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Validity and Reliability Test of Mathematical Representation Ability Test Instruments in Mathematics Learning

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a b s t r a c t

Mathematical Representation Ability (MRE) is one of the important competencies that need to be mastered by students in learning mathematics. One aspect that can affect students' MRE is the character or thinking patterns possessed by the students. This study aims to evaluate the level of validity and reliability of the test instrument designed to measure the mathematical representation ability of junior high school students in solving algebra problems. The method used is a quantitative descriptive method. Based on the results of the validity test using the Aiken's V formula, the four questions were said to be valid, which indicates that the instrument has very good validity and is suitable for use. Meanwhile, the results of the reliability test showed a correlation coefficient value of 0.795, which indicates a fairly good level of consistency in the reliability category so that it is considered reliable. Thus, this instrument is considered suitable for use by teachers in measuring students' mathematical representation abilities in algebra material.

K e y w o r d s :
Mathematical Representation Ability; Test Instrument; Validity and Reliability; Algebra; Mathematics Learning.

INTRODUCTION

Mathematics is closely related to everyday life. As stated by Tampubolon et. al (2019) stated that mathematics has an important role in everyday life, because humans need it to support various activities to meet their life needs. Therefore, mathematics is taught at every level of education as an essential subject. According to Nasution et al. (2017), mathematics is a subject that is given from elementary school to college. One of the topics that is often taught in mathematics education is algebra, which plays an important role in developing students' mathematical skills. According to Wibawa (2019), algebra includes representations in the form of symbols, mathematical language, and modeling, all of which function to help students understand mathematical relationships.

For example, Erbilgin and Şahin Erbilgin & Şahin (2021) emphasized the importance of integrating technology in algebra teaching, which allows students to be more engaged and understand concepts better. This study shows that a professional development program focused on technology-integrated algebra teaching can improve student engagement in learning.

Teaching algebra is not only limited to algebraic symbols and operations, but also involves a deep understanding of mathematical representation. Ünal et al. Ünal et al. (2023) stated that visual and symbolic representations are important components of algebraic reasoning, so students' representation skills must be developed so that they can switch between different forms of representation comfortably.

The importance of teaching algebra and representation skills is supported by research showing that the use of different representations can improve students' understanding of mathematical concepts, strengthening the argument that mastery of algebra is fundamental to mathematics education. However, specific references stating this could not be found. Thus, the ability to understand and use algebra is not only essential in formal education but also has practical implementation in everyday life, making this lesson one of the key components in the mathematics curriculum at all levels of education.

Rahayu and Hidayati (2018) stated that although mathematics has a very important role, many students consider it a difficult subject. This is also seen in the field of algebra. Research conducted by Sari and Nasution (2023) shows that students experience difficulties in understanding algebraic concepts, including when re-explaining the material on the System of Linear Equations in Two Variables (SPLDV). These difficulties include challenges in using algebraic symbols and methods to simplify algebraic expressions (Herawati & Kadarisma, 2020). Furthermore, the results of a study conducted by Lestari and Suryadi (2020) show that algebra is one of the most difficult topics faced by students, often leading to learning difficulties worldwide. These difficulties stem from the complexity of applying algebraic rules and the variety of ways to solve existing problems. In this case, students often have difficulty transferring the knowledge they have learned into more complex problems (Ruspa & Marlina, 2022).

Based on these findings, it can be concluded that the complexity of algebra, coupled with the diversity of formulas and rules, makes algebra one of the most challenging areas for students in learning mathematics. Therefore, improving students' understanding of algebra is very important so that they can master this concept well.

LITERATURE REVIEW

According to NCTM (2000), there are five process standards in mathematics learning, namely problem solving, reasoning, communication, connections, and representation. One important aspect that students must master in solving flat geometry problems is representation ability. NCTM (2000) explains that representation is a way for students to present a mathematical idea or concept again to make it easier for them to find solutions to the problems they face. This view is in line with the opinion of Syabaniah & Nuraeni (2023) who state that representation is the result of students' interpretation of a problem that they use to solve it. In addition, Hardianti & Effendi (2021) also state that representation ability refers to students' ability to convey mathematical ideas or concepts through various forms of presentation.

