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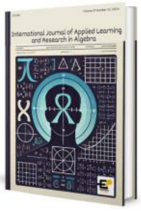

Comparative Praxeology: Assessing High-Level Cognitive Skills in TIMSS and Indonesian National Examinations

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Abstract

Indonesian students perform inadequately in the International Mathematics and Science Study (TIMSS). Before utilising National Examination (UN) questions as measures of learning accomplishment, evaluating them within the context of a theoretical framework for mathematics education is imperative. They analyse student mathematical proficiency using TIMSS and National Examination questions and apply pedagogic anthropological theory, particularly praxeology. This study employed content analysis as a qualitative research method. An algebraic analysis was conducted using the praxeological technique. This entails evaluating concerns, approaches, and technological and theoretical alternatives (logo block). The results indicate that the TIMSS questions require careful consideration and analytical thinking. In contrast, National Examination questions restrict students' cognitive capacities to acquire knowledge on specific topics. The placement of national test question types will be determined based on analytical data. Indonesian students must enhance their arithmetic scores, which consistently remain low. To promote the growth of a highly skilled labour market, the government must comprehend the intricacies involved. Teachers should customise their classes to align with the individual learning objectives of each student.

Keywords: Anthropological theory; Higher-order thinking skill; Mathematical thinking skill; Praxeology; Test of algebra

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1. Introduction

The Trends in International Mathematics and Science Study (TIMSS) is a comprehensive assessment that evaluates students' mathematical proficiency on a global scale. The data has been extensively utilised to produce global comparisons of mathematics and science proficiency (Bhutoria & Aljabri, 2022; Gantt et al., 2023; Note et al., 2022). This program provides member countries with information about scientific advancements and their pupils' mathematical knowledge and skills (Lay & Ng, 2021). The system conducts each examination, encompassing a variety of cognitive abilities, including knowledge acquisition, application, and logical reasoning. Most evaluations of students' aptitude in TIMSS focus on assessing their acquired knowledge, problem-solving skills, and ability to deliver reasoned explanations through analysis and logical thinking (Mullis & Martin, 2015; Utomo & Syarifah, 2021).

The implementation of TIMSS began in 1995 (Alshaikh, 2021) and has since occurred every four years (Hadi & Novaliyosi, 2019; Nilsen et al., 2022). (Mullis et al., 2015; Prastyo, 2020) conducted a study in which Indonesia participated. However, (Munaji Setiawahyu, 2021) mentioned that the survey conducted in 2015 did not include Indonesia. The program classifies participants into four levels: low (400), medium (475), high (550), and advanced (625). Indonesia has frequently received low rankings based on these criteria. The subsequent data illustrates Indonesia's standings in each year of their participation:

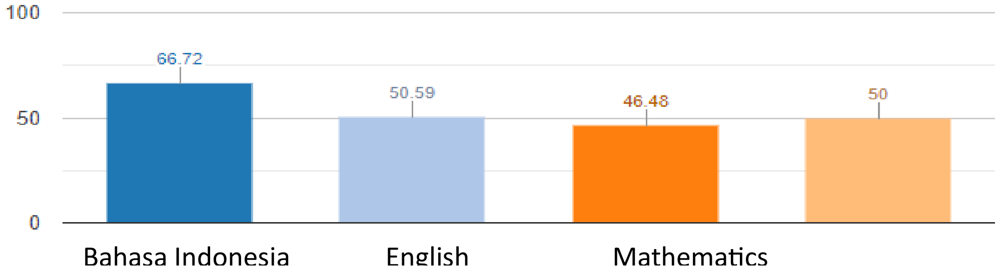
Table 1 - Indonesia's rank in TIMSS

Year	Indonesia Average Score	International Average Score	Rank	Participant
2003	411	467	35	46 Countries
2007	397	500	36	49 Countries
2011	386	500	38	42 Countries
2015	397	500	44	49 Countries

Table 1 illustrates that Indonesia's average score is significantly lower than the worldwide mean. Furthermore, the TIMSS results consistently demonstrate a decline in Indonesia's ranking across all TIMSS evaluations, as evidenced by (Fenanlampir et al., 2019 Khodaria et al., 2019; Setiawan et al., 2022). The data indicate that Indonesian students' mathematical proficiency remains lower than the global average, emphasising significant difficulties in studying the subject (Utomo, 2021; Wijaya, 2017). Several studies have verified the high precision of TIMSS outcomes in evaluating the mathematical competence of Indonesian students (H. King & Kong-can, 2021; Tallberga & Axelsson, 2021; Utomo & Syarifah, 2021). The intellectual achievement of pupils is also evident in their National Examination (UN) scores. The purpose of the UN is to evaluate the competence of students in elementary and secondary school based on the Graduate Competency Standards (SKL) set by the learning process (Rosidin et al., 2019; Sukyadi & Mardiani, 2011).

