The influence of self-directed learning on mathematical problem solving ability in problem-based learning with ethnomathematics nuances

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Abstract. The ability that students need in problem solving is self-directed learning which is the ability to determine the learning objectives to be achieved by paying attention to their learning conditions and needs, determining the appropriate learning method of the learning material they want to study, and determining the evaluation methods to assess their learning progress and observe the rapidity of learning according to their respective ability. This research aimed to analyze the effect of self-directed learning on students’ mathematical problem solving ability in ethnomathematics problem-based learning model with Whatsapp group. This research used a combination of quantitative and qualitative methods. The model used in this research was a sequential explanatory model with a posttest-only control design. There were two groups in this research, namely the experimental group and the control group. Randomized class technique was used by the researchers to determine sample of two groups selected from a homogeneous population. The subjects in this research were determined using purposive sampling technique. The results showed that self-directed learning affected students’ mathematical problem solving ability in problem-based learning with ethnomathematics nuances assisted by Whatsapp groups. It was based on the students’ achievement in three self-directed learning categories, namely high category with three indicators, medium category with two indicators, and low category with one indicator.

1. Introduction

Based on the results of the 2018 PISA, Indonesia has experienced a decline in its average mathematics achievement with a score of 379 from the average mathematics achievement in PISA 2015, which is 386. Indonesia's average mathematics achievement in PISA 2018 was at level 1; students can answer questions that involve a familiar context, in which all relevant information is present and the questions are identified. Students can identify information and take routine procedures according to direct instructions in explicit situations. Students can take actions that are almost clear and immediately follow the given stimulus [1]. Therefore, in other words the ability to solve math problems in Indonesia is still lacking.

One important aspect of planning rests on the teacher's ability to anticipate needs and materials or models that help students achieve learning objectives. The learning objectives can be achieved if in learning mathematics, a teacher can find out difficulties experienced by students so that the right solution can be given. As a result, efforts are needed to improve students’ mathematical problem-
solving skills. One effort that can be done is by giving an active and innovative learning model, such as Problem-Based Learning (PBL) [2].

PBL model has enormous potential in making learning becomes more meaningful for students because students are given opportunities to solve problems. It provides students opportunities to explore, collect, and analyze data completely to solve the problems at hand [3,4]. The application of problem-based learning has a positive impact on students that they become more active in building their knowledge to gain new knowledge through problems that have been provided by the teacher [5]. Besides, designing PBL programs can be challenging since teachers can integrate new subject matters, skills, and teaching methods [6]. The essence of PBL learning lies in group work in which possible solutions can be reached after independent learning is carried out, and after that, students are asked to conclude what they have learned and taken full responsibility for the learning process [7].

Not to mention that lack of student interest in mathematics is one of the obstacles in learning. Students perceive mathematics as a difficult and boring subject so that many of them have difficulties in solving math problems. One approach that can help students easily understand problems and attract their interest in learning is cultural nuanced learning. Mathematical concepts related to culture are known as Ethnomathematics. Ethnomathematics is conceptually designed as mathematics that is practiced, used, or combined in cultural practices in society [8]. By applying ethnomathematics in education, especially mathematics learning, hopefully students can better understand mathematics and their culture. Later on, educators will find it easier to instill cultural values in students so that the cultural values which are part of the national character can be attached students. Accordingly, this can facilitate students in understanding mathematical material well. This is because ethnomathematics has the potential to increase student’s involvement and interest in learning mathematics [9].

Each student has different potential in solving math problems so that skills are needed to optimize the potential in learning. In solving problems, it is necessary for students to have an ability to determine learning objectives they want to achieve by paying attention to their learning conditions and needs, determine the appropriate learning method of the learning material they want to study, and determine evaluation methods to assess their learning progress and observe the rapidity of learning according to their respective ability. This ability is known as Self-Directed Learning (SDL). In this way, students will get independent learning since they can manage their learning by themselves. This independent learning can improve student’s achievement since it familiarizes concepts based on what students independently find during the independent learning process. This is obviously significant for math problem-solving skills. The goal of problem-solving in mathematics is to increase students' readiness to improve their ability to solve problems and make students aware of problem solving strategies [10]. SDL arises students’ awareness and empowers them that it is their own responsibility to determine their learning process [11].

