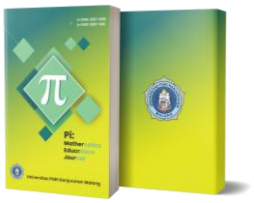
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Analysis of Instrument Quality Mathematical Representation Ability and Self-Confidence in Circle Learning

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ABSTRACT
This study aimed to develop and validate instruments for measuring students' mathematical representation ability and self-confidence in learning about circles. Using a quantitative descriptive method, the study involved 30 junior high school students in Yogyakarta. The instruments consisted of a mathematical representation ability test and a self-confidence questionnaire. The results showed that both instruments had high validity and reliability. The test items demonstrated moderate difficulty and good discrimination. Thus, the instruments were considered feasible for measuring students' mathematical representation ability and self-confidence. Furthermore, students' mathematical representation ability was categorized as moderate. In terms of representation indicators, symbolic representation was in the high category, while visual and verbal representations were in the moderate category. Students' self-confidence was also classified as moderate. These findings suggest that although the developed instruments demonstrated good measurement quality, students' mathematical representation ability and self-confidence still need improvement, particularly in visual and verbal representation.

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1. Introduction

Mathematics learning aims to develop students' skills in understanding various mathematical concepts and applying this knowledge in everyday life. According to[1], one of the important capabilities students have in learning mathematics can be claimed as an ability to represent mathematics. Mathematical representation ability is defined as a student's skills in communicating mathematical ideas through various means, such as images, tables, graphs, numbers, and symbols [1]. This ability is very important because it helps students bridge abstract mathematical ideas into a more concrete and easily understood form ([2], [3], [4]). However, the reality students often difficulties in representing their mathematical ideas. Research results [5] indicate that students' ability of mathematical representation is low: of the 33 8th-grade students studied, only 21.21% were in the high category, 33.33% in the medium category, and also almost half, or 45.46%, in the category

of low. Reinforced by the outcomes of research by [6], which revealed that 67.5% of mathematical representation ability was classified as very low.

Low mathematical representation ability affects students' self-confidence in learning mathematics. Students feel that math is difficult and boring, thus reducing their confidence in learning ([7], [8]). Students with high self-confidence tend to use various forms of representation (visual, symbolic, verbal) to solve math problems, whereas students with low self-confidence tend not to use these representations optimally. The results of [3], [9]stated that 50% of students had low representation skills, 25% were moderate, 20% were high, and 5% were very high. This ability of mathematical representation and also self-confidence of students are cognitive and affective aspects that play a crucial role in supporting student learning success. This causes students to have difficulty understanding mathematical concepts in depth, be less able to solve problems using various strategies, and tend to be passive and hesitant when expressing opinions in class. This condition will certainly affect the quality of mathematics learning. Therefore, it is important to thoroughly evaluate learning. Evaluation can be interpreted as an assessment process that aims to measure the level of ability students have achieved in meeting the expectations set in a learning environment [10].

To evaluate learning, various types of measurement instruments are used, such as test questions and questionnaires. The instrument needs to be analyzed for each item to determine its quality. [11]explained that item analysis has a crucial role in ensuring that evaluation instruments can provide valid and reliable information. Validity means that a question measures in accordance with predetermined objectives, while reliability means that the results are consistent when used repeatedly [12]. In addition, through item analysis, it is possible to help determining the level of difficulty and also differentiation of the questions, so that the questions used serve as a tool for teachers to evaluate student abilities and improve learning [13].

Although many research have indicated that students' skills of mathematical representation and self-confidence remain low, most focus only on students' performance. In fact, to accurately assess students' abilities, high-quality instruments are needed [13]. If the instruments used are not good enough, the measurement results may also be inaccurate and do not reflect actual abilities [14]. In addition, there have been few studies that specifically analyze the test items qualitu and also questionnaires used to measure skills of mathematical representation and also self-confidence, particularly in concepts of validity, reliability, level of difficulty, and also discriminating power ([10], [15].