The 2019 National Examination results data, released by the Ministry of Education and Culture, aligns with the findings of the TIMSS results, revealing a concerning depiction of mathematics competency among Indonesian students. The mathematical achievement gap is evident, as indicated by the average score of 46.48 out of 100 on the PBB scale. This calls for immediate intervention. These results highlight the significance of focused interventions and extensive restructuring in mathematics education to equip Indonesian students with essential abilities for triumph in an ever more cutthroat global environment.

The average scores of the National Examination for Indonesian Middle School students in 2019 are as follows:



Source: hasilun.puspendik.kemdikbud.go.id

Figure 1 Average national examination scores of indonesian students

The objective of this study is to discern the patterns of congruence and divergence between TIMSS and UN questions while also examining and elucidating the questions employed to assess students' cognitive abilities. The analysis is grounded in the Anthropological Theory of Didactic (ATD) (Chevallard, 2007, 2019; Chevallard & Sensevy, 2014). This theory aims to scientifically examine the process by which bodies of knowledge spread within human organisations (Chevallard, 2006). It assumes that any activity associated with the creation, dissemination, or acquisition of information should be considered a typical human activity. Hence, it introduces a conceptual framework of human behaviour grounded in the fundamental principles of praxeology (Artigue & Bosch, 2014). This idea centres on the pedagogical process of transmitting scientific knowledge from one institution to another. By employing this idea, researchers can evaluate teaching methods without being impacted by social variables.

ATD asserts that every concept and action executed by people serves a distinct objective. People derive these actions from logical inference. An essential aspect of ATD is the structuring of practice. Praxis refers to the practical application of knowledge, while logos pertains to the theoretical aspect of a subject. Moreover, the praxeological organisation comprises four distinct elements: types of inquiries, methodologies, technological tools, and theoretical frameworks. ATD enables researchers to analyse the TIMSS and UN questions by logical deduction. This tool facilitates the description, analysis, questioning, and design of essential content for the teaching and learning process.

The questions pertain to higher-order thinking skills (HOTS). In Indonesia, the inclusion of HOTS in the 2013 curriculum has become a standard expectation over the past decade. According to Bloom's Revised Taxonomy, the HOTS capacity is comparable to the cognitive abilities of analysing (level 4), assessing (level 5), and generating (level 6). HOTS entails the analysis of intricate material into distinct components, identification of connections, and integration of novel information with students' preexisting knowledge through the utilisation of innovative problem-solving techniques (F. King et al., 2013).

This study seeks to examine and explain the potential of utilising the TIMSS and UN questions for assessing students' HOTS through practical analysis. TIMSS data facilitate curriculum development by allowing for comparisons between the implemented, intended, and analysed curricula (Garden et al., 2006). This facilitates the enhancement of essential education, effectively contributing to the advancement of teaching and learning processes that align with contemporary trends in scientific and mathematical education. This study presents three inquiries: (1) What are the procedural stages involved in the development of the task design used in the Indonesian TIMSS and UN assessments? In what manner is the work approach in the task design produced by Indonesian TIMMS and UN implemented? (3) Does the task design aim to facilitate the development of critical and creative thinking skills in students?

Based on the theoretical framework of ATD, we conducted this study. Praxeology is a crucial element in ATD. Praxeology is a discipline that combines the terms "praxis," referring to practical action, and "logos," denoting theoretical knowledge. Additionally, it comprised four distinct elements, specifically categories of inquiries, methodologies, technological tools, and theoretical principles. Like any other learning practice, it is crucial to keep in mind the many categories of questions that can be understood either in a specific or generic manner. In order to do this, a range of methodologies and technologies are necessary to support the methodology and principles for timely validation. The lack of a solid definition inside the praxeology organisation is due to its purpose of analysing human life comprehensively.

ATD focuses on the "systematic examination of how knowledge is disseminated within human organisations" (Chevallard, 2006). Chevallard and Sensevy (2014) developed the ATD framework, which outlines four essential elements of practice in educational institutions for engaging with mathematical objects: task, technique, technology, and theory. Artigue & Bosch (2014) investigated this idea, which posits that mathematical objects emerge from systems of practical application (or praxeologies):

1) Challenges involving embedded objects
2) Techniques employed to solve these challenges
3) Technology is a form of communication that provides explanations and justifications for various procedures.
4) Theory refers to a form of communication that provides a rationale for technological discourse.

2. Methods

ATD postulates that every human endeavour entails the fulfilment of a design task [T], employing a specific methodology [τ], facilitated by a technology [θ] that enables its contemplation or creation, and hence supported by theory [Θ]. To put it simply, all individuals engage in actions within a company that may be seen using praxeology, also referred to as organisational praxeology.

Praxeology is derived from The Anthropological Theory of Task Design (T). The task design (T) is typically articulated using verbs, such as the multiplication of a specified algebraic expression. Technique, as a means of accomplishing tasks and demonstrating, is not always algorithmic or quasi-algorithmic. Technology is a discipline that provides justification, explanation, and the production of techniques. The technique uses the "rational" approach to guarantee the feasibility of executing Task Design [T]. The concept of theory [Θ] defines a methodology that assesses advancements in theoretical knowledge. It represents a more advanced form of argument or explanation.

