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Item Analysis of Mathematics Questions on the Topic of Units of Time at 116 Percontohan State Elementary School

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Abstract

The purpose of this study was to measure the quality level of the mathematics test instrument on the unit of time material. A quantitative approach with a descriptive type was used in this study. The participants involved were 20 students of SDN 116 Percontohan. Data collected in the form of question sheets, answer sheets, and answer keys. Data analysis was carried out with the help of Microsoft Excel application. The results showed that 70% of the questions were in the valid category, 70% of the items tested were reliable, the level of difficulty of the items was in the poor category, and the differentiating power was in the weak category. Thus, the items of mathematics questions used as test instruments need to be improved and reviewed. This research contributes to teachers to revise questions that are not yet feasible and store good category questions in the question bank.

Keywords: Item analysis, math, time, primary school

Abstrak

Tujuan penelitian ini yaitu untuk mengukur tingkat kualitas instrument tes matematika materi satuan waktu. Pendekatan kuantitatif dengan jenis deskriptif digunakan dalam penelitian ini. Partisipan yang dilibatkan yaitu 20 siswa SDN 116 Percontohan. Data yang dikumpulkan berupa lembar soal, lembar jawaban, dan kunci jawaban. Analisis data dilakukan berbantuan aplikasi Microsoft Excel. Hasil penelitian menjukkan bahwa 70% soal termasuk dalam kategori valid, 70% butir soal yang diujikan telah reliabel, tingkat kesukaran butir soal termasuk dalam kategori kurang baik, dan daya pembeda termasuk dalam kategori lemah. Dengan demikian, butir-butir soal matematika yang dijadikan instrument tes perlu diperbaiki dan dikaji kembali. Penelitian ini berkontribusi bagi guru untuk merevisi soal yang belum layak dan menyimpan soal berkategori baik ke dalam bank soal.

Kata kunci: Analisis butir soal, matematika, waktu, sekolah menengah pertama

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INTRODUCTION

National education aims to build human quality and develop individual potential and character (Indonesia, 2003). The quality of education is not only measured by the objectives and learning process, but also by the learning outcomes obtained by students (Arikunto, 2010). Activities to assess learning outcomes are known as evaluation or assessment of learning outcomes (Patriana et al., 2021; Sa'dijah et al., 2015). In other words, learning outcomes assessment acts as a pillar that builds the quality of education in a better direction.

Assessment of learning outcomes is an aspect that counts in the education process (Sudjiono, 2005). Assessment plays a role in measuring the achievement of learning objectives (Anwar et al., 2022; Arikunto, 2010; Gronlund, 1998). In addition, the assessment of learning outcomes becomes a benchmark in decision making for policy makers in the world of education (Ernest, 1991). For example, at the school level, formative assessments such as daily tests are

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one of the evaluation stages aimed at measuring student competence after going through a series of learning processes (Ardiansyah, 2021; Mania et al., 2020; Sa'dijah et al., 2015).

One important element of formative assessment is to give tests in accordance with the competencies that have been taught (Mania et al., 2020). Tests are given with the aim of obtaining information about a person's understanding, knowledge, or skills of a material or concept. A good test is prepared with test instruments that are tested, valid, and accountable. This means that the test is made through a series of measurable stages, not done suddenly without any preparation. Therefore, the preparation of a good test instrument greatly affects the quality of the test results given.

One way to test the quality of a test instrument designed is by analyzing the items. Good items need to accurately describe students' abilities (Arikunto, 2010). The accuracy of the items used is assessed through item analysis (Anas, 2006). Therefore, item analysis is an important step to ensure that the questions used in the test have quality by analyzing the validity test, reliability test, differentiator analysis, and difficulty level analysis (Susanto et al., 2015; Tilaar et al., 2020).

According to Suzana (2018), ignoring item analysis results in questions having many weaknesses when used to assess learning outcomes. These weaknesses include incompatibility with material coverage, predictable answer options, and unbalanced difficulty levels (Susanto et al., 2015; Suzana, 2018; Tilaar et al., 2020). These weaknesses cause the assessment results to not reflect student competence objectively (Sa'dijah et al., 2015). Therefore, item analysis plays a role in knowing the items that are 'not worth' testing, so that the assessment can measure student competence fairly and accurately.

In the scope of mathematics education, item analysis has an essential role (Anwar et al., 2022; Suzana, 2018; Utomo, 2018). Learning mathematics requires understanding concepts as well as skills in thinking and problem solving (Alghar, 2022; Huincahue et al., 2021; Kilpatrick et al., 2001). Therefore, the mathematics test items need to be designed to measure various aspects of students' abilities, from understanding and applying concepts to analysis and evaluation(Anwar et al., 2022; Hardianti, 2019). Without good assessment, the assessment results do not reflect students' abilities objectively (Sa'dijah et al., 2015).

Based on this description, this study intends to conduct item analysis on the mathematics test instrument implemented at the 116 Percontohan State Elementary School in Mandailing Natal. The test instrument presented focuses on the unit of time material. This research will evaluate the quality of test instruments made based on the criteria of validity, reliability, differentiation, and difficulty level. Thus, the title of this study is an analysis of the quality of

mathematics test items on unit time material at 116 Percontohan State Elementary School.

METHODS

A quantitative approach with a descriptive type was used in this study. The descriptive quantitative approach aims to describe the characteristics of a particular population or phenomenon without testing the relationship between variables (Creswell & Creswell, 2017). The data obtained is classified into quantitative data, namely the formative test instrument of time unit material in mathematics subjects. The data collected are in the form of test sheets, answer sheets, and answer keys. The participants in this study were 20 class 5A students at the 116 Percontohan State Elementary School in the 2023/2024 school year in Mandailing Natal Regency. Evaluation was carried out on the test instrument items. Data analysis was carried out with the Ms. Excel application. The analysis technique applied consists of validity test, reliability test, level of difficulty, and differential analysis of questions. The results of the analysis are represented in tables and interpreted descriptively.

RESULTS AND DISCUSSION

Validity Test Results

Item validity is defined as a measure of the extent to which a question can measure what should be measured. The validity of a question item is fulfilled if it has a significant correlation with the total score. The score on the item supports the increase or decrease in the total score. In other words, a question item gets a good validity value if the item score has parallels with the total score. The product moment correlation formula is used to calculate validity (Sudjiono, 2005).

$$r_{hitung} = \frac{N\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{\{N\Sigma X^2 - (\Sigma X)^2\}\{N\Sigma Y - (\Sigma Y)^2\}}}$$

Description
r_{hitung} : correlation coefficient
N : number of students
X : score on the question item
Y : total score

The results of the item validity test on the mathematics test instrument on the unit of time material at the 116 Percontohan State Elementary School in the 2023/2024 school year, which was analyzed using the Ms. Excel application, are shown in Figure 1.

No.	Nama Siswa	Butir Soal (X)										Skor Total (Y)
		1	2	3	4	5	6	7	8	9	10	
1	Firiyal Aprilia.	1	1	1	1	1	1	1	1	1	1	10
2	Dzakira Talita	1	1	1	1	1	1	1	1	1	1	10
3	Aura Az-zahra	1	1	1	1	1	1	1	1	1	1	10
4	Azka Athifa.	1	1	1	1	1	1	1	1	1	1	10
5	Reza Aditya	1	1	1	1	1	1	1	1	1	1	10
6	Muhammad S.	1	1	1	1	1	1	1	1	1	1	10
7	Muhamad F.	1	1	1	1	1	1	1	1	1	1	10
8	Haikal Nanda	1	1	1	1	1	1	1	1	1	1	10
9	Mutiara J.	1	1	1	1	1	1	1	0	1	1	9
10	Rafa Aziz	1	1	1	0	1	1	1	1	1	1	9
11	Rehan Nawfal	1	1	1	0	1	1	1	1	1	1	9
12	Muazzara H.	1	1	1	1	0	1	1	1	1	1	9
13	Akbarzak A.	1	1	1	1	1	1	1	0	1	1	9
14	Farid.	1	0	1	1	1	1	1	1	1	1	9
15	Zidan Afrian	1	1	1	1	1	0	1	0	1	1	8
16	Muhammad N.	1	1	1	0	1	1	1	1	1	1	9
17	Liyana Z.	0	1	1	1	1	0	0	0	1	1	6
18	Salahuddin	0	0	1	1	1	0	1	0	1	1	6
19	Nayla Thalita	0	0	1	1	0	0	1	1	0	1	5
20	Rizki Yani	0	0	0	1	1	0	0	0	0	1	3
	Σx	16	16	19	17	18	15	18	14	18	20	
	Σy											171
	r hitung	0.917	0.723	0.658	-0.098	0.267	0.880	0.697	0.581	0.783	0	
	t tabel (95%,27)	0.444	0.444	0.444	0.444	0.444	0.444	0.444	0.444	0.444	0.444	
		VALID	VALID	VALID	TIDAK VALID	TIDAK VALID	VALID	VALID	VALID	VALID	TIDAK VALID	

Figure 1. Validity Test Results of the test instrument

Figure 1. shows the results of the validity test of the test instrument. The validity test results show that of the 10 questions designed, there are only 7 questions that fall into the valid criteria. This criterion is met because the results of the calculated r value on the seven questions are greater than r table (0.444). While 3 questions are not said to be valid because the results of the r value are smaller than the r table value (0.444). This means that of the 10 questions submitted as a test instrument, only 70% of the questions meet the valid criteria. Valid questions can be used as evaluation materials because they meet the criteria and do not deviate from the measurement objectives. Conversely, invalid questions need to be revised or even avoided using them because they do not meet the appropriate measurement criteria.

