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Attitude towards problem-solving as the effect of problem-posing approach

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Abstract

This study aims to examine whether students' achievement of attitude towards problem-solving by problem-posing approach better than by direct approach. This study was a quasi-experimental. The population was all students at Junior High School 8 Bandung, 8th-grade for a total of 8 classes, with two classes as the sample. The instrument used to get the data was a questionnaire with five indicators (patience, persistence, perseverance, willingness, and confidence). Data analysis was performed using the t-test and Mann-Whitney U. The results of this study revealed that overall the attitude of students towards problem-solving by problem-posing approach was not significantly better than by direct approach; more specifically, it was equally good, while for each indicator, the result was varied. Moreover, in the class of problem-posing approach, students had patience and persistence in solving problems that were more prominent than aspects of perseverance, willingness, and confidence.

1. Introduction

The problem-posing approach has long been recognized as an important aspect of learning mathematics. The National Council of Teachers of Mathematics in 1989 states that problem-posing is "an activity that is at the heart of doing mathematics" (Malaspina et al., 2015), and now experts in cognitive and educational science also hold the same principle, they have recommended a teaching and learning environment that can encourage students to ask more quality questions (P. Mishra & Koehler, 2006). Developed countries like Japan have long been implementing problems posing learning in their education systems, such as in lesson study that developed a long time ago in Japan; in the 1910s, the topic of lesson study in Japan was mathematics for life, including problem posing (Isoda, 2010). In his article, Isoda underlined the relationship between problem-solving, open-ended problems, and problem posing.

Problem posing and problem-solving have a very close relation. According to Cail and Hwang (2002), problem-posing is not independent of problem-solving. This is reinforced by Lowrie (Guvercin & Verbovskiy, 2014), who said that as a cognitive process, problem-posing has a strong relationship with problem-solving. In agreement with Cankoy and Darbaz (Arıkan & Ünal, 2015), people become unable to find and implement appropriate strategies if they do not understand the problem given to them. Thus, they become unable to give an explanation about what they have done and what the reason, and this will surely decline their motivation to solve the problem. Guvercin and Verbovskiy (2014) added that the main purpose of problem posing is not about creating the best problem poser, but rather it is about creating a good problem solver. In his research, learning with the problem-posing approach had significantly improved students' achievement. Students not only found the solution but also could follow the correct steps in solving the problem.

Ellerton (2013) argued that problem-posing is fundamental in mathematics as well as problem-solving; a person cannot solve a problem unless he first formulates the problem. Pinter (P. Mishra & Koehler, 2006) reinforced with the opinion that the process of problem posing always exists before the

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problem-solving process and is a specific activity that is very important in solving problems. That is, if someone wants to solve a problem, in his mind, there is always a question in advance about the problem. For example, in everyday life, when we want to buy six donuts, we will ask, "how much is the price of a donut? Is the money we have enough to buy six donuts? How if it's not enough? ". Therefore, from some of the expert opinions, it is clear that learning mathematics in schools today should be directed to be able to train students in formulating problems or asking questions. But what more important is the learning should be able to improve student's ability to ask. This ability is not just about asking many questions but also asking a good and meaningful question. By doing this, students start to think about the solution when they formulate mathematical problems; thus, indirectly, students learn to solve problems (Cail & Hwang, 2002).

Problem-solving is not only about the cognitive challenge but also an effective challenge. Student involvement in the process of problem-solving builds students' affective engagement: moods, feelings, attitudes. Student' attitude towards mathematics correlates strongly with their attitude towards problem-solving. If a positive attitude towards mathematics, such as feeling happy towards learning mathematics, in solving problems, students also behave positively (Zakaria & Ngah, 2011). This is reinforced by the opinion of O'Connell (Mohd & Tengku Mahmood, 2011), which emphasized that students must have a positive attitude in problem-solving if they want to be successful in learning mathematics. When choosing a particular strategy, students must be willing to accept the risk of whether the strategy is appropriate to find a solution or not so that if it is not appropriate, the students accept the consequences of trying other strategies to find the solution. In their research, Zakaria & Ngah (2011) classified attitude towards problem-solving into three indicators: willingness, perseverance, and confidence.

