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HARD WORK AND PROBLEM SOLVING BASED ON KRULIK-RUDNICK'S HEURISTIC THEORY ON PROJECT BASED LEARNING WITH OQALE APPROACH OF 5th GRADE ELEMENTARY SCHOOL STUDENTS

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Abstract

The study aimed to describe the state of early poblem solving, the effectiveness of learning, and discription the application of the learning to had work character and problem solving mathematics students. The research is the kind of research concurerent embedded. Technic the data with using interviews, observation, and tests. Technic data analysis using analysis discriptif and statistical tests influence regression, the appeal, and test an increase in the gain. The results of the study showed that the initial conditions problem solving students average be low; effectiveness of indicated by the average capability problem solving mathematical students experiment has reached KKM that is above 74,5%, the ability problem solving mathematical class experiment better than class control, hard work and skill problem solving mathematical students have had a positive impact of the ability of mathematical problem soling students, with big the influence of 88,7%, increased capacity problem solving mathematical class experiment higher than class control; the results of a description of this research is improving hard work students; skills literacy mathematics; and ability problem solving mathematical stdents with a score of the gain 0,59; 0,66; 0,70.

Keywords: Oqale; Hard Work; Krulik-Rudnick; Problem Solving; *Project Based Learning*

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INTRODUCTION

Problem solving in mathematics acts as context, skill, and art. As a context, it is used as a justification in teaching mathematics, motivation, recreation, and practice. As a skill, it trains students to perform common routine problem solving procedures and directs them to solve non-routine problems. As an art, it developes students' skills as capable and passionate problem solver as well as independent thinkers who are capable of overcoming ill-structured and open-ended problems (Stanic & Kilpatrick, in Schoenfeld, 1992). Five stages of problem solving according to Krulik-Rudnick (1995) as heuristic cover: read and think, explore and plan, select a strategy, find and answer, and reflect and extend.

Based on the results of the PISA 2015 survey, as many as 40.7% of Indonesian students were able to solve routine problems whose context was still common, 26.9% were able to solve mathematical problems using formulas, and 19.1% were able to implement procedures and strategies in problem solving. Meanwhile, 10.6% could relate problems with real life and 4.3% were able to solve complicated problems, formulate, and communicate their findings (OECD, 2016: 192). The findings of the preliminary research on the students of grade V State Elementary School (SDN) Ngaliyan 03 Semarang (2016) obtained the ability of problem solving student achieved 18,75% with good category, 25% with enough category, and 56,25% with less category. Judging from the problem solving indicator, students in the good category always tried to implement all the troubleshooting steps, except on the reflect and extend. Students with sufficient category had explore and plan, reflect and extend steps into rare activities. Meanwhile, students with less categories indicated that all indicators of problem solving implementation got low quality.

Such problem was caused by the students' tendency of using the formula that were known without considering the existing problems on Geometry exercises. Students have not been able to link information to each other and sought information that was needed or not needed. The knowledge gained by students was not built on the students' own understanding but only from the material given by the teacher. Many students did not try hard when they found difficult problems, did not do homework and submitted it beyond the time limit specified. These showed the students lacked the character of hard work.

Hard work is a behavior that shows a genuine effort to overcome various barriers to learning and tasks, and complete the tasks as well as possible (Mustari, 2011: 51), in other words hard work is a never-giving attitude that must be owned by students to succeed in the process Learning. Therefore, hard work needs to be developed in students attitude in order to be able to interpret the process of learning mathematics in real life, so that the learning process occurs optimally. In order to grow the hard work in learning that can finally affect the problem solving ability of the students, there will be applied Project Based Learning with OQALE (Observation, Question, Analyze, Logic, Express) approach and apply Krulik-Rudnick's heuristic. The Project Based Learning with OQALE approach is a project-based learning model done collaboratively

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and innovatively, uniquely, and focuses on solving problems related to students' daily life. In this learning model and approach, there given driving question that requires deep investigation and supported by structured tasks. AS a result, students are used to identifying questions, visualizing situations, and doing further action plans as well as in heuristic steps of Read and Think and explore and plan. Through the worksheet, students organize activities in completing projects and explore new ones to form an understanding of material concepts. With the project, students will practice in groups and work hard to understand firsthand and know the concept thoroughly. Moreover, the familiarity done to the students in carrying out heuristics in the process of calculation (find an answer) is done by giving routine exercise in the form of questions for students with numeracy and geometric ability through practice at each meeting.

By practicing problem solving skills through project based learning with OQALE approach, students' problem solving skills will increase because the mindset developed in solving problems requires some skills so that students are able to quickly draw conclusions from the facts or data they get. Project Based Learning enhances student involvement (Bernt, et al, 2005), autonomy (Worthy, 2000), skills development on the 21st century (Ravitz, et al, 2011), reflective experiences (Grant & Branch, 2005), and cognitive academic achievement (Geier in Holm, 2015).

The objectives of this research are (1) to describe the initial condition of the fifth grade students of SDN Ngaliyan 03 Semarang problem solving abilities in learning mathematics, (2) to know the effectiveness of mathematics learning using Project Based Learning model with OQALE approach in improving problem solving ability, problem solving skills and hard work character (3) to describe problem solving abilities, problem solving skills and hard work character of upper, middle and lower class students on the learning model of Project Based Learning with OQALE approach.

METHOD

This research was a mix method research, that is merging between quantitative and qualitative method to be used together in a research activity, so that the obtained data are more comprehensive, valid, reliable and objective (Sugiyono, 2015). Further, the population in this research were all student of SDN Ngaliyan 3 in the academic year of 2016/2017. They were sampledrandomly. It resulted VB class as the experimental class which implemented Project Based Learning with OQALE approach and the VA as the control class.

This research was conducted in SDN Ngaliyan 03 Semarang and done in the even semester ofthe academic year 2016/2017 in April. Moreover, the subjects in this study were 5 students of choice.

The data in this research included hard work observation data, problem solving test, result of interview with students about problem solving and hard work of students. Qualitative data analysis were done to analyze the initial condition data in preliminary step. It resultedthe

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grouping of subjects into 3 groups, namely: Upper Group Students (UGS), Middle Group Students (MGS), and Lower Group Students (LGS). Qualitative analysis was also conducted for the data of problem solving skills and hard work character. It was done through observation and interview method for 5 selected students. In addition, quantitative data analysis was done to test the effectiveness of learning, including learning outcomes completeness, test appeal, the influence of hard work and problem solving skills towardsproblem solving skills and hard work as well as the increase ofproblem solving. Then,there happened the overall interpretation of the data analysis to get a conclusion and suggestions. In qualitative analysis, the data validation was done by using Miles and Huberman model, covering data reduction, display data, and conclusion drawing/ verification.

RESULTS AND DISCUSSION

Initial Condition

The data obtained showed that most students of grade V SDN Ngaliyan 03 have not been able to solve the solving problem exercises. The students found it difficult to solve problems related to the real world exercises in the form of stories. Also, the students have not been able to relate what they learned and how the knowledge would be utilized. This happened because the ability of students to understand, determine the strategy, apply, and interpret the mathematics was still low. The following are the descriptions of the initial conditions of math problem solving skills in each group.

Table1.1 The Description of Initial Condition of Students Problem Solving

Problem Solving Indicators	Upper Group	Middle Group	Lower Group
1.Read and think	Wrote what is known and asked	Wrote what is known and asked, yet ineffective	Have not written what is known and asked
2. Explore and plan	Able to decide the necessary and unnecessary information, and able to visualize situation	Able to decide the necessary and unnecessary information, not able visualize situation yet	Have not decided the necessary and unnecessary information and visualized situation
3. Select a strategy	Wrote problem solving plans, but not yet systematic	Wrote problem solving plan, but not yet systematic and complete	Have not written problem solving plan systematically and complete
4. Find an answer	Did problem solving based on the plan, showed the correct heuristic use	Did problem solving based on the plan, not yet showed the correct heuristic use	Have not done problem solving based on the plan, and showed the correct heuristic use

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5. Reflect and extend	Have not checked the problem, not yet presented the alternative and extension of the solution	Have not checked the problem, not yet presented the alternative and extension of the solution	Have not checked the problem, not yet presented the alternative and extension of the solution

The above descriptions of the initial conditions were obtained from the initial problem solving test results. There, students were exposed to material issues of cube and block volumes relating to daily life. The types of questions given in the pretest were different and new for the students and have been in trial in advance. In general, out of 31 students, on average, working on three problems out of four, only some of the upper group students attempted to solve all four problems thoroughly. Therefore, the researcher chose 5 research subjects representing each group, from the upper group, the researcher chose students initial U1, U2 and M1 students from middle group, L1 and L2 from lower group. The five research subjects would be interviewed more deeply about problem solving and hard work after following the Project Based Learning with OQALE approach.

The Effectiveness of Learning

The effectiveness indicators in this study included four things. First, the completeness of learning outcomes analysis using proportion test. The proportion test in this research use done tail test assisted by Microsoft Excel program, using formula. With this formula, the researcher got the value of z = 1.97 bigger than z_{table}, namely 0.98, with error level 5%, soH_0 was rejected. Based on this result, it could be concluded that the problem solving ability of VB class students who have passed the passing grade score (KKM) of 70 in Project Based Learning with OQALE approach were more than 75%. This could be achieved because the use of heuristics helps one to solve and find the solution of a problem (Lidinillah, 2008).

Second, the comparative test whether the mathematics problem solving ability of the experimental class who achieved Project Based Learning with OQALE approach better than the class with conventional learning. Based on the comparison test with SPSS using Independent Sample T test with 5% significance level, it was found that the significance value in Sig column. (2-tailed) in the Independent Sample Test was 0.00 <0.05, then H_0 was rejected, and H_1 was accepted. This indicated that the average test result of problem solving ability of the students of the experimental class was more than the average of the control class student learning outcomes. It showed that learners who were given problem solving exercises have higher scores in problem solving tests than those who practice less (Suherman, 2003: 93).

Third, the test of the the influence of hard work and problem solving skills on problem solving abilities. Based on the Anova table of SPSS output, it was obtained the Sig. value = 0,000 <0.05, so H_0 rejected. Thus, it could be concluded that problem solving skills and hard work have a positive effect on problem solving ability. Based on the output, it was obtained the

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coefficient of determination (R square) of 0.887. Hence, it could be concluded that problem solving skills and hard work together have a positive effect on problem solving ability of 88.7%, while 11.3% was influenced by other factors. According to the opinion of Wati (2016) reading, understanding, and presenting the discussion result give positive influence to the students' motivation of learning and growing hard work character so that the model of project based learning is also able to increase the hard work of students in solving the problem based on Krulik-Rudnick's Heuristics.

Fourth, the gain test of hard work and problem solving. Based on the recapitulation of individual gain values, it could be seen that there found the improvement of problem solving skills of each student. The result of the analysis showed that 2 students (6.45%) had improvement of low category problem solving skills, 19 students (61.29%) had fair category of problem solving skills and 10 students (32.25%) had high category of problem solving skills. Based on the recapitulation of individual gain values, it could be seen the improvement of hard working character of each student. The result of the analysis showed that 1 student (3,22%) had the improvement of hard work character in low category, 19 students (61,29%) experienced the improvement of hard work character in medium category and 11 students (35,48%) experienced the improvement of hard work character in high category. Based on the recapitulation of individual gain values, it could be seen the problem solving ability of each student. The result of the analysis showed that 3 students (7.4%) had the improvement of problem solving ability in low category, 12 students (48,2%) had the improvement in medium category of problem solving ability and 16 students (44,4%) had the improvement of problem solving capability in high category. In accordance with the opinion of Novotna (2014) the comparison on the initial conditions and the final test can show increased use of Heuristics in mathematics. In addition, almost all problems which were solved by using the solving strategies in the final test were done correctly.

Based on the above explanation, as the four aspects of effectiveness have been fulfilled, it can be said that learning by Project Based Learning with OQALE approach on class V with geometry material is effective to improve the problem solving and the hard work of students. Thus, this model is very well used to be used and applied by teachers of mathematics in schools as one form of learning variation.

Description of troubleshooting and hard work

The problem solving steps introduced by Krulik-Rudnick are the development of the Polya's heuristics that emphasizes the importance of reflection and extension of the answers (developing) to another situation of five stages of problem solving by which they are called heuristics by Krulik-Rudnick (1995), including: read and think, explore and plan, select A strategy, find and answer, and reflect and extend.

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Based on the results of written tests and interviews, the five research subjects could solve the problem on the story exercises well. However, the process they went through to solve the problem and the results obtained were vary. Furthermore, the results obtained data analysis was used to describe the problem solving and hard work of students in solving problems.