This finding is in line with Tilaar et al. (2020) which shows 40% of the items on the final semester exam are in the invalid category. Research by Khasanah et al. (2023) showed 47% of daily exam items were in the invalid group. On the other hand, Arifin (2017) describes three aspects that affect item validity, including aspects of test instruments, scoring aspects, and aspects of student answers. In addition, item validity can be improved by ensuring students read the questions carefully, answer carefully, and double-check their answers before submitting the answer sheet (Gronlund, 1998).

Reliability Test Results

Reliability refers to the level of reliability of a test. This means that reliability measures the extent to which the test provides consistent results when used repeatedly. Reliability test is measured by the Kuder Richardson-20 (KR-20) method (Ntumi et al., 2023). This method is suitable for testing the reliability of questions with correct (point 1) or incorrect (point 0) answer formats. The KR-20 formula

is

$$r_{11} = \left(\frac{k}{k-1}\right)\left(\frac{s^2 - \Sigma pq}{s^2}\right)$$

Description

r_{11} : internal reliability coefficient for all question items
p : proportion of subjects who are correct in answering the question item
q : the proportion of subjects who answered the item incorrectly $(q = 1 - p)$
Σpq : the sum of the results of p multiplied by q
k : number of items
s : standard deviation

The results of the item reliability test on the mathematics test instrument on the unit of time material at the 116 Percontohan State Elementary School in the 2023/2024 school year, which was analyzed using the Ms. Excel application, are shown in Figure 2.

No.	Nama Siswa	Butir Soal (X)							Total Skor Valid (Y)
		1	2	3	6	7	8	9	
1	Firiyal Aprilia.	1	1	1	1	1	1	1	7
2	Dzakira Talita	1	1	1	1	1	1	1	7
3	Aura Az-zahra	1	1	1	1	1	1	1	7
4	Azka Athifa.	1	1	1	1	1	1	1	7
5	Reza Aditya	1	1	1	1	1	1	1	7
6	Muhammad S.	1	1	1	1	1	1	1	7
7	Muhamad F.	1	1	1	1	1	1	1	7
8	Haikal Nanda	1	1	1	1	1	1	1	7
9	Mutiara J.	1	1	1	1	1	0	1	6
10	Rafa Aziz	1	1	1	1	1	1	1	7
11	Rehan Nawfal	1	1	1	1	1	1	1	7
12	Muazzara H.	1	1	1	1	1	1	1	7
13	Akbarzak A.	1	1	1	1	1	0	1	6
14	Farid.	1	0	1	1	1	1	1	6
15	Zidan Afrian	1	1	1	0	1	0	1	5
16	Muhammad N.	1	1	1	1	1	1	1	7
17	Liyana Z.	0	1	1	0	0	0	1	3
18	Salahuddin	0	0	1	0	1	0	1	3
19	Nayla Thalita	0	0	1	0	1	1	0	3
20	Rizki Yani	0	0	0	0	0	0	0	0
	Σ	16	16	19	15	18	14	18	116
	s^2	0.618	0.618	0.05	0.197	0.095	0.221	0.095	
	s^2 t								0.994
	s^2 X total								3.958
	R_{11}								0.873

Figure 2. Results of the Reliability Test on the test instrument

Figure 2. shows the results of the reliability test on items that have met the validity test. Questions that did not meet the validity test were not tested for reliability. This is because these questions are considered unfit for use. Testing the reliability of multiple-choice question items is done by comparing R_{11} with an alpha value of 0.6. Based on Figure 2, the seven questions that were tested reliably produced a value of R_{11} = 0.873. This means that the seven question items have met the reliability value, so they are said to be reliable..

The results of this reliability test are in line with Khasanah et al. (2023) who explained that the

daily test questions have met the rules of reliability. Research by Hanan et al. (2023) reported that the story items on the KPK and FPB material had fulfilled the reliability aspect. Good reliability indicates that the questions have been designed according to evaluation standards and are able to support objective assessment (Arikunto, 2010; Gronlund, 1998). Things that affect reliability are the level of difficulty, the number of questions, and the objectivity of scoring (Khasanah et al., 2023).