Therefore, one of the things that need to be considered by a teacher in the success of his learning is to create a condition and learning environment that can stimulate and enhance students' positive attitudes towards problem-solving. Akey said that elements of the school, for example, teacher support, teacher expectations, and behavior, are significantly correlated with students' attitudes and behavior. Akey concluded that the classroom environment in which the teacher supports student activities could make students have the confidence to succeed (Mata et al., 2012). Thus, the learning approach used by the teacher certainly affects the attitude of students.

Based on the opinions of these experts, the researcher conducted this study to examine whether the problem-posing approach could have a positive effect on students' attitudes in solving problems, considering the relation between problem-posing approach and attitude towards problem-solving had not been examined by any researcher yet. This research was conducted in a public junior high school in Indonesia. Given the mathematical achievement of junior high school students in the latest TIMSS and PISA study result was still in the back row. To examine the effectiveness of the problem-posing approach, then a direct approach, specifically by using an expository teaching strategy, was chosen as a comparison. Expository is commonly used by teachers in Indonesia. Expository learning is a form of teacher-oriented learning strategy. This strategy was mentioned by Ausubel, an American psychologist whose most significant theory is meaningful learning. He had indicated that the acquisition of any knowledge in any culture is basically a disclosure of reception learning. That is, the core content of knowledge to be learned is customarily delivered to the learner through expository teaching (D.P. Ausubel, 2000). He also mentioned the term "expository organizer" as a part of what he called "advance organizers" to help to bridge new knowledge with current related ideas. The expository is typically verbal instruction. In line with his theory, expository teaching in this study provided new knowledge that students would have to master by verbally directing the knowledge to students, and the teacher played as the center in class.

Problem posing approach in this study used a cycle of instructional strategy created by Mishra and Iyer (2015), which consists of three phases: *initial instruction phase*, *problem-posing phase*, and *address phase*. The initial phase is a semi-structured situation that is started by initial instructions from the teacher. The contents of the initial instructions consist of fundamental sub-topics that are critical for the examination of the core topics. The initial instructions are less in content and short of time. In the problem-posing phase, students were asked to pose questions about the content they were learning (*think and tag sub-phase*). After each student had finished pose questions, they shared their questions with other students (*share and tag sub-phase*). Students were challenged to review other students' questions and ensure that questions made by others were not a repetition of theirs. In the address phase, the teacher and

students discussed the questions. Started from the question type "clarification" (*clarify sub-phase*), then the question type “exploration” (*explore sub-phase*). Clarification is a question that needs repetition of content that have been explicitly taught in previous learning. Exploration refers to questions that lead to the unfolding or construction of new knowledge. Lastly, the teacher and students summarized the question which most relevant to the core topic being studied (*summarize sub-phase*) (S. Mishra & Iyer, 2015).

There were five indicators of attitude towards problem-solving in this study, namely, willingness, patience, confidence, persistence, and perseverance. Students were expected to have the willingness to start an effort, worked on various types of problems, looked back on what they had done, and felt happy while solving problems. Willingness was also to support patience in understanding problems and to initiate problem-solving steps, as well as to be patient in trying to reach completion. Students were expected to have persistence, kept trying when facing difficulties, had the awareness to practice solving problems, and to be serious in solving problems. Besides, self-confidence reflected students' beliefs in presenting their idea of solutions, that they could solve various types of problems, and not hesitate to provide solutions. In terms of perseverance, it was marked by not giving up easily, had a high curiosity, persevere in his own opinion, and tenacious in trying to find solutions.

In brief, the process of posing questions from a particular situation encourages students to think of the solution. By continuously practicing solving problems in an unusual way, which is posing questions first, it is expected students have a positive attitude towards problem-solving then result in their good achievement in mathematics and daily life in general. Hence, this research was conducted to answer the following questions,

a. Is the attitude towards problem-solving of students who get learning by the problem-posing approach better than by the direct approach?”
b. For each indicator of attitude, is the attitude towards problem-solving of students who get learning by the problem-posing approach better than by the direct approach?”

