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Mathematical Reasoning Based on Belief in PBL with Dyadic Interaction Approach

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Abstract

The purposes of this research were (1) to describe the learning quality of PBL through dyadic interaction approach to mathematical reasoning ability of grade X students of IT Al Irsyad Purwokerto High School (2) to find pattern of students reasoning ability based on mathematical belief. This study uses a mixed method. Data analysis started from the analysis of test items. The analysis uses the prerequisite test and then hypothesis testing uses rara average (t-test), then the proportion of comparative tests (test-z) is to calculate the classical completeness. Further testing of determining the difference between the two classes uses different test average (t-test right side). Qualitative data analysis uses qualitative description. The results of quantitative research shows that learning class with PBL and dyadic interaction approach reached classical total 80%. The average difference test showed class' results with PBL dyadic interaction approach better than a class activity with PBL. Subjects with very low belief can only fulfill 1 reasoning indicator well. Subjects with low belief can fulfill 3 reasoning indicators well and have not been able to fulfill 1 other indicator. Subjects with high belief can fulfill 4 indicators where 1 indicator is imperfect and subject with very high belief can fulfill all the indicators of reasoning well and complete.

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INTRODUCTION

Mathematics is an instrument for developing ways of thinking (Hudojo, 2003). Mathematics is formed as a result of human thought related to ideas, processes, and reasoning. Mathematics subjects need to be given to all students as a basis for improving logical, analytical, systematic, critical and work ability skills (Depdiknas, 2006). This is in line with the opinion of Prabawa and Zaenuri (2017), that Mathematics has an important role in the development of science and technology, both as an instrument in the application in other disciplines as well as a means of logical, analytical, creative and systematic thinking.

Realizing the importance of mathematics, Mathematics is necessary to be understood and controlled by all levels of society, especially those students of elementary school to universities. The results of TIMSS 2015 evaluation shows that the Students' Mathematics skills in Indonesia are low. According to that International Survey, the average score of Mathematics achievement of students in Indonesia is still significantly below the international average. The lowest average percentage achieved by Indonesian learners is in the cognitive domain at the reasoning level of 20%. The low Mathematics skills of learners in the domain of reasoning needs to get much deeper attention (Fauziyah, Isnarto, & Mariani, 2017).

The low achievement of students in mathematics other than influenced by cognitive aspects, can also be influenced by affective aspects. One of the affective aspects that affect mathematical achievement is belief (Sumpter, 2013). Belief can be a positive influence when students do not know how to solve mathematical problems. Mathematical belief according to Sumpter (2013) is the understanding and feelings of a person that shape the ways that the individual conceptualizes and engages in mathematical behavior that encourages and emerges as a way of thinking in his mind. Based on these definitions, it is known that beliefs will encourage a person to play an active role in mathematical behavior including mathematical reasoning.

In mathematics, reasoning involves drawing logical conclusions based on evidence or stated assumptions (NCTM, 2000). Reasoning can also be viewed as a thinking process, the product of thought processes, or both (Lithner, 2008). In addition, Mathematical reasoning is reasoning about and with the objects of mathematics (Brodie, 2010). Based on the above description can be concluded that the reasoning of mathematics is reasoning about and with the object of mathematics which is the process of thinking or the result of thought processes needed to draw conclusions or make a new statement is correct based on some statement that the truth has been proved or assumed before.

Reasoning and mathematics can not be separated from each other because in solving mathematical problems requires reasoning whereas reasoning ability can be trained by learning mathematics. The ability to reason can access problems in life, inside and outside school (Junaedi & Asikin, 2012). Learning model that can be used to focus students on the ability of mathematical reasoning is PBL or Problem Based Learning. PBL is one of the learning models used to improve problem-oriented high thinking level, including learning how to learn (Arends, 1997). One of the high order thinking learning is reasoning (Madu, 2017). Therefore, the PBL model can be used in learning that focuses on students' reasoning abilities.

Learning is an activity undertaken in interaction with the social and physical environment (Sugihartono, 2007). The learning process should be designed to provide a learning experience that involves mental and physical processes through interaction between students, students with teachers, the environment, and other learning resources in the context of achieving basic competencies (Kartono, 2010). Learning activities require interaction with the people around, such as between students and teachers, students and students, so that learning needs to be applied in the learning approach. Type of approach used in this research is dyadic interaction approach. Dyadic interaction is seen as a process by which knowledge is built socially. The dyadic interaction approach, which is characteristic of this learning approach, involves two students in the delivery of the material. Dyadic interaction approach can be used as an alternative learning process that produces better reasoning ability (Mellone, Verschaffel, & Dooren, 2017).

The problems in this research are (1) how is the quality learning of PBL through dyadic interaction approach to mathematical reasoning ability of grade X students of SMA IT Al Irsyad Purwokerto ?, and (2) how is students mathematical reasoning ability based on belief on PBL through dyadic interaction approach?

