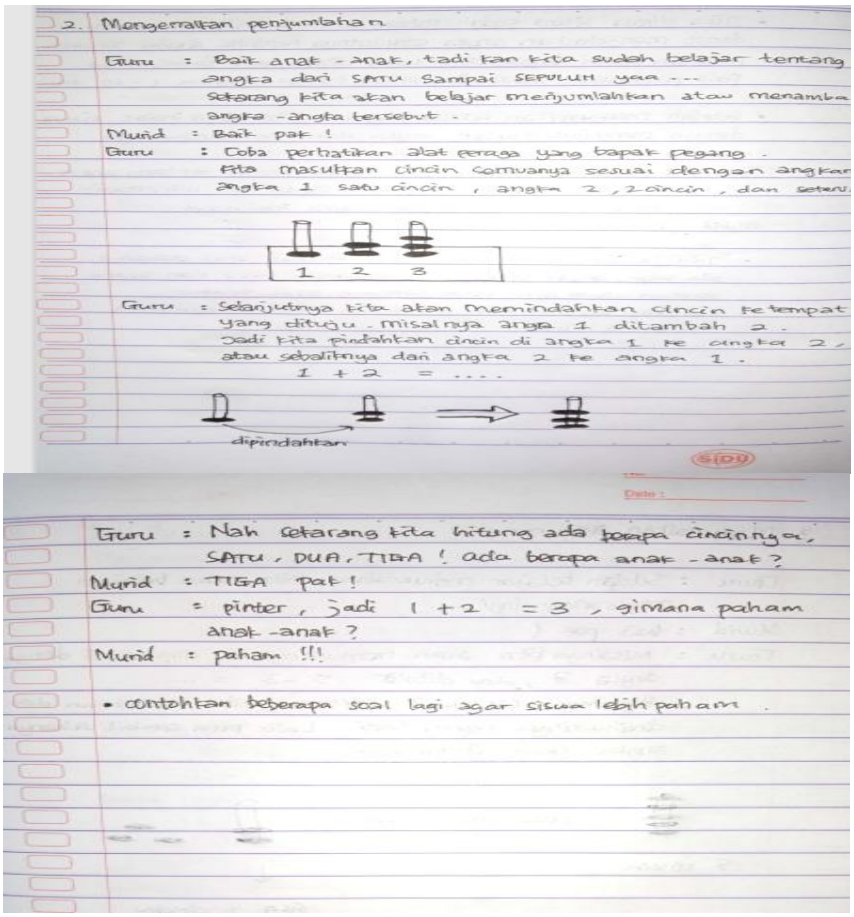


Figure 3. Example of student answers to question A

The figure shows student answers in the form of teacher and student conversations in introducing addition using teaching aids. Students can explain how to add integers complete with illustrations. As for Question B, it was almost the same as Question A, only 25% of students were able to design very good and complete teacher and student learning scenarios, starting with preliminary activities, continuing with core activities, and ending with closing activities. Figure 4 below is an example of student answers

accompanied by Figures of props that make these answers different from the answers of other students. The examples of questions given have more data than data from other friends. Find the mean, median, and mode of the following data: 2 6 4 9 10 4 7 5 5 1 1 2 2 9 3

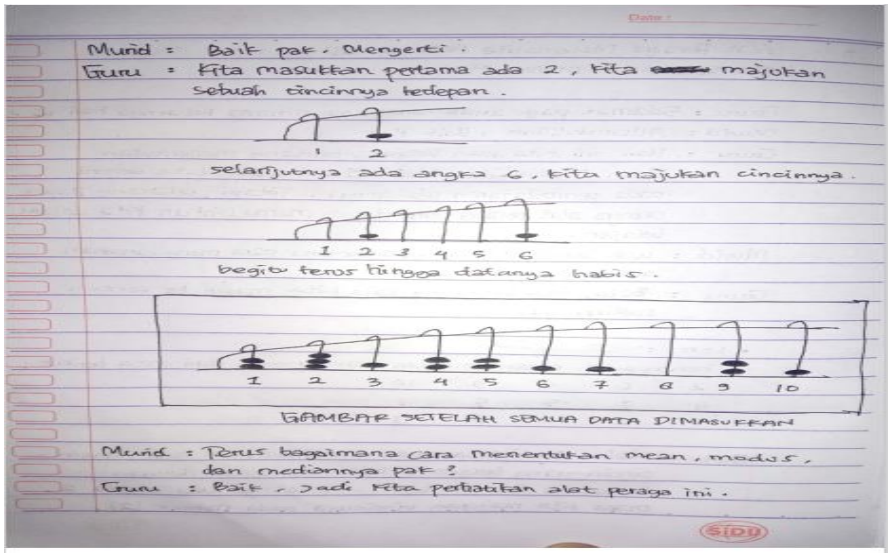


Figure 4. Example of student answers to question B part 1

This student explained well that the first step that must be taken before determining the mean, median and mode is to arrange the data in props by inserting a ring into the wire.