Praxeology is the study of the smallest unit of human activity, which consists of four elements: task design (T), engineering (τ), technology (θ), and theory (Θ). The task type (T) specifies the nature of the activity, whereas the technique (τ) refers to the method or approach used to accomplish it. Technology (θ) refers to the knowledge and discussion that creates, supports and explains specific techniques. On the other hand, theory (Θ) encompasses a broader range of discourse that generates, supports and explains technology as a whole (Chevallard, 2006, 2019). The symbols [T, τ, θ, Θ] represent Praxeology.

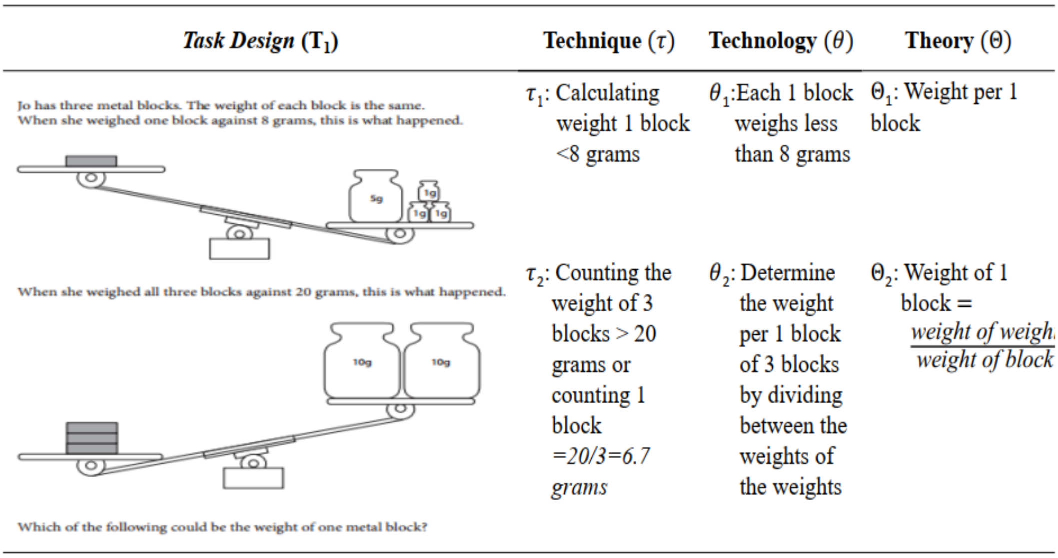
3. Results and Discussion

3.1 Results

3.1.1. TIMSS *question*

The 2011 TIMSS assessment extensively explored the field of algebra, to measure students' ability to use logical thinking and reasoning to solve algebraic problems. This evaluation examined students' proficiency in algebraic concepts and their capacity to employ logical thinking in mathematical problem-solving situations. The objective of this test was to obtain essential knowledge on pupils' cognitive processes, namely their proficiency levels and the approaches they used when faced with algebraic problems. These assessments are essential for educators to understand how practical their algebra training is and to guide the creation of a curriculum to improve students' mathematical ability in this vital subject.

