Students’ responses to the test instruments on geometry reasoning ability in senior high school

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Abstract. This study aims to determine students’ responses to the geometry reasoning ability test instruments in high school. The research instrument used was the student response questionnaire to the test of geometrical reasoning ability. The study subjects took 28 students of grade XI. The data was obtained after the students having examined with the instrument test of geometrical reasoning ability. The research procedures include; first, the researcher gave the students questionnaire responses after they were asked to do a test of geometrical reasoning ability. Second, the researcher collected data obtained from the students’ response questionnaire. Third, the researchers conducted data analysis by calculating percentages to find out the number of student responses. Fourth, the researchers draw conclusions. The results of the analysis show that the students’ response to the geometry reasoning ability test instruments were very well. Most students show a positive response to the instrument, according to the language used in the instrument is easy to understand, the design of drawings and colors are interesting, and the materials used were adjusted to the level of ability of high school students.

1. Introduction

Education is a human need throughout life. Without human education, it will be difficult to develop and become retarded. While the quality of education is often used as a barometer of a country’s development [1]. Educational success is identifiable through the existing quality of education, including the quality between processes and graduates. Education is considered successful if the teaching and learning process runs well and produces quality output. One indicator of the success of the education level of a nation is identifiable through the number human development index (HDI). However, according to the United Nations for Development Program (UNDP), Indonesia is 108 of the 110 countries in the world that have alarming education levels and far behind neighboring countries in ASEAN [2]. The low quality of education in Indonesia is caused by several factors. One of them is an internal factor such as the ability of students to process lessons received.

Mathematics is one science that has an important role in the development of logical thinking ability, analytical, systematic, critical, and creative, and can be used to solve the problems faced in everyday life [3]. Mathematics is an excellent vehicle for the development and improvement of a person’s intellectual competence of a student [4]. Complex mathematical tasks that can encourage higher order thinking skills...
that involve thinking, analysis, and synthesis [5]. Mathematics appears from the results of human thought related to ideas, processes, and reasoning. As mathematical material and mathematical reasoning cannot be separated, this is because mathematics is understood through reasoning and reasoning understood and trained through mathematical material [6]. Reasoning is a skill that demonstrated during an advanced stage of thinking in the problem-solving process. Mathematical reasoning also refers to the ability to formulate a given mathematical problem to explain and justify solutions or arguments [7]. According to Permendiknas Number 22 of 2006, reasoning ability is one of the competencies that every student should have [8]. The reasoning is important in learning mathematics because it helps students to construct their knowledge and support their academic development [9]. It should be noted that during this time the central problem in mathematics education is that we want student to become problem solvers, but many students still do rote thinking [10]. Certainly, this phenomenon somewhat deviates from the objectives of mathematics learning, from which the management of mathematics learning in schools is so meaningful and able to stimulate students to apply their mathematical knowledge into the context of everyday life and other fields, skilled in solving problems both in mathematics and in fields other related, and students are able to develop their reasoning forces. However, the reality that occurred in the field was that students' reasoning abilities were still relatively underdeveloped, this was indicated by the low quality of the students' own understanding. The reasoning ability is not an innate ability, but reasoning is influenced by many factors. One of the factors that can influence the development of scientific reasoning is the approach, models and teaching methods used by teachers [11]. Accordingly, the teacher must also have the ability of mathematical reasoning inhabiting to be able to assist students in improving their reasoning. In fact, teachers often only invite students to learn routine questions, so students have not honed their mathematical reasoning ability in mathematical materials [7]. Teachers are too concentrated on procedural matters and mechanistic, mathematics concepts are often delivered is informative, and students are trained solve a lot of problems without a deep understanding [12]. In this case, the teacher more often delivered material through the method of lecturing and provided examples. It was found that teachers rarely asked students to find their own mathematical concepts. Consequently, this leads students’ ability to work on math less developed, they tend to work on tasks based on the examples delivered by the teacher. In case students found any mathematical problem they tend to be confused in dealing with it. Moreover, if the tasks were unfamiliar to them, or things beyond people's common everyday life. This problem in mathematics is called a non-routine problem and requires organizing knowledge at the end. The non-routine problems are applied to train students' reasoning skills in dealing with them. This problem needs to be systematically resolved through mathematical concepts that have been studied. However, in reality, in solving mathematical problems students have not used systematic methods because they are not used to using their reasoning skills to think. Therefore, students' ability to solve math problems is less than optimal. As a result, mathematical reasoning ability of students do not develop properly. This can be seen from the lowest average percentage achieved by Indonesian students in the cognitive domain at the level of reasoning (17%) [13]. Priatna in Nataliasari [14] also argues that the quality of reasoning and mathematical understanding of students is far from satisfactory, where each is only about 49% and 50% of the ideal score. As for one factor the low reasoning ability of students is the unavailability of training questions that teach students about how to start and develop reasoning skills. In line with Pulungan's criticism [15] that mathematical literacy ability including reasoning, has not been maximally trained due to the unavailability of practice questions implemented as measuring indicators of the students' mathematical literacy abilities.

