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A Diagnostic Analysis of Junior High School Students' Difficulties in Solving TIMSS Model Mathematics Test

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abstract

This research aims to diagnose students' difficulties in solving the TIMSS model mathematics test. This research used quantitative descriptive research method. The subjects of study is eighth-grade students of junior high school in Cirebon, Indonesia. Data collection was carried out through a simple random sampling technique including 676 students of junior high school from 13 public and private schools. The research instrument is the TIMSS model-mathematics test in the form of multiple-choice and short answers as many as 35 items which are translated into Indonesian. Data analysis was using cognitive diagnostic modeling (CDM) in R programe. The research result showen: 1) In the knowing Domian have been dificulties to understand: commutative properties of on natural numbers, estimating the result of the nearest decimal number, identify the appropriate table with the information on the pictogram graph and read the values of the two line charts; 2) in the applaying Domian have been dificulties in: choose and combine information from two different sources to solve problems with multiple steps and in the number series, in find solutions in linear equations of two variables, compiling and using solutions of linear equations to solve problems, and calculating the side lengths of triangles based on linear equations, symmetry properties of reflection and using information from tables to draw a bar chart and compare two possible events; (3) In reasoning domain have been dificulties in to find number patterns and to use the Pythagorean theorem to find the perimeter of a quadrilateral or triangle.

Keywords:
Diagnostic's Analysis, Student's difficulties, TIMSS, CDM

INTRODUCTION

Learning difficulties in mathematics are still common and experienced by junior high school students. So that learning outcomes can achieve learning goals and targets, the teacher should know where the students' learning difficulties lie. The errors experienced may be due to counting errors or errors caused by the inability of students to understand the text of the test. As shown by the results of research which states that students with learning difficulties in mathematics often make mistakes in learning to count and make mistakes in solving story test. The difficulties that are often experienced by students are difficulties when working on story problems because they are not able to understand the meaning of the test and are confused when determining which arithmetic operations to use (Utari et al., 2019). Learning difficulties can also be caused by students' inability to think critically and lack of strong learning motivation, as shown by the results of a study by Amin and Murtiyasa (Amin & Murtiyasa, 2021), which stated that the difficulty in learning mathematics is the difficulty of students in critical thinking which is influenced by motivation. Learning difficulties in mathematics still common and experienced by junior high school students. Learning difficulties are defined as not having certain competencies by students related to understanding certain teaching materials, cognitive processes, or problem solving skills. Students who have learning difficulties will be able to make errors in answering test. Errors made by students are defined as responses to test that are not in accordance with the expected response or answer (Isgiyanto, 2013). Diagnosis of errors made by students is based on attributes. Attributes are defined as procedures, processes, skills, or competencies that students must possess to complete the items (Gierl et al., 2008). Attributes in the content category are the materials used in the test framework. The attribute of the process category is a general skill. This process category is a skill that students want to achieve after following the learning process with the material provided during the learning process.

One of the software that can be used to diagnose student learning difficulties is Software R. In the R was package namly Cognitive Diagnostic Model (CDM). CDM as a diagnostic analysis tool has several advantages over other diagnostic tools, namely (1) it is easy to use and does not require complicated syntax (2) it can execute a lot of data in a relatively short time, (3) CDM can also be accessed free of charge from the developer. CDMs are latent class models that classify test takers into latent classes based on the similarity of their responses. To put items through testing they are known as restricted latent class models because the number of latent classes is limited by the number of attributes used to answer test items. With K attributes as the foundation respondents will be divided into two groups based on their performance on a given test. There are K latent classes (the number 2 indicates that there are two possible outcomes for each attribute: mastery or nonmastery). In the current study, for example, test takers were classified into $2^3 = 8$ latent classes based on the three attributes required to perform successfully on the items of the test under study. CDM is confirmatory, which means that the latent variables in CDM are defined a priori through the Q-Matrix which is a hypothesis about the skills needed to get each item answered correctly. It is a matrix of as many rows as there items on the test and as many columns as there are attributes underlying performance on the test. In each latent class, there is a unique profile attribute that shows whether or not students master certain attributes expressed in the form of binary numbers 0 and 1 in a Q-Matrix, for example for α_1 (000) and α_8 (111). The 1st latent class shows that none of the attributes are mastered by students while the 8th latent class all students have mastered all of the tested attributes. The percentage of students who have mastered each latent class can be seen from the value of the Class Probability, and how many students have mastered the attributes in each latent class can be seen from the value of the Class

Expected Frequency. There are several types of CDM models, namely: deterministic input, noisy-or gate model (DINO), compensatory Reparameterized unified model (CRUM), determinist icinput, noisy-and gate model (DINA), noncompensatory reparematerized unified model (NC-RUM), general diagnostic model (GDM), log-linear CDM (LCDM), and generalized-DINA (G-DINA) (Ravand & Robitzsch, 2015).

There have been several previous studies that examined the diagnosis of students' difficulties in solving math problems using R software, including research related to diagnosing students' difficulties in completing the junior high school mathematics national exam using R software (Retnawati, 2017). Research related to diagnosing students' difficulties in completing math tests that focus on circle material using R software has also been carried out (Abidin & Retnawati, 2019). From the two studies above, there is no research that examines the diagnosis of student difficulties in completing the TIMSS model of mathematics tests, even though knowing the difficulties of students in solving TIMSS model math problems is important considering the ranking of Indonesian students' TIMSS scores. still low. Therefore, researchers are interested in conducting research related to the diagnosis of students' difficulties in completing the TIMSS model math test.