Table 2 - Task design (T_1) TIMSS

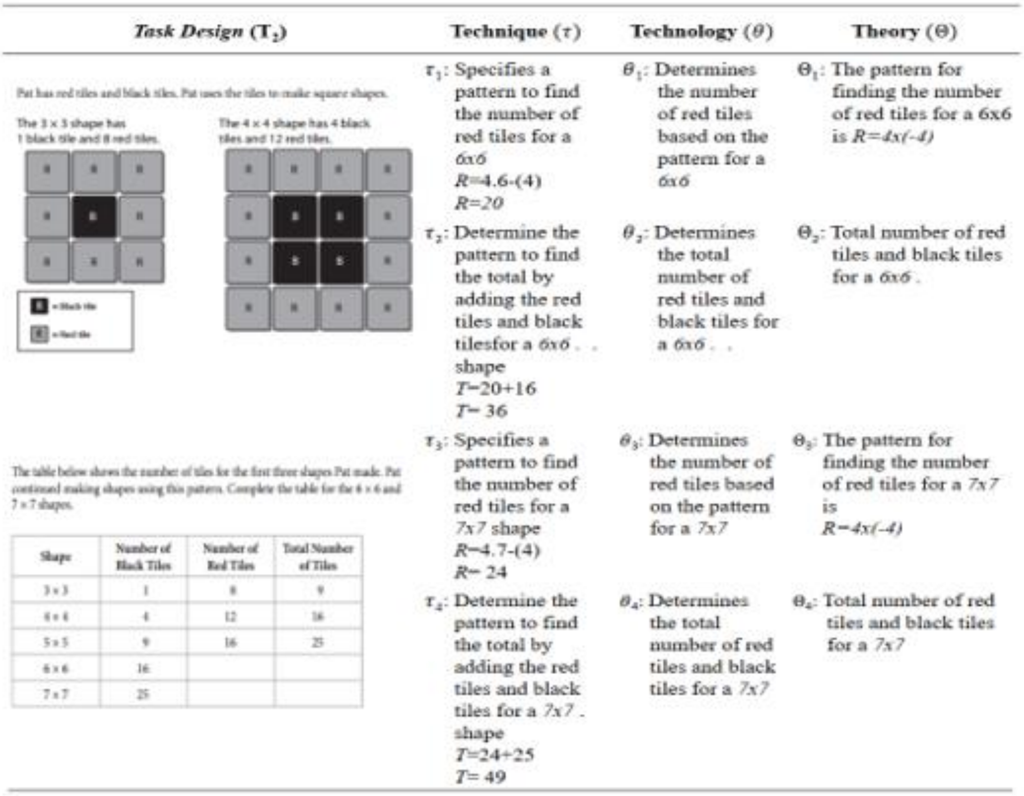


Task Design (T_1)	Technique (τ)	Technology (θ)	Theory (Θ)
Jo has three metal blocks. The weight of each block is the same. When she weighed one block against 8 grams, this is what happened.	τ_1: Calculating weight 1 block <8 grams	θ_1:Each 1 block weighs less than 8 grams	Θ_1: Weight per 1 block
When she weighed all three blocks against 20 grams, this is what happened. Which of the following could be the weight of one metal block?	τ_2: Counting the weight of 3 blocks > 20 grams or counting 1 block *=20/3=6.7 grams*	θ_2: Determine the weight per 1 block of 3 blocks by dividing between the weights of the weights	Θ_2: Weight of 1 block = $\frac{weight\ of\ weigh}{weight\ of\ block}$

The research emphasises the importance of students' ability to use prior knowledge when tackling complex problem-solving tasks, such as T_1. (Kania et al., 2023) states that students' core mathematical understanding and skills can be utilised to comprehend and solve issues with more advanced mathematical ideas. At this educational institution, students must showcase their proficiency in analytical thinking skills by accurately estimating the weight of a block and deconstructing the question into its fundamental elements. By leveraging their understanding that the block is lighter than 8 grammes of iron, students can make educated conjectures and develop theoretical frameworks concerning the weight of the block ($Θ_1$). In addition, the use of existing information allows students to expand their comprehension and improve their approach to problem-solving, as seen by the calculation of the mass of an individual block using the given parameters. This style of problem-solving is thorough and promotes HOTS students. It corresponds to the analytical thinking level (C4) and emphasises the importance of deep comprehension to navigate complex mathematical situations effectively. Enhanced proficiency in mathematics necessitates a strong prior knowledge of the subject. The study by Kania and Juandi (2023)) found that students who possess high self-standards or demonstrate exceptional abilities may exhibit excessive confidence in their aptitude for solving mathematical problems. In contrast, those with low self-standards or who perform poorly are more likely to be pessimistic.

The 2011 TIMSS assessment specifically targeted the algebraic domain, evaluating the degree to which students utilised rational reasoning. The objective of this test was to evaluate the cognitive processes involved in solving algebraic problems, offering valuable insights into the proficiency level and strategic methods students adopt when confronted with mathematical challenges in this specific domain.

Table 3 - Task design (T_2) TIMSS

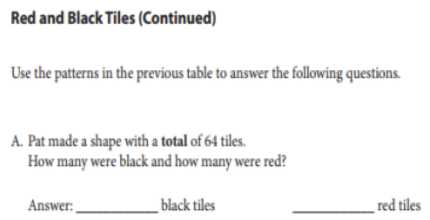


Task Design (T_2)	Technique (τ)	Technology (θ)	Theory (Θ)
Pat has red tiles and black tiles. Pat uses the tiles to make square shapes. The 3 × 3 shape has 1 black tile and 8 red tiles. The 4 × 4 shape has 4 black tiles and 12 red tiles. B = Black tile R = Red tile	τ_1: Specifies a pattern to find the number of red tiles for a *6x6* $R=4.6-(4)$ $R=20$	θ_1: Determines the number of red tiles based on the pattern for a *6x6*	Θ_1: The pattern for finding the number of red tiles for a 6x6 is $R=4x(-4)$
	τ_2: Determine the pattern to find the total by adding the red tiles and black tilesfor a *6x6* . . shape $T=20+16$ $T=36$	θ_2: Determines the total number of red tiles and black tiles for a *6x6* . .	Θ_2: Total number of red tiles and black tiles for a *6x6* .
The table below shows the number of tiles for the first three shapes Pat made. Pat continued making shapes using this pattern. Complete the table for the 6 × 6 and 7 × 7 shapes.	τ_3: Specifies a pattern to find the number of red tiles for a *7x7* shape $R=4.7-(4)$ $R=24$	θ_3: Determines the number of red tiles based on the pattern for a *7x7*	Θ_3: The pattern for finding the number of red tiles for a *7x7* is $R=4x(-4)$
	τ_4: Determine the pattern to find the total by adding the red tiles and black tiles for a *7x7* . shape $T=24+25$ $T=49$	θ_4: Determines the total number of red tiles and black tiles for a *7x7*	Θ_4: Total number of red tiles and black tiles for a *7x7*

