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Measuring of student learning performance based on geometry test for middle class in elementary school using dichotomous Rasch analysis

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Abstract. Understanding of geometry concept properly and precisely can stimulate students to representing and expressing the world around in orderly order. This study was designed to measure student’s ability in answered geometry exam. The study involved 186 students in elementary school. Data collected based on the results of midterm examination; conducted in March 2018 and analysed using dichotomous Rasch model approach. The results of this study show that overall the students ability in identifying the number of sides in geometry image is fascinating. Unfortunately, students get it difficult to work on narrative test in geometry. It is clearly recognized that students experience difficulties in explaining and determining the circumference and square area, rectangular and triangular and second-rank relations with square roots. Furthermore, there are excellent students taking on geometry questions on certain competency requirements; and there are students failed to finish geometry exam properly. The quality of tests applied to students in mathematics exams is also a substantial issue into the discussion on this article. The findings of this research can be a substantial input for classroom teachers in developing suitable geometry learning methods and dealing with the issues linked to students' ability to learn geometry in elementary schools.

1. Introduction
Mathematics is a complex study and indeed become a "scourge" for some students in school [1–4]. Students' reactions toward mathematics can also be determined by notices on whether math is entertaining, valuable and essential for success in school and future career goals [5]. Nevertheless, the teacher takes the responsibility to prepared and managing students to understand the math subject dealing to the standard of competence required in the school. It is essential that elementary teachers find out the nature and extent of the critical part that they participate in learning mathematics to their students [6,7].

Information about students' learning ability and performance on mathematics or other subject matter in school can be identified through exams. One of the exams operated as an assessment index in this article is a midterm exam. The results of the test can provide a profile of learning performance of
elementary school students to the subjects on mathematics, which can formerly to be applied to determine the steps as follow-up for optimization on mathematics learning and student’s achievement.

1.1. Geometry test in elementary school
The learning of geometry in the school designs to facilitate students, (1) to gain confidence in their mathematical abilities, (2) to be suitable problem solvers, (3) to get through mathematically, and (4) reasoning in math [8,9].

On-hands activities, such as operating geoboards or paper dots to build and explore the properties of various polygons, are extremely important to the development of student reasoning [10]. In addition to other factors, the selection of test types to assess students' mathematical skills is also significant for teachers to recognized.

1.2. Dichotomous rasch analysis
The obvious difficulty in constructing such measures in the human sciences is the unclear nature of the qualities of persons and phenomena to be quantified[11]. Learning ability as latent variable. Most people are familiar with the calculation of a test score based on a simple summation of correct responses to a set of dichotomously scored multiple-choice items (incorrect = 0, correct = 1)[12].

The statistical point of view is thus unavoidable. From this point of view, the sufficiency of the raw score is crucial[11]. Measurement using Rasch model can overcome those weaknesses [13–16]. The Rasch model is a useful tool for converting raw observational data into item difficulty and person ability estimates on an approximately linear measurement and not dependent on sample size [17–19].

The Rasch Model for Dichotomous Data. The relationship between the person ability and an item difficulty is described by a probability. The probability of the same person not correctly answering the same item is given by P = 1 – Pni. If one looks carefully at the model, it really summarizes the key ingredients of Rasch, and one can see that the Rasch model really emphasizes the importance of a single trait [20].

2. Methods

2.1. Participants
The research covered 186 students (mean age = 9.67 years old) grade IV elementary school in South Jakarta. Students are enrolled and engaged in teaching-learning projects at school. Furthermore, no credit earned by students from the schools where the student works for his/her participation in this research. All student actions in this research is a credential.

2.2. Procedures
The geometry test is administered by the classroom teacher. The execution of the test was organized in March 2018. Students deal with the geometry questions in paper-based format. The duration of the exam is 90 minutes. No students are slow in securing test proceeds.

