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Construction of Open-Ended Problems for Assessing Elementary Student Mathematical Connection Ability on Plane Geometry

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Abstract. The aim of this study is to construct open-ended problems about plane geometry for measuring mathematical connection ability. And to determine the profile of mathematical connection ability. The instrument test is 4 geometry problems. The problems is assessing four ability in mathematical connection at elementary school. The subject of this research is 50 students 6th grade of one elementary school in Bandung. The instrument is repairing base on suggestions from the four expert validation. The result validity of instrument show that problem no. 1 is 0,579 with categories enough validity, problem no. 2 is 0,809, no. 3 is 0,765, and no. 4 is 0,790 with categories high validity. The validation test show that instrument is a good quality. The reliability of instrument show 0,762 with categories high reliability. The distinguishing capacity for instrument no. 1 is 0,2857 with categories enough, no. 2 is 0,8036 and no. 3 is 0,7679 with categories very good, no. 4 is 0,4643 with categories good. The difficulty level of question for no. 1, 2, 3 is moderate, and no. 4 is difficult. The profile of mathematical connection ability of 6th grade elementary students on plane geometry is low. Base on result and analysis, the conclusion is that open-ended problem can be used to assessing elementary student mathematical connection ability.

1. Introduction

One of the six principles fundamental to high-quality mathematics education is assessment. The term *assessment* is defined as “the process of gathering evidence about a student’s knowledge of, ability to use, and disposition toward mathematics and of making inferences from that evidence for a variety of purposes”[1]. Note that “gathering evidence” is not the same as giving a test or quiz. Assessment can and should happen every day as an integral part of instruction. Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.

The Assessment Principle stresses two main ideas: (1) Assessment should enhance students learning, and (2) assessment is a valuable tool for making instructional decisions [2]. It means assessment should not merely be done to students; rather, it should also be done for students, to guide and enhance their learning. Assessment that includes ongoing observation and student interaction encourages students to articulate and, thus, clarify their ideas. Assessment is important role in learning process until after learning ending. Whereas assessment is the most important in the evaluation of learning. It due to evaluation of student learning is done by the teacher to monitor the process and the



progress and improvement of learning outcomes on an ongoing basis. This indicates that evaluation is feedback for what learning goes well or not.

Mathematical connection is one of five process standards refer to the mathematical processes through which students should acquire and use mathematical knowledge. The connections standard has two parts. First, it is important to connect within and among mathematical ideas. Second, mathematics should be connected to the real world and to other disciplines [3]. Students should see that mathematics plays a significant role in science, language arts, and social studies. This suggests that mathematics should frequently be integrated with other discipline areas and that applications of mathematics should be explored in real world contexts.

Mathematical connection supports students to comprehend a concept substantially and assists them to improve their understanding and it's helps students provide a mathematical model that illustrates the relationship among concepts, data, and situation [4]. In fact, many find the questions of connection still become a problem for student as especially for elementary student. It show in some research said student have a low of mathematical connections ability [5]. This means that evaluations need to be considered.

The type of problem used in learning proces with open-ended approach is not routine and open problem. Open process means that the task type has several correct ways. Open end products mean that the task type has multiple answer possibilities. Finally, open ways to develop means that when the students have solved their previous problems, they can solve new problems by changing the condition of the previous problem [6]. Using the open-ended approach, students is working individually or in groups, are expected to apply their own unique methodology to solve given problems. These problems are so designed, that there may be more than one correct answer or there may be more than one way of arriving at an answer, thus they are able to challenge students at various levels of cognitive development [7].

To construct open-ended problem we can develop from the given problem. It is easy for students to start mathematical activity from the given open ended problems. It is also so suitable for teachers to investigate how their formulated open-ended problems have been engaged in by the students [8]. One more advantage of open-ended problems is that every student, no matter if he/she is highly capable or struggles with mathematics, can try and find his own solutions to the problems depending on his own scope and level of abilities [9].

The study of geometric shapes and their properties is an essential component of a comprehensive elementary mathematics curriculum [10]. So it's important for elementary student to learn about geometry. Geometry is rich in concepts, problem-solving experiences, and applications [11]. Learn about geometry not just learn about formula, but we can learn others subject to solving problems of geometry. So by using open ended problems on geometry we can give student an experience to solving problems and to applied their knowledge about plane geometry.

Based on some preconception, we try to make a constructing an instrument test for measuring students mathematical connection ability using open-ended problems.