Shape	Number of Black Tiles	Number of Red Tiles	Total Number of Tiles
3 × 3	1	8	9
4 × 4	4	12	16
5 × 5	9	16	25
6 × 6	16		
7 × 7	25		

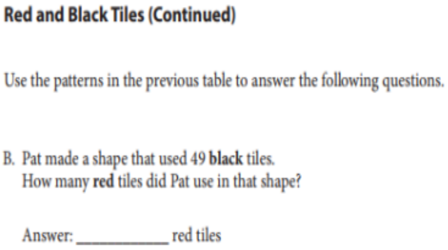
The approach to resolving T_2 places great importance on the detection of patterns and the use of logical deduction in the problem-solving process. Junarti et al. (2022), algebra is considered a tough subject by students, despite its importance in acquiring more advanced mathematical studies. Students initiate the task by discerning a pattern (τ_1) within the 6x6 grid and ascertaining the number of red tiles within it. The consistent difference of 4 between the red tiles serves as a vital point of reference, allowing for a more thorough analysis of larger grid dimensions. By making this discovery, students deduce a universal formula (Θ_1) that can be used to determine the number of red tiles (*R*) in any nxn grid. This procedure enhances their understanding of mathematical patterns and relationships. Through the iterative application of this method, students may accurately compute the quantities of red tiles (*R*) and total tiles (*T*) in various grid sizes, showcasing their proficiency in recognising patterns and their ability to derive and apply abstract mathematical ideas [τ_4, θ_4, Θ_4]. In addition, the utilisation of this deductive method aligns with the cognitive level of creative thinking (C6) within the HOTS framework. This emphasises the deep analytical understanding and innovative problem-solving strategies students employ when tackling complex mathematical problems. Xiao et al. (2021) research findings indicate that the problem-solving process provides valuable insights into respondent behaviour and cognitive processes, which are crucial in understanding significant difficulties.

Table 4 - Task design (T_3) TIMSS

Task Design (T_3)	**Technique** (τ)	**Technology** (θ)	**Theory** (Θ)
 **Red and Black Tiles (Continued)** Use the patterns in the previous table to answer the following questions. A. Pat made a shape with a **total** of 64 tiles. How many were black and how many were red? Answer: __________ black tiles __________ red tiles	τ_1: Determine the number of red tiles from a total of 64 tiles of the form n x n with $R=4\sqrt{64}-4$ $R= 4.\ 8\text{-}4$ $R= 28$	θ_1: Define shape *nxn* black tiles	Θ_1: Number of red tiles = *4.n-(4)*
	τ_2: Determine the number of black tiles by subtracting $B= 64\text{-}28= 36$	θ_2: Determines the total number of tiles for a *nxn* .	Θ_2: The shape of the black tile is *7x7*

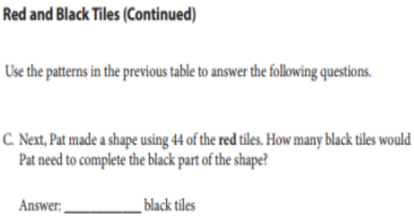
Step T3 builds upon the foundational structure established in Step 2, requiring students to integrate their findings from the previous task to progress effectively. Before commencing T3, students must satisfy the prerequisite of completing T2 since it provides crucial requirements for acquiring further information. By applying the learned knowledge from T_2, students can deduce the total number of a specific type of tile, either red or black, within the grid. Students begin by recognising the red tiles and subsequently use the formula derived from T_2 to compute the quantity of red tiles. This indicates their comprehension of mathematical patterns (θ_1). Students employ a systematic strategy to ascertain the amount of black tiles by deducting the quantity of red tiles from the overall size of the grid. This showcases their proficiency in utilizing mathematical ideas within a particular context (θ_2). Moreover, this approach allows students to ascertain the dimensions of the grid, specifically 7×7, using their deductive reasoning (Θ_2). This analytical evolution showcases students' ability to evaluate patterns and data discerningly. It is also associated with the C5 level of evaluation in the context of HOTS, emphasizing the deep analytical understanding and logical reasoning used in problem-solving.

Table 5 - Task design (T_4) TIMSS

Task Design (T_4)	**Technique** (τ)	**Technology** (θ)	**Theory** (Θ)
 **Red and Black Tiles (Continued)** Use the patterns in the previous table to answer the following questions.	τ_1: Find the n x n form of the number of black tiles with $\sqrt{49}=7$	θ_1: Define shape *nxn* black tiles	Θ_1: The shape of the black tile is *7x7*
B. Pat made a shape that used 49 **black** tiles. How many **red** tiles did Pat use in that shape? Answer: __________ red tiles	τ_2: Determine the number of red tiles of the shape *7x7* with *R=4.7-(4)* *R= 24*	θ_2: Determine the number of tiles of shape *x* using pattern	Θ_2: Number of black tiles = total number- red tiles