The low TIMSS score of Indonesian students can be seen in the results of the 2011 TIMSS research report that Indonesia's score that included class VIII in each content was a number content score of 375, an algebraic content score of 392, a geometry content score of 377, a data and chance content scroe of 376 with an average TIMSS score of 500. Thus, Indonesian students are still weak in doing the TIMSS model mathematics test. The average result of Indonesian students' work on the TIMSS model of correct number content is 24% while the international average of students who answered correctly is 43% (Ina V.S. Mullis, Michael O. Martin, Pierre Foy, 2012). The results of research by Munaji and Setiawahyu (Munaji & Setiawahyu, 2020) in Cirebon City stated that the scores of students in Cirebon City who enrolled in class VIII obtained an average score of 49% or had not reached the target. This is in line with the results of the national TIMSS which placed Indonesian junior high school students in 38th place out of 42 countries that took part in the (TIMSS) survey in 2011 (Wardhani & Rumiati, 2011).

Some research results related to the efforts of students' ability to complete the TIMSS model of mathematics tests have been carried out including by Adi (2019) by developing the TIMSS model test as an instrument to measure the mathematical abilities of class VIII students and the analysis using the Rasch model. The ability of students who worked on the TIMSS model questions was categorized as 16 high-ability students, 88 moderately capable students, and 15 low-ability students. Similar research has also been carried out by Hapsari (2016) who developed a TIMSS-like question to measure critical thinking and problem-solving skills in class VIII algebraic content. students' critical thinking skills. As for this study, the efforts made to improve students' ability to complete the TIMSS model of mathematics tests are by diagnosing students' difficulties to all of the topic at the TIMSS domain. By diagnosing students' difficulties, it is hoped that mathematics teachers can find out comprehensively which parts of the TIMSS domains are still weak that need to be improved in teaching and learning practices in the classroom.

Diagnostic analysis is used to find out the strengths and weaknesses of students in solving a series of tests. Information on the results of the diagnostic analysis is related to not having or not mastering certain competencies needed to complete the items. The information is in the form of attributes that underlie the questions, incompleteness of attributes, and errors made by students. Knowing which parts are student weaknesses is important to be recommended to stakeholders for improving teacher abilities, developing questions, and for improving the mathematics learning process, it is necessary to do research to diagnose student difficulties (Isgiyanto, 2013).

Based on the background described above, the aim of this research is to diagnose students' difficulties in solving the TIMSS model mathematics test using the CDM with GDINA model with describe the student's dificulties of on each domian of TIMSS.

METHODS

This research design uses a survey method with a cross-sectional survey model with a descriptive-quantitative approach that describes the difficulties of students in solving the TIMSS model of mathematics tests. Students' difficulties are grouped based on their thinking process abilities according to the cognitive domains in TIMSS, namely difficulties in the domains of knowing, applying, and reasoning. These cognitive domains are described in four content domains, namely the domain of numbers, algebra, geometry, and data and cahance.

The subjects in this study were junior high school students of class VIII from 10 goverment schools and 3 private schools in the city of Cirebon as many as 676 students. 518 students came from goverment schools and 158 students came from private schools. Selection of research subjects using simple random sampling technique.

The data collection of students' difficulties was obtained by giving a TIMSS model of mathematics test that had been translated into Indonesian, without changing the essence and form of the original test with a test instrument of 35 multiple-choice test items with four answer choices and a short answer form test. The test was carried out online using a google form because the test was carried out during the COVID-19 pandemic. Data collection was carried out in September and October 2020. The TIMSS test model used in this research is the 2015 TIMSS, which examples of tests can be seen in the 2015 TIMSS results published by the Association for The Evaluation of Educational Achievement (IEA) (Mullis et al., 2016).

Data analysis techniques used in this research was the CDM with GDINA model using R Softwere. R is a programming language and software for statistical and graphical analysis. The R language is now the de facto standard among statisticians for statistical software development, and is widely used for statistical software development and data analysis. Analysis of the GDINA model requires deriving the attributes of each item. Attributes are defined as procedures, processes, skills, or competencies that students must possess to complete the items. The attributes for each item consist of number content, algebra conten, geometry conten and data and chance. Attributes for each item consist of content attributes and process skill attributes. Thus, an example of a 3x3 ordo Q matrix is presented as follows.

$$\begin{array}{cc} & \begin{array}{ccc} A_1 & A_2 & A_3 \end{array} \\ Q_{3\times 3} = \begin{array}{c} I_1 \\ I_2 \\ I_3 \end{array} & \begin{bmatrix} 1 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 1 & 1 \end{bmatrix} \end{array}$$

Students must master attribute 1 (A_1) in order to complete item 1 (I_1), attribute 3 (A3) is required to complete item 2, and attribute 2 (A_2) and attribute 3 (A_3) are required to complete item 3 (I_3). As a result, item 1 is used to measure attribute 1, item 2 is used to measure attribute 3, and item 3 is used to measure attributes 2 and 3, requiring students to master all attributes.

The data to be analyzed are student response data and Q-matrix data consisting of attributes that must be mastered by students. Further analysis is carried out by implementing the CDM package from the R softwere which produces latent attributes. Furthermore, these attributes will be interpreted and the interpretation includes understanding the sub-skills that are relatively difficult compared to other sub-skills in a material group based on the attributes in the Q-Matrix.

