Development of a HOTS-Leveled Two Tier Multiple Choice (TTMC) Test to Measure Student Misconceptions in Islamic Studies

M. Nurul Humaidi[1*], Fadli Agus Triansyah[2], Rahmad Sugianto[3], Alfi Rachma Nisfi Laila[4]

[1,4] Muhammadiyah Malang University, Malang
[2] Universitas Pendidikan Indonesia
[2] SMA Wakhid Hasyim 2 Taman

Abstrak

Penelitian ini bertujuan untuk mengembangkan tes level HOTS Two-Tier Multiple Choice (TTMC) untuk mengukur miskonsepsi siswa dalam pembelajaran agama Islam. Metode penelitian yang digunakan adalah metode 4-D oleh Thiagarajan dengan analisis data deskriptif. Hasil uji miskonsepsi menggunakan TTMC menunjukkan variasi jawaban siswa antara yang paham konsep, miskonsepsi murni, menebak miskonsepsi, dan tidak paham konsep. Kelayakan alat evaluasi terpenuhi, dan identifikasi miskonsepsi dibagi menjadi empat kategori. Persentase siswa yang paham konsep 49%, miskonsepsi murni 11%, miskonsepsi menebak 17%, dan tidak paham konsep 23%. Penelitian ini berkontribusi untuk mengukur miskonsepsi siswa dalam pembelajaran Islam dan dapat digunakan untuk meningkatkan efektivitas pengajaran dan pemahaman konsep siswa.

Kata Kunci: *alat evaluasi, HOTS, miskonsepsi, pilihan ganda dua tingkat*

ABSTRACT

This study aims to develop a Two-Tier Multiple Choice (TTMC) HOTS-level test to measure student misconceptions in Islamic learning. The research method used is the 4-D method by Thiagarajan with descriptive data analysis. The results of the misconception test using TTMC showed variations in students' answers between those who understood the concept, had a pure misconception, guessed the misconception, and did not understand the concept. The feasibility of the evaluation tool is met, and the identification of misconceptions is divided into four categories. The percentage of students who understand the concept is 49%, pure misconception is 11%, guesses the misconception is 17%, and does not understand the concept is 23%. This study contributes to measuring students' misconceptions in Islamic learning and can be used to improve teaching effectiveness and students' understanding of concepts.

Keywords:; evaluation tool, HOTS, Misconceptions, two-level multiple choice

Introduction

Mathematics learning in the 21st century is an era where the competition for human resources is very fierce, where humans are required to be able to think critically in solving problems. The quality of good human resources must be supported by a good quality of education as well, it starts with the simplest thing, namely by improving the quality of learning. To improve the quality of learning, it must begin with the objectives of the learner the right and good (Ahmed & Kumalasari, 2023; Amany & Puteri, 2023; Arif et al., 2023).

The quality of education in a country is equal to the progress of development in a country, therefore it is important to create a better quality of education to produce quality human resources. Education in schools is an education that a person will get systematically, stratified, structured, and there are clear and strict rules (Cahyadi & Ariansyah, 2023; Darmayanti et al., 2023; Inganah et al., 2023).

The purpose of education being carried out or not, can be measured by evaluation activities in schools (Jayanti et al., 2023; Lestari et al., 2023; Muhammad, Darmayanti, et al., 2023). Evaluation activities in learning must be balanced with the application of the applicable curriculum, currently in Indonesia the applicable curriculum is the 2013 curriculum. This curriculum is focused on strengthening character in the learning process consisting of nationalist, religious, manidir, mutual aid and integrity (Muhammad, Triansyah, Fahri, & Gunawan, 2023; Mustakim & Ngaliyah, 2023; Nasiha et al., 2023). According to the Ministry of Education and Culture, if integrated with learning in the 21st century, these abilities are called 4C (*creative, critical thinking, communicative, and collaborative*) and *High Order Thinking Skills* (HOTS). The 2013 curriculum learning focuses on student-centered learning (Pradana & Uthman, 2023; Rachmawati et al., 2023; Santiago, 2023).