2.3. Measuring
Geometry test was to serve in this research. The test is arranged by classroom instructors by pointing out to the competency standards and key competencies of students in learning geometry in elementary schools. The phenomenon is verified, i.e. the student is qualified to (1) analysing the properties of many irregular and irregular facets (KD 3.8); (2) explaining and determining the girth and area of the square, rectangular and triangular and the strength of two with the square root (KD 3.9), and; (3) describe the relation between lines (parallel, intersect, coincide) using concrete design (KD 3.10). The three-competency test of geometry study was drawn up into 35 multiple choice questions; which a score 1 is provided for the correct answer and score 0 for the incorrect answer.
2.4. Data analysis

The results of the data collection were analysed using dichotomous Rasch analysis performed by WINSTEPS 3.73 [21] and the datasets can be accessed on osf.io/dev7g Open Science Framework [22].

3. Analysis and results

To accomplish the objectives on this research, the report is driven out in two stages: (1) assessing the properties and quality of geometry tests handed over by the instructor to the students, and (2) assessing each student's ability in performing the geometry test.

3.1. Quality of geometry test for elementary students

There are four aspects of testing performed to evaluate the geometry test, namely (1) reliability and separation index, (2) dimensionality test, (3) fit and misfit items, and (4) test information function [23].

Table 1. Summary of quality test items.

| Estimation                        | Values |
|-----------------------------------|--------|
| Item Reliabilities                | .96    |
| Separation Index of Items         | 5.07   |
| Mean OUTFIT MNSQ                  | 1.44   |
| Raw variance explained by measures| 27.9%  |
| Raw variance unexplained by measures| 72.1% |
| Observed average (Label 0)        | -.25   |
| Observed average (Label 1)        | 1.36   |

First, we reviewed the reliability of the geometry test. The result of the estimation in table 1 indicates that the reliability of the geometry test produce is at an excellent level. This is also supported by the value of the separation index that can organize the items into five parts, from the simplest to the heaviest. Furthermore, seeking at the observed value is noticed that students are not distracted in figuring out the correct choice of item (Label 1) and incorrect (Label 2). This is proved by a monoatomic development of the observed average value from -.25 logit (low) to +1.36 logit (highest). The fact of the 35 items tested to the students there are 3 items in a misfit geometry test, i.e. item no. 7 (+2.99 logit); item no. 32 (+1.58 logit); and item no 34 (+1.55 logit). The remaining 32 items are declared fit (Item OUTFIT MNSQ <+1.44 logit). The fourth estimate is to identify the extent of information that can be set up by the geometry test instrument as displayed in figures 1 and 2.
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**Figure 1.** Test information function (TIF) of geometry test.

**Figure 2.** Probability of student answers on each choice answer.

In figure 1 it is noted that the output of information collected by the geometry test is at the maximum level for students with moderate ability. Geometry tests are fewer efficient to provide specific information for students with poor or great ability. This is also supported through figure 2 where the probability of a correct and incorrect choice of answers revolves around a moderate level.

3.2. *Actual student learning performance on geometry test based on rasch fit statistics.*

Students' capability to work geometry tests can be evaluated through (1) person measure and (2) person fit. Both are used as the basis for determining which students have strong and/or poor abilities, and also which students are giving answers that do not pair the applied geometry test.

| Estimation                  | Values |
|-----------------------------|--------|
| Person Reliabilities        | .86    |
| Separation Index of Person  | 2.43   |
| Mean Person                 | .75    |
| Mean OUTFIT MNSQ            | 1.42   |
| Minimum Extreme Person Score| 1      |
| Cronbach alpha (KR-20)      | .88    |

In general, students' ability to manage geometry tests is above average (+.75 logit> 0.00 logit). In other words, most students are capable to deal with the test geometry well and correctly. Consistency of students is also acceptable; as well as the interaction between students with items (α = .88). However, out of 186 students there was 1 student (024P) who had a minimum extreme person score, i.e. students who did not have the correct answers in the geometry test.

We also explored the students who provided the answer not in accordance with the presented test (Misfit). Of the 186 students there are 18 students who have OUTFIT MNSQ> +1.42 logit. The eighteen students as displayed in table 3.