The research procedure used in diagnosing students' difficulties in solving the TIMSS model mathematics test with CDM follows the steps suggested by Ravand and Robitzch as follows: (1) Designing attribute specifications. In this step the researcher defines the attributes to be tested. These attributes are contained in the content domains of numbers, algebra, geometry, and data and chance. For the effectiveness of the analysis of these attributes are grouped into 9 Q-Matrix; (2) Analysis of the test items and delineating skill by-item relationships in a Q-matrix; (3) Model specification. Several diagnostic models are available in CDM (Ravand & Robitzsch, 2015). In this researh, the researcher chose the GDINA model because this model was considered the most suitable for use according to the model-fit test results the CDM model used is the GDINA model. Based on the results of testing by Ravand and Robitch G-DINA has the best relative fit index, consistency, and significance test results if compared to other models (Ravand & Robitzsch, 2015). ; (4) Estimating the profiles of skill mastery for taker examinees based on actual test performance data using the CDM.

Based on the description above, the purpose of this research is to diagnose students' difficulties in solving the TIMSS model of mathematics test using the CDM with G-DINA model for all content domains and cognitive domains of TIMSS by describe the student dificulties in each domain of TIMSS model of mathematics test .

RESULT AND DISCUSSION

Result

The results of the analysis are presented into three parts based on a Q-Matrix taken from 35 test items, namely Q1-Matrix, Q2-Matrix and Q3-Matrix related to the domain content of number. Q4-Matrix and Q5-Matrix related to the domain content of algebra. Q6-Matrix and Q7-Matrix related to the domain conten of geometry. Q7-Matrix and Q9-Matrix related to the domain conten of data and chance.

Content Domain : Number

Analysis for the Q1-Matrix

Q1-Matrix consists of five test items, namely items numbered 3, 4, 7, 8, and 9. The five items are attributes of the Q1-Matrix which is written as (A1) calculates positive integers, (A2) performs mixed arithmetic operations on integers, (A3) understands the commutative nature of integer arithmetic operations, (A4) estimates the result of the nearest decimal number from a fractional number, and (A5) completes the table with the right proportions. These five attributes have the cognitive domain of knowing.

Table 1. The Items and Attributs of Q_1-Matriks

Items	Attribute: A3	A4	A7	A8	A9	Cognitive Domain
3	1	0	0	0	0	Knowing
4	0	1	0	0	0	Knowing
7	0	0	1	0	0	Knowing
8	0	0	0	1	0	Knowing
9	0	0	0	0	1	Knowing

Based on these 5 attributes, the number of possible latent classes is 32 latent classes. To identify students' difficulties, the researcher took the 4 most dominant probability classes from 32 latent classes as shown in Table 2.

Tabel 2. Class Probabilities of Q_1 - Matriks

Latent Clasis ($\boldsymbol{\alpha}$)	Attribute Profile	Class Probability	Class Excpected Frequency

1	00000	0.2821	190.4427
2	10000	0.0296	19.9976
…	…	…	…
17	00001	0.1140	76.98701
…	…	…	…
32	11111	0.1014	68.4288

Attribute profile α_1(00000) has the most dominant probability class, which is 0.2821. So, as many as 28.21% of respondents or around 190 students could not answer any of the questions correctly. Meanwhile, α_{32}(11111) has a class probability value of 0.1014. So about 10.14% of respondents or about 68 students have mastered the test items of all attributes in Q1-Matrix. Attribute profile α_{17}(00001) has a second dominant probability class, which is 0.1140 So, about 11.40% of respondents or about 78 students have difficulty solving questions on attribute test items: A3, A4, A7, and A8. The attribute profile α_2(10000) has a class probability value of 0.0296, which means that about 2.96% of respondents or about 20 students do not master the attribute test items A4, A7, A8, and A5. Thus it can be said that students have the most dominant difficulty on attribute test items A4, A7, and A8. Thus, it can be said that students are unable to perform mixed arithmetic operations with integers, cannot understand the commutative nature of integer arithmetic operations, and cannot estimate the result of the nearest decimal number from a fractional number, with each of these attributes included in the knowing domain..

Analysis for the Q2-Matrix

The Q2-Matrix consists of five test items, namely items numbered 15, 16, 21, 22, and 23. The five items are attributes of the Q2-Matrix which is written as (A5) selects information from two sources to solve the problem with multiple steps, with cognitive domain applying, (A16) combines information from two sources to solve multi-step problems, with cognitive domain applying, (A21) number sequence, with cognitive domain applying, (A22) reasoning on fractions is part of the whole, with cognitive domain reasoning, and (A23) explains that the answer to the fraction problem is part of the whole, with the cognitive reasoning domain. Items, attributes, and cognitive domains of Q-Matrix 2 are shown in Table.

Table 3. The Items and Attributs of Q2-Matriks

Items	Attribute: A15	A16	A21	A22	A23	Cognitive Domian
15	1	0	0	0	0	Applyaing
16	0	1	0	0	0	Applying
21	0	0	1	0	0	Applying
22	0	0	0	1	0	Reasoning
23	0	0	0	0	1	Reasoning

Based on these 5 attributes, the number of possible latent classes is 32 latent classes. To identify students' difficulties, the researcher took the 4 most dominant probability classes from 32 latent classes as shown in Table 4.

Table 4. Class Probabilities of Q2-Matriks

Latent Clasis ($\boldsymbol{\alpha}$)	Attribute Profile	Class Probability	Class Excpected Frequency
1	00000	0.1947	131.6229
…	…	…	…
17	00001	0.1681	113.6418
..	…	…	…
26	10011	0.1339	90.5587
..	…	…	…
32	11111	0.1315	88.9152

Attribute profile α_1(0000) has the most dominant probability class, which is 0.1947. So, as many as 19% of respondents or about 130 students could not answer any of the questions correctly. Attribute profile α_{32} (11111) has the second dominant probability class, which is 0.1315. This shows that about 13% or about 89 students have mastered all the attributes in the Q-2 matrix. Based on the profile attribute α_{17} (00001) it has a class probability of 0.1681 or about 113 students have difficulty in solving attribute items A15, A16, A21, and A22. Meanwhile, based on the attribute profile α_{26} (10011) it has a class probability of 0.1339 or about 90 students have difficulty mastering attribute items A16 and A21. Thus, the most dominant difficulty experienced by students is the lack of mastery of attribute items A16 and A21. So it can be said that many students cannot combine information from two different sources to solve multi-step problems and number sequence problems.