The results of the preliminary study by interviewing one of the mathematics teachers of MTs Darul Hikmah Tulunagung, mathematics learning in schools has applied various approaches such as inquiry and cooperatives intended to provide variations in the learning process to be active in the teaching and learning process. The average character of students VII-B MTs Darul Hikmah Tulungagung has an interest in learning in the moderate category. The average learning outcomes of students VII-B MTs Darul Hikmah Tulungagung are 85 in the even semester of the 2021/2022 school year. MTs Darul Hikmah Tulungagung still uses the usual multiple choice or level one multiple choice type test which is still a prima donna to assess the knowledge of its students and the essay form test

The types of questions given are also still included in the questions at the Lower Order Thinking (LOT) level (Segara et al., 2023; Sugianto, 2023; Triansyah, Muhammad, et al., 2023). The assessment used in mathematics learning at MTs Darul Hikmah Tulungagung, does not stimulate students to think systematically, critically, logically and analytically. The assessments used are mostly only in the form of questions at the level of knowledge (C1), understanding (C2), application or application (C3), and Analysis (C4) So that students find it difficult to answer questions at the level of analyzing (C4), evaluating (C5) and creating (C6). The ability to think at a high level requires an understanding of concepts about mathematical material.

The learning of mathematics can be said to be successful if in the process the student understands well the concepts consisting of knowledge about groupings, principles, models, generalizations and theories that will later be associated with a certain material (Angraini et al., 2023; Maryanto et al., 2023; Muhammad, Triansyah, Fahri, & Lizein, 2023; Siahaan et al., 2023). The understanding of concepts in mathematics subjects is still relatively low. The inability of students to distinguish correct concepts results in the appearance of misconceptions. To overcome this misconception, it is necessary to apply diagnostic assessments, the purpose is to find out the cause of the misconception and later a solution to the problem will be determined (Angraini et al., 2022; Muhammad et al., 2022; Soraya et al., 2023; Triansyah, Yanti, et al., 2023)

A diagnostic test is a test intended to measure a student's concept comprehension ability, especially on weaknesses (misconceptions) in certain material, which will later get the weaknesses that students have and will find solutions (Angraini et al., 2022; Soraya et al., 2023; Triansyah, Yanti, et al., 2023). According to this test, it is intended to assess the extent of students' ability to understand key concepts in certain materials, especially in materials where there is a wrong understanding of concepts.

The diagnostic test that is assessed to measure students' comprehension ability is the Two-Tier Multiple Choice (TTMC) Test. According to the Two-Tier Multiple Choice (TTMC) Test, it is intended to detect misconceptions of learners because there are 2 important points that are the benefits of multiple-choice questions. First, students are able to investigate two aspects of the same phenomenon. Second, students are able to minimize the uncertainty of students' guesses (Aji et al., 2023; Laila et al., 2023).

The test is one of the tools used to evaluate learning. The first thing that must be done in developing a test is to establish a test specification, where this specification includes exposure to the quality and characteristics that must be possessed by the test that will be developed later. Based on this

statement, the test to be used must be in line with what will be measured and the instrument has been standardized. A standardized test is a test that has a high degree of validity and reliability based on trials of large and representative samples.

The use of multiple-choice instruments is considered to be able to only see knowledge in the absence of a reason why to choose the choice. (Pantiwati & Mahmudati, 2021) Not allowed to be used, there are several reasons that come with it. In the first, multiple choice encourages students to guess the answer. Second, content is not based on phenomena in everyday life (contextual). Third, it is considered unfriendly to students because it does not connect with field facts and the nature of guessing.

There are 2 other reasons presented by those who reinforce that multiple-choice questions are ineffective, firstly students have extracted the correct answer choices by false combinations. Second, multiple-choice instruments rely heavily on the ability to read and understand. The multiple choice test is very easy to apply and the analysis process is quick and easy but in terms of effectiveness it is still lacking. To cope with it, students are recommended to justify their answers. Therefore, there will be an extension of the multiple-choice test to several levels, two or three levels.

Two-tier Multiple Choice (TTMC) is a tool that takes the form of a question but is more sophisticated than multiple choice questions. The first level is similar to traditional multiple choice in that it is generally related to a statement of knowledge. The second level is similar to traditional multiple choice but the goal is to encourage higher *order thinking and* reasoning.