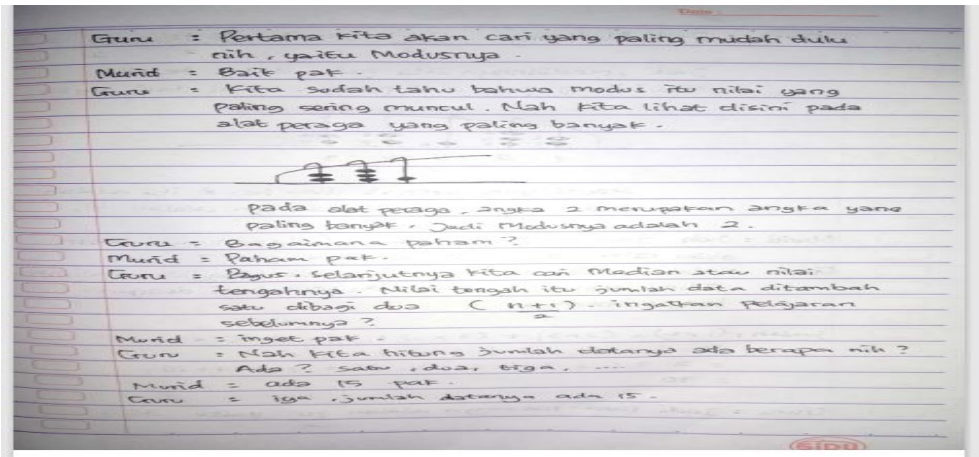


Figure 5. Example of student answers to question B part 2

It can be seen in the Figure that the next conversation written by the students is about how to find the mode by looking at the most amount of ring clusters.

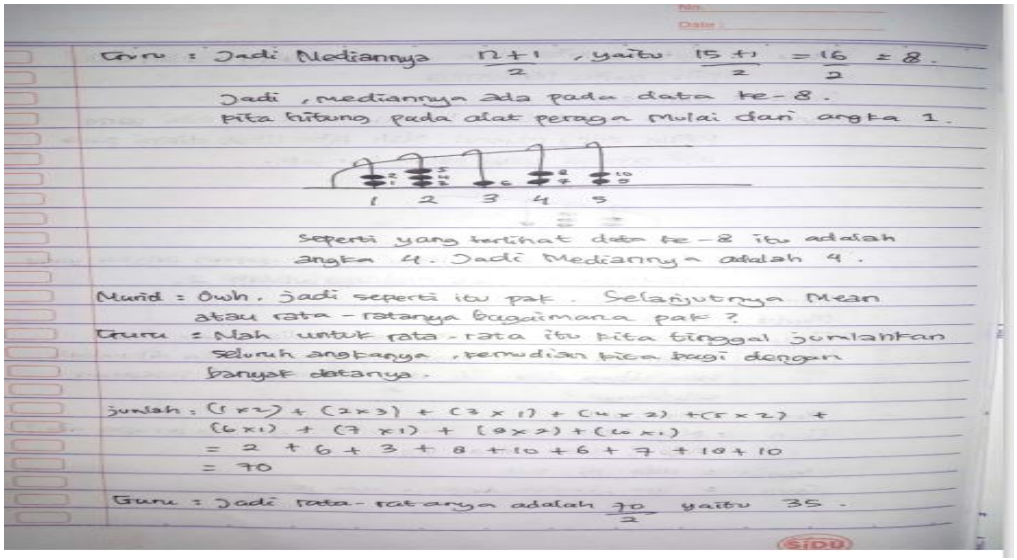


Figure 6. Example of student answers to question B part 3

Figure above is a continuation of the conversation conducted by the students which shows that from the Figure it can be seen that the conversations conducted by the students are appropriate in explaining the complete and comprehensive study of statistics about mean, mode and median interesting. method. Not seen in the Figure, the complete and intact student answers indicate that students have been able to design teacher and student learning scenarios very well and completely, starting from preliminary activities, continuing with core activities, and ending with closing activities.