Analysis for the Q3-Matrix

Q3-Matrix consists of four test items, namely item numbers 25, 30, 31, and 32. The four items are attributes of Q3-Matrix which is written as (A25) understands percentage calculations in everyday life, with cognitive domain applying, (A30) lists numbers to find patterns, with cognitive reasoning domain, (A31) finds number patterns, with cognitive reasoning domain (A32) using formulas from number patterns, with cognitive reasoning domain. Items, attributes, and cognitive domains of Q3-Matrix 5 are shown in Table 5.

Table 5. The Items and Attributs of Q_3-Matriks

Items	Attribute: A25	A30	A31	A32	Cognitive Domian
25	1	0	0	0	Applyaing
30	0	1	0	0	Reasoning
31	0	0	1	0	Reasoning
32	0	0	0	1	Reasoning

Based on these 4 attributes, the number of possible latent classes is 16 latent classes. To identify student difficulties, the researcher took 4 latent classes from the most dominant probability class as shown in Table 6.

Table 6. Class Probabilities of Q3-Matriks

Latent Clasis	Attribute Profile	Class Probability	Class Excpected Frequency
1	0000	0.1570	106.1054
…	…	…	…
11	0101	0.2436	138.1479
12	1101	0.0820	55.4425
..	…	…	…
16	1111	0.3869	261.5759

Attribute profile α_{16} (1111) has the most dominant probability class, which is 0.3869. So, about 38.69% of respondents or about 260 students mastered all attribute items in the Q3-matrix. The attribute profile α_{11}(0101) has the second dominant class probability value with a value of 0.2436 which indicates that about 24.36% of respondents or about 138 students have not mastered the attribute items A25 and A31. Attribute profile α_1(0000) has a third-class probability value with a value of 0.1570 which indicates that about 15.70 % of respondents or about 106 students do not master any of the attribute test items from the Q3-Matrix. As for the attribute profile α_{11}12 (1101) it has a class probability value of 0.0820, which means that about 8.20% of respondents or about 55 students do not master the A31 attribute item. Thus, based on the attribute profile α_1(0000), α_{11}(0101), and α_{12}(1101) the most dominant item that has not been mastered by students is item attribute A31, which means that students cannot find number patterns.

Content Domain : Algebra

Analysis for the Q4-Matrix

The Q4-Matrix consists of two test items, namely items 5 and 12. The two items are attributes of the Q4-Matrix which is written as: (A5) performs arithmetic operations in addition to algebraic forms, with the cognitive domain of knowing, and (A12) finds solutions from the system linear equation of two variables, with cognitive domain applying. Items, attributes, and cognitive domains of Q4-Matrix are shown in Table 7.

Tabel 7. The Items and Attributs of Q4-Matriks

Items	Attribute: A15	A16	Cognitive Domian
5	1	0	Applyaing
12	0	1	Reasoning

Based on the 2 number of attributes in Table 7, the number of possible latent classes is 4 latent classes. The most dominant class probability values of the two attributes are as shown in Table 8.

Tabel 8. The Class Probabilities of Q4-Matriks

Latent Clasis	Attribute Profile	Class Probability	Class Excpected Frequency
1	00	0,3281	221.8114
2	10	0,1718	116.1801
3	01	0,0918	62.0985
4	11	0,4081	275.9099

Attribute profile α_1(00) has the most dominant probability class, which is 0.3218. So, about 32% of respondents or about 221 students could not answer any of the questions correctly. Attribute profile α_4(11) has a second dominant probability class, namely 0.4081 which indicates that about 40% of respondents or about 275 students have mastered all attributes in Q4-Matrix. Based on the profile attribute α_2(10) has a class probability of 0.1718 or about 116 students have difficulty in solving the item attribute A12. Thus, based on attribute profile α_1(00) and attribute profile α_1(10), the most dominant item that students have not mastered is attribute A12. So it can be said that many students have difficulty in finding a solution from a two-variable linear equation system, with the cognitive domain applying

Analysis for the Q5-Matrix

The Q5-Matrix consists of four test items, namely items numbered 18, 24, 26 and 27. The four items are attributes of the Q5-Matrix which is written as: (A18) determines the value of an algebraic expression involving parentheses and negative numbers, with knowing cognitive domain, (A24) understanding the graph properties of linear functions, applying cognitive domain, (A26) compiling and using solutions from linear equations to solve problems with applying cognitive domains, (A27) calculating the sides of a rectangle based on known linear equations. Items, attributes, and cognitive domains of Q5-Matrix are shown in Table 9**.**

Tabel 9. The Items and Attributs of Q4-Matriks

Items	Attribute: A18	A24	A26	A27	Cognitive Domian
18	1	0	0	0	Applyaing
24	0	1	0	0	Reasoning
26	0	0	1	0	Reasoning
27	0	0	0	1	Reasoning

Based on the 4 total attributes in Table 9, the number of possible latent classes is 16 latent classes. To identify student difficulties, the researcher took the five most dominant probability class values in 16 latent classes as shown in Table 8.