In learning mathematics, there is a subject which is fundamental and important, the so called geometry. Geometry is sometimes thought of an investigation or discovery of pattern and relationship in shape, size and place (position). In other words, in geometry will be studied the relationship between point, line, plane and space to conduct the investigation [16]. The geometry material is taught by students since they are at the elementary to high school level. But, in fact, students get difficulty on learning geometry [17]. This is in
line with Maharani's opinion [18] that in general, the students' creative thinking ability in the field of geometry is still relatively low. Yuwono [19] also argues the same thing, where students find it difficult to remember geometric formulas and arrange the steps used in solving problems in the geometry domain, this shows that a number of students still have difficulty in solving geometry problems. In part of solving geometry problems, it is required the ability to reason both to understand mathematical concepts and strategies used to solve geometry problems [20]. Therefore, to cope with such problems, a series of instruments for geometrical reasoning are needed to be tested on students, so that at certain points in the individual mathematics learning process, they are familiar with geometry problems.

This study aims to determine students' responses to the instrument test geometry reasoning abilities. The responses of students in learning are responses and reactions from them towards learning conditioning by the instructor [21]. In this case, students provide responses to the test instrumentss used by the teacher to evaluate mathematics learning. This study is technically still dependent on geometry ability test instruments. Thus the sample used remains depends on small research. This consequently concludes the instrument which is only limited to the school environment where the research is conducted. Further research is expected to be able to expand the sample and broader research variables.

2. Method
This study conducted in one of the high schools in Surakarta was chosen using purposive sampling. This study belongs to the type of research and development study. The data were obtained based on the results of student response questionnaires given after they used the test instruments for geometrical reasoning abilities. This method applied in this study significantly aims to find out the aspects of presentation, graphics, and feasibility of test instrumentss for geometrical reasoning abilities. The research subjects took 28 students of heterogeneous characters. The research instruments were in the form of questionnaires on student responses to tests of geometrical reasoning abilities. The research procedure was divided into several activities; firstly, the researchers gave students’ response questionnaire after they implemented the geometry reasoning ability test instruments. Secondly, the researchers collected data obtained based on student response questionnaires. Thirdly, the researchers conducted an analysis with a percentage that aimed to determine the numbers for students' responses regarding the test instrumentss they were working on. Fourthly, the researchers draw a conclusion. The instrument assessment was carried out by 8 validators. Based on the results of the assessment, Aiken's index is calculated for each item. Overall, the Aiken’s index on each item fulfills the criteria of \( \geq 0.30 \), therefore, the items are demmed to be valid.

In this study, the students' responses percentage was calculated using the following formula [22]:

\[
\text{Percentage} = \frac{\text{total number of the obtained scores}}{\text{maximum score}} \times 100\%
\]

The conversion of the students' responses to their level of achievement on the geometrical reasoning abilities tests, which was highly inspired from the developed model by Stefany [23] as illustrated in Table 1.

| Achievement level (%) | Category          |
|-----------------------|-------------------|
| 90 – 100              | Very good         |
| 80 – 89               | Good              |
| 65 – 79               | Enough            |
| 55 – 64               | Less              |
| 0 – 54                | Very Less         |

Table 1. The Conversion of the Students' Responses Level of Achievement.
One of the test instruments on geometry reasoning ability was addressed in this study, namely a seminar where the speakers were given a memento in the form of a miniature Tugu Jogja. The miniature at that time was packed in a pyramid-shaped package with a square base with 16 cm ribs. The mat is made of black wood and reads “TUGU JOGJA” while the lid is made of glass. The wood mat is inside the glass. If the width of one upright side is 160 cm², then what is the length of the upright ribs of miniature packaging? What is the area of glass used in creating the miniature? If the first base thickness is 2 cm, what is the maximum height of the Tugu Jogja miniature that must be made? Explain your answer!

3. Result and Discussion

The filling in the questionnaire responses of the students was carried out on a limited scale test which took 28 students of grade XI. The students' responses to the geometrical reasoning ability test instrument focus on aspects of presentation, graphics, and the appropriateness of the instruments they were described in Table 2, Table 3, and Table 4.