PjBL steps in this research are 1) planning activities, 2) identifying problems, 3) formulating problem-solving strategies, and carrying out planning 4) evaluation. In planning activities students visit schools and make observations to find existing problems, then students identify problems found, look for alternatives and formulate problem-solving strategies, and carry out planning. The formulation of the problem, alternatives and problem solving strategies are outlined in the paper. Alternative solutions can be in the form of interesting learning activity designs, Student Worksheets (LKPD), quizzes, digital media such as learning videos or teaching aids. The results of the implementation of this project were then presented in front of the class. Other students and lecturers provide input for improving the works that have been made.

In the evaluation process, students present their project results in front of the class witnessed by lecturers and other students. Students also do teaching practice using the media that has been made. In its implementation, it was found that several mistakes were made by students so that they needed to be corrected. The description of the error as follows displays mathematical symbols that are not appropriate for the age of elementary school students, does not use props on material that requires demonstration of concrete objects, presents the level of questions not in stages, does not use props to the fullest, does not demonstrate in finding concepts, uses symbols not consistently / not using standard symbols, not using safe materials in making props and props that are not attractive.

Children aged 7 to 11 years experience the concrete operational stage. Concrete operations are reversible mental actions related to real objects, which are concrete

(Santrock, 2014). This means that if the teacher uses concrete objects in teaching the material, it will make it easier for students to understand the material. In mathematics, this can be done by using props. For example, in the area of a circle material, the teacher can use visual aids that make it easier for students to find the concept of the area of a circle.

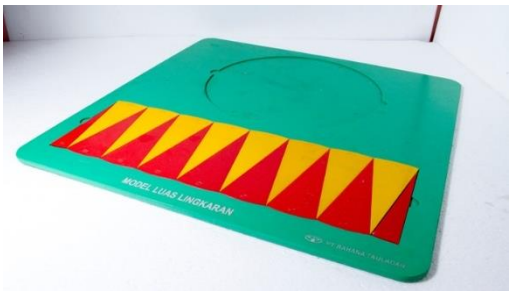


Figure 7. Circle area props

However, this was not done by the students who got the part to develop this material in the Mathematics Capita Selecta course. The student only added an image of the circle area model to the learning video that was made as a solution to the circle area learning problem in the elementary school he was observing.

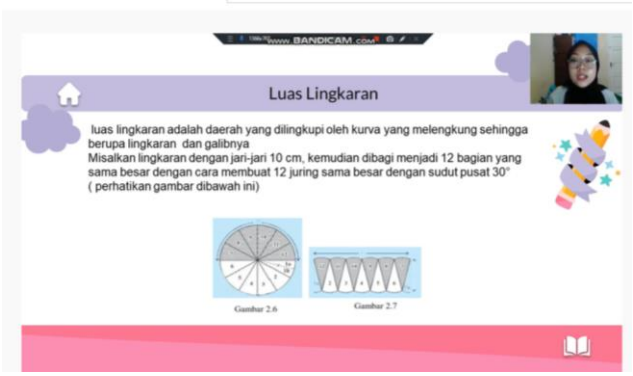


Figure 8. Screenshot of the learning video containing a circle area demonstration

The disadvantage of using Figures compared to teaching aids is that students do not have the opportunity to demonstrate directly finding the area of a circle. Even though the age of elementary school students is an age that still needs concrete objects around them to understand a concept.

▪ CONCLUSION

The results of the study show that student learning outcomes are above the value of 75 obtained from the t test using SPSS software, where P-Value is > 0.05. In addition, the results of the study also showed that students' responses to learning were very good with a percentage of 64.52% and good with a percentage of 35.48%. This means that the application of the Project Based Learning model affects the learning outcomes and responses of students in mathematics education.

The results of this study add to one important fact that the PjBL model has a positive impact on students, so it is highly recommended for coaches to apply PjBL in learning activities. The weakness of this research is that it only uses one class of research and does not use a pre-test to produce comparisons of data with a post-test. But behind these shortcomings, improvements can be made if you want to do similar research in the future.

▪ REFERENCES

Al-Busaidi, S., & Al-Seyabi, F. (2021). Project-based learning as a tool for student-teachers' professional development: A study in an Omani EFL teacher education program. *International Journal of Learning, Teaching and Educational Research*, *20*(4), 116-136.

Beckett, GH, & Slater, T. (2018). Project-based learning and technology. *The TESOL encyclopedia of English language teaching*, 6(1) 1-7.

Belagra, M., & Draoui, B. (2018). Project-based learning and information and communication technology's integration: Impacts on motivation. *International Journal of Electrical Engineering Education, 55* (4), 293-312.

Bishop, CM. (2006) *Pattern Recognition and Machine Learning.* New York: Springer.