Tabel 10. Class Probabilities of Q5-Matriks

Latent Clasis $\boldsymbol{\alpha}$	Attribute Profile	Class Probability	Class Excpected Frequency
1	0000	0,3388	229.0872
2	1000	0.0064	4.3539
3	0100	0,1534	103.7287
….	….	…	…
10	1001	0,0943	63.7851
..	..	..	..
12	1101	0,2121	143.3866
..	…	…	…
16	1111	0.0197	13.3404

Attribute profile α_1(0000) has the most dominant probability class, which is 0.3388. So, about 33% of respondents or about 229 students could not answer any of the questions correctly. Attribute profile α_{12}(1101) has the second dominant probability class, which is 0.2121 or about 143 students have not mastered item attribute A26. Based on the attribute profile α_3(0100) which has a class probability of 0.1534 which indicates that about 15% of respondents or about 103 students have not mastered the attribute items A18, A26, and A27. Thus, it can be said that the most dominant item that has not been mastered by students is the attribute item A26 A27, namely students do not compose and use solutions from linear equations to solve problems and do have not calculate the sides of a rectangle based on known linear equations, with the cognitive domain of applying nad . Only 1.97% of students have mastered all the attributes in the Q5-Matrix indicated by the attribute profile α_{16}(1111) with a class probability value of 0.0197.

Content Domain : Geometry

Analysis for The Q6-Matriks

The Q6-Matrix consists of four test items, namely items numbered 6, 10, 13, 17 and 19. The five items are attributes of the Q6-Matrix which are written as: (A6) Understanding the position of a point on Cartesian coordinates, with the cognitive domain of knowing, (A10) Identify opposite sides of the cube net, with the cognitive reasoning domain, (A13) understand the nature of symmetry in reflection with the applying cognitive domain, (A17) Identify the correct formula for the area of the rectangle, with the applaying cognitive domain. (A19) Solve problems involving angles of triangles and parallel lines, with the cognitive domain of applying. Items, attributes, and cognitive domains of Q-Matrix 2 are shown in Table 11.

Tabel 11. The Items and Attributs of Q4-Matriks

Items	Attribute: A6	A10	A13	A17	A19	Cognitive Domian
6	1	0	0	0	0	Knowing
10	0	1	0	0	0	Reasoning
13	0	0	1	0	0	Applaying
17	0	0	0	1	0	Applaying
19	0	0	0	0	1	Applaying

Based on the 5 attributes in Table 11, the number of possible latent classes is 32 latent classes. To identify student difficulties, the researcher took the five most dominant probability class values from 32 latent classes as shown in Table 12.

Tabel 12. The Class Probabilities of Number Geometri A21 – A25

Latent Clasis $\boldsymbol{\alpha}$	Attribute Profile	Class Probability	Class Excpected Frequency
1	00000	0.0679	45.8988
…	…	…	……
24	11101	0.0674	45.5596
….	….	…	…
28	11011	0.0919	62.1614
..	..	..	..
32	11111	0.3252	219.8587

attribute profile α_{32}(1111) has the most dominant probability class, which is 0.3252. So, about 32.52% of respondents or about 219 students can answer all the attributes in the Q6 matrix correctly. Attribute profile α_{28}(11011) has the second dominant probability class, which is 0.0919. So, 9.19% of respondents or about 62 students have not mastered item attribute A13. Based on the attribute profile α_1(0000) which has a class probability of 0.0679 which indicates that about 6.79% of respondents or about 46 students have not mastered all items in Q6-Matrix. And based on the profile attribute α_{24}(11101) has a class probability of 0.0674. Thus, it can be said that about 6.74% of respondents or about 45 students have not mastered item A17. Thus it can be said that most students have mastered all the attributes in the Q6-Matrix, and only 9.19% of students still have not mastered the attributes A13 and attribute 17, which means that students have difficulty understanding the properties of symmetry in reflection, and students have difficulty identifying the formula that the exact area of the rectangle, with the cognitive domain of the two attributes being applying.

Analysis For The Q7-Matrix

Q7-Matrix consists of four test items, namely items numbered 28, 33, 34, and 35. The four items are attributes of Q7-Matrix which is written as: (A28) Using the Pythagorean theorem to find the perimeter of a trapezoid, with cognitive reasoning domain, (A33) Determine the area of one square, with cognitive reasoning domain, (A34) Determine the side length of the square if the area is known, with cognitive reasoning domain, (A35) Determine the perimeter of the square if one side length is known, with cognitive domain applaying. Item, attribute, and cognitive domain of Q-Matrix 2 are shown in Table 13.

Tabel 13. The Items and Attributs of Q4-Matriks

Items	Attribute: A28	A33	A34	A35	Cognitive Domain
28	1	0	0	0	Reasoning
33	0	1	0	0	Reasoning
34	0	0	1	0	Reasoning
35	0	0	0	1	Applaying

Based on the 4 attributes in Table 13, the number of possible latent classes is 16 latent classes. To identify student difficulties the researcher took the four most dominant probability class values from 16 latent classes as shown in Table 14.

Tabel 14. The Class Probabilities of Number Geometri A26 – A29

Latent Clasis ($\boldsymbol{\alpha}$)	Attribute Profile	Class Probability	Class Excpected Frequency
1	0000	0,4270	288,6922
…	…	…	..
3	0100	0,1107	74,8089
...	…	…	…
15	0111	0,1106	74,7896
16	1111	0,1114	75,3067

Attribute profile α_1(0000) has the most dominant probability class, which is 0.4270. So, about 42.7% of respondents or about 228 students could not answer any of the tests correctly on the Q7-Matrix attribute. Attribute profile α_3(0100) has the second dominant probability class, namely 0.1107 or which indicates that about 74 students have not mastered the attribute items A28, A34, and A35. Attribute profile α_{15}(0111) has a class probability of 0.1106 which indicates that about 11.06% of respondents or about 74 students have not mastered the attribute item A28. The latent class 16(1111) has a class probability of 0.1114 which indicates that 11.14% of respondents or about 75 students have mastered all the attributes in the Q7-Matrix. Thus, based on latent classes α_{15}(100) and α_{15}(0111) it can be said that the most dominant item that has not been mastered by students is attribute item A28, namely students do not use the Pythagorean theorem to find the perimeter of a trapezoid, with cognitive reasoning domain.