2. Method

This research was a quasi-experimental study using posttest-only-controlled-group design, meaning that the attitude data was only collected at the end of a series of learning in both classes. The experiment was carried out for two months, eight times a class meeting. The sample in this study was chosen by using a purposive sampling technique. Those were two classes of 8th-grade students in Junior High School 8 Bandung, one class as an experimental group, and one class as a control group from a total of 8 classes as the population.

The instrument used to get students' attitude data was a questionnaire. The items of the questionnaire were modified from the items developed by Charles et al. in 1987 (Zakaria et al., 2004). In their research, the questionnaire consisted of 3 indicators of attitude: willingness, perseverance, and confidence. At the same time, this study added two indicators: patience and persistence. Items developed by them were then interpreted into the Indonesian language. Some items that were considered as not appropriate to Indonesian meaning were excluded and or modified, but still with the same idea. The researcher added items to indicate patience and persistence. To have content validity and face validity, the questionnaire items were validated through an expert judgment method by three experts. Based on the experts' opinions and recommendations, the items were revised. Through some improvements, the questionnaire was then tested on 44 students outside the study sample before being used in the experimental and control groups. After fulfilling the validity and reliability criteria, the questionnaire was then used in the study. The total number of items was 18 with five-degree Likert scale answer choices, namely Strongly Agree=5, Agree=4, Hesitate=3, Disagree=2, and Strongly Disagree=1.

To analyze student’attitude data, the following steps were carried out:

1) Converted each student' attitude score per item of the questionnaire from an ordinal scale to interval scale using the help of stat97 software
2) Identified the maximum and minimum score for each item of the questionnaire based on the result from step 1
3) Summed up the maximum and minimum score for the 18 items of the questionnaire to get the ideal maximum score and minimum score. The ideal maximum was 85.90, and the minimum was 18.

4) Calculated the maximum and the minimum percentage score based on step 3.
   $\max = \frac{85.90}{85.90} x100\% = 100\%$
   $\min = \frac{18}{85.90} x100\% = 20.96\ \%$

5) Based on step 4, attitude percentage score was divided into five intervals and classified as follow,

Table 1. Classification of Students' Attitude

Percentage Score	Category
$84.19 < x \leq 100$	Very Good
$68.38 < x \leq 84.19$	Good
$52.57 < x \leq 68.38$	Sufficient
$36.76 < x \leq 52.57$	Less
$20.96 < x \leq 36.76$	Very Less

6) Calculated the percentage of each student' attitude score by the formula:
   $Percentage = \frac{Total\ Score\ Per\ Each\ Student}{Score\ of\ Ideal\ Maximum}\ 100\%$
7) Run a prerequisite analysis testing, which was a normality test and a homogeneity test for the percentage data with the help of SPSS for Windows software at a significance level of 5%
8) Run a hypothesis testing with the Independent-Samples T-test if the pre-analysis requirements were met. Otherwise, a Mann-Whitney U test was used with the help of SPSS for Windows software at a significance level of 5%. The statistical hypotheses of the test were :
   $H_0 : \mu_1 \leq \mu_2$ (The attitude towards problem-solving of students who get learning by the problem-posing approach is not better than by the direct approach)
   $H_1 : \mu_1 > \mu_2$ (The attitude towards problem-solving of students who get learning by the problem-posing approach is better than by the direct approach)
9) Made conclusion based on the hypothesis testing result
   Conclusion criteria:
   If $sig.(1-tailed) = \frac{sig.(2-tailed)}{2} < 0.05$, then H_0 is rejected
   If $sig.(1-tailed) = \frac{sig.(2-tailed)}{2} \geq 0.05$, then H_0 is accepted

3. Results & Discussions

3.1. Result

The description of student' attitude data illustrates the results of attitude measurement after the students obtaining treatment. The following table is the description of the percentage of attitudes towards the problem-solving score in both classes.