METHODS

This research is a combination of qualitative and quantitative research. The design used in this research is concurrent embedded design. This design can be characterized as a mixed method strategy that applies a single stage of quantitative and qualitative data collection at a time where qualitative research is the primary method while quantitative research is secondary. In this study there are three stages of research where the study begins preliminary studies in order to identify problems in the field by conducting studies on data, interviews with teachers, and studies in the literature. In the preliminary study phase a problem was discovered which was then examined through a series of quantitative and qualitative studies in phase two.

In stage two, the researcher gives intervention (treatment) to students using PBL with dyadic interaction approach. At this stage the researchers obtained qualitative data in the form of implementation quality learning. In the quantitative research at stage two, the experimental research used quasi experimental design, a research design involving two groups (experiment and control) in which the selection of both groups was not randomly selected. In the experimental group were treated while the control group was not treated. Both were given pretest and postes that served to determine whether there was an increase from the initial and final state of the two groups. Quasi experimental design chosen in this quantitative research is Nonrandomized Control Group Pretest-Postest Design.

The population in this research is the students of class X MIPA SMA IT Al Irsyad Al Islamiyyah Purwokerto even semester of academic year 2017/2018. Of the six classes of MIPA of SMA IT Al Irsyad Al Islamiyyah Purwokerto, two classes were chosen as research samples, namely experimental class applying PBL with dyadic interaction approach and control class applying PBL. Determination of research sample based on the consideration of researchers and teachers. To know the class under the same preliminary conditions it is necessary to hold some prerequisite tests, including normality test, homogeneity test, and equality test average. The data used as a prerequisite test in the sample selection is pretest prerequisite data. Questionnaires of mathematical beliefs were given before the study. Research subjects were taken from experimental class students based on a questionnaire of mathematical beliefs, then consulted with classroom teachers, two students with very high mathematical beliefs, two students who had high mathematical beliefs, two students who had low math beliefs and two students who had beliefs very low mathematics to be analyzed his reasoning mathematical ability.

Sources of data in this study are an answer sheet of mathematical reasoning test (Tes Kemampuan Penalaran Matematika or TKPM), mathematical belief questionnaire, interview result of learners, and observation of quality learning. TKPM is given twice as pre test and post test. TKPM is done in the experimental class and control class. Students responses to TKPM were analyzed and the subjects interviewed. The data obtained were tested using normality test, homogeneity test, average equality test, completeness test, average difference test and math assurance improvement test. While the qualitative data analysis is done by reducing the data, presenting the data, and drawing conclusions from data that has been collected and verify the conclusion.

RESULT AND DISCUSSION

The results of qualitative research is the result of research that includes qualitative of learning quality and questionnaire of mathematical belief. Learning quality is a series of activities that can improve student competence (Hightower et al., 2011). The quality of learning is measured from 3 stages: (1) planning and preparation, (2) implementation (classroom environment and instruction), (3) assessment (professional responsibility).

Qualitative of learning qualities include the planning and implementation phases. At the planning stage the researcher makes learning instrument include syllabus, RPP, student book, and LKS validated by 3 expert validators. The results of each validator's assessment of the learning tool can be seen in Table 1

Table 1. Results of Objective Assessment of Learning Instrument

Instrument	Skor Average Validator			Total Average	Category
	V001	V002	V003		
Syllabus	4.00	4.00	4.22	4.07	Good
RPP	4.17	4,00	4.13	4.10	Good
Student Book	4.13	4.00	4.00	4.04	Good
LKS	4.11	4.00	4.22	4.11	Good

Based on table 1, the result of objective assesment of learning instrument obtained the average value for syllabus, RPP, Student Book, and LKS entered in good category. Based on the assessment of expert validator, the device that has been made by the researcher is feasible for use in the research.

At the implementation stage, measurement of learning quality at the implementation stage is seen from the quality observation sheet and the implementation of learning. The implementation of learning is said to be of quality if the results of observation of learning quality and implementation of learning at least enter the good category. The average value of quality observation and implementation of learning from the first meeting to the last included in good category, so it can be concluded that the ability of researchers in the preparation and manage the learning included in good category.

The last evaluation of the learning quality is at the stage of assessment. Qualitative assessment of learning is done by providing a questionnaire of student responses to the learning that has been done. Based on the questionnaire the students response indicates that the majority of students assess the learning that has been well implemented.