Results of Problem Difficulty Analysis

The purpose of analyzing the level of difficulty is to group questions into difficult, moderate, or easy categories (Arikunto, 2010). A question item is considered appropriate if the level of difficulty is not too difficult or too easy. That is, a proportional level of difficulty describes a quality question. The formula used to measure the level of difficulty is

$$P = \frac{\bar{S}}{S_{maks}}$$

Description:
P : difficulty index
S : average score on the item
S_{maks} : the maximum score for the item

The results of the analysis of the level of difficulty of the items on the mathematics test instrument on the unit of time material at the 116 Percontohan State Elementary School in the 2023/2024 school year, which were analyzed using the Ms. Excel application, are shown in Table 1.

Table 1. Results of item difficulty analysis

Problem number	Number of students answering correctly (NP)	Problem difficulty inde $(P) = \frac{NP}{N}$	Description
1	16	0.8	Easy
2	16	0.8	Easy
3	19	0.95	Easy
4	17	0.85	Easy
5	18	0.9	Easy
6	15	0.75	Easy
7	18	0.9	Easy
8	14	0.7	Medium
9	18	0.9	Easy
10	20	1	Easy

Based on the information included in Table 1, it can be seen that the level of difficulty for 10 multiple choice questions is at the level of easy difficulty 90% and moderate 10%. This means that there are 9 questions in the easy category and only one question in the medium category. The question with

a moderate category is number 8, with a difficulty index of 0.7. Thus, it can be concluded that the question instrument presented is dominated in the easy category.

This finding is in line with Febriani's research (2016) which shows 47.5% of the questions are at an inappropriate level, because they do not reflect a balanced composition for easy, medium, and difficult levels. Meanwhile, according to Arikunto (2010), questions with easy difficulty levels should be made in moderation. This is to increase student motivation in working on problems. Easy category questions also help low-ability students understand the mathematical concepts they have learned (Anas, 2006).

Differentiated power analysis results

The ability of an item to differentiate between high- and low-ability students is referred to as differentiability. The high differentiating power of an item indicates the better its ability to differentiate students based on their ability level. To analyze the differentiating power, the following formula is used

$$DB = \frac{BaB}{Ba} - \frac{BbS}{Bb}$$

Description
DB : a differentiation index
BaB : many students who answered correctly in the upper group
Ba : many students in the upper group
BbS : many students who answered correctly in the lower group
Bb : many students in the lower group.

The results of the differentiability analysis on the mathematics test instrument on the unit of time material at the 116 Percontohan State Elementary School in the 2023/2024 school year, which was analyzed using the Ms. Excel application, are shown in Table 2.

Table 2. Results of differential analysis on question items

Question number	BaB	BbS	Ba	Bb	DB	Description
1	10	6	10	10	0.4	Fair
2	10	6	10	10	0.4	Fair
3	10	9	10	10	0.1	Poor
4	9	8	10	10	0.1	Poor
5	10	8	10	10	0.2	Poor
6	10	5	10	10	0.5	Good
7	10	8	10	10	0.2	Poor
8	9	5	10	10	0.4	Fair
9	10	8	10	10	0.2	Poor
10	10	10	10	10	0	Jelek

The results in Table 2 show the percentage that 10% of the questions belong to the good category, 30% of the questions belong to the sufficient category, 60% of the questions belong to the weak category, 20% of the questions belong to the bad category, and 0% of the questions belong to the very

good category. The number of questions in the poor category indicates that the items used are not effective in measuring differences in student abilities. This may be due to two things. First, the questions were too difficult, so even high-ability students had difficulty answering. Secondly, many of the students in the class may have low ability, so they are not able to solve questions that require high analytical skills.

The results of this difference power analysis are reinforced by Magdalena et al. (2021) who explained that questions with weak differentiation often show a mismatch between student competence and the level of difficulty of the question. Febriani (2016) states that questions with too weak differentiating power are not suitable for use in learning evaluation. According to Anas (2006), differentiating power is very important to ensure that questions can measure competencies in accordance with learning objectives. Questions with high differentiating power indicate that the questions are able to differentiate students' abilities effectively and relevantly (Anas, 2006; Arifin, 2017).

CONCLUSION

Based on the research findings, the researcher concluded that the quality of the mathematics test instrument on the unit of time material showed poor quality and needed to be improved. The validity results show 70% of the questions are in the valid category. Item reliability showed that seven items met the reliability criteria. The level of difficulty of the items has a poor quality with 90% of the items classified as easy and 10% classified as sufficient. The differential power used in the questions needs to be improved, because the percentage is dominated in the poor (60%), fair (30%) and good (10%) categories. Overall, the items used in the test instrument still need to be revised and reviewed to be more effective in evaluating students' abilities.

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