Table 2. Student'Attitude Percentage Score

Class	N	$\bar{x}$	s	Category
Direct approach	33	60.50	7.02	Sufficient
Problem posing	34	63.46	7.69	Sufficient

Based on Table 2, it was found that the mean percentage score of students' attitudes in the class of problem-posing approach was 63.46, and the direct approach was 60.50. The score of the problem-posing approach was higher than the direct approach. To find out whether this score reflected the problem-posing approach was significantly better than the score of the direct approach or not, a hypothesis test was conducted. Firstly, the prerequisites analysis tests were run, namely normality and homogeneity test of the

data. The prerequisite test results were normally distributed and homogeneous so that a t-test with a significance level of 5% was carried out using SPSS software. The result of the test is presented in Table 3 as follow.

Table 3. Hypothesis Test Result

Statistical test	***Sig. (2-tailed)***	***Sig. (1-tailed)***	**Conclusion**
t-test	0.105	0.0525	H_0 accepted

Based on Table 3, the significance value for the 2-tailed test was 0.105. Then, the significance value for the 1-tailed test (sig.1-tailed) was 0.0525. This result was greater than 0.05, so according to the conclusion criteria, H_0 was accepted. This means that the attitude towards the problem-solving of students who got learning by the problem-posing approach was not significantly better than the attitude of students who got learning by the direct approach. In detail, viewed from the mean percentage score of the two classes based on Table 2, the problem-posing approach class was 63.46, and the direct approach class was 60.50; the attitude towards problem-solving of students in both classes was in the same category "sufficient".

Furthermore, to find out the difference in each attitude indicator, a mean difference test was performed. Data description of the percentage of attitudes towards the problem-solving score in both classes for each indicator is presented in Table 4.

Table 4. Students'Attitude Percentage Score for Each Indicator

Indicator	**Class**	**N**	$\bar{x}$	***s***
Patience	DA	33	62.913	8.307
	PPA	34	68.136	14.157
Perseverance	DA	33	56.406	8.967
	PPA	34	59.568	11.386
Persistence	DA	33	66.163	10.898
	PPA	34	68.467	10.665
Willingness	DA	33	60.999	11.484
	PPA	34	66.294	10.786
Confidence	DA	33	51.617	12.348
	PPA	34	58.313	16.021

Note :

DA = direct approach

PPA = problem-posing approach

Based on Table 4, the mean percentage of students'attitudes in the problem-posing approach class on each indicator was higher than in the direct approach class. To test whether the difference was significant or not, a mean difference test was performed on data per indicator. Previously, normality and homogeneity data were tested. The mean difference test used for the patience indicator was the Mann-Whitney U test based on the 2-Independent Samples test at a significance level of 5%. While the mean difference test for the indicators of perseverance, persistence, willingness, and confidence was done using the Independent Sample T-Test at a significance level of 5%. Table 5 presents the results of the test.

Table 5. Hypothesis Test for Each Indicator

Indicator	Statistical Test	*Sig.(2-tailed)*	*Sig. (1-tailed)*	Conclusion
Patience	Mann-Whitney U	0.138	0.069	H_0 accepted
Perseverance	t-test	0.212	0.106	H_0 accepted
Persistence	t-test	0.385	0.1925	H_0 accepted
Willingness	t-test	0.056	0.028	H_0 rejected
Confidence	t-test	0.060	0.030	H_0 rejected

Based on Table 5, patience, perseverance and persistence had a significance value (sig.1-tailed) which were still lower than 0.05, thus $H_{0(s)}$ were accepted. This means that the patience, perseverance, and persistence aspect of students who got learning by the problem-posing approach were not significantly better than those of students who get learning by the direct approach. While H_0 of willingness and confidence are rejected, this means that willingness and confidence aspects of the attitude of students who got learning by the problem-posing approach were significantly better than those of students who get learning by the direct approach.