Recent studies have addressed the development and evaluation of instruments for measuring mathematical representation ability and self-confidence. [16] developed an assessment instrument for mathematical representation ability and examined its psychometric properties. Similarly, [17] investigated the validity and reliability of a mathematical representation ability test, while [18] developed and validated a self-confidence measurement instrument for mathematics learning using the Rasch model. Previous studies have also examined mathematical representation, mathematics assessment, and students' self-confidence. [19] investigated students' mathematical representation in set theory learning, while [20] analyzed mathematics test items developed by junior high school teachers. [21] examined students' self-confidence in online mathematics learning. Furthermore, [22] investigated the relationship between students' mathematical problem-solving abilities and metacognitive activities, while [23] analyzed students' conceptual errors in solving trigonometry problems. These studies provide relevant perspectives on mathematical representation, assessment, and students' learning characteristics. Nevertheless, further investigation is needed to examine both instruments within the context of circle learning. In addition to evaluating instrument quality, describing students'

performance can provide insights into their mathematical representation ability and self-confidence. Therefore, the primary objective of this study was to analyze the quality of the mathematical representation ability test and self-confidence questionnaire, including their reliability and, for the test items, difficulty and discrimination indices. The secondary objective was to describe students' mathematical representation ability and self-confidence based on the results obtained from these instruments.

2. Methods

This study applied such a descriptive, quantitative approach to help analyze the quality of the items in the measuring instruments developed. The participants in this study comprised 30 students enrolled at a public junior high school within the Yogyakarta region. Subjects were selected using a random sampling technique. Item analysis in this study focused on validity, reliability, differentiation, and difficulty level of mathematical representation ability and also questionnaire of self confidence. Before testing, the mathematical representation ability test and the self-confidence questionnaire were reviewed by two experts in mathematics education and/or educational assessment to establish their content validity. The experts rated the instruments using a five-point scale ranging from 1 to 5. The ratings were analyzed using Aiken's V coefficient to evaluate the content validity of each instrument. The resulting coefficients were interpreted according to the predetermined Aiken's V criteria to determine whether the instruments met the established validity requirements. The item differentiating power and difficulty level were analyzed using Anbuso 8.0, while the reliability of the items of test and questionnaire was measured by applying Microsoft Excel with the Cronbach's Alpha formula. By using these programs, the researcher was able to help determining the items quality based on their reliability, difficulty, and differentiating power.

2.1 Reliability Analysis

Test reliability refers to the degree of trust that a test can produce consistent scores, even when administered under different conditions [12]. To measure the instruments reliability of, the Cronbach's Alpha formula was applied. Reliability analysis using the Alpha Cronbach formula with Microsoft Excel. With the Alpha Cronbach formula as explained by [11].

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum si^2}{st^2}\right) \quad (1)$$

r_{11} = Reliability
n = Number of question items tested
$\sum si^2$ = The number of variance of scores for every item
st^2 = Total Variance
According to the criteria [12], which are seen in Table 1.

Table 1. Reliability Criteria

r_{11}	Interpretation
0,00 – 0,20	Very Low
0,21 – 0,40	Low
0,41 – 0,60	Medium
0,61 – 0,80	High
0,81 – 1,00	Very High

2.2 Difficulty Level Analysis

The item difficulty measurement aims to determine how difficult a test item is. His study examined the difficulty index of each test item. According to [13] the formula used is:

$$P = \frac{B}{J_s} \tag{2}$$

P = Difficulty indicator
B = The amount of student scores on a particular item
J_s = Maximum number of student scores

With the criteria that are contained in Table 2, which is:

Table 2. Difficulty Level Criteria

Difficulty Level	Interpretation
0,00 – 0,30	Difficult
0,31 – 0,70	Medium
0,71 – 1,00	Easy

2.3 Differentianting Power Analysis

The discrimination power of each item was analyzed to determine its ability to distinguish between students with higher and lower overall test scores. Students were divided into higher and lower groups based on their total test scores. The proportions of correct answers in both groups were then compared to calculate the discrimination index.

$$DP = \frac{JBA}{JSA} - \frac{JBB}{JSB} \tag{3}$$

DP = Differentianting Power
JBA = Number of student in the higher group who answered correctly
JBB = Number of student in the lower group who answered correctly
JSA = Total number of students in the higher group
JSB = Total number of students in the lower group

With the criteria that are contained in Table 3, as follows.