2. Experimental Method

The research method was used quantitative method. Quantitative research was an approach for testing objective theories by examining the relationship among variables. These variables, in turn, could be measured, typically on instruments, so that numbered data can be analyzed using statistical procedures [10]. The final written report had a set structure consisting of introduction, literature and theory, methods, results, and discussion. Like qualitative researchers, those who engage in this form of inquiry have assumptions about testing theories deductively, building in protections against bias, controlling for alternative explanations, and being able to generalize and replicate the findings.

The purpose in this study was construction question and determine the profile of mathematical connection ability elementary students. Type of question was open ended problem in plane geometry. The sequential exploratory strategy was used in this research. The first, collection and analysis data. Two steps for this stage were literature study and expert validity. Instrument test for measuring connection ability in geometry were data obtained. Then data were analysed. Analysis was done for gotten a good instrument test. The second, collection and analysis data were done by statistical

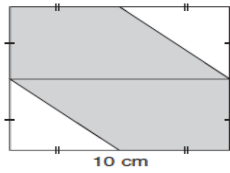
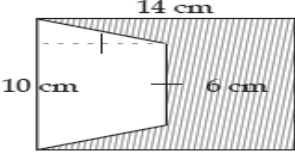
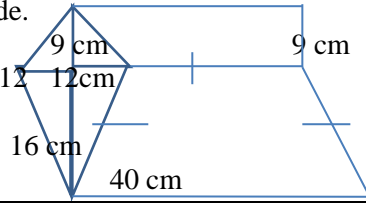
procedures. The steps for this stage were reliability, distinguishing capacity, and difficulty level of questions. Then these data were analysed. The last, we were getting full data and were interpreted.

The population of this study was student of 6th grade from one of elementary school in Bandung. Then sample based on population is two of four class with sampling technique used was purposive sampling class. The number of student were 50 as participant. Generally, several steps were needed to construct instrument test was include: 1) Made test specification, such as determine the purpose of test, blue print of test, shape of test, and determine length of test, 2) Wrote question of test, 3) Checked question of test, 4) Done try out of test, 5) Analyzed every question of test, 6) Repaired question of test, 7) Remaked test, 8) Done test, and 9) Interpreted result test [11].

3. Result and Discussion

The purpose construction of instrument test was determine student's connection ability about geometry at elementary school. So that geometry was focus of material in this study. Based on this purpose, the shape of test in this research was open-ended problem. After made test specification and wrote blue print of test, open-ended problems consist of 4 problems, with specification one problem for every indicator in mathematical connection ability. The open-ended problems in plane geometry which contain indicator in mathematical connection ability are presented in Table 1.

Table 1. The open-ended problems in Mathematical Connection Ability

Mathematical Connection Ability	Indicator	Open-Ended Problem
To connect inter-topics in mathematics that connect inter-concept or principle in the same topic	Describe connection inter-topics in mathematics	Mr. Amir is a gardener. He will make a parallelogram garden with 18 m ² area. a. Determine the measurement of Mr. Amir garden? Make it in table! b. Determine the biggest around of Mr. Amir garden? Make it in table!
Connection between topics in mathematics that connect one material and other materials in mathematics	Determine solving way that connect one and other materials in mathematics	A rectangle tablecloth look like the picture beside. It's have a 4: 5 proportion between long and wide.  a. Determine the long and wide of the tablecloth? b. Determine the area of the tablecloth? c. Determine the shaded in area of the tablecloth?
Connection between mathematics materials and other science	Solve the problem which connect mathematics materials and other science	Mr. Ali have a rectangle garden look like the picture beside. He will plant guava at trapezoid area and papaya at the shaded in area.  a. Count the whole area of Mr. Ali garden? b. Count the area of guava garden? c. Count the area of papaya garden?
Connection between mathematics and everyday life which can be found by students	Checking the effective way to solve problem with others procedure	A flower park look like picture beside. The park will have fence.  a. Count the around of the park? b. Count the area of the park with 2 different way?

Once the open ended problem was made, the assessment then validated by the expert. Validity was a measure that indicates the level of validity or validity of an instrument [12]. Validity can be analyzed by asking expert opinion (expert judgment). Expert judgment was done by asking for ratings of four experts in accordance with the scope of the investigation to ensure that the instruments was made in accordance with the aspects to be measured in the study. The four persons who have experts give feedback and suggestions on instruments had made in terms of material and suitability indicators with questions that are made at follow in Table 2.