Overall, it can be concluded that the attitude towards problem-solving of students who get a problem-posing approach is not significantly better than a direct approach, which in detail both of them are in the sufficient category. However, viewed on each indicator of the attitude, the aspects of willingness and confidence in the problem-posing approach is significantly better than the aspects of willingness and confidence in the direct approach.

3.2. Discussion

3.2.1. Research question 1: Is the attitude towards problem-solving of students who get learning by the problem-posing approach better than by the direct approach?

In connection with students' attitudes towards problem-solving based on the learning approach, the research hypothesis was "the attitude towards problem-solving of students who get learning by the problem-posing approach is better than by the direct approach". Based on the results of data analysis using statistical tests, H_1 was rejected. It is inferred that the attitude of students who learn using the problem-posing approach is not significantly better than the direct approach. The attitude of students in both classes is in the same category, sufficient.

This is an interesting result that the problem-posing approach has an effect on attitude as well as a direct approach. Problem posing started with a situational problem, which is fundamental to build new knowledge. Students had engaged actively in the learning process. Posed a good question also develops their ability in problem-solving. As a consequence, the student gradually showed a positive attitude towards problem-solving. This is a good approach because commonly, students have a hard feeling in math. Brown & Walter (2012), in their book entitled "The Art of Problem Posing" admitted that there are many reasons why people have this feeling, for instance, because of the focus on "right" answers. Consequently, people worry that they will not be able to reach what they believe as the "right" answers. Brown & Walter concluded, "*… given a situation in which one is asked to generate problems or ask questions—in which it is even permissible to modify the original thing—there is no right question to ask at all. Instead, there are an infinite number of questions and/or modifications and, as we implied earlier, even they cannot easily be ranked in an a priori way. Thus, we can break the "right way" syndrome by engaging in problem generation*" Brown & Walter (2012:5).

Thus, considering their perspective, the researcher also accepts that flexibility and freedom of students to generate their questions lead to a positive attitude towards problem-solving in this study. It breaks the "right" answer syndrome. There is no false questioning.

While the direct approach by using the expository method in this study promoted meaningful learning to build students' attitudes. Ausubel, in his study, also said that the advantage of expository leaning is much knowledge is trained meaningfully in a short time (Yildiz & Karabiyik, 2012). In this study, the teacher's role as the center of the learning allows him to control the flow of students' thinking in a more

effective and efficient time, which part students should learn first and what next. It reduces the waste of time in learning and also can play as scaffolding. Pursuant to Vygotsky's theory, "scaffolding" is a piece of his well-known concept, the zone of proximal development (ZPD). ZPD is an area that represents the distance between the level of students' actual mental function development as determined by independent problem solving and the level of potential mental function development as determined by problem-solving through the help of other persons (Vygotsky, 1930).

In line with Vygotsky's theory, the researcher believes that good scaffolding may produce better students' attitudes, as this study depicts a sufficient category of attitude towards problem-solving through a direct approach. The teacher, as the center, has the freedom to guide students to learn step by step according to their level. But, of course, to do this, the appropriate teacher must know better how actual students' condition is such that he also might have a foresight of what to do to strengthen students' attitude towards problem-solving. This possibly one of the reasons why this approach also produces achievement in attitude towards problem-solving as good as the other one. Besides, the direct approach has several powers, such as feedback takes the measure of all students' understanding of the content, the teacher focuses on class objectives, the teacher provides clarity through explanation, all students work on the same assignment (Orlich et al., 2009).

3.2.2. Research question 2: For each indicator of attitude, is the attitude towards problem-solving of students who get learning by the problem-posing approach better than by the direct approach?"

According to the descriptive data, the mean of patience, persistence, and perseverance by problem-posing was higher than by direct approach. But, this result did not contribute to a meaningful difference as proven by the mean difference test for each attitude indicator. The test resulted in patience, persistence, and perseverance by the problem-posing was indeed not better than the direct approach. Looking more detailed into the standard deviation of the three indicators for each class, the range of the lowest and highest score for each class was not much different. It is interpreted that the range of attitude levels in both classes also is the same. This could happen because ordinarily, both approaches have the same goal that is to make students understand, comprehend, and internalize the knowledge given. When students accept the learning process positively, they will show positive attitudes.