Online policies are a new challenge for educators in implementing learning. One of the media in implementing distance learning or online is WhatsApp. As of February 2016, it was recorded that active WhatsApp users reached 1 billion each month [12]. Indirectly, this application is widely used by all levels of society. WhatsApp in its use as a digital chat media includes text messages, pictures, videos, and an ability to make calls into a complete unit to help people establish communication in all parts of the world.

WhatsApp Group is one of WhatsApp application features that can be used as a medium for distance learning. Discussion through the WhatsApp Group helps users communicate in distance learning [13,14]. Mostly, the learning process carried out by teachers and students is in form of students’ works submission based on material studied, and after that the teachers examine whether or not the results of solving the questions are true. Students can also ask questions related to exercises given. It can be done through WhatsApp Group by first taking a picture or photo of solving the practice questions. Images or photos that are sent can be seen by all group members via smartphone so that other students can try to solve or answer these problems before they are resolved or answered by the teacher [13].
2. Methods
This research was a mixed-method with a sequential explanatory model with the population of
students of VIII grade of a junior high school in Semarang in the 2019/2020 academic year, while the
samples were selected by random class. The quantitative research used posttest-only control design, in
which the experimental class received Ethnomathematics PBL Models with WhatsApp Group, and the
control class used PBL learning. In addition, the research subjects in the experimental class were
selected based on the SDL level. In details, the research design is presented in Table 1.

| Class    | Treatment | Posttest |
|----------|-----------|----------|
| Experiment | X₁       | O        |
| Control   | X₂       | O        |

Notes: X₁ is Ethnomathematics PBL Models with WhatsApp Group, X₂ is PBL Models with
WhatsApp Group and O is a test of mathematical problem solving abilities

3. Results and Discussion
The results of SDL and mathematical problem solving ability data analysis to test the effects of two
variables are presented in Table 2. The hypotheses used are followed.

H₀ : there is no influence between SDL and mathematical problem solving ability
H₁ : there is an influence between SDL and mathematical problem solving ability

| Model   | Sum of Squares | df | Mean Square | F    | Sig |
|---------|----------------|----|-------------|------|-----|
| Regression | 99.884        | 1  | 99.884      | 4.320| 0.046|
| Residul  | 693.616        | 30 | 23.121      |      |     |
| Total    | 793.500        | 31 |             |      |     |

Based on the results of the Sig. In Table 2 = 0.046 <5%, H₀ is rejected, meaning that there was an
influence between SDL and mathematical problem solving ability. The magnitude of the influence of
SDL on the ability to solve math problems was 12.8%. Corresponding research also revealed that SDL
increased knowledge, skills, achievements, or personal development that students chose from their
efforts under any circumstances and at any time [15,16,17].

The use of the ethnomathematics PBL model assisted by WhatsApp Group could help students
improve their abilities. It could be concluded that the incorporation of ethnomathematics in the PBL
model would provide a stable increase in students' mathematical problem-solving abilities [18].

Besides, problem solving skills become important when students carry out group discussions since
they practice understanding problems, organizing, presenting, selecting, developing, creating and
interpreting, and solving problems independently with teacher guidance.

Based on the analysis of the SDL questionnaire at PBL class, there found 16 students with
ethnomathematics nuances assisted by WhatsApp Group at high-level SDLs, 14 students at medium-
level SDLs, and 2 students at low-level SDLs. The next stage, 6 subjects were selected from the
experimental class by considering the results of the mathematics problem solving ability test.

After selecting the research subjects, interview process was carried out on the subjects. The results
of the interview process were used as technical triangulation that later used by the researchers to
compare with the results of students’ works analysis. The results were that students in the high SDL
category could fulfill all indicators at the stage of mathematical problem-solving abilities, namely the
stage of understanding problems, planning problem solving, implementing completion plans, and
checking again. Students in the medium SDL category could only fulfill the indicators at the stage of
understanding the problem, planning problem solving, and implementing the solution plan. Furthermore, students in the low SDL category were only able to fulfill the indicators at the problem
understanding stage. This is in line with the results of a research on the improvement of mathematics
learning by students with high SDL categories [15] and students who have high self-directed learning
that both of them have a desire to learn from intrinsic motivation, such as considering learning as a hobby and fun, a sense of desire know the strength, and hoping to become a competent human being.

4. Conclusion
There is a positive influence on the SDL level on students' mathematical problem-solving abilities in Ethnomathematics PBL Models with WhatsApp Group. There is a need for more intensive guidance on the steps of mathematical problem-solving abilities that have not been achieved in students with medium self-directed learning levels and students with low self-directed learning levels.

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