The first subject of study (U1) who belonged to the upper group experienced significantly increased hard work. In the first meeting U1, obtained a score of 32 which meant that students did not have the character of hard work, then at the fifth meeting, U1 got hard work character score of 51 which meant that this student got high / good hard work character. Meanwhile, this student problem solving skills at the first meeting scored 43 which meant that this student was not yet skilled in working on problem solving exercises. Then, U1 got quite skilled to work on problem solving exercise, it appeared in the score obtained by 67. The end result obtained by U1 student appeared in the last meeting or the fifth meeting. This student was declared very skilled at working on problem solving problems and marked with scores obtained by 74. In solving the problem, in the Explore and Plan stage, U1 got no significant difficulty in determining the information required in the plan, eliminated (not writing) unnecessary information in the plan, and wrote the illustrations / sketches accordingly. U1 used his imaginative power to imagine the problems that occurred in the exercise and could connect to the real world, so writing the description of the problem was considered easy for U1.

The second and third study subjects U2 and M1 who belonged to the middle group experienced a relatively similar improvement. U2 had good ability and focus on the tasks assigned by the teacher. This could be seen from the observation of each indicator, namely always participate in class discussion and provide questions as well as responses, participate in the discussion on matters based on the topic by exchanging ideas with other students. Meanwhile, M1 obtained a score of 28 which meant that this student did not have hard work character, then over time in the fifth meeting, M1 obtained hard work character score of 50 which meant high hard work character/good. Basically, M1 had good character of hard work. In the steps of Reflect and extend, M1 declared that he examined the problem solving solution by recalculating and reading the problem solving results that he has done from scratch. He claimed to still had difficulties if he should check the problem solution by using other strategies. U2 tried to check the problem solving solution with reversed working techniques. The following was the result of the U2 examination of the solution of the problems that have been found. Further, M1 problem solving skills at the first meeting earned a score of 40 which meant that this student was not yet skilled in working on problem solving exercises. In the last meeting or the 5th meeting, M1 was declared very skilled to do problem solving problems, he was marked with a score of 68.

The fourth and fifth subjects, L1 and L2 who belonged to the lower group experienced relatively similar improvement. L1 had less ability on the tasks assigned by the teacher. This could be seen from the observation of each indicator that L1 did not appear to participate in class discussions and provide questions and responses, has not followed the discussion on topics

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by exchanging ideas with other students, L1 also listened and followed to his friends' explanation when discussing or doing serious presentation, but not giving any response. Besides, L2 student got score 23 which meant that this student did not have hard work character, then, over time and during the implementation of Project Based Learning with OQALE approach at the fifth meeting, L2 obtained a score of 45 hard work characters which meant that his student had a high/ good character of hard work. In the problem solving stage of Select a strategy, L1 got difficulties in designing problem solving strategies because he did not understand the purpose of the problem, but the end result showed that L2 has improved and has good problem solving. In other condition, L2 in the first meeting scored 38 which meant that was not skilled in working on problem solving exercises. The final results obtained by L2 students in the last meeting or the 5th meeting was that this student was declared quite skilled to do problem solving problems with score obtained for 59.

CONCLUSION

The conclusions of the results of this study are (1) the initial condition of students' ability to solve mathematical problems is still low; (2) the learning of using Project Based Learning with OQALE approach is said to be effective, because the classical completeness of the average score of TKPM experiment class with Project Based Learning with OQALE approach is achieved; students 'mathematical problem solving skills who were taught by using Project Based Learning with OQALE approach is higher than those who were taught by using conventional learning; the hard work character and mathematical problem solving skills of students have a positive effect on students' math problem solving skills; there happened an increase in the character of hard work, problem solving skills, and problem solving ability of mathematics subject by the students after getting Project Based Learning with OQALE approach treatment; (3) the application of Project Based Learning with OQALE approach impacts affective aspects, cognitive aspects, and psychomotor aspects, by which each of them has different results in learning. The affective result of this research is the good increasing of hard work character of student. For psychomotor results in this study, students are skilled in solving math problem solving exercises through a series of learning activities that have been done. As for the cognitive results in this study, the character of hard work and mathematical problem solving skills can positively affect the ability of problem solving in math.

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