Characteristics of pre-service teachers’ performance in problem posing

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Abstract. Problem posing is as much important as problem solving. In order to enhance problem solving skill, students need to be trained to pose a question or problem. Hence, teachers need this ability. This study was a descriptive research which aimed to describe the characteristics of pre-service teachers’ performance in problem posing. The research participants were 34 pre-service mathematics teachers who were enrolled in the Assessment Course in 2017/2018 academic year. The research instrument was a validated problem posing worksheet. Data were collected through a test. The results showed that the students preferred to make free essay problems than the structured ones, and only a few made open problems. All of the students’ problems were resolvable. The difficulty level of the problems was varied from high (dominated by analytical problem), medium, to low (dominated by understanding) level. Related to the type of the problems, the ability of pre-service teachers in posing questions with the type of post-solution was the lowest, and the type of within-solution was the highest. This results implicate that pre-service teachers need to be accustomed to creating open and good problems for their future students.

1. Introduction
The school mathematics curriculum has not paid much attention to students' problem posing instead puts more emphasis on solving mathematical problems. Basically, the topic of problem posing is a long-standing issue. Singer, Elerton, and Cai suggested that the new issue of problem posing is the awareness of various parties regarding the need for content of problem posing in the mathematics curriculum at all levels, both as a learning tool and as an object of learning [1]. Kilpatrick argued that problem posing is an essential content in mathematics and the essence of mathematical thinking, and an important part of mathematical problem solving [2]. A person cannot solve the problem if it is not formulated or filed properly by the problem compiler. Shriki pointed out the importance of problem posing that "Problem formulation is more essential than the solution" [3]. Raising new problems, new possibilities, looking at old problems from a new point of view requires creative imagination and marks real progress in science.

The importance of problem posing in solving mathematical problems, among others, was described in Polya's suggestion to assist students in overcoming their difficulties when solving problems. Polya suggested that we can help students in solving a problem by: a) providing questions that lead students to solve problems, b) helping students to explore their knowledge and compile questions by themselves, c) providing meaningful cues to solve problems but not solution of the problem, d) helping students solve their own difficulties [4]. The importance of the study of mathematical problem
posing was also embodied in the statement of Ellerton and Clarkson that the development of mathematical ability requires the ability of creative mathematical imagination that, among other things, is developed when raising new questions, creating new opportunities, and looking at old questions from a new point of view [5]. The rationale of the need and importance of developing the ability to apply mathematical problems to students, pre-service teachers, and mathematics teachers is implied in the advice of the National Council of Teachings of Mathematics (NCTM) which suggested that students should be trained to formulate problems or questions based on various situations presented either in or beyond mathematics [6]. Students should also be given the opportunity to develop their own problems or questions, find conjectures, and generalize and expand the problems by compiling the next question of the existing question and then solving the problems.

In any mathematics learning approach, mathematics teachers should present problems or mathematics questions that encourage students to learn, stimulate students' critical and creative thinking. For example, in contextual and problem-based learning approaches, mathematics learning begins with the presentation of contextual problems that match with the mathematical concepts to be taught and in accordance with students' pre-existing mathematical knowledge. Then during the lesson, the teachers must also select mathematical problem or task that is relevant to the mathematical ability to be developed. If the mathematical problem does not encourage students to think further then the students will only have procedural or mechanical knowledge and not used to apply high order mathematical thinking.

Silver argued that the posing of mathematical problems helps develop mathematical thinking, problem-solving skills, attitudes and self-esteem in learning mathematics and broadening the understanding of mathematical concepts [7]. Cai suggested that submission of mathematical problems is one of the key components of mathematical exploration [8]. Therefore, allowing the students to pose mathematical problems is a way to investigate the students' way of thinking in terms of perspectives.

Mathematics education students are teacher candidates who are required to have good understanding of mathematics content and teaching strategies. They need to know how to teach according to curriculum requirement. In addition, pre-service teachers should also have good skills in conducting an authentic assessment in order to assess the success of a learning process. This is in accordance with the competence of teachers that must be owned by mathematics education students as stated in the curriculum of Mathematics Education. "The four teacher competencies that must be possessed by teachers are pedagogical, personality, professional, and social competencies" [9]. Pedagogical competence is the ability to understand students, the design and implementation of learning, evaluation of learning outcomes, and the development of students to actualize the various potentials they have.

In conducting assessment activities, there are several capabilities that must be possessed by pre-service teachers. One of the abilities is the ability of problem posing and problem solving, especially in mathematics. Because this ability is needed in order to be able to explore and evaluate the extent to which learners understand the material being taught. In addition, the teacher's ability to pose problems can assist students in reducing their dependence on textbook and help students to become more involved in learning activities [3].

The curriculum applied in mathematics education at Universitas Negeri Surabaya has been revised to meet the current curriculum requirements of primary and secondary schools. The lecturers understand important aspects that must be done and applied in the learning process at the university. One important aspect that must be considered by the lecturers of Assessment is the aspect of students' ability in raising mathematical problems, because this is a prerequisite ability that must be possessed by pre-service teachers. A good teacher must be able to design a learning well, carry out learning with a method or model of learning that fits well, and also able to assess the efficiency of the learning. The objective of this research was to describe the characteristics of pre-service teachers’ performance in problem posing.
2. Problem Posing
According to Brown and Walter, the term problem posing was officially recognized by the National Council of Teachers of Mathematics (NCTM) as part of the National Program for Re-Direction of Mathematics Education [10]. The formal enactment of the term mathematics problem is related to education reform by NCTM in 1991 [10].