The results of quantitative research is data of learning quality in assesment stage. Quantitative research results include initial and final data of reasoning ability tests. Initial data of the experimental class and control class students were obtained from the average pre test value of the prerequisite material. The average pre test of the experimental class is 74.32 and the average pre test of the control class is 70.57. Based on the normality test with the help of SPSS using Kolmogorof-Smirnov test with 5% real level, the initial data of the experimental class and the control class are normally distributed. Based on the homogeneity test with the help of SPSS using Levene's Test test with 5% real level, the experimental class variance is the same as the control class variance. Based on the average equality test with the help of SPSS using Independent Sample T-Test with 5% real level, the average of initial data of experimental class students is the same as the average of initial data of control class students.

The final data of reasoning ability is obtained from the post test of mathematical reasoning test. The average post test result score from TKPM experimental class was 86.08 while the mean post test value of TKPM control class was 75.50. Based on the normality test with SPSS using Kolmogorof Smirnov test with 5% real level, the result of post test TKPM class of experimental class and the post test value of the control class is normally distributed.

The result of post test TKPM students in the experimental class obtained the lowest score is 76 and the highest value is 95, whereas the KKM score is 80. The total number of complete learners is 24 students. From the calculation obtained $z_{hitung} = 2.00$, whereas with $\alpha = 5\%$ obtained $z_{tabel} = 1.64$. Because $z_{hitung} = 2.00 > z_{tabel} = 1.64$ then H_0 is accepted, it means that the proportion of learning result of experiment class students which is subject to PBL with dyadic interaction approach has reached 80%.

Based on the results of the calculation of different test average obtained $t_{hitung} = 1.94$ with 5% significance level and dk = 51 obtained $t_{tabel} = 1.67$. Because $t_{hitung} > t_{tabel}$, it can be concluded that the students mathematical reasoning ability in the experimental class is better than the students' mathematical reasoning ability in the control class. Thus, learning with PBL model through dyadic interaction approach can be said to be qualified.

The quality of PBL also can not be separated from the activities during the learning process. PBL used in this research using dyadic interaction approach. PBL encourages students to be self-directed in learning at higher motivation, better material memory, reasoning development and problem-solving skills, and developing a better understanding of students from group processes and skills needs for successful collaboration (Ball and Pelco, 2006). The PBL model can organize students into groups in learning. PBL model with dyadic interaction approach, making the interaction between students in groups more maximal so as to improve the ability of mathematical reasoning.

During the learning process, students are grouped into PBL groups to discuss a problem. Between members of the PBL group are paired for interaction process. This interaction is a dyadic interaction, which results in mutual understanding to improve the ability of mathematical reasoning. This is consistent with Mellone's research et. al (2017) that dyadic interactions produce better reasoning abilities than non-dyadic interactions or individual learning.

The result of questionnaire of students mathematical belief before learning in the experimental class as showed in Table 2.

Tabel 2. Pengelompokkan Siswa ditinjau dari Keyakinan Matematika

Belief Characteristic	Banyaknya Siswa	Persentage
Very high belief	2	8
High belief	13	52
Low belief	6	24
Very low belief	4	16
Total	25	100

Based on Table 2, two research subjects were chosen from each characteristic to be analyzed their mathematical reasoning ability. In this study, the pattern of students mathematical reasoning abilities is analyzed based on students mathematical beliefs, where students mathematical beliefs are divided into four levels: very low belief, low belief, high belief and very high belief. The pattern of students' mathematical reasoning ability refers to the mathematical reasoning indicator of NCTM (2000), that is the ability to analyze the problem, the ability to implementation strategy, the ability to search and use relationships of different mathematical domains, different contexts and different representations and the ability to interpret solutions and how to answer problems.

Subjects with very low belief can only fulfill the indicators of analyzing the problem. The answer is less precise and hesitant in providing reasons for answering questions and less confident in answering interview questions. Subjects with low belief have not been able to fulfill the indicators interpreting the solution and how to answer the problem. The answer is right but not complete and still hesitant in providing reasons to answer questions and less confident in answering interview questions. Subjects with high belief can fulfill all reasoning indicators but are not perfect in interpreting solutions and how to answer problems. The answer is right but still incomplete in giving reasons to answer the question. During the interview smoothly in answering questions. Subjects with very high belief can fulfill all mathematical reasoning indicators. The answer is right and complete in providing reason to answer the problem and smoothly in answering the interview.

CONCLUSION

PBL with dyadic interaction approach to mathematical reasoning ability of class X students included in good category and can be said good quality. Subjects with very low belief can only fulfill 1 reasoning indicator well. Subjects with low belief can fulfill 3 reasoning indicators well and have not been able to fulfill 1 other indicator. Subjects with high belief can fulfill 4 indicators where 1 indicator is not perfect and subject with very high belief can fulfill all the indicators of reasoning well and complete.

SUGGESTION

Based on the above conclussion, the use of PBL with dyadic interaction approach is considered qualified and can improve students' mathematical reasoning ability. Therefore, the researcher gives suggestion of PBL with dyadic interaction approach can be chosen in learning that aim to improve the ability of mathematical reasoning.

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