Table 3. Differentiating Power Criteria

Differentiating Power	Interpretation
0,00 – 0,19	Less
0,20 – 0,39	Enough
0,40 – 0,69	Good
0,70 – 1,00	Very Good

2.4 Analysis of student's mathematical representation ability and self-confidence

$$KK = \frac{Score\ obtained}{Score\ maximum} \times 100\% \tag{4}$$

KK = Persentage mathematical representation ability and self-confidence

With the criteria that are contained in Table 4, as follows.

Table 4. Classification of test scores for mathematical representation skills and self-confidence

Percentage of Achievement	Interpretation
$90 \leq KK \leq 100$	Very High
$75 \leq KK < 90$	High
$55 \leq KK < 75$	Moderate
$40 \leq KK < 55$	Low
$KK < 40$	Very Low

3. Result and Discussion

It shows data from research activities. The data collected includes student answers to questions about ability of mathematical representation and also student self-confidence questionnaires. The data obtained are analyzed using Anbuso 8.0 and Microsoft Excel, and the results of the calculations are interpreted. In addition to presenting the results of the instrument quality test, this section also explains the profile of students' abilities of mathematical representation and also self-confidence, based on data from the instrument.

3.1 Analysis of Mathematical Representation Ability Questions

The questions about ability of mathematical representation consisting of 5 items were analyzed to help determining reliability, level of difficulty, and also distinguishing power. Before analysis, this question was tested for validity and found valid—the outcomes of the reliability, level of difficulty, and also power of distinguishing are presented in Tables 5 and 6.

Table 5. Reliability of Mathematical Representation Ability Question

Reliability Statistics	
Cronbach's Alpha	N of item
0,84851	5

Table 6. Difficulty Level and Differentianting Power of Mathematical Representation Ability Question

Number	Difficulty Level		Differentianting Power	
	Coeficient	Description	Coeficient	Description
1	0,656	Medium	0,678	Good
2	0,667	Medium	0,637	Good
3	0,656	Medium	0,653	Good
4	0,667	Medium	0,588	Good
5	0,633	Medium	0,647	Good

Table 5 shows that the reliability value for the essay question (0,84851) falls within the very high category, indicating good quality. According to [24], reliability with a coefficient between 0.61 and 0.80 is categorized as high and feasible to use. This is in line with [4] 's opinion, which states that instruments with a reliability value above 0.60 are considered good enough and can be used.

Table 6 shows that the level of difficulty and differentiantin power for every item of mathematical representation ability is categorized as moderate. According to [13], questions with a difficulty index between 0.30 and 0.70 fall under the moderate category. This shows that the question is neither too easy nor too difficult, so it can be used to optimally measure

students' abilities. [25] also states that questions of moderate difficulty are more appropriate for differentiating student abilities, as most students can answer them but remain challenging for those who do not understand. The differentiating power of mathematical representation ability questions is categorized as good. According to [13], questions with high differentiating power are categorized as good, meaning they can clearly distinguish of students that have high and also low abilities. Questions with strong differentiating power are highly recommended because they contribute to the quality of instruments that are effective and accurate in assessing students' abilities.

3.2 Analysis of Student Self-Confidence Questionnaire

This study employed a self-confidence questionnaire consisting of 20 Likert-scale statements to assess participant scores. Before being analyzed, the questionnaire was tested for content validity and declared valid. The analysis was conducted to determine reliability. The calculation of questionnaire reliability was carried out using Cronbach's Alpha using Microsoft Excel. 1

Table 7. Reliability of self-confidence questionnaire

Reliability Statistics	
Cronbach's Alpha	N of item
0,94660	20

Table 7 indicates that the reliability value obtained is 0.94660, included in the very high category. According to [24], The reliability value between 0.81 to 1.00 is claimed as very high, which is meant that the questionnaire instrument has quality internal consistency. Thus, the questionnaire of self-confidence used is applied on purpose to help measuring students' self-confidence in styding process. In preparing learning evaluation instruments, it is important to first conduct trials and analyze the results to assess the feasibility of the instrument before it is widely used [26]. Instruments that have gone through the validation process and show valid and reliable results are considered quality instruments because they are able to produce accurate and consistent data [27]. According to [28], instruments that meet quality criteria are suitable for use in classroom learning, because they can provide an accurate picture of student abilities. Therefore, the evaluation process requires item analysis to ensure that each item can measure the desired aspect accurately. A good instrument must really be able to represent students' abilities, both in cognitive and affective aspects, because the instrument quality directly impacts the accuracy of the evaluation results and the learning decisions taken based on these results.