Meanwhile, according to Law Number 14 Year 2005 regarding teachers and lecturers, pedagogic competency is a skill that is related to students' understanding and educational and dialogical learning. Substantially, this competency is a teacher's ability to evaluate students' learning outcomes. This is in accordance with the opinion of Masriyah which stated that one of the competencies teachers must have is the ability to conduct assessments, both in the process and product of learning [11]. Thus, all pre-service teachers must have the ability of problem posing for each learning activity that they do.

In any mathematics learning approach, mathematics teachers should be able to construct questions that encourage students to learn, stimulate students' critical and creative thinking. During the lesson, they must be able to choose appropriate mathematics problems or tasks that are relevant to the mathematical ability to be developed.

According to Siswono, problem posing has several advantages, they are: (1) provides opportunities for students to achieve a broader understanding and analyse more deeply about a topic, (2) motivates students to learn more, (3) provides an opportunity for students to develop creative, responsible, and independent attitudes, (d) knowledge which is gained from experimental learning which has close relation with students’ daily life will be well remembered by students [12].

Silver proposed that the term problem posing applies to three different forms of mathematical cognitive activity [7]:
- Pre-solution posing, i.e. a student makes a problem of the situation held.
- Within-solution posing, a student re-formulates the problem as it has been completed. That is, students can create a question that can lead to the answer to the problem created previously.
- Post-solution posing, i.e. a student modifies the goal or condition of the completed problem to create a new problem. That is, students create new problems similar to those that have been resolved.

Judging from how to present a question, the form of essay questions can be grouped into two kinds, namely: structured essay and free essay. The structured essay form is presented in detail of several sections that are mutually supportive. Problems are usually arranged from the simplest to the most complex. The question of a free essay is presented globally, not in detail. In answering it, students asked questions are allowed to do part of the answer freely. Single problem have generally included as free essay form [13].

The difficulty level of a problem can be categorized into high, moderate, and low. The difficulty level is high or high order thinking if it measures the achievement of indicators for analysis, evaluation or create category. The level is moderate if the question measures the achievement of indicators for the applying category, and it is low category when measuring the achievement of indicators for remembering or understanding category. In addition, a problem is said to be open, if the problem has several ways of settling or many solutions [14].

3. Method
This study was a descriptive research. In this article we described the characteristic of pre-service teachers’ performance in problem posing. The participants of this research were 34 pre-service teachers who were enrolled in the Assessment Course. The steps that researchers conducted in this research were (1) preparing research proposal, (2) developing research instruments, (3) conducting validation of research instruments, (4) revision of research instruments to be used in research (if needed), (5) after the research instruments have been declared valid by the validators, the next step is giving a brief information about the problem posing, (6) giving the task of filing the problem to all research subjects, (7) conducting data analysis, and (8) preparing research report.
This research was conducted using a validated problem posing worksheet. Data analysis was done by 1) separating the results of the students’ tasks in the filing of the problem for pre-solution, within-solution and post-solution; 2) supervising the results of the task of filing the problem while taking into account: (a) the kind and type of questions, (b) the structure of the language/problem sentence, (c) whether the problem could be solved, (d) whether the problem posed contained open-ended questions, (e) correctness of the problem, and (f) the level of difficulty of the questions made by the pre-service teachers.

4. Result and discussion
Based on the study, the pre-service teachers’ performance in problem posing could be expressed that 85% of them made free essays and 15% of them made structured essays. Only 5.88% of them made open-ended questions with many ways of solution, and only 11.76% of them made open-ended questions with many solutions. The structure of the sentences/language used was in good category (73.52%) and fair category (26.48%). All of the problems that the students made could be solved. The difficulty level of the designed problems could be categorized into high (29.41% dominated by the problems that belonged to the analysis category), medium (79.41%), and low (17.64% dominated by understanding category). Almost all of the students (94.12%) could solve the problems they made. Only 14.71% of the students posed problems of post-solution type, 23.52% of pre-solution type, and 88.24% of within-solution type.

This study showed that pre-service students preferred making the within-solution problem type. This was because they just needed to compose some questions related to the answer of the previous problem that have been solved. In addition, they preferred making free essays rather than structured essays. This was understandable, because a free essay could be presented globally and did not need to be structured in detail.

Only a few of the participants made open-ended questions with many ways of solution. This was understandable because the students were not used to dealing with solving open-ended problems when they were in elementary, junior or senior high school. While the structure of the sentences/language used can be categorized as good or good enough. This was understandable because they were pre-service teachers.

All of the problems that were made could be solved because the problems they made were at junior or senior high school level. Almost all of the pre-service teachers could solve the problems they made. This was understandable because the problems were for junior or senior high school students.

Furthermore, the difficulty level of the problems was varied from high (dominated by analytical problem), medium, to low (dominated by understanding) level. Related to the type of the problems, the ability of pre-service teachers in posing questions with the type of post-solution was the lowest, and the type of within-solution was the highest. In general, problems are made with moderate difficulty. This is in accordance with the criteria of questions that should be made by the teacher in making the problem should be a comparison of problems made between difficult, medium and easy questions have a ratio of 3:5:2 or 2:5:2 [11].

When viewed from the type of problem created, the ability of pre-service teachers in posing problems with the type of post-solution was the lowest, and the type of within-solution was the highest. This is similar with the finding of a research was conducted by Kurniasari et al that the ability of posing problems of post-solution was the lowest with the average of 56.62%, the type of within-solution was 62.75%, and the the type of post solution is the highest with the average of 82.84% [15].

5. Conclusion
Based on the results of the study, it could be concluded that pre-service teachers could pose good quality problems. The researchers suggest to the lecturers of the Assessment Course to train pre-service teachers to make open-ended questions with many solutions or many ways so that they can apply this knowledge when they become teachers at a school. In addition, students need to be trained to make problems with good quality, they should always be accustomed to check the truth of a
problem by making the key answer to the problem or alternative solutions, and check whether the problems they make can be solved.

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