**Table 2.** Summary of quality person in geometry examination.

| #Student | OUTFIT MNSQ | #Student | OUTFIT MNSQ | #Student | OUTFIT MNSQ |
|----------|-------------|----------|-------------|----------|-------------|
| 167L     | 3.24        | 178L     | 1.94        | 021P     | 1.51        |
| 161P     | 3.17        | 047P     | 1.85        | 023P     | 1.49        |
| 163L     | 2.72        | 158P     | 1.82        | 018P     | 1.48        |
| 180L     | 2.52        | 025P     | 1.65        | 084L     | 1.46        |
| 177P     | 2.46        | 036L     | 1.61        | 148L     | 1.46        |
| 044L     | 2.07        | 027L     | 1.54        | 121P     | 1.45        |

**Table 3.** Misfit student in geometry test.

Note: Based on Gender: L=Laki-laki (Male), and P=Perempuan (Female). OUTFIT MNSQ in Logit.
Rasch modeling of students' actual ability (beyond misfit students) is worked out by adjusting the individual person's individual measure. The results indicate that students with the code of 137 male (+3.15 logit) are the students who have the highest ability in test geometry among 186 other students. By contradiction, the female 024 code (-5.55 logit) is the lowest-ability student in the geometry test of all students who attend the geometry test.

We also analyzed items with a high degree of difficulty for students in the test geometry. The item difficulty level is determined from the item's logit value measure. We divide the difficulty level based on the students' geometry learning reference competencies.

| Table 4. Most difficulties and easily items in geometric test. |
|---------------------------------------------------------------|
| Perceived | Item | Measure | Student Basic Competence |
| Most Difficult | No. 22: Mother has a rectangular cloth Length with length 43cm and width 12 cm. Calculate the area of the cloth! | +1.51 | Describes and determines the circumference and area of square, rectangle and triangle and the relation of the two with the square root. |
| Most Easily | ![Hexagon](image) No. 4: The picture on the side has as many sides as ... sides | -3.43 | Analyze the properties of many irregular and irregular facets. |

Based on table 4 identified the information that in general students have difficulty in dealing with the question no. 22. Conversely, question 4 is the easiest question for students to reach. The difficulty level of question 22 is four times higher than the question no. 4.

4. Discussions

In principle, the quality of geometry tests that teachers provide to students is extremely satisfactory. In terms of reliability, separation index, and unidimensional tests are wholly adequate. However, some aspects of the geometry test requiring to be focused on, among others (1) on items that are misfit or outlier, i.e. items that are not suited of performing the measurement function accurately, and (2) the measurement information function which merely shows the optimal measurement for students who have moderate abilities, and complex to maintain optimal information on students who have lower or higher ability. The three items that are misfit or outlier need to be considered or removed can even be dropped from the geometry test. Furthermore, in terms of measuring the student’s ability in geometry test is seen to have 18 students who misfit or outlier, i.e. students who presented a response not in accordance with the tests made. Misfit or outlier students may be inaccurate, there are traces of cheating, or answering by guessing. Misfit or outlier students cannot be measured in current capabilities. Moreover, 168 students can be calculated for their ability in Geometry test presented. There are 3 competencies measured in the test geometry of students in elementary school. In three competencies noticed that students have difficulty in pointing out the competence and determine the circumference and area of square, rectangular and triangle and the relationship of the rank of two with a square root. This is indicated by the logit value of the person measure reaching +1.51 logit (highest among all questions given in geometry test). Conversely, questions relating to student competence to analyse the properties of many irregular and irregular facets are the easiest (-3.43 logit).

Based on the data in this study, it is certain to underline the learning of geometry in the classroom as much as possible dealing with various aspects of student competence. Although the tests given are acceptable, but in reality, the situation at the time of geometry tests carried out less well. This is marked by the presence of 18 students who misfit or outlier because not focus during the test held place.
5. Conclusions and recommendation
In general, the conclusions in this study show that most students demonstrate an adequate proficiency in the geometry tests handed over by the instructor. Students have difficulty explaining and determining the circumference and area of square, rectangle and triangle as well as the relation of the second rank with the square root is. In contrast, students are most likely to analyse the properties of many irregular and irregular facets. Assigned to geometry test instruments issued, although the quality is extremely good but instructors need to look at to change or revise 3 items which indicated misfit or outlier. This is essential because items indicated by misfits or outliers will reduce the quality of measurements performed. Furthermore, students who are misfit or outlier and have inadequate competence in tests require to receive specific attention to promote their quality and keenness in studying geometry.

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