3.3 Profile of Mathematical Representation Ability and Self-Confidence of Students

Data on students' ability of mathematical representation and also self-confidence profiles were obtained from 30 students who had taken a mathematical representation test and filled out a self-confidence questionnaire. The instruments used had previously been declared valid and reliable, making them suitable for objectively describing students' ability and self-confidence.

Table 8. Recapitulation of Essay Test Scores: Mathematical Representation Ability

Statistic	Value
Total of Respondents	30
Total of Questions	5
Maximum Score	15
Minimum Score	3
Total Score	295

Variance	7,79
Standard Deviation	2,74
Average	9,83

The outcomes showed consisting of 5 essay questions, show that, out of 30 students, a number of score 295 was obtained, with an average of 9.83 out of a maximum of 15. The score of minimum was 3, and the ideal maximum was 15. The standard deviation was 2.74 with a variance of 7.79. When converted into a percentage, the average student achievement was 65,53% of the maximum score. These results show that students' ability in mathematical representation is in the category of moderate. It is also supported by [29], overall, students' mathematical representation abilities fall into the moderate category with an average score of 62,66%.

Table 9. Average Mathematical Representation Ability per Indicator

Aspect	Value
Visual Representation	2,41
Verbal Representation	2,41
Symbolic Representation	3,13

When viewed based on mathematical representation ability indicators, differences in achievement were found in each aspect. Symbolic representation obtained an average score of 3,13 or equivalent to 78.25%, which is in the high category. Meanwhile, visual and verbal representation obtained an average score of 2,41 or 60.25%, which is in the moderate category. These results indicate that students are relatively more capable of expressing mathematical ideas in symbolic form or mathematical models than of presenting them in visual form or explaining them verbally.

Table 10. Recapitulation of Questionnaire Scores: Self-Confidence

Statistic	Value
Total of Respondents	30
Total of Questions	20
Maximum Score	80
Minimum Score	36
Total Score	1792
Variance	157,51
Standard Deviation	12,33
Average	59,73

According to the outcomes of the analysis of self-confidence questionnaire, consisting of 20 statements, a total score of 1792 was obtained from 30 students, with an average of 59.73 out of a score of maximum 80. The minimum score earned by students was 36. The standard deviation of 12.33 and the variance of 157.51 indicate that there is variation in students' self-confidence levels. When converted into a percentage, the average self-confidence of students was 74.66% of the maximum score. Based on the criteria used in this study, this achievement is in the moderate category. This outcomes are supported by [30], that the students' confidence level was in the moderate category.

4. Conclusion

The five-item mathematical representation test yielded a Cronbach's alpha coefficient of 0.84851, indicating very high internal consistency according to the criteria

used in this study. The item difficulty indices ranged from 0.633 to 0.667, indicating moderate difficulty, while the discrimination indices ranged from 0.588 to 0.678, indicating good discrimination. The 20-item self-confidence questionnaire also demonstrated very high internal consistency, with a Cronbach's alpha coefficient of 0.94660. Regarding students' performance, the mean mathematical representation score was 65.53%, which fell into the moderate category. Symbolic representation achieved 78.25%, placing it in the high category, whereas visual and verbal representation each scored 60.25%, placing both in the moderate category. The mean self-confidence score was 74.66%, which also fell into the moderate category.

This study was limited to 30 junior high school students from a single school in Yogyakarta. Therefore, the findings should be interpreted within this context. Further studies involving larger and more diverse samples, as well as additional validity analyses, are needed to obtain more comprehensive evidence of the instruments' measurement properties and to examine their applicability in other educational settings.

For mathematics teachers, these findings provide insights into students' mathematical representation ability and self-confidence in learning about circles. The results suggest that greater emphasis could be placed on activities that help students interpret diagrams, construct visual representations, and explain mathematical ideas verbally. Teachers could also encourage students to communicate their reasoning and participate actively in classroom discussions to support their confidence in learning mathematics.

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