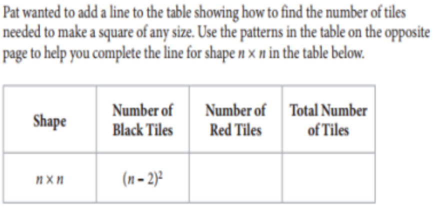
The resolution of T_4 requires a systematic approach that involves identifying patterns and applying logical thinking. By identifying the next arrangement in the grid, students infer that there are 49 black tiles, suggesting that the dimensions of the grid are 7×7 (τ_1, θ_1). Students then use the information acquired from T_2 to deduce the number of red tiles in the grid, strengthening their comprehension of mathematical patterns and relationships (τ_2, θ_2). The equivalence between the number of black tiles and the total number of red tiles underscores the interdependence of these mathematical components inside the grid layout. As the analytical path outlined here demonstrates, students can integrate information and employ deductive reasoning to resolve complex problems. This corresponds to the assessment level (C5) within the scope of HOTS. Through this methodical approach, students showcase their proficiency in scrutinising patterns and data and manifest their capacity to derive meaningful deductions from mathematical observations. Basic problem-solving tactics such as trial and error and issue simplification are employed during the action stage. However, in the formulation and validation stages, more advanced strategies, such as reasoning and evidence, are given priority (GENC & ERGAN, 2022).

Table 6 - Task design (T_5) TIMSS

Task Design (T_5)	**Technique** (τ)	**Technology** (θ)	**Theory** (Θ)
 **Red and Black Tiles (Continued)** Use the patterns in the previous table to answer the following questions.	τ_1: Find the *nxn* form of the number of red tiles with $44=4.n-(4)$ $n=10$	θ_1:Define shape nxn of red tiles	Θ_1: Black tile shape *=10x10*
C. Next, Pat made a shape using 44 of the **red** tiles. How many black tiles would Pat need to complete the black part of the shape? Answer: __________ black tiles	τ_2: Determine the number of black tiles with the 10th pattern with $n^2=10^2$ $n^2= 100$	θ_2: Determine the number of black tiles of the form *nxn*	Θ_2: Number of black tiles = n^2

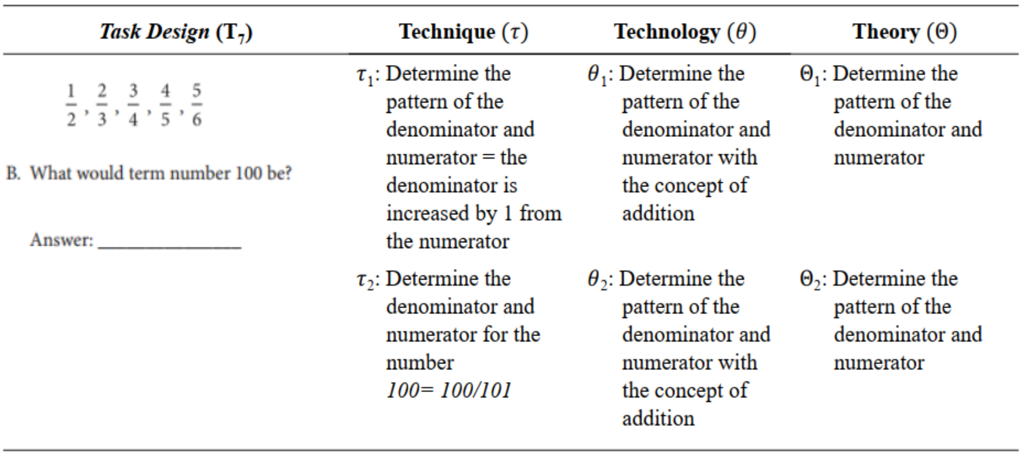
Completing T_5 requires a systematic strategy based on identifying and utilising mathematical patterns. At first, students observe the next pattern in the grid to find the number of red tiles, denoted as τ_1=44=4n-4. As a result of this deduction, a 10 ×10 pattern (θ_1, Θ_1) can be identified inside the grid structure. Expanding on this basic knowledge, students utilise the knowledge gained from T_2 to infer the number of black tiles in the grid, confirming their understanding of mathematical connections (τ_2, θ_2). The number of black tiles equal to n^2 highlights the interconnectedness of various elements in the grid. This analytical development demonstrates students' ability to combine information and use deductive reasoning to solve intricate issues, which corresponds to the evaluation level (C5) in the higher-order thinking skills (HOTS) framework.

Table 7 - Task design (T_6) TIMSS

<table>
<tr><th>Task Design (T_6)</th><th>Technique (τ)</th><th>Technology (θ)</th><th>Theory (Θ)</th></tr>
<tr><td rowspan="2">
Pat wanted to add a line to the table showing how to find the number of tiles needed to make a square of any size. Use the patterns in the table on the opposite page to help you complete the line for shape $n \times n$ in the table below.
<table>
<tr><th>Shape</th><th>Number of Black Tiles</th><th>Number of Red Tiles</th><th>Total Number of Tiles</th></tr>
<tr><td>$n \times n$</td><td>$(n-2)^2$</td><td></td><td></td></tr>
</table></td>
<td>τ_1: Determine the general form of the problem for the number of tiles = black tiles+red tiles $=nxn$</td>
<td>θ_1: Determine the number of tiles of the form nxn</td>
<td>Θ_1: General form = nxn</td></tr>
<tr><td>τ_2: Determine the number of red tiles - the number of black tiles
$=nxn-(n-2)^2$
$=n^2-(n^2-4n+4)^2$
$=n^2-n^2+4n-4$
$=4n-4$</td>
<td>θ_2: Determine the general shape of the red tile from the number of tiles and black tiles</td>
<td>Θ_2: Red tile pattern= $4n-4$</td></tr>
</table>

The ultimate stage of resolving T_6 involves a methodical strategy based on recognising and utilising mathematical patterns. At first, students determine the total number of tiles by multiplying the dimensions of the grid ($n \times n$), recognising that the sum of red and black tiles equals this amount. As a result of this detection, a nxn pattern (θ_1, Θ_1) can be identified within the grid structure. Expanding on this fundamental comprehension, students utilise knowledge gained from prior assignments to infer the number of red tiles, showcasing their mastery of mathematical relationships (τ_2, θ_2). Using deductive reasoning, students can determine a formula that calculates the number of red tiles (τ_2) based on the dimensions of the grid. This demonstrates their analytical and creative problem-solving capabilities (θ_2, Θ_2). This approach explicitly emphasizes the students' capacity to creatively combine information and develop new solutions, which aligns with the level of creative thinking (C6) in the framework of HOTS. Students demonstrate their aptitude for identifying and examining patterns by employing a systematic and creative approach. Additionally, they display their skill in drawing significant conclusions from mathematical observations, enhancing their comprehension and expertise in solving mathematical problems.

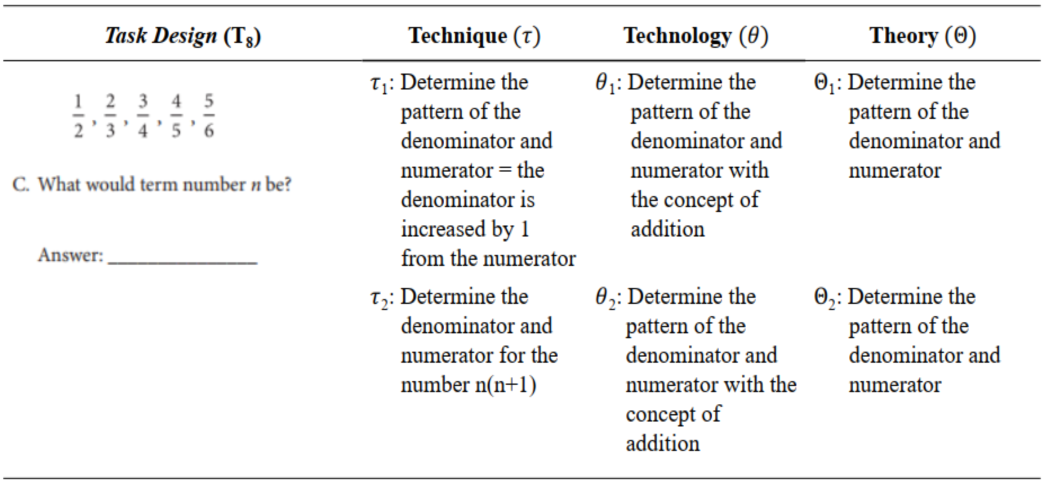
Table 8 - Task design (T_7) TIMSS



Task Design (T_7)	Technique (τ)	Technology (θ)	Theory (Θ)
$\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \frac{5}{6}$ B. What would term number 100 be? Answer: _______________	τ_1: Determine the pattern of the denominator and numerator = the denominator is increased by 1 from the numerator	θ_1: Determine the pattern of the denominator and numerator with the concept of addition	Θ_1: Determine the pattern of the denominator and numerator
	τ_2: Determine the denominator and numerator for the number *100= 100/101*	θ_2: Determine the pattern of the denominator and numerator with the concept of addition	Θ_2: Determine the pattern of the denominator and numerator

The resolution of T_7 depends on a methodical examination of the patterns present in the numerator and denominator. At first, pupils observe that each numerator and denominator regularly rise by 1 (τ_1), indicating a recurrent pattern for both parts. This realisation results in developing a pattern (θ 1, Θ 1) that governs the progression of the denominator and numerator. Expanding on this basic knowledge, students see that the numerator and denominator always differ by 1 (τ_2), strengthening their understanding of the underlying pattern (θ_2, Θ_2). By employing this systematic technique, students demonstrate their capacity to accurately identify and examine patterns, thereby exhibiting their mathematical analysis and logical thinking expertise. Higher-order thinking skills, specifically at the analysing level (C4), emphasise students' capacity to analyse complex issues and derive meaningful insights from mathematical data. This technique improves students' problem-solving skills and cultivates a more profound comprehension of mathematical concepts and patterns.

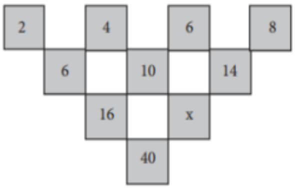
Table 9 - Task design (T_8) TIMSS



Task Design (T_8)	Technique (τ)	Technology (θ)	Theory (Θ)
$\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \frac{5}{6}$ C. What would term number *n* be? Answer: _______________	τ_1: Determine the pattern of the denominator and numerator = the denominator is increased by 1 from the numerator	θ_1: Determine the pattern of the denominator and numerator with the concept of addition	Θ_1: Determine the pattern of the denominator and numerator
	τ_2: Determine the denominator and numerator for the number n(n+1)	θ_2: Determine the pattern of the denominator and numerator with the concept of addition	Θ_2: Determine the pattern of the denominator and numerator

Expanding on the analytical method employed in T_7, students will address T_8 by identifying the pattern within the denominator and numerator. By doing a methodical investigation, students determine that the formula for τ_2 is n (n +1), revealing a coherent pattern that governs both components (θ_2). This observation clarifies the connection between the numerator and denominator and offers a structure for comprehending their advancement within the problem's setting. Through advanced cognitive abilities, specifically at the level of analysis (C4), students demonstrate their capacity to break down intricate mathematical formulations and extract significant patterns. The systematic approach improves students' problem-solving skills and cultivates a more profound comprehension of mathematical topics and their interrelationships. By engaging in these analytical processes, students acquire expertise in mathematical reasoning and cultivate vital critical thinking abilities necessary for efficiently addressing various mathematical issues.

Table 10 - Task design (T_9) TIMSS

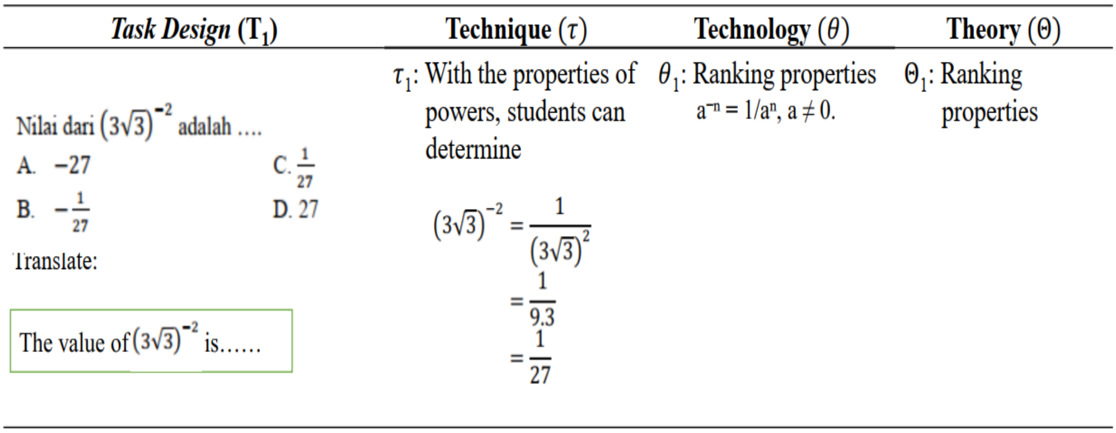
Task Design **(T_9)**	**Technique (τ)**	**Technology (θ)**	**Theory (Θ)**
 What is the value of x in this pattern? Answer: _______________	τ_1: Determining the value in a column is to add up the two boxes above it	θ_1: Determine the pattern based on squares in parallel columns	Θ_1: Specifies the pattern to find the value of x
	τ_2: Determine the value of x by adding $10 + 14= 24$	θ_2: Determining the value of x in the pattern	Θ_2: The value of x is the sum of the 2 boxes above it

When students reach T9, they begin a deliberate journey to identify patterns inside each square, which forms the basis for a systematic solution. Students can see a pattern of the squares above where the sum of the values of the two squares directly above determines the value of each square. The pattern, represented as Θ_1, acts as a guiding concept for populating the integers in the grid. Expanding on this fundamental comprehension, students utilise observations from identifying patterns in the numerator and denominator to compute τ_2, equivalent to the total values in the specified squares. During this procedure, students derive a pattern (θ_2) to ascertain the value of x, thus creating Θ_2 as a comprehensive framework for inferring the value of x within the problem's context. The analytical stages, part of the C4 analysis level of the HOTS Assessment Level, highlight students' ability to break down complicated issues, identify hidden patterns, and develop meaningful answers using systematic analysis and logical reasoning. Through such analytical pursuits, students improve their problem-solving capabilities and develop critical thinking skills for effectively navigating mathematical difficulties.

3.1.2. Indonesian National Examination (UN) Questionnaire

The set of queries from the United Nations being examined encompasses a comprehensive collection of algebraic inquiries administered in 2019. This compilation of questions provides insight into the complex nature of algebraic concepts and the mathematical difficulties students encounter throughout exams. Algebra plays a crucial role in mathematics. Analysing these questions helps us get a vital understanding of how students think and solve problems involving algebra. Through careful analysis and examination of the question set, educators, policymakers, and researchers can develop a more comprehensive picture of students' skill levels, instructional requirements, and prospective areas for academic improvement in the field of algebraic mathematics. Hence, scrutinising this chosen assortment of UