Innovative Journal of Curriculum and Educational Technology
7 (2) (2018) : 78 – 85

https://journal.unnes.ac.id/sju/index.php/ujet/article/view/29103

The Effectiveness of the Problem Based Learning Model Assisted by Interactive CD on Mathematical Problem Solving Ability Reviewed from Students' Cognitive Style

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Article Info

History Articles
Received:
October 2018
Accepted:
November 2018
Published:
November 2018

Keywords:
cognitive style,
interactive CD,
mathematic,
problem-based learning,
problem solving

DOI
https://doi.org/10.15294/ijcet.v7i2.29103

Abstract

This study was based on the low ability of mathematical problem solving in students of SMK Negeri 1 Dukuhturi, Tegal. The purpose of this study was (1) analyzing the effectiveness of the PBL Model assisted by Interactive CD in improving the ability to solve mathematical problems reviewed from the cognitive style of Vocational students, (2) analyzing mathematical problem solving ability reviewed from the cognitive style of FD of Vocational students in the PBL model assisted by Interactive CD, (3) analyzing the mathematical problem solving ability reviewed from the cognitive style of FI Vocational students in the PBL Model assisted by Interactive CD. The study used sequential explanatory mixed methods which were combination research methods that combine quantitative and qualitative research methods in sequence. The results showed that the average value of Post-test on students with PBL learning models assisted by interactive CD was 76. Meanwhile, the average score of Post-Test of students with interactive lecture learning was 70. The increased of the mathematical problems solving of the students achieve the classical completeness with a significance level of 0.05 obtained $z_{value} = 0.9901 < z_{table} = 2.035$. The results of data reduction showed that FI students with PBL models assisted by CD Interactive had better mathematical problem-solving ability than FI students with interactive lectures. FD students with PBL models assisted by CD Interactive have better mathematical problem-solving ability than FD students with interactive lecture learning. This research can be used as an alternative to answering the problem-solving ability that occurs in mathematics learning.

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p-ISSN 2252-7125
e-ISSN 2502-4558

INTRODUCTION

Mathematics is very instrumental in the development of science and technology, among others as a tool in the application of other disciplines and as a means of logical, analytical, creative and systematic thinking. The results of Trends in the International Mathematics and Science Study (TIMSS) in 2015 Indonesia ranked 45th out of 50 countries with an average score of 397 and the results of the Program for International Student Assessment (PISA) survey, in 2012 Indonesia was ranked 71 out of 72 countries, while in 2015 Indonesia rose six ranks to rank 64 from 72 countries. This fact shows that mathematics learning in Indonesia needs to be improved. According to Minister of Education and Culture No. 21 of 2016 concerning content standards, one of the competencies to be achieved in the learning process of mathematics is problem-solving ability. Problem-solving is the essence and has a role as the core of the domain of competence in the implementation of the mathematics learning process.

Based on the observation of the learning process and the results of interviews with the X grade mathematics teacher in the preliminary research at Dukuhturi 1 State Vocational School in Tegal related to the learning model showed that mathematics learning, in general, is still teacher centered (teacher center). The teacher still uses interactive lecture learning models and group discussions but does not emphasize the active role of students in learning activities, therefore, students were not trained to always think critically in solving mathematical problems. Teachers were more concerned with achieving material targets than students' creative thinking abilities so that students memorize formulas more than applicants. As a result, students have difficulty when solving problems related to mathematical problems solving.

Teachers need to choose a learning model that requires active student involvement and can also develop their thinking skills during the teaching and learning process such as the Problem-based Learning model. Model problem-based learning (PBL) is a learning model that uses problems as contexts and exposes students to real issues and challenges students to "learn how to study" so that students are expected to think critically, be skilled in solving problems, and gain knowledge from the subject matter. This is in accordance with what was stated by Tan in Rusman (2013) that PBL is an innovation in learning because in PBL students' thinking ability is really optimized through a systematic process of group work or teams, so students can empower, sharpen, test, and develop abilities think it on an ongoing basis.

Jacobsen (2009) states that there are three objectives in PBL. First is that a student can develop their ability to solve a problem systematically. Second is students can develop their learning skills and be responsible for their learning. The third is students can master the content or components of a subject.

Suherman, Turmudi, Suryadi, Herman, Suhendra, Prabawanto, Nurjanah, and Rohyati (2003) argue that mathematics grows and develops for itself as a science, also to serve scientific needs in its development and operations. Mathematics has a major role in the learning process. One of the abilities that must be improved is the ability to solve problems as part of high-order thinking skills or High Order Thinking Skill (HOTS).

According to Hoy (1993), cognitive style is a different way to see, recognize, and organize information. Each has a particular way that is preferred in processing and organizing information in response to environmental stimuli. Even more, Hoy stated that each could respond quickly and some to be slow. These ways of responding also relate to personal attitudes and qualities. A person's cognitive style can show individual variations in terms of attention, acceptance of information, remembering, and thinking that arise or differ between cognition and personality.

The study of Sunandar, Zaenuri, and Dwidayati (2018) state that learning with PBL models with ethnomathematics nuances has an impact on the quality of students' problem-solving abilities. Maretasani, and Dwijanto research (2017) states that problem-based

learning is effective against students' problem solving and metacognition abilities. Prabawa, and Zaenuri research (2017) states that students' problem-solving abilities are by the classification of cognitive style types they have. Riau, and Junaedi (2016) stated that every different learning style has different problem-solving abilities. Vendiagrys, Junaedi, and Masrukan (2015) state that FI and FD subjects have different profiles in solving mathematical problems. Muzakkir, Samsudi, and Rifa'i (2015) states that the development of interactive multimedia-assisted inquiry-based learning tools effectively improves student learning outcomes.

On the other hand, so that the learning process is more alive and active, there is a need for learning media that can support the success of the learning process. With the help of computers and various animation programs, the concepts and problems of learning materials that were previously only written and illustrated in the book can then be displayed in the form of shows through audio media which are packaged on an interactive CD. Schramm (1984) argues that computers have extraordinary capabilities compared to other media, and interactive CD (compact disk) is one of the designed learning resources (learning resources by design) in which programs have been installed which are prepared for specific learning purposes. Arsyad (2006) refers to it as a computer-based, up-to-date media which is believed to be able to create more "life" learning and involve student interactivity.

Sulistyorini (2014) in his research found that the frequency of student activities in teaching and learning activities has shown a tendency towards interactive multimedia learning principles. Research by Ahmadi, Sutaryono, Witanto, and Ratnaningrum (2017) states that the development of multimedia Indonesian Culture (MIC) is very effective to be used as a reinforcement of character education in elementary schools with an increase of 33.21 and N-gain of 0.68 which is in the medium category. Research by Sari, Widodo, and Wibawanto (2017) showed that there are differences in learning outcomes between the experimental class and the control class in interactive multimedia learning. Research by Kuswanto, and Walusfa (2017) mentions that interactive learning multimedia developed in grade VIII ICT subjects are appropriate for use in learning by teachers and students.

Students' problem-solving abilities are still lacking the need to be studied further so that the teacher can improve students' problem-solving skills. Students are directed to use problem-solving steps according to Pólya (1945) given to PBL learning models. Research by Fitriyantoro, and Prasetyo (2016) states that the character of hard work influences mathematical creative thinking abilities. Noriza, Kartono, and Sugianto (2015) indicate that there are differences in problem-solving abilities in level 1 students (analysis), level 2 (informal deduction) and level 3 (deduction).

Based on the research that has been done, there are some differences appear compared to this study. This current study is intended to analyze the effectiveness of problem-based learning model assisted by interactive CD on mathematical problem-solving abilities reviewed from the students' cognitive styles. This study is necessary to be done by considering that the discussion of the previous researches has not intended to determine the problem solving viewed from this cognitive style.

The purpose of this study was to analyze the effectiveness of the Problem Based Learning Model assisted by interactive CD in improving the mathematical problem-solving ability reviewed from the students' cognitive styles. The benefit of this study is to provide an overview of the ability to solve mathematical problems reviewed from student cognitive style.

METHODS

This study applied a combination method or sequential explanatory mixed methods. The sequential explanatory model or design is a combination of quantitative and qualitative research methods in sequence, which in the first stage of research is carried out using quantitative methods and in the second stage is done by qualitative methods (Creswell, 2014). This

research was conducted to answer the formulation of quantitative and qualitative problems.

The population in this study were students of grade X of SMK Negeri 1 Dukuhturi in the odd semester of academic year 2018/2019. Two classes were selected from 16 classes of SMK Negeri 1 Dukuhturi as the research sample, grade X TKJ 2 as an experimental class that applied PBL learning models assisted by Interactive CD and grade X TKJ 1 as a control class that applied interactive lecture learning models. The determination of research samples was based on random cluster sampling. To find out the class in the same initial conditions, several prerequisite tests need to be held, including the normality test and homogeneity test. The data used as a prerequisite test in selecting samples is the pre-test data. The GEFT test was given before the study was conducted.

The subjects of the study were taken from the experimental class students based on the results of GEFT. The selection of the subject of qualitative research uses a purposive sampling technique that is done with certain considerations. The research subjects were selected from the experimental class based on the results of the GEFT of the students namely: the Independent Field and Dependent Field categories. Each category was chosen by three students to analyze their problem-solving abilities. Sources of data in this study were the answer sheets for problem-solving ability tests (TKPM), GEFT results and student interview results sheets. TKPM was conducted in the experimental class and the control class. Student answers to TKPM were analyzed, and the research subjects were interviewed. Quantitative data were tested using a normality test, homogeneity test, completeness test, and average difference test while qualitative data analysis is done by reducing data, presenting data, and drawing conclusions from data that has been collected.

RESULTS AND DISCUSSION

This research was carried out from September to October 2018 at SMK Negeri Dukuhturi 1, Tegal Regency, Central Java.

The Effectiveness of Problem Based Learning Assisted by Interactive CD

Problem Based Learning model assisted by interactive CD was effectively improved student learning outcomes after conducting problem-solving ability tests and prerequisite tests.

Problem Solving Ability Test

The problem-solving ability test was carried out twice, namely before the implementation of learning (pre-test) and after the implementation of learning (post-test).

Table 1. The Score of Pre-test and Post-test of Problem Solving Ability

Class	Number of students	Pre-test score			Post-test score		
		Highest	Lowest	Average	Highest	Lowest	Average
Experiment	34	75	17	46	96	46	76
Control	36	77	48	58	85	38	70

Table 1 it can be seen that the average of pre-test results for the experimental class is 46 while for the control class is 58, the average value of learning outcomes in the experimental class is 76 while in the control class is 70. Based on the results of the pre-test and post-tests such as those shown in table 1, it can be seen that there is an increase in the learning outcomes in the experimental class that receives learning treatment with the Problem Based Learning model assisted by Interactive CD.

Prerequisite Test with Normality Test of Post-test Data

Based on the results of the Normality Test with SPSS 24 using the Kolmogorov-Smirnov test with a significance level of 5% that the significance value = 0.59 = 5.9% > 5% then H_0 is accepted. This is by Santoso opinion (2015) that

if the significance value is > 5% then H_0 is accepted or H_a is rejected. Because H_0 is accepted, it can be concluded that the sample comes from a population with a normal distribution. This shows that the results of the problem-solving ability test with the Interactive CD-assisted Problem Based Learning model are normally distributed.

Homogeneity Test of Post-Test Data

The homogeneity test with SPSS using the Levene test. The test with a 5% level of significance obtained a significant value in the Levene Test for Equality of Variances column in the Independent Sample Test was 0.082 = 8.2% > 5% then H_0 was accepted. This means that the variance of students in learning with PBL models assisted by Interactive CD is the same as the variance of students in interactive lecture learning. This is by the opinion of Santoso (2015) that accept H_0 if the value of $F_{value} > F_{table}$, the meaning of the two samples have the same variant.

Completeness Test

The results of the calculation obtained Z_{value} = 0.9901 with a real level of 5% obtained Z_{table} = 2.035. Since $z_{value} < z_{table,}$ then H_0 is accepted, therefore, the proportion of students in the learning with the model of Problem Based Learning assisted by Interactive CD has achieved classical completeness of 75%. This is by the test of the proportion of one party according to Sudjana (2005) that if $z_{value} < z_{table}$ then H_0 is accepted.

The Average Different Test

The results of the analysis of the average difference test with SPSS 24 using Independent Sample t-test with a real level of 5% obtained that the significance value is 0.008 = 0.8% < 5%. Then H_0 is rejected. This means that students' mathematical problem-solving abilities in the PBL learning model assisted by Interactive CD are better than those who are learning with interactive lectures.

Based on the findings of Tan in Rusman (2013) which states that PBL is an innovation in learning because in PBL students' thinking skills are optimized through systematic group work or team processes. Therefore, students can empower, sharpen, test, and develop their thinking skills continuously, the condition of the students of SMK Negeri 1 Dukuhturi is conducive and able to carry out complex activities as evidenced by students in groups able to solve mathematical problem solving with student worksheets. The based problem-based learning assisted by interactive CD also trains students to build their knowledge in groups and individuals.

These results illustrate that the problem-based learning model can increase the activity of students in learning activities that have a positive relationship to learning outcomes. The positive relationship of student activity can be seen from the use of problem-based learning models assisted by interactive CD in mathematics learning. The problem-based learning model assisted by interactive CD was designed to contain complex tasks based on very sophisticated statements and problems and requires students to design, solve problems, make decisions, and carry out group activities. The purpose of group work was to make students be able to develop patterns of thinking on an ongoing basis with the problems that they faced. This proves that by using problem-based learning, a learning model can improve student learning outcomes.

Student Problem Solving Ability Field Independent

Interviews with 3 Field Independent Subjects who were selected by purposive sampling and the results of the reduction in the problem solving ability test showed that the problem-solving ability of Field Independent subjects in the steps of problem-solving according to Pólya (1945) was understanding the problem, planning a settlement, carrying out a settlement and re-checking/evaluating is good. Students with the cognitive style of the Independent Field who receives treatment with the ^{Problem} Based Learning assisted by interactive CD have better abilities than Field independent students with interactive lecture learning.