Conten Domain : Data and Chance

Analysis For Q8-Matriks

The Q8-Matrix consists of 3 test items, namely items 1, 2, and 11. The three items are attributes of the Q8-Matrix which are written as: (A1) Using information from the table to draw a bar diagram, with the cognitive domain applaying, (A2) Identify the table that matches the information on the pictogram graph, with the cognitive domain of knowing, (A11) Reading the values of the two line charts correctly, with the cognitive domain of knowing, Items, attributes, and the cognitive domain of the Q8-Matrix shown in Table 15.

Tabel 15. The Items and Attributs of Q8-Matriks

Items	Attribute: A1	A2	A11	Cognitive Domian
1	1	0	0	Applaying
2	0	1	0	Knowing
11	0	0	1	Knowing

Based on the 3 attributes in Table 15, the number of possible latent classes is 8 latent classes. To identify student difficulties, the researcher took the four most dominant probability class values from the 8 latent classes as shown in Table 16.

Tabel 16. The Class Probabilities of Q8-Matriks

Latent Clasis (**α**)	Attribute Profile	Class Probability	Class Excpected Frequency
1	000	0.1356	91.6581
…	…	…	..
4	110	0.1639	110.8188
...	…	…	…
7	011	0.0459	31.0023
8	111	0.5660	382.6161

Attribute profile α_8(111) has the most dominant probability class, which is 0.5660. So, as many as 56.6% of respondents or about 328 students have mastered all the attributes in the Q8-Matrix. Attribute profile α_4(110) has the second dominant probability class, namely 0.1639 which indicates that 16.39% of respondents or about 110 students have not mastered the item attribute A11. Attribute profile α_7(011) has a class probability of 0.0459 which indicates that as many as 4.59% of respondents or about 31 students have not mastered the item attribute A1. The latent class α_1(000) has a class probability of 0.1356 which shows that as many as 13.56% of respondents or about 91 students have not mastered all the attributes in the Q8-Matrix. Thus, based on latent classes α_1(000), α_4(110) and α_7 (011) it can be said that the most dominant item that has not been mastered by students is attribute item A1 and A11 which means that students, namely students cannot use information from tables to draw bar chart, with the cognitive domain of applying and students cannot read the value of the two line charts correctly, with the cognitive domain of knowing.

Analysis For Q9-Matriks

Q9-Matrix consists of 3 test items, namely items 14, 20, and 29. The three items are attributes of the Q9-Matrix which is written as: (A14) identifies the probability of an event, with cognitive reasoning domain, (A20) compares two possibilities events that may occur, with the domain applying, (A29) understand the average value for solving everyday problems, with the cognitive reasoning domain, item, attribute, and cognitive domain of the Q9-Matrix shown in Table 17.

Tabel 17. The Items and Attributs of Q9-Matriks

Items	Attribute: A14	A20	A29	Cognitive Domian
14	1	0	0	Reasoning
20	0	1	0	Applaying
29	0	0	1	Reasoning

Based on the 3 attributes in Table 17, the number of possible latent classes is 8 latent classes. To identify student difficulties the researcher took the four most dominant probability class values from the 8 latent classes as shown in Table 18.

Tabel 18. The Class Probabilities of The Q9-Matriks

Latent Clasis ($\boldsymbol{\alpha}$)	Attribute Profile	Class Probability	Class Excpected Frequency
1	000	0.3093	209.0764
2	100	0.1524	103.0392
...	...	...	...
6	101	0.1401	94.7407
....	....	....	....
8	111	0.1988	134.3740

Attribute profile $\alpha_1(000)$ has the most dominant probability class, which is 0.3093. So, as many as 30.93% of respondents or about 209 students did not master any of the attributes in the Q9-Matrix. Attribute profile $\alpha_8(111)$ has the second dominant probability class, namely 0.1988 which shows that as many as 19.88% of respondents or about 134 students have mastered all attributes in Q9-Matrix. Attribute profile $\alpha_2(100)$ has a class probability of 0.1524 which indicates that 15.24% of respondents or about 103 students have not mastered the A14 attribute. The profile attribute $\alpha_6(101)$ has a class probability of 0.1401 which shows as many as 14.01% of respondents or about 94 students have not mastered the A20 attribute. Thus, based on latent classes $\alpha_1(000)$, $\alpha_2(100)$ and $\alpha_6(101)$ it can be said that the most dominant item that has not been mastered by students is attribute item A20 and A29 which means that many students cannot compare two possible probabilities that may occur, with the application domain, and cannot calculate the average value for solving everyday problems, with the cognitive reasoning domain

Discusison

Based on the results of the analysis on the Q1-Matrix involving number Domian, it was found that of the five existing attributes, the most dominant students could not answer the test correctly on attributes A2, A3, and A4. The following is an example of a test in which the most dominant students have not mastered it, namely attribute 3.

The A3 attribute is related to the commutative property of integer arithmetic operations, as shown in Figure 1.