Table 2. Feedback and suggestion from expert validation

No.	Expert Validation	Aspect	Feedback and suggestions
1	Expert Validation I	Material	<ul style="list-style-type: none"> The problem must be able to assess connection ability The problem must contain geometry which is open ended problem
2	Expert Validation II	Compliance material with indicators	<ul style="list-style-type: none"> The problem must contain open problem in plane geometry The material must be show the mathematical connection in plane geometry The student must have hands on activities so they make conclusion about the formula in plane geometry
3	Expert Validation III	Language and writing	The picture must be clear and proportion so the student can get information by the picture
4	Expert Validation IV	Language and writing	The language and instruction must be clear so the student known must to do

Based on suggestions from the four expert validation, the instrument repaired with the feedback that had been given. After the repair was completed, the instrument then assessed from the aspect of content, technical, and construct. Assessment conducted by two teachers who are already teaching at 6th grade in elementary school. The result validation show that instrument is a good quality.

After validation expert made, the next step was done validity testing. Instrument validity test performed by the test technique that is by trying out the instrument in a different class. Validity is degree to which evidence and theory support the interpretation of test scores entailed by proposed uses of tests. It is our interpretations of the scores that are either valid or invalid. We might interpret this score as representing how much each student has learned relative to other students [13]. The equation used to determine the validity of the instrument at Equation 1.

$$r_{xy} = \frac{N \sum xy - (\sum x)(\sum y)}{\sqrt{(N \sum x^2 - (\sum x)^2)(N \sum y^2 - (\sum y)^2)}}$$

After we determine validity, the results of calculating of validity was interpreted in a category are presented in Table 3.

Table 3. Interpretation validity in categories

Limited	Category
$0,80 < r_{xy} \leq 1,00$	Very high
$0,60 < r_{xy} \leq 0,80$	High
$0,40 < r_{xy} \leq 0,60$	Enough
$0,20 < r_{xy} \leq 0,40$	Low
$0,00 < r_{xy} \leq 0,20$	Very Low

The analysis process to determine the validity of the instrument was used SPSS 21. The result validity of instrument showed that problem no. 1 was 0,579 with category enough validity, problem no. 2 was 0,809, no. 3 was 0,765, and no. 4 was 0,790 with category high validity.

After validation expert made, the next step was done reliability testing. Instrument reliability test performed by the test technique that is by trying out the instrument in a different class. Reliability is measured by the correlation coefficient of result test. When the positive and significant correlation coefficient of the instrument has been declared reliable [14]. The equation used to determine the reliability of the instrument at Equation 2.

$$r_{11} = \frac{2r_{\frac{1}{2}\frac{1}{2}}}{(1 + 2r_{\frac{1}{2}\frac{1}{2}})}$$

Having calculated the coefficient of reliability, this value is interpreted in a category at follow in Table 4.

Table 4. Interpretation reliability in categories

Limited	Category
$0,80 < r_{11} \leq 1,00$	Very high
$0,60 < r_{11} \leq 0,80$	High
$0,40 < r_{11} \leq 0,60$	Enough
$0,20 < r_{11} \leq 0,40$	Low
$0,00 < r_{11} \leq 0,20$	Very Low

The analysis process to determine the reliability of the instrument was used SPSS 21. The result reliability of instrument showed that 0,762 with category high reliability.

After reliability tests was conducted, the distinguishing capacity intended to determine the extent of open ended problem could differentiate high-ability students with low-ability students [15]. The equation used to determine the distinguishing capacity of the instrument at Equation 3.

$$DP = \frac{JBA - JBB}{JSA}$$

After we determine distinguishing capacity, the results of calculating of distinguishing capacity was interpreted in a category at follow in Table 5.

Table 5. Interpretation distinguishing capacity in clasification

DC Value	Clasification
$0,00 < DC \leq 0,20$	Bad
$0,20 < DC \leq 0,40$	Enough
$0,40 < DC \leq 0,70$	Good
$0,70 < DC \leq 1,00$	Very Good

Based on the results of calculating, distinguishing capacity for problem no. 1 was enough, problem no. 4 was good, and problem no. 2, 3 was very good.