Boss, S., & Krauss, J. (2022). *Reinventing project-based learning: Your field guide to real-world projects in the digital age*. International Society for Technology in Education. Retrieved from: https://books.google.co.id/books

Cervantes, B., Hemmer, L., & Kouzekanani, K. (2015). The impact of project-based learning on minority student achievement: implications for school redesign. *Education Leadership Review of Doctoral Research, 2* (2), 50-66.

Condliffe, B. (2017). *Project-Based Learning: A Literature Review*. Working Papers. MDRC. Retrieved from: https://files.eric.ed.gov/fulltext/ED578933.pdf

Fini, EH, Awadallah, F., Parast, MM, & Abu-Lebdeh, T. (2018). The impact of project-based learning on improving student learning outcomes of sustainability concepts in transportation engineering courses. *European Journal of Engineering Education*, *43* (3), 473-488.

Guo, P., Saab, N., Post, LS, & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research*, *102*, 101586.

Hixson, NK, Ravitz, J., & Whisman, A. (2012). *Extended professional development in project-based learning: Impacts on 21st century skills teaching and student achievement*. West Virginia: West Virginia Department of Education.

Holmes, V. L., & Hwang, Y. (2016). Exploring the effects of project-based learning in secondary mathematics education. *The Journal of Educational Research*, *109*(5), 449-463.

Howard, J. (2002). Technology-enhanced project-based learning in teacher education: Addressing the goals of transfer. *Journal of Technology and Teacher Education*, *10*(3), 343-364.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving schools*, *19* (3), 267-277.

Kurniasih, Imas & Sani, Berlin. (2014). *Implementation of the 2013 curriculum concept &. Application [Implementasi kurikulum 2013 konsep dan aplikasi]*. Surabaya: Kata Pena

Larmer, J., Mergendoller, J., & Boss, S. (2015). *Setting the standard for project based learning*. Alexandria: ASCD.

Lestari, KE, & Yudhanegara, MR (2018). *Mathematics education research [Penelitian pendidikan matematika]*. Bandung: Refika Aditama.

Meyer, D. K., Turner, J. C., & Spencer, C. A. (1997). Challenge in a mathematics classroom: Students' motivation and strategies in project-based learning. *The Elementary School Journal*, *97*(5), 501-521.

Noviyana, H. (2017). The effect of the project based learning model on students' mathematical creative thinking abilities [Pengaruh model pembelajaran berbasis proyek terhadap kemampuan berpikir kreatif matematis siswa]. *JOURNAL e-DuMath, 3(2),*110-116.

Pujiriyanto. (2019). Professional Education Pedagogic course module Teacher (PPG) In Position (Teacher's Role in 21st Century Learning). Retrieved from https://repository.bbg.ac.id › FY_Modul_2_print

Retnawati, H. (2016). Quantitative analysis of research instruments (researcher, student, and psychometrician guide) [Analisis kuantitatif instrumen penelitian (panduan peneliti, mahasiswa, dan psikometrian)]. Yogyakarta: Parama Publishing.

Roessingh, H., & Chambers, W. (2011). Project-based learning and pedagogy in teacher preparation: Staking out the theoretical mid-ground. *International Journal of Teaching and Learning in Higher Education*, *23*(1), 60-71.

Rogers, M. A. P., Cross, D. I., Gresalfi, M. S., Trauth-Nare, A. E., & Buck, G. A. (2011). First year implementation of a project-based learning approach: the need for addressing teachers'orientations in the era of reform. *International Journal of Science and Mathematics Education*, *9*(4), 893-917.

Santrock, J, W. (2014). *Educational Psychology*. Jakarta: Salemba Humanika

Solomon, G. (2003). Project-based learning: A primer. Technology and learning-dayton, 23(6), 20-20.

Sugiyono. (2013). Quantitative qualitative research methods and R&D [Metode penelitian kuantitatif, kualitatif dan R&D. Bandung: CV. Alphabet.

Sugiyono. (2011). Quantitative qualitative research methods and R&D [Metode penelitian kuantitatif, kualitatif dan R&D]. Bandung: Afabeta.

Suyono & Hariyanto. (2012). Learning and Learning [Belajar dan Pembelajaran]. Bandung: Youth PT. Offset Rosdakarya

Viro, E., Lehtonen, D., Joutsenlahti, J., & Tahvanainen, V. (2020). Teachers' Perspectives on Project-Based Learning in Mathematics and Science. *European Journal of Science and Mathematics Education*, *8*(1), 12-31.

Widoyoko. (2009). Evaluation of learning programs [Evaluasi pembelajaran]. Yogyakarta: Learning Library.