For every whole number n, are these statements true are false?

	statements	true	false
A	$n + 4 = 4 + n$	.....	.....
B	$n - 5 = 5 - n$	.....	.....
C	$n \times 6 = 6 \times n$	.....	.....
D	$n: 7 = 7: n$	.....	.....

a. A true, B False, C False, D. False
b. A true, B true, C False, D False
c. A true, B True, C True, D False
d. A True, B False, C True, D False

Figure 1. Examples of Commutative Properties of Integer Number Counting Operations

Type of test is multiple choice. To be able to answer the questions in Figure 2 correctly students must understand that $n + a = a + n$, $n - a \neq a - n$, $n \times a = a \times n$ and $a: n \neq n: a$ where a and n are whole number. Thus it can be said that students do not understand the commutative properties of integer in addition, subtraction, multiplication, and division operations. This shows that the integer material is still a difficult material for junior high school students (Laamena & Laurens, 2020).

The following is an example of a test that most students have not mastered, namely the A7 attribute. Attribute A7 is related to the ability of students to combine information from two different sources to solve multi-step problems as in the example problem in Figure 2.

Mobile Telphone

Kate was oing to buy a new supertext mobile phone. She looked at these two advertisements.

Company X	**Company Y**
The New Supertext Mobile Phone Get this great phone free 250 zeds monthly charge Calss zeds per minute Text message 2 zeds each	The New Supertext Mobile Phone Cheap rates calls and texts! Buy the phone for 2500 zeds Only 50 zeds monthly charge. Calla only 2 zeds per minute. Text message only 1 zed each

Kate estimates she should call 500 minutes in a year and 200 message. How much does it cost to make calls and message in one year?

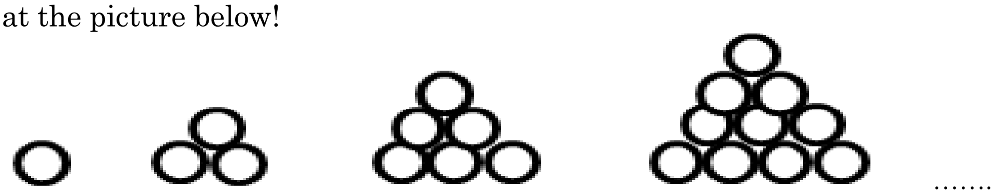
Company X : Rp ……………………….. Company Y : ………………………..

Figure 2. Example of the test a related to problem combining information from two different sources to solve a multi-step problem

Type test is short answer test. In the example problem Figure 5 tests students' ability to formulate mathematical problems, tests the ability to apply concepts, facts, procedures and reasoning in mathematics, interpret, apply and evaluate the results of the mathematical process, and compare two different quantities. To solve this test actually does not require calculations or difficult mathematical formulas because the main thing that is needed is imagination and creativity. The possibility of students in the city of cirebon have been difficulties because they are not accustomed to doing multi-step analysis. The test in Figure 2 requires the ability to solve unstructured problems. Meanwhile, according to Mahhmud and Pratiwi the difficulty of students in solving unstructured problems is due to the lack of students in understanding the prerequisite material; difficulty building a strategy of completion; and difficulty in drawing conclusions (Mahmud & Pratiwi, 2019).

Based on the results of the analysis on the Q3-Matrix, it was found that dominantly students have not mastered the A13 attribute, which means that students cannot find number patterns. Examples of questions related to number patterns are presented in Figure 3.

Look at the picture below!



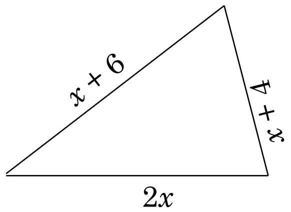
Picture I Picture II Picture III Picture IV Picture V

How many circels in picture V?

Figure 3. Example of the test related to number patterns

Students experience a lot of difficulties the cause is the possibility because students can't find the pattern of numbers the impact is that students can't find the number of circles in the 5th picture. Because students can't find the pattern of numbers, the impact is that students can't find the number of circles in the 5th picture. The mathematical problem solving ability of students on number pattern material is still low caused by the lack of students in identifying known data, the data being asked, the adequacy of data for problem solving, identifying strategies that can be taken, completing mathematical models with reasons, checking the correctness of the solutions obtained (Nurhayati & Zanthy, 2019).

The most dominant students could not answer the test correctly on attributes A27. Attribute 27 is related to the students' ability to calculate the sides of a rectangle based on the equation as shown in figure 4.

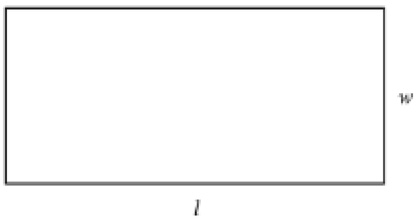


If the sum of the sides of the triangle is 30 cm, how many centimeters is the longest side of the triangle above?

Figure 4. For Example Related to calculating the sides of a rectangle based on known linear equations

The first thing to do is create a mathematical model of the problem. Many students have difficulty answering this question, maybe they are not able to make a mathematical model of the test, so they cannot find the value of the variable x, and as a result they cannot find which side is the longest side of the arbitrary triangle. Algebraic addition operations are also applied in solving the test. Students' difficulties could be because they misunderstood the problem and did not solve the algebraic addition operation according to the algorithm. This is similar to the research conducted by Noto at.all (Noto et al., 2020).

The following will discuss examples of the most dominant attribute that has not been mastered by students, namely attribute A17. Attribute A17 is related to identifying a formula that represents the area of a plane figure, as presented in figure 5.



