Teacher’s Problem and Scientific Learning Approach: An Investigation on Teacher's Problem-Posing Ability

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Abstract. We investigated teacher’s ability to propose a problem and to use the problem as the core activity in the implementation of the scientific learning approach. The study is associated with a qualitative research design with documents analysis as the main source of the data. The documents were collected from 10 teachers which have implemented the scientific learning approach for at least two years of practices. Based on data analysis, the study uncovered three major issues related to problems and the implementation of scientific learning approach. The issues are teacher various ways in resenting the problem, teacher inability to used type of problem other the problem to find, and the problem failure to facilitated the scientific learning stages to be implemented. As a result, the finding suggested conducting further research in assessing teacher knowledge about the problem, developing teacher ability in proposing the problem, and finding the character of the problem that can be utilized as the core activity in the implementation of the scientific learning approach of 2013.

1. Introduction
Problem-solving is considered closely related to human level of thinking. Research suggested that problem-solving activity contribute to the development of level of thinking especially higher order thinking [1–4] and to the way of assessing higher order thinking [5,6]. The success of problem-solving in supporting the development of the higher order thinking triggered the development of learning models or approaches. This trend also becomes one factor for curriculum development in Indonesia. It is clearly stated as one of the main principles of curriculum 2013 development [7]

The newest curriculum development in Indonesia is the implementation of 2013-curriculum. This curriculum specialized the learning process should use the scientific learning approach [8,9]. There are 5 stages in scientific learning approach namely observing, questioning, experiencing, associating and communicating [10]. Learning object, situation, event, phenomena, or problem is presented at the beginning of the learning activities. The learning materials that presented should initiate all stages in scientific learning approach including the problem. The problem should create a situation or condition that allows students to use logic, to discuss, to formulated simple questions that give guidance to solve the primary problems, to formulate theories or several possible ways to solve the problems or several solutions, to conduct experiments and to draw conclusion based on the collected data or result of experimenting. As a result, not all problems can be used and the used problem should be well-designed.

Considering the fact that the teacher is one of the important elements in the successful teaching and learning processes[11–14], teacher readiness to implement the scientific approach is considered a crucial aspect. Teacher readiness became one factor that triggered the government decided to postpone...
the implementation of 2013-curriculum in 2014 [15]. A year later, in 2015, the government announced the implementation of the 2013-curriculum will be continued gradually [16].

Studies related to the implementation of the curriculum were conducted in different focuses such as in developing teaching material [17], the implementation in various learning subjects [18–19] evaluating students’ achievement [20], and teacher perception about the 2013-curriculum [21-23]. However, research related to teacher performance in implementing the scientific approach is hard to be found.

One way to evaluate teacher performance is analyzing teacher documents such as lesson plan, learning media, and the learning resources. This study will focus on assessing teacher ability in proposing problem by using the problem that was used in teaching and learning processes with scientific learning approach. This approach has not been used previously in accessing the successful the implementation of 2013-curriculum. The idea of using posed problem to analyzed problem posing ability and the quality of the problem was already reported [24-26]. reported that analyzing the proposed problem enclosed pre-service teachers difficulties in designing or proposing the problem which was correlated with lack of experience, lack of knowledge, not recognizing the cognitive levels of students, lack of curriculum knowledge, and difficulties in writing problem texts. The next study analyzed the given problem in term of problem text, the compatibility of the problem with mathematical concepts, problem structure, and problem solvability resulted in the new insight of problem poser ability [27]. This idea was used to conduct research in investigating teachers’ ability in posing mathematics problem correlated with the implementation of scientific learning approach.

2. Methodology
The study aimed to investigate teacher ability in designing problem that was used in the implementation of scientific learning approach in the 2013 curriculum. It was expected to provide information about types of used problems, teacher difficulties in proposing a problem and teacher’s ability in designing a problem. Therefore, this study employed a qualitative research design. This design is well-suited in exploring and understanding situations, events, and issues [28]. The main data was collected through documentation. The 10 Mathematics teachers which selected by utilizing the purposive sampling method were involved in this study. They come from three different senior high schools which are located in Padang Pariaman regency and Pariaman City. The teachers had been trained to implement the scientific learning approach and have been practicing it for at least two years long period. Teachers’ lesson plan, students’ worksheets, and learning sources were analyzed comprehensively. The validity of the data was confirmed by using the sources triangulations. The data were analyzed by following three data analyzing processes which are data reduction, data display and conclusion drawing [29].