In this second-level multiple choice, the format asks for reasons for the response of students at the first level. In the first level the form of multiple choice is still traditional which is generally related to the knowledge of students At the second level the model is similar to the first level but the purpose is to hone the reasoning of students, According to the advantage of the two-level multiple choice test is that students in doing test questions can reveal certain concepts and state the reasons why they chose the answer. With choices and reasons in answering, it can hone students' mathematical creative thinking skills. In addition, the two-level multiple-choice test is easy to implement and also makes it easier for teachers to assess.

The advantages of the *two-tier multiple choice question form,* one of which is used for the purpose of tests that measure the cognitive abilities of students at a higher level (*Higher Order Thinking).* The *two-tier multiple choice question* form can be used to help measure students' mathematical creative thinking ability.

Based on the description above, it is necessary to develop a *Two Tier Multiple Choice* test instrument to Measure Student Misconceptions, because there is still not much use of the test applied to learning evaluation. Thus, researchers will discuss research on how to "Development of *a Two Tier Multiple Choice* Test to Measure Student Misconceptions in Junior High School".

Methodology

The research method used in this study is the 4-D method by Thiagarajan, namely *Defind, Design, Develop, Disseminate*. As for this study, it only reached the trial stage and conducted data analysis to test whether the questions were valid and reliable to be able to identify student misconceptions.

Figure 1. Research procedure

The purpose of conducting observations and interviews is to identify the difficulties that students experience. While the reason for choosing open questions is to dig deeper into the thoughts and concepts

that students have. At the stage of capturing *options* , the most students' answers are obtained to be included in the multiple choice questions. Furthermore, after validating the questions, a trial was carried out and data analysis was carried out. After data analysis states that the instrument is valid and reliable, the questions can be redistributed to obtain a description of the misconceptions that students have.

The population in this study were junior high school students who had studied the flat Build material. For ease of accessibility, MTs Darul Hikmah Tulungagung was chosen. The overall population used was 32 students.

The data analysis technique used in this study is descriptive. TTMC test results are analyzed based on the answers that students choose each answer choice, both for the first level and at the second level. Then the results of the analysis are made in the form of percentages. The percentage shape is created by using the following formula:

$$percentage\ value = \frac{a}{b}x100\%$$

Information:

a = the number of students who answer with a specific answer to each question

b = the number of students taking the TTMC test

The students' answers are then grouped into groups of understanding, pure misconceptions and guessing. Students who answer correctly both the answer and the reason will be the understanding group, while the student whose answer is right but wrong on the reason becomes a pure misconception group and the student whose answer is wrong but the reason is correct becomes the guessing group. The grouping of students' answers can be seen in Table 1 below:

Table 1 Student Answer Categories by student answer type

Categories	Student answer types
Know the Concept	Correct-Reasoned Answers Are Right (B-B)
Pure Misconceptions	Right-Reason Wrong Answer (B-S)
Misconceptions of Guessing	Wrong Answer-Reason Right (S-B)
Don't Understand	Wrong Answer-Wrong Reason (S-S)

Findings and Discussion

The study was conducted at MTs Darul Hikmah Tulunagung on June 13, 2022 using the Two-Tier Multiple Choice (TTMC) test which consists of 10 questions where at the first level students are asked to choose the most correct answer and at the second level students are asked to choose the most appropriate reason for the answer taken at the first level which can be seen in Table 2.

Table 2 Two-Tier Multiple Choice (TTMC) Test Results

No	First-Level Answer Choices	Second Level Answer Choice (%)				No	First-Level Answer Choices	Second Level Answer Choice (%)			
		A	B	C	D			A	B	C	D
1.	A	0	0	0	0	6.	A	0,53	0,19	0	0
	B	0	0	0	0		B	*0,28	0	0	0
	C	*0,69	0,16	0	0		C	0	0	0	0
	D	0	0,06	0,09	0		D	0	0	0	0
2.	A	0	0	0	0	7.	A	0,09	0,06	0	0
	B	0	0	0	0		B	0	0	0	0