The shape above is a rectangle, with length l width w.
If length is doubeld and the width stays the same, wich formula gives the area (A) of the new rectangle?

a. $A = 2l + 2w$ b. $A = 2l + 4w$ c. $A = 2lw$ d. $A = 4lw$

Figure 5. Identify a formula that represents the area of a plane shape

In this test, there is no need to do calculations, but only need to know the area of the rectangle, which is the area (A) of recangle is = lengeth × wedth = lw. Students just need to do a little reasoning that the length of the rectangle is twice the original length. Thus the area of the new rectangle is A = 2lw. Students experience many difficulties because they are not familiar with math problems that require reasoning or creativity.

The attribute A28 is related to the use of the Pythagorean theorem to find the perimeter of a trapezoid, as shown in the example problem in Figure 6.

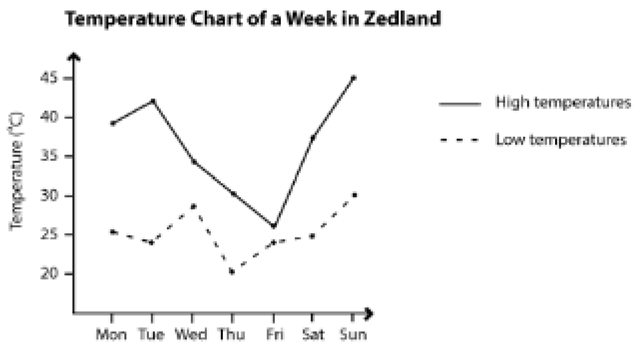
ABCD is trapezoid with *AB* = 10 cm, *CD* = 16 cm. *AD* = *BC*. Distance between parallel line, *AB* and *CD* is 4 cm. What is perimeter?

a. 36 cm b. 34 cm c. 32 cm d. 30 cm

Figure 6. Example for tsts related uses the pythagorean theorem in finding perimeter of a trapezoid

Students have a lot of difficulty solving problems maybe due to ignorance. Students can apply the Pythagorean theorem to find one of the unknown sides of the trapezoid, so they cannot determine the perimeter of the trapezoid. This test is an application test. This is in line with research by Prasetyo & Rudhito which states that students' ability to solve application problems in geometry topics is still low (Prasetyo & Rudhito, 2016).

The following wouled have been discussed two examples of the most dominant attribute that has not been mastered by students, namely attribute A20. Attribute 20 is related to read two values line graphs to solve a problem such as the example test showen in Figure 7.



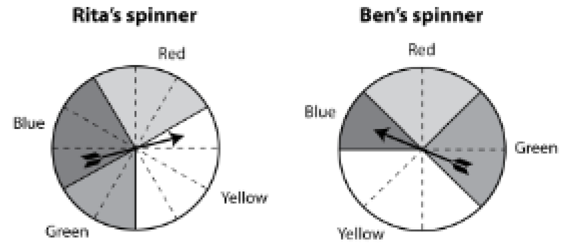
The graph above show the daily high and low temperatures for a week at place in zedland. On wich day is diference between highest and lowest temperatures 10^0C?

a. Wendesday b. Thursday c. Friday d. satruday

Figure 7. Example for tsts related to read two values line graphs to solve a problem

If students can interpret the graph data correctly into numerical data then students will find that the difference between the highest and lowest temperatures of 100 ^{o}C occurs on Thursday. Students experience many difficulties, apparently because students have not correctly translated graphic data into numerical data.

A21 atribute related to compares the chances of two outcomes such as showen at the Figure 8.



Supose Rita and Ben spin their spiners.
Wich the folowing is true?

a. Red is more likely on Ben's spinner than on Rita's
b. Red is more likely on Rita;s spinner than on Bens's
c. Red is impossible on both spiner
d. Red is equaly likely on both spinners

Figure 8. Example for test related to compares the chances of two outcomes

The test in the example of Figure 8 tests students to be able to solve unstructured problem and make an accurate estimate of the possibility of two different objects or events. Because the two objects are given the same treatment, the shape and size of the object are also the same, but what distinguishes the location of the needle tip on the different colors. So if the two spinners are rotated simultaneously, the chances of the tip of the needle stopping right at the red color are the same. Students have difficulty with the possibility because they cannot make a precise estimate and then put it in a statement. Students' difficulties in the unstructured problem in the Figure 8 test may be caused by students' difficulties in building strategies (Mahmud & Pratiwi, 2019).

CONCLUSION

Based on the results of the analysis, we can conclude that the difficulties of students in the city of Cirebon in solving the TIMSS model of mathematics tests are the most dominant in the cognitive knowing, applaying and reasoning domains, respectively, as follows: (1) in the domoain cognitive of knowing, which means that students still do not master the mathematics test that contains the thinking process of remembering, recognizing, calculating, measuring, classifying, sorting which is related to the dominant content of numbers, namely the ability to perform mixed arithmetic operations on integers. Understanding the commutative properties of arithmetic operations on natural numbers, estimating the result of the nearest decimal number from a fractional number. In the domain of data content and opportunities related to the ability to identify the appropriate table with the information on the pictogram graph and Read the values of the two line charts correctly; (2) in the cognitive application domain, which means that students lack mastery of math tests which contain the thinking process of choosing, representing, modeling, applying, solving routine problems in the number content domain related to the ability to choose and combine information from two different sources to solve problems with multiple steps. and in the number series. In the domain of algebraic content related to solutions of systems of linear equations of two variables, compiling and using solutions of linear equations to solve problems, and calculating the side lengths of triangles based on linear equations. In the content domain geometry it is related to the symmetry properties of reflection and in the data and probability domain it is related to the ability to use information from tables to draw a bar chart and compare two possible events; (3) In the cognitive reasoning domain in the number content domain it is related to the ability to find available number patterns and in the geometry cognitive domain it is related to the ability to use the Pythagorean theorem to find the perimeter of a quadrilateral or triangle.

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