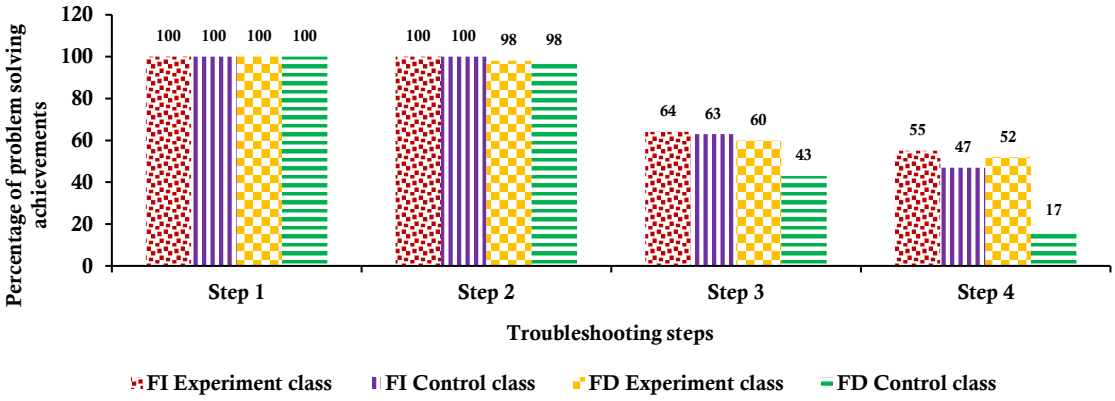

Figure 1. Graph of Problem Solving Ability Achievement

Figure 1 it shows that the Independent Field subject can understand the problem well, the subject can write down the elements that are known and asked from the problem completely and correctly. This is by the research of Geni, and Hidayah (2017) which states that students with yield Independent cognitive style have better problem-solving skills than students with cognitive style Field Dependent. The problem of solving mathematical problems requires analytical skills from problem solvers. Field Independent subjects were better able to solve analytic problems. This is in line with the opinion of Kozhevnikov, M. (2007) which states that independent field students are more analytical in processing complex information, whereas field dependent students are more likely to use a more global visual approach.

Based on the findings of Usodo (2011) which states that independent field subjects can describe complex information from the problems faced, the condition of students of SMK Negeri 1 Dukuhturi in the Field Independent category with a problem-based learning model assisted by interactive CD can improve mathematical problem-solving abilities. Independent Field students with problem-based learning model assisted by interactive CD were better than Field Independent students with interactive lecture learning.

These results illustrate that the problem-based learning model assisted by interactive CD can improve the activity of Independent Field students in the learning activities that have a positive relationship to the learning outcomes. The positive relationship of student activity can be seen from the use of the problem based learning models assisted by interactive CD in mathematics learning. PBL is an innovation in learning since in PBL students' thinking skills are optimized through a systematic process of group work or teams. Therefore, students can empower, sharpen, test, and develop their thinking skills on an ongoing basis.

Students' Mathematical Problem Solving Ability Field Dependent

Interviews with 3 Field Dependent Subjects selected by purposive sampling and the results of the reduction in the problem solving ability test showed that the subject matter problem-solving abilities of Field Dependent in the steps of solving problems according to Pólya (1945) understood the problem, planning a solution, carrying out a settlement and re-checking/evaluating was quite well. Field Dependent students who receive learning treatment with the Problem Based Learning model assisted by Interactive CD obtained better results than Field-dependent students with interactive lecture learning.

Figure 1 the subject of the dependent field category can understand the problem quite well; the subject can write the elements that are known and asked from the problem well but still use everyday sentences. This is by the study of Riau, and Junaedi (2016) which states that students with divergent learning styles are only able to complete the steps of planning problem solving and failing to solve problems.

Based on findings from Winkin and Goodenough (Danili, and Reid, 2006) that defines the main characteristics of field dependent - field independent cognitive styles, individuals with cognitive field dependent styles are individuals who lack or cannot separate a part of a unit and tend to accept the dominant part or context immediately, then the condition of the students of SMK Negeri 1 Dukuhturi in the Field Dependent category with the problem-based learning model assisted by interactive CD was able to improve mathematical problem-solving abilities. Mathematical problem-solving abilities of Field Dependent students with problem-based learning models assisted by interactive CD was better than Field Dependent students with learning interactive lecture.

These results illustrate that the problem-based learning model assisted by interactive CD can improve the activity of Field Dependent students in learning activities that have a positive relationship to learning outcomes. The positive relationship of student activity can be seen from the use of problem-based learning models assisted by interactive CD in mathematics learning. PBL is an innovation in learning since in PBL students' thinking skills are optimized through a systematic process of group work or teams, so students can empower, sharpen, test, and develop their thinking skills on an ongoing basis.

CONCLUSION

Based on the data and discussion presented, it can be concluded that the Problem Based Learning model assisted by an interactive CD can effectively improve students' mathematical problem-solving abilities. Based on his cognitive style, students with cognitive field independent styles can solve problems well. Students with a field dependent cognitive style, have lower problem-solving abilities.

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