No	Opt					No	Opt				
	C	0	0	0,06	*0,81		C	0,03	0	*0,81	0
	D	0	0,04	0	0,09		D	0	0	0	0
3.	A	0,06	0	0	0,03	8.	A	0	0	0,06	*0,34
	B	0,16	0	0,13	0		B	0	0	0,16	0,22
	C	0	0	0	0		C	0	0,22	0	0
	D	*0,59	0	0,06	0		D	0	0	0	0
4.	A	0	0	0	0	9.	A	0		0	0
	B	0	0	0	0		B	*0,28	0,19	0	0
	C	0,06	*0,63	0,09	0,22		C	0,22	0	0	0
	D	0	0	0	0		D	0	0	0	0,31
5.	A	0,37	0,22	0	0	10.	A	0	0	0	0,19
	B	0	0	0	0		B		0,25	0,19	0
	C	0	0	0	0,25		C	0	*0,25	0,31	0
	D	0	0	0	*0,16		D	0	0	0	0

Description: * is the answer key

Table 2 is processed and obtained the results of the students' correct answers at the first level and the correct answers of students at both levels. The results of the students' answers are concentrated so that the percentages for correct answers from both stages are highest in numbers 2 and 7 (81%) and lowest in number 5 (16%). The correct answer at both levels is smaller or comparable to the correct answer at the first level alone which can be seen in Table 3.

Table 3 Number of Correct Answers at the First Level and at the Second Level

| No | Subkonsep | Problem Number | Number of students who answered correctly | | | | difference |
| | | | First Level | | Second Level | | |
			n	%	n	%	
1.	properties of different types of quadrilaterals	6	9	0,28	17	0,53	0,25
		7	27	0,84	26	0,81	0,03
2.	Define circumference and area formulas for different types of quadrilaterals	5	5	0,16	13	0,41	0,25
		8	13	0,4	18	0,56	0,16
3.	Explain the definition of a quadrilateral flat build	1	27	0,85	22	0,69	0,16
4.	Mentioning the properties of different types of quadrilaterals	2	28	0,87	29	0,9	0,03
		3	21	0,65	26	0,81	0,16
		4	32	1,00	20	0,63	0,37
5.	Solving contextual problems related to the area and circumference of a quadrilateral flat build	9	15	0,47	16	0,50	0,03
		10	18	0,56	16	0,50	0,06

The answer categories of students who experience misconceptions are re-described based on Table 1 so that the identification of misconceptions is divided into 4 categories, namely understanding,

misconceptions, guessing, and not understanding concepts. The percentage of these categories can be seen in Table 4 below

Table 4 Percentage 4 Numbering Categoriesand Questions

No	Subkonsep	Problem Number	Student Answer Categories (%)							
			Understand		Misconceptions				Not Understand (S-S)	
					Murni (B-S)		Guess (S-B)			
			n	%	n	%	n	%	n	%
1.	properties of different types of quadrilaterals	6	9	28	0	0,00	17	53	6	19
		7	26	81	1	3	0	0,00	5	15
		Average	54		1,5		26,5		17	
2.	Define circumference and area formulas for different types of quadrilaterals	5	5	16	0	0,00	8	25	19	59
		8	11	34	2	6	7	22	12	38
		Average	25		3		23,5		48,5	
3.	Explain the definition of a quadrilateral flat build	1	22	69	5	16	0	0,00	5	15
		Average	69		16		0,00		15	
4.	Mentioning the properties of different types of quadrilaterals	2	26	81	2	6	3	9	1	4
		3	19	59	2	6	7	22	4	13
		4	20	63	12	37	0	0,00	0	0,00
		Average	67		16		10,3		5	
5.	Solving contextual problems related to the area and circumference of a quadrilateral flat build	9	9	28	6	19	7	22	10	31
		10	8	25	10	31	8	25	6	19
		Average	26,5		25		23,5		25	
	Total Average		48,3		10,3		16,76		22,1	

In Table 4, it can be seen that the overall percentage of students who understand the concepts of quadrangles and triangles is 48.3%, while students who experience pure misconceptions are 10.3%. The percentage for students who guessed was 16.76% and students who did not understand concepts was very large at 22.1%.

Overall, a comparison of the average student who experienced understanding, pure misconceptions, guessing misconceptions, and not understanding concepts in thermodynamic concepts can be seen in Figure 2 below.
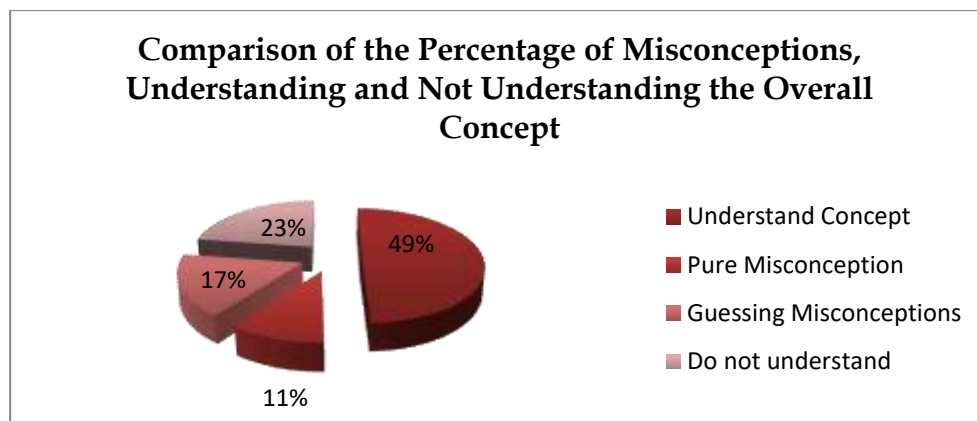

Figure 2. Comparison of Percentages of Misconceptions, Understanding and Not Understanding the Overall Concept

Identification of misconceptions experienced by students after learning is carried out to measure the level of understanding of students. The learning carried out by students is formal, planned and carried out with the guidance of school teachers. Both teaching materials, learning methods, and learning aids are prepared as well as possible in accordance with the school curriculum.

The results obtained on the misconception diagnostic test with the two-level multiple choice test (TTMC) can be seen that students' answers vary between the percentage of many students who experience misconceptions, understand concepts, and do not understand concepts in each question item. The overall percentage of students who understood the concept was 49%, experienced pure misconceptions by 11%, guessing misconceptions by 17% and those who did not understand the concepts by 23% (Figure 2). The achievement of student learning completion based on the concept of complete learning is 75%-90% of the material that must be mastered by students. However, based on Table 4. It is known that the average achievement of student learning outcomes is low (still below 50%).

The results of observations during the learning process, there are several obstacles that occur so that it is known that the teacher and the learning process contribute to the occurrence of misconceptions in students. 2 This can be seen from:

1. Repeatedly explaining the materials asked by students with inconsistent parables is done by the teacher.
2. The teacher does not correct with the students the assigned assignment. Correcting together can straighten out and provide re-understanding for students who still don't understand or hesitate in doing the questions.
3. The learning time is too short because there are activities outside of learning.

The subconcept that reaches 50% is the subconcept Mentioning the properties of different types of quadrilaterals. The percentage of understanding shows good understanding because it can be seen in Table 3 in the subconcept that there is not too much difference between students who answer correctly at the first level and answer correctly at both levels. However, when viewed as a percentage below 50%, there are several subconcepts that have a considerable difference between students who answer correctly at the first level and correct at both levels. The subconcept is Determining the formula of circumference and area for different types of quadrilaterals. Determining the nature of jajargenjang and belahketupat, The difference between correct answers at the first level and correct at both levels for the subconcept is more than 20%. The magnitude of the gap may explain that many students understand concepts but not in their entirety or misconceptions. This happens because students can answer the questions asked correctly, but students are unable to explain the exact reasons for choosing the chosen answer.

The low understanding of students revealed from the learning outcomes through the TTMC test shows that students have a low understanding of concepts. Table 4 shows students who understand concepts by 49%, experience pure misconceptions by 11%, guessing misconceptions by 17% and those who do not understand concepts by 23% Using this category, there are 23% of students who do not understand concepts. The largest subconcept is solving problems related to quadrilateral and triangular matter. The category of not understanding the concepts in the TTMC test is seen from the type of answers of students who answer incorrectly at both levels of questions.

For the student misconception category of both pure misconceptions and misconceptions due to guessing, the average overall percentage is 11% and 17%. Pure misconceptions are students who answer right at the first level and wrong at the second level, while misconceptions due to guessing are wrong at the first level but right at the second level. Three out of five subconcepts have an average of pure misconceptions above 10.3% with the largest subconcept being solving contextual problems. Meanwhile, the three subconcepts have a misconception value because guessing is above 16.74% with the largest subconcept, which is solving contextual problems.

Misconceptions revealed using the TTMC instrument can be a record for teachers in carrying out learning, especially on the concept of thermodynamics. Knowing the location of student misconceptions will make it easier for teachers to carry out remediation (improvement) learning.

Details of student answer categories and misconceptions that occur per subconcept tested are seen in the discussion below.

1. Subconcepts of properties of different types of quadrilaterals

   In this subconcept, there are some students who experience misconceptions, although in this subconcept it is only knowing from the properties of the quadrilateral wake (Cognitive level C1). However, the biggest pure misconception is seen in number 7, which is a question about determining which one belongs to the rhombus and to the misconception by guessing at number 6 which is about determining which one belongs to the wake. Although this subconcept is only remembering, quite a lot of students are fooled. This is because students misanalyze and distinguish between the nature of peregi and belahketupat. Invisibly rhombic and square builds have similarities but they have different properties. According to (Samosir et al., 2023) A rhombus is a wake whose angles are equal in size and the opposite side is equal in length and the kite is a quadrilateral construct with one of its diagonals dividing the other diagonal into two equal parts of length and the diagonals are perpendicular to each other

2. Subconcepts determine the formula of circumference and area for different types of quadrilaterals

   In this subconcept, students still experience misconceptions, and the misconceptions with the largest percentage are in guessing misconceptions. In numbers 5 and 8 students do not understand how to solve the problem, and how it is applied. Students just guess so that the answer is wrong but the reason is right. This is because students do not understand how to use formulas and how to just guess.

3. Subconcept Explaining the definition of a quadrilateral flat build

   In this subconcept, it is among the least misconceptions because the problem is only C1, namely remembering. Students with pure misconceptions there are 16% where students are correct in answering but in giving incorrect reasons

4. Subconcepts Mentioning the properties of different types of quadrilaterals

   In this subconcept, students have quite a lot of misconceptions, this is because students underestimate questions that seem easy but students are wrong in analyzing. In determining the sifta of rectangles and parallels, students only know the shape but in analyzing their nature there are many misconceptions.

5. Subconcepts Solving contextual problems related to the area and circumference of a quadrilateral flat build

   In this subconcept, it is among the most misconceptions, this is because students must first understand and analyze the problem to be able to do and solve it. Students also don't remember the extent of each flat wake so there are pure misconceptions and guessing misconceptions.

When analyzed more thoroughly for answers from students, based on the number of correct answers to tier I questions and those that answered correctly at both levels, it was found that the correct student answers in tier I were greater than the correct answers at both levels. This is because the response to the first-level question is relatively straightforward, but the second-level question requires a deep investigation into the understanding behind the answer at the first level. Like the research conducted by (Triansyah, Komaliddin, et al., 2023) which mentions most students are unable to give a correct reason for their answers.

Conclusion

Research on the Development of a Two Level Multiple Choice Test (TTMC) for Quadrilateral and Triangular Flat Building Materials in Measuring Misconceptions at MTs Darul Hikmah Tulungagung concludes as follows: First, the suitability of the evaluation tool has been achieved with

predetermined success criteria, namely the completion of learning by students by 75% - 90% of the material mastered by students. Through the statistical tests carried out, the instrument has met the predetermined criteria so that this evaluation tool can be used. Second, the identification of misconceptions is divided into four categories, namely understanding, pure misconception, guessing, and not understanding the concept. The overall percentage of students who understand the concept is 49%, experiencing pure misconceptions is 11%, misconceptions due to guessing are 17%, and students who do not understand the concepts are 23%. Based on the results of this study, the researchers made several suggestions. First, this TTMC-based evaluation test can be used to identify misconceptions in four categories, namely understanding, pure misconception, guessing, and lack of understanding of concepts in rectangular and triangular flat shapes. The results of this test can be followed up with follow-up by subject teachers so that students do not experience obstacles in the next material. Second, in preparing evaluation tests, educators are expected to pay attention to the quality of the test questions. For further research, it is recommended to apply this approach to other materials to see its effectiveness.

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