Table 2. The Results of Students' Responses Questionnaire on the aspect of Presentation.

| No | Statements of the Questionnaire | Percentage |
|----|--------------------------------|------------|
| 1. | The instructions for working on the reasoning ability test instruments are both comprehensible and clear. | 83.93% |
| 2. | The sentences in the test questions do not offend me. | 89.29% |
| 3. | The sentences used as the instrument test questions for reasoning ability are relatively easy to understand. | 81.25% |
| 4. | The presentation of questions on the instrument of reasoning ability test begins from the easy to difficult. | 82.14% |
| 5. | The information and images as the test instrumentss in measuring the reasoning abilities are realized based on truth facts. | 77.68% |

Table 2 concludes that in terms of presentation, the geometry reasoning test instruments is classified as good with an average percentage of 82.86%. A total of 28 students on a limited scale test showed that the presentation of language and construction of the instrument was good. This was identified by students' responses when filling out the questionnaire, where most students gave a score of 4 (very good) in each statement.

The first statement reflects the instructions for using the instrument, there are 13 students giving a score of 4 (very good), 12 students giving a score of 3 (good), and 3 students giving a score of 2 (less). Based on the student's response reached 83.93% which indicates the instructions for using instrument are classified as good. This is because the instructions have already been clear and easily understood by students. In the second statement, 16 students gave excellent responses and 12 students gave good responses. In the second statement, about 89.29% is classified as good. That means, the sentences that compose an idea are expressed through correct grammar and imply meanings that hurt the reader. In the third statement, as many as 7 students responded with very good and 21 students gave good responses. In the third statement 81.25% is classified as good. This means that the sentence used in the test questions is easily understood by students. In the fourth statement about the difficulty of the questions being tested, 11 students gave very good responses, 14 students gave good responses, and 3 students gave less responses. In the fourth statement, the percentage of 82.14% is classified as good. Despite the fact that there are students who respond less but most students identify the presentation of questions is good for it has been adjusted based on the level of difficulty of students ranging from easy to difficult. In the fifth statement discussing the presentation of information and images, 7 students gave excellent responses, 18 students gave good responses, 2 students gave less responses, and 1 student gave very little response. In the fifth statement found the result of 77.68% is categorized as enough. That is, the presentation of information and images is still not in accordance with the reality that exists for it received enough responses from students.
Table 3. The results of Students’ Questionnaire Responses for Graphical Aspect.

| No. | Statements of the Questionnaire                                                                 | Percentage |
|-----|-----------------------------------------------------------------------------------------------|------------|
| 1.  | The figures displayed in the reasoning ability test instruments have been adjusted to the questions being asked. | 83,04%     |
| 2.  | The figures displayed in reasoning ability test instruments have been presented interestingly.  | 73,21%     |
| 3.  | The texts written on the test instrumentss of reasoning ability are easy to read.              | 80,36%     |
| 4.  | The type and size of the selected letters are appropriate, thus the instrument test becomes more appealing. | 78,57%     |
| 5.  | The reasoning ability test instruments is neatly printed.                                       | 87,50%     |
| 6.  | The selected colors on the cover of the test instruments for reasoning ability have been appropriate and appealing. | 79,46%     |

Table 3 concludes that in terms of graphics, the geometry reasoning test instruments is classified as good with an average of 80.36%. A total of 28 students on the limited scale test gave their responses that the images, writing, and colors used in the instrument were good. This refers to each statement, where each of them is identifiable to obtain a good response.

In the first statement about the image, as many as 11 students gave a very good response, 16 students gave a good response, and 1 person gave very little response. Based on the students' responses, 83.04% were classified as good. Even though there are students who respond less but most students judge that the images presented are good. The response is in accordance with the questions on the test instruments. In the second statement, 2 students gave very good responses, 23 students gave good responses, 2 students gave less responses, and 1 student gave very little response. The second statement amounted to 73.21% which was classified as enough. Based on the students' responses, the use of images is still not very interesting, it is not surprising that such statements only get enough responses from students. In the third statement about text and writing, as many as 8 students gave very good responses, 18 students gave good responses, and 2 students gave less responses. In the third statement a number of 80.36% is classified as good. This means that the writing texts used in the instrument are clearly informed, thus, easy to read. In the fourth statement about the type and size of letters, as many as 7 students responded very good, 18 students gave good responses, and 3 students gave less responses. In the fourth statement, a percentage of 78.57% is classified as enough. Based on these results, students respond related to the writing of letters and views classified as less appealing, this is the reason the students only gave enough responses. In the fifth statement regarding the neat points of the instrument, 14 students gave excellent responses, and 14 students gave good responses. In the fifth statement, it was found that 87.50% were classified as good. This means that the instrument has been presented neatly. In the sixth statement about color display, as many as 5 students responded with very good, and 23 students responded with good. In the sixth statement obtained at 79.46% classified as Enough. This means that the display of colors presented is still relatively unattractive, it is not surprising that the points of this statement only get enough responses from students.

Table 4. The results of the Students' Questionnaire Responses on the Aspects of Instruments Feasibility.

| No. | Statements of the Questionnaire                                                                 | Percentage |
|-----|-----------------------------------------------------------------------------------------------|------------|
| 1.  | The reasoning ability test instruments presents questions according to the material I have learned. | 87,50%     |
Table 4 concludes that in terms of instrument feasibility, the geometry reasoning test instruments is classified as good with an average of 81.25%. It was found that most of the students responded to the test instruments to motivate students to be active in working on the questions and encourage them to do reasoning activities. The results can be seen from the percentage of each statement, each of the statements mostly classified into good categories.

In the first statement about material compatibility, as many as 15 students gave very good responses, 12 students gave good responses, and 1 person gave less response. Based on student responses, the percentage of 87.50% is categorized as good. Although there are students who responded less but most students believed that the materials are in accordance with the material they are learning in. In the second statement, 8 students gave very good responses, 18 students gave good responses, and 2 students gave less responses. In the second statement, the result of 80.36% is classified as good. That is, the test items in the geometry reasoning instrument are in accordance with the students' knowledge. In the third statement, as many as 10 students gave very good responses, 16 students gave good responses, and 2 students gave less responses. In the third statement a total of 82.14% were classified as good. The geometry reasoning test instruments challenges students to work on each given question. In the fourth statement regarding the presentation of information, as many as 7 students responded very well, 17 students gave good responses, 2 students gave less responses, and 2 students responded very less. In the fourth statement a total of 75.89% is considered enough. Based on these results, students responded that information related to the questions given was still rare, as a result this statement only received enough response. In the fifth statement about the benefits of the instrument, as many as 11 students gave very good responses, 16 students gave good responses, and 1 student gave less response. In the fifth statement, the percentage of 83.93% is classified as good. This means that geometrical reasoning instruments provide benefits both directly and indirectly to students. In the sixth statement, 7 students gave very good responses, and 21 students responded with 'good'. In the sixth statement, a total of 81.25% is categorized as good. This means that the items in the instrument strongly provide motivation for students to be more active in other math problems. In the seventh statement, 8 students gave very good responses, 17 students gave good responses, and 2 students gave less responses. In the seventh statement a total of 81.25% is classified as 'good'. This means that the test instruments proved not to lead students lazy in learning about mathematics. In the eighth statement, as many as 5 students responded with very good, 21 students responded with only 'good', and 2 students responded with less. In the seventh statement there is 77.68% which is classified as 'enough'. Based on these results, it implies that students' responses are related to geometrical reasoning instruments which in practice lack encouragement for students to be consistent in learning mathematics. Therefore, this statement only gets 'enough' responses from students.
The results of the analysis related to the presentation aspects of the geometry reasoning ability test instruments showed 82.86% were categorized as good. Good categories of presentation aspects mean that the test instruments used are well understood by students. Likewise the language used is not difficult to understand especially cause multiple interpretations, which is thus able to motivate students to work on various instrument questions. This is in accordance with Sitepu’s suggestion that the use of appropriate language facilitates understanding, thereby increasing learning motivation [22]. As for the graphical aspects, the geometrical reasoning ability of the test instruments was 80.36%, is categorized as good. The results above show that the test instruments has been constructed according to the students’ ability in addition to the presentation looks neater. The design of images and colors used is also appealing, this allows attracting students’ interest and motivation to learn. It is in line with Posia’s study which concluded that the use of image media participated in increasing the students’ learning motivation [24]. For the feasibility aspect the geometry reasoning ability test instruments shows 81.25% which is categorized as ‘good’. The questions reflected in the test instruments are in accordance with the students’ common given materials at the high school level. Thus, it encourages students to work on the questions.

4. Conclusion
The average percentage of students’ responses regarding instrument testing was aimed at exploring and determining the students' geometrical reasoning abilities, in the aspect of presentation it was obtained 82.86%, graphical aspects showed 80.36%, and the instrument feasibility aspect was 81.25%. Overall, students' responses to the test instruments were categorized as good as 81.49%. The indicators of this category include the use of language of easily understand, the designing aspects of having an appealing sense on both drawings and colors, as well as material questions have been set out in accordance with the high school students’ level. Therefore, the geometry reasoning ability test instruments can be well received by students.

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