After distinguishing capacity was conducted, then we calculating the level of convenience. The level of convenience is a number that indicates something about the difficult and the easy [16]. Convenience items is an overall proportion of students who answered correctly on the item was. To calculate the level of ease of each items used Equation 4.

$$P = \frac{\sum B}{N}$$

After calculating, we interpreting in a category at follow in Table 6.

Table 6. Interpretation the level of convenience in categories

Value	Category
$0,00 < P \leq 0,30$	Difficult
$0,30 < P \leq 0,70$	Moderate
$0,70 < P \leq 1,00$	Easy

The results of calculating found that category difficult for question no. 4, and then 3 for category moderate for no. 1, 2, 3. After analysis of all questions, 4 questions were made.

The ability in mathematical connection at elementary school can be represented by four indicator as follows; (1) to connect inter-topics in mathematics that connect inter-concept or principle in the same topic, (2) connection between topics in mathematics that connect one material and other materials in mathematics, (3) connection between mathematics materials and other science, (4) connection between mathematics and everyday life which can be found by students. The profile of elementary student's mathematical connection ability on geometry can be seen from the answers and the obtained scores on open ended problems. The four mathematical connection ability are presented in Table 7, 8, 9, and 10.

Table 7. Ability profile in connect inter-topics in mathematics

Interval Value	Frequency	Percentage (%)	Category
$75 < t \leq 100$	1	2	Very good
$58.33 < t \leq 75$	6	12	Good
$41.67 < t \leq 58.33$	21	42	Enough
$25 < t \leq 41.67$	16	32	Low
$0 < t \leq 25$	6	12	Very low
The average value		40.00	Low

Table 7 shows that the ability profile in connect inter-topics in mathematics is low. Only one student who have very good category. And 6 students who have very low category. The student still have some difficulty to determine parallelogram measurement with certain area. And to determine the biggest around of parallelogram with certain area. It's shows that the students ability to connect between area, measurement, and around concept on plane geometry is still low.

Table 8. Ability profile in connection between topics in mathematics

Interval Value	Frequency	Percentage (%)	Category
$75 < t \leq 100$	10	20	Very good
$58.33 < t \leq 75$	2	4	Good
$41.67 < t \leq 58.33$	8	16	Enough
$25 < t \leq 41.67$	7	14	Low
$0 < t \leq 25$	23	46	Very low
The average value		34.50	Low

Table 8 shows that the ability profile in connection between topics in mathematics that connect one material and other materials in mathematics is low. Ten students have very good category. And 23 students have very low category. The student still have some difficulty to determine area from the proportion of long and wide that given. And determine the shaded area from picture given. It's show that the students ability to make connection between proportion with plane geometry topics is low.

Table 9. Ability profile in connection between mathematics materials and other science

Interval Value	Frequency	Percentage (%)	Category
$75 < t \leq 100$	14	28	Very good
$58.33 < t \leq 75$	3	6	Good
$41.67 < t \leq 58.33$	3	6	Enough
$25 < t \leq 41.67$	9	18	Low
$0 < t \leq 25$	21	42	Very low
The average value		40.00	Low

Table 9 shows that the ability in connection between mathematics materials and other science is low. 14 students have very good category. And 21 students have very low category. The students still have some difficulty to count whole area and certain area from picture given. The picture are show trapezoid in rectangle. It's show that students ability to make connection between plane geometry topics with garden area context is low.

Tabel 10. Ability profile in connection between mathematics and everyday life

Interval Value	Frequency	Percentage (%)	Category
$75 < t \leq 100$	2	4	Very good
$58.33 < t \leq 75$	1	2	Good
$41.67 < t \leq 58.33$	7	14	Enough
$25 < t \leq 41.67$	17	34	Low
$0 < t \leq 25$	23	46	Very low
The average value		21.00	Low

Table 10 shows that the ability in connection between mathematics and everyday life which can be found by students is low. Only two student have very good category. And 23 students have very low category. The students still have some difficulty to count the around and area from picture given. Student can see the picture as kite and two trapezoid, or trapezoid, rectangle and two triangle. It's need spatial ability to solving the problem. It's show that student ability to make connection between logical ability and spatial ability is still low.

4. Conclusion

The open ended problem on plane geometry can used to assessing mathematical connection ability at elementary student. The mathematical connection ability profile of 6th grade students in elementary school on plane geometry is low. To construct open ended problem at plane geometry, we must to consider what student already about that subject so we can give them new experiences by solving the open-ended problems.

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