In the indicator of willingness and confidence, the mean difference test decision is interpreted as these attitudes in problem-posing class are better than in the direct approach. The confidence in posing a question is to believe that he is able to solve the problem, and the willingness is a will of oneself with a positive intention to start solving the problem and accept the risk if the steps chosen do not easily reach the solution, as stated by experts Beaver (Zakaria et al., 2004) and O'Connell (Mohd & Tengku Mahmood, 2011). Problem posing activities are preceded by a willingness and confidence to be able to ask a good question about the problem faced before taking the process of persistence and perseverance with patience in carrying out the settlement plan. Through learning by using the problem-posing approach, both aspects are trained continuously so that the achievement of these two indicators is better than learning with the direct approach.

In this study, students are accustomed to asking good questions. Along with the willingness to ask, students feel more confident in expressing their opinions, students increasingly believe in their ability to solve problems. These factors are a good provision for students to solve problems. This result strengthens the study of Guvercin and Verbovskiy that active students' engagement and more participation promote better confidence and positive attitudes. Problem posing has a positive effect on self-efficacy. This approach lessens students' anxiety that is not a good cause for self-efficacy beliefs. Freedom of asking question and discussion with the teacher equip a good improvement for students' self-confidence (Guvercin & Verbovskiy, 2014). Charles and Lester (Labe, 2015) also agreed that the willingness to be involved in tasks and the confidence to succeed is the most important characteristics in problem-solving. In their study, Zakaria & Ngah (2011) found that willingness is at a high level, while perseverance and confidence of students toward problem-solving are at a sufficient level.

What the researcher found interesting is in problem-posing class, the mean of patience and persistence is higher than the mean of perseverance, willingness, and confidence. Those indicators are the new indicators that the researcher added from the previous research. Analyzed from the items of the questionnaire, it is probably because when students practice formulating the problem from a given situation, they need the patience to reach a solution. If it fails in the first step, students must be patient to

find other appropriate steps. If the problem spawned a long step, students must be patient to run the step carefully. Students read the questions carefully to understand the purpose of the problem before starting to solve; they are not in a hurry in finding the right answer; that's what is also taught in learning by using a problem-posing approach.

In addition, for students to formulate problems at first is not easy, because learning with the problem-posing approach is a new way of thinking for students. Therefore, persistence is very necessary to formulate the most relevant question to the given situation. Getting used to being involved in problem-posing activities and then solving problems can thus foster student persistence in solving problems. Students are not easily discouraged when the answers they give to a problem are not yet correct. From the results of the questionnaire, students remember the questions that they have not been able to solve. Even they continue to think about the solution even though class time is over. Students work hard at solving problems, take a break, then think harder when they have not found the right answer yet. Therefore, from the results of this study, in problem-posing teaching and learning, the aspects of patience and persistence also need to be maintained.

4. Conclusion

Considering the learning approach, the attitude towards problem-solving by problem-posing approach was not significantly better than by direct approach; specifically, it was equally good and at a sufficient level. However, viewed more detail in each indicator of attitude, students' willingness and confidence in solving problems by the problem-posing approach was better than the direct approach. In the class of problem-posing approach, this approach had made students had patience and persistence that were more prominent than aspects of perseverance, willingness, and confidence in solving problems. Thus, it is suggested that teachers and educators to try to perform the problem-posing approach. Moreover, the problem-posing instructional strategy theory used in this study is also interesting to become an alternative for teachers.

This is an experimental study. Hence, the finding can only be generalized to its population. Expanding the population and sample size might result in different achievements. The indicator of attitude in this study might be useful. Educators necessarily have to be aware of students' attitude towards problem-solving. Instrumentation in this study was adapted from previous research. Nevertheless, it needs adjustment to a different culture and sense of meaning. This step might need a longer time and more effort from the researcher. Initiate further research using the indicator in this study would be meaningful.

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