Based on a number of opinions from previous researchers, it can be concluded that mathematical representation ability refers to students' ability to re-express a concept or idea into various forms of presentation, such as images, graphs, mathematical symbols, or verbal descriptions. The purpose of this ability is to facilitate the process of solving a mathematical problem.

Mathematical representation ability plays a very crucial role because it can help students understand and interpret various mathematical concepts. Some experts argue that mathematical representation ability is very important for students to have because it plays a role in helping them understand the material and solve various problems. However, in reality, the important role of this ability has not been fully reflected in the implementation of learning in schools (Wijaya, 2018). Most teachers in the field have not placed mathematical representation as a key element in the learning process. This causes the learning process to be more teacher-centered, and students tend to only imitate the solution steps given without developing their own way of thinking or representation (Huda et al., 2019).

In a study, obtaining precise and accurate data is very important for researchers. The selection of appropriate data collection techniques and the use of valid instruments play a major role in determining the level of accuracy and reliability of the data produced in a study (Ardiansyah et al., 2023). Instruments in research function as valid and reliable tools to obtain the required data, so that the process of compiling them is an important step in carrying out research (Mufidah, 2021). In scientific research, the existence of instruments is very important because without the right instruments, a study can be considered unsuccessful. This instrument can be a test or non-test, adjusted to the needs of the study being conducted. Researchers also have various alternative ways to obtain data that is relevant to their research objectives (Nasution, 2016).

The instrument used in this study focused on analyzing the mathematical representation ability of junior high school students in solving flat geometry problems. To measure this ability, indicators were used that were adapted from Mudzakir's opinion (in Herdiana et al., 2019), which include: a) visual representation, namely the ability to present information through images, diagrams, graphs, or tables; b) symbolic representation, namely the ability to use symbols or mathematical expressions in problem solving; and c) verbal representation, namely the ability to explain the steps to solving a problem in writing using language.

The preparation of this instrument was motivated by the low achievement of students in the three indicators of mathematical representation ability. Research shows that even though students have high mathematical abilities, they tend to only be able to fulfill the symbolic representation aspect, while students with medium and low abilities have not been able to master the three forms of representation as a whole (Mulyaningsih et al., 2020). The results of the study showed that the level of self-efficacy affects the achievement of students' mathematical representation abilities, where students with high self-efficacy can master all indicators optimally, while students with medium self-efficacy levels are only able to achieve it to a limited extent, and students with low self-efficacy generally only master one form of representation (Andini et al., 2021).

The creation of an instrument that aims to measure the ability of mathematical representation in solving flat geometry problems is carried out so that, if the instrument is proven to be valid and reliable, the indicators contained in it can be used effectively to assess this ability. Therefore, it is important to pay attention to the quality of the instrument. According to Setiyawan and Wijayanti (2020), it is important for researchers to analyze the quality of the test instrument as an initial step in ensuring the quality of the instrument used. Therefore, the validation process needs to be carried out first before the instrument is applied in the study in order to determine the level of validity and reliability.

METHODS

This research method uses a quantitative approach with a descriptive method. Sulistyawati et. al (2022) stated that quantitative descriptive research is research that explains an event using numbers without intending to test a hypothesis. The instrument containing 4 indicators of mathematical representation ability is poured into 1 question which will then be tested for validity and reliability.

According to Hakim et. al (2021), validity is one of the indicators to assess the quality of the content of an instrument. The purpose of this validity test is to ensure that the instrument used is truly appropriate and precise in measuring what should be measured in the study. The validity test process is carried out by distributing a validation questionnaire to two experts, namely a mathematics education lecturer and a junior high school mathematics teacher. The questionnaire covers seven aspects of assessment, consisting of material, construction, and language aspects. To calculate the validity of the instrument, the Aiken's V formula is used.

$$\boldsymbol{V = \frac{\sum(X_i - L)}{(n.(k - L)}}$$

Where:
Xi = value given by each validator to the item (rating scale)
L = lowest value on the rating scale.
k = number of validators
n = number of items evaluated

The level of validity of the test items is then determined based on the Aiken's V value category as explained by Suhardi (2022) which is listed in Table 1.