3. Finding
3.1 The used problems
Data analysis provided several common used problems in the implementation of scientific learning approach. The main features of the problems were word problem, figure or image problem, formula or symbol problem, and undetermined problem. The classification of problems based on the purpose of the problems which are a problem to find, a problem of construction, a problem to prove and a rate problem is also examined in this study [30]. The analyzed data showed that the proposed problems were dominated by the problem to find.

3.1.1 Word problem
The first common problem that is used by the teacher as the core activity in the implementation of the scientific learning approach was a word problem. The word problem that was presented was problems that illustrated a condition or a situation of actual life activity and a contextualized problem. The used of illustration in word problem can be seen in figure 1 below
The illustration of the activity is a real situation and can be visualized by the student. The activities which are "step forward 3 steps, step backward 3 steps, jump forward 2 times and jump backward 1 time" can be easy to be understood by the student. However, the main problem of this proposed problem laid in the question sentence. The question that was asked the definition of the absolute value based on the illustration. Meanwhile, the word “absolute value” was never used in the illustration. Moreover, student’s activity to drawing or visualizing the story in the number line provided the opportunity to misconception. Starting position and the statement to ignore the direction of the activity should be started clearly otherwise the learning goals which understanding the concept of absolute value would not be achieved. If it is not stated clearly, the absolute value would be understood to have directions or negative or positive value. It obviously contradicts with the concept of absolute value which is the distance or magnitude that do not have direction [31]. Even though, this question seemed to have greater proposed which are helping students to understand and learn about the concept of absolute value, the purpose fall apart along the discussion. It could be considered a bad question [30].

Figure 1. Word problem that illustrated a situation or event

3.1.2 Figure or image problem
Figure or image problem is defined as a problem that is presented by utilizing pictures. The picture can be in the form of photographs, graphs, diagrams, table or any other visual representations. It can be two or three-dimensional picture. [31] Believed that presenting problems with the image have both of negative and positive effect. Positively, the image provides opportunities to understand the given problem easily since the information already given in the images and be observed directly without imagining the given situation. Negatively, it leads to ambiguity and bias since it reaches with information. Therefore, students were required to sort the given information carefully. The figure
problem can be the combination of word problem and figure, a combination of two or more figures or only on the figure. Example of them has presented the figure 2 and figure 3

Ayo kita mengamati gambar dan cerita berikut:

A. SISWA di beri stimulus dengan gambar pohon

Dani ingin menentukan tinggi pohon, pada jarak 10 m dari pohon dengan sudut pandang 60°, seperti gambar berikut. Tentukan tinggi pohon tersebut. (tinggi Dani 155 cm)

![Figure 2. Figure problem which is the combination of figure and word problem](image)

Both of the problems in figure 2 and 3 might be well-suited to be used in scientific learning approach. The problem in figure 2 gave students clear ideas about the known and the unknown information, including what was needed to be found. I created the situations for students to generate several simple questions and created many possible ways that were worth to be confirmed. As a result, students could conduct several experimentations in confirming the possible ways to solve the problems and drawing the conclusion. The same cases also can be implemented for the problem in figure 3. The activities of finding the value of the function for the given problems were parts of experiencing the process of constructing knowledge and it was followed by generalizing ideas about the characteristic of the function.
3.1.3 Formula problem

The formula problem is a problem that is usually presented to students as their regular example of the application of a concept or as practice questions. The question can be in the form of symbols, equations or abstract mathematics question. The example of problems is presented in figure 4 and figure 5.

\[ \lim_{x \to \frac{\pi}{4}} \frac{\cos 2x}{\cos x - \sin x} = \ldots \]
\[ \lim_{x \to \frac{\pi}{4}} \frac{1 - \sin 2x}{\sqrt{\sin x} - \sqrt{\cos x}} = \ldots \]

**Figure 4.** Example of formula problem

Selesaikanlah soal-soal dibawah ini dengan teman sebangkumu !

1. Diketahui matriks \( A = \begin{bmatrix} 2 & 3 \\ 4 & 0 \end{bmatrix} \)
    a. Tentukanlah ordo matriks \( A \)
    b. Sebutkan unsur-unsur matriks baris ke 1
    c. Sebutkan unsur-unsur matriks kolom ke 2

2. Tentukanlah transpose matriks \( A = \begin{bmatrix} 2 & 0 & -1 \\ 4 & 3 & 2 \end{bmatrix} \)

3. Diketahui matriks \( A = \begin{bmatrix} 1 & 0 & 2 \\ 2 & 4 & 0 \\ 0 & 2b & 6 \end{bmatrix} \) dan \( B = \begin{bmatrix} 5 & 1 & 0 \\ 2 & 4 & 6 \\ 3c & d & 4d \end{bmatrix} \). Jika \( A = B \) maka tentukanlah elemen matriks \( A \) baris ke dua kolom ke 3 !

4. Diketahui matriks-matriks \( A = \begin{bmatrix} 3 & 2 \\ 7 & 5 \end{bmatrix} \) dan \( B = \begin{bmatrix} 5 & 1 \\ 2 & 3 \end{bmatrix} \). Tentukan matriks \( X \) berordo 2x2 yang memenuhi persamaan berikut !
    a. \( A \cdot X = B \)
    b. \( X \cdot A = B \)

**Figure 5.** Example of formula problem

This problem can be categorized as a non-routine problem. [32] Stated that non-routine problem as condition or situation that has not been encountered by problem solver. However, analyzing this type of problem by considering students previous knowledge about the given situation, it failed to fulfill the requirement as a problem. A question or a situation is considered as a problem if it is given to problem solver who has prior knowledge and wants to solve the problem; however, the direct ways or procedures to solve it have not been known yet. The problem solvers might have prior knowledge about the given situation, for example, in figure 4, the knowledge about trigonometry, however, the ideas about limits have not been introduced yet. Cases in figure 5 situated students in the obvious darkness. The idea of matrices was never introduced in the previous learning and students are forced to solve matrices problems with unfamiliar terms and conditions.
3.1.4 Undetermined problem
The undetermined problems referred to a condition or situation such that the problems were found or determined by the problem solvers. The only clue that was provided in constructing the problem where it should be related to certain mathematics concepts. The example of the use of this type of instruction is presented in figure 6.

Figure 6. Example of undetermined problem

In these instructions, students were asked to find problem-related to the concept that will be learned. They supposed to understand the concepts of limit for different type of function and found the value of the limit of a function. The teacher did not have control over what kind of problems that will be solved, is the problems conceptually related, or was it solvable. The instructions created situations for students to proposed many questions, however, it possibly led to unclear purposed of study and difficulties in determining to what extent students understanding about the concepts.

3.2 Teachers ability in designing or proposing a problem
We examined the proposed problems to evaluate teacher ability in designing or proposing problems. The teacher used different ways in presenting the problems such as by using word problem (see figure 1), using a combination of word problem and figure (see figure 2) and using a combination of two figures. However, analyzing the variety of problems the proposed of the presented problem, teacher’s ability was considered low. Among the four types of problem that are proposed by [33] namely problem to find, the problem of construction, the problem to prove and a rate problem, all the problems were categorized as a problem to find. It indicated that the teacher was not familiar with another kind of problems.

Considering the procedures in scientific learning approach which are observing, questioning, experiencing, associating, and communicating [10], the problems that were used by teachers were not fulfilled classification to be used in scientific learning approach. The problem that was proposed in the implementation of scientific learning approach should provide the opportunity to use logic, to discuss, to formulated simple questions that give guidance to solve the primary problems, to formulate theories or several possible ways to solve the problems or several solutions, to conduct experiments and to draw conclusion based on the collected data or result of experimenting. [32] formulated two different types of problem namely problem that expects students to apply the known procedures and problem that requires students to use logical reasoning, to communicate ideas, to present their idea, to solve and to discover the correlation among mathematics concepts. The most suitable type of problem to be used in scientific learning approach was the second types, meanwhile, most of the discussed problem fall in the first type of categorization. Although problems in figure 2 and figure 3 in synchronized with scientific learning approach steps, the problem itself did not design by the teachers. However, teachers showed a good judgment in proposing the problem to the students.

In the linguistic perspective, there were several aspects that were needed to be improved. The case that was present in figure 1 where the question was directly asked about the definition of absolute
value when the term itself was not introduced in the given situations. This problem showed teacher weakness in writing the problem text.

4. Conclusion
Although this study was limited to the analysis of teachers’ documents without observation of the actual teaching and learning processes in the classroom to gain how the proposed problem was used, it provides the new insight of types of problems and teacher ability in designing and proposing the problem. The various ways of presenting the problem had been regulated in the implementation of the scientific learning approach such as the use words problem, figure problem, formula problem, and undetermined problem. It also uncovered a teacher's lack of knowledge about types of research based on the purpose of solving the problem. Among the four types of problem namely problem to find, the problem of construction, problem to prove, and a rate problem, the teacher only proposed the problem to find. Another finding was the proposed problem did not facilitate to create a situation where the scientific learning approach stages could be implemented. It was suggested that further research in assessing teacher knowledge about the problem, developing teacher ability in proposing the problem, and characteristic of the problem that can be utilized as the core activity in the implementation of the scientific learning approach of 2013.

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