Table 1.
Aiken's V Formula Score Range Categories

Score Range	Category
0,80 – 1,00	Very high
0,60 – 0,799	High
0,50 – 0,599	Moderate
<0,50	Low

Anggraini et al. (2022) explained that reliability is a form of testing of research instruments that aims to determine the extent to which the measuring instrument can produce consistent data. The level of reliability of the test items is then determined based on the correlation coefficient value, with reference to the categories as shown in Table 2 (Hikmah & Muslimah, 2021).

Table 2
Correlation Coefficient Interrelation

Coefficient Interval	Category
0,80 – 1,00	Very High
0,60 – 0,799	High
0,50 – 0,599	Moderate
<0,50	Low

In the process of validating assessment instruments, the use of assessment criteria for instrument items by the validator is very important to assess the quality and suitability of the test items listed in Table 3:

Table 3
Criteria for Assessment of Instrument Items by Validator

Value	Description
1	Not Valid
2	Less Valid
3	Quite Valid
4	Valid

In the evaluation of measurement instruments, the Cronbach's Alpha category is an important tool to assess the level of instrument reliability. Table 4 presents the categories according to the Cronbach's Alpha score range as follows (Júnior et al., 2024):

Table 4
Cronbach's Alpha Categories

Score Range	Category
$\alpha \geq 0,9$	excellent reliability
$0,8 \leq \alpha < 0,9$	good reliability
$0,7 \leq \alpha < 0,8$	acceptable reliability
$0,6 \leq \alpha < 0,7$	questionable reliability
$0,5 \leq \alpha < 0,6$	poor reliability
$\alpha < 0,5$	unacceptable reliability

The use of Cronbach's Alpha as a reliability indicator serves to ensure that the measurement instrument is consistent and reliable in providing the same results when repeated. This is important, considering that the internal consistency of the instrument can affect the validity of the research results produced (Gabrielsson et al., 2019).

RESULT AND DISCUSSION

The diagnostic assessment instrument that has been created is in the form of 4 descriptive questions that aim to measure students' mathematical representation abilities with algebraic material. Validity testing is a process to measure the extent to which a research instrument or measuring instrument (such as a questionnaire, test, or scale) is able to measure what should be measured according to the research objectives. Validity is related to the validity of the results obtained from the measuring instrument. In other words, the validity test aims to ensure that the measuring instrument used is indeed appropriate and relevant to measure the variables to be studied. There are several types of validity tests, including:

Content Validation

Content validity refers to the suitability between the test items and the ability indicators to be measured. In this case, the validation questionnaire was filled out by two expert mathematicians who stated all the questions as valid. This assessment refers to the established Instrument Item Assessment Criteria, which shows all items are in accordance with the mathematical representation ability indicators. Content validity is very important to ensure that the measuring instrument is reliable in the educational context (Leppink & Pérez-Fuster, 2017).

Content validity is related to the level of conformity between the test items and the question indicators and the mathematical representation ability indicators. The content validity analysis of the test instrument using the Validator's Instrument Item Assessment Criteria is shown in Table 4. The validation questionnaire for the mathematical representation ability instrument in solving flat geometry problems was filled out by 2 mathematicians as validators. The validation questionnaire sheet consists of 4 questions that are assessed. The results of the questionnaire distribution are presented in Table 5.

Table 5
Questionnaire Results from Validator

Validator	Item 1	Item 2	Item 3	Item 4
I	Valid	Valid	Valid	Valid
II	Valid	Valid	Valid	Valid
Suggestion I	The question is appropriate	The question is appropriate	The question is appropriate	The question is appropriate
Suggestion II	The question is appropriate	The question is appropriate	The question is appropriate	The question is appropriate

The instrument created by the researcher was tested for validity using Aiken's V. The results of the validity test calculations are presented in Table 7.

Table 6
Results of Validity Test Calculation Using Aiken's V

Validator	Item 1	Item 2	Item 3	Item 4
I	4	4	4	4
II	4	4	4	4
Description	Valid (*excellent reliability)*	Valid (*excellent reliability)*	Valid (*excellent reliability)*	Valid (*excellent reliability)*

So based on the results of content validity using Aiken's V, the four questions are said to be valid. In the next stage, a construct validity test will be carried out.

Validity Test

Validity test was conducted using SPSS by correlating each indicator item score with the total construct score. The level of significance used was 0.05. The data used were data obtained from 35 grade VII students. With a table R value = 0.349 (student score data attached).

Table 7
Results of R Table Values

Question Items	r_{hcount}	Sig. (2-tailed)	Conclusion
1	0,760	<.001	Valid
2	0,682	<.001	Valid
3	0,713	<.001	Valid
4	0,806	<.001	Valid

Construct validity was tested using SPSS with correlation between question indicators and total scores. The results of the analysis showed that all questions had r_count values above the significant threshold (p <0.05), which confirmed that all questions in this instrument can be considered valid. This assertion is in line with the approach adopted by previous studies that applied construct validation to measure ability through newly developed measuring instruments (Wibowo et al., 2024).

Reliability Tes

Reliability testing can be used to determine the consistency of the measuring instrument, whether the measuring instrument remains consistent if the measurement is repeated. A measuring instrument is said to be reliable if it produces the same results even though measurements are taken many times. Reliability testing is carried out using SPSS, with the Cronbach's Alpha method. A research instrument is said to be reliable if the Cronbach's Alpha value is > 0.60 (Ghozali, 2016).

Table 8
Reliability test

Cronbach's Alpha	N of Items
0,795	5

After the instrument is declared valid, the next step is to conduct a reliability test. The reliability test is measured using the Cronbach's Alpha coefficient. So based on the results of the SPSS data processing, the Cronbach's Alpha figure obtained was 0.795 indicating that the instrument is in the "fairly good" category, which implies that the instrument can be relied on to measure students' mathematical representation abilities. This is in line with the recommendation that a Cronbach's Alpha value above 0.60 is sufficient for a reliable instrument (Vrinten et al., 2023). In addition, research by Mohammad et al. Mohammad et al. (2018) shows the importance of conducting a reliability evaluation using Cronbach's Alpha to ensure that the instrument has good internal consistency.

This reliability test shows consistent results in measurement. When the test is carried out several times, the results obtained remain stable and reliable, which is one of the main objectives in developing research instruments (Yeng et al., 2021). In addition, this study is in line with recommendations that clarify that reliability evaluation with Cronbach's alpha is an effective method for assessing internal consistency (Chen et al., 2024).

CONCLUSION AND IMPLICATION

Conclusion

The results of the validity test with SPSS show that the significance value (sig.) of the 4 essay questions are all less than 0.05, so we can conclude that the four essay questions are valid. A significance value below 0.05 indicates a significant relationship between the question items and the total score, so the questions can be said to have adequate validity and are able to measure what should be measured. In addition, the results of the reliability test produce a reliability coefficient value of r = 0.795, so the questions can be said to have quite good reliability. Based on the content validity, construct validity, and reliability tests, the test instrument for testing students' mathematical representation abilities in algebra material is considered a test instrument that is suitable for use in research.

Based on the results that have been tested for content validity and construct validity, as well as instrument reliability, it can be concluded that the instrument for assessing mathematical representation ability in solving algebraic problems is suitable for use in research or classroom measurement. The validation and reliability processes carried out in this study provide confidence that the instrument can be used to accurately measure the level of students' mathematical representation ability, as proposed by previous researchers (Chen et al., 2024).

Implication

The importance of valid and reliable instruments in the educational context cannot be ignored. These instruments provide important data for evaluating students' abilities and provide useful feedback for teaching (Tumanggor & Supahar, 2021). With valid instruments, educators can design more appropriate interventions and provide the support needed by students to improve their mathematical representation skills. As shown by the variation in mathematical representation results based on gender or educational background, these instruments can identify areas where students may need more attention (Ratnasari et al., 2018; Sormin & Ratuanik, 2023). Thus, these instruments not only function as evaluation tools but also as diagnostic tools to improve teaching strategies (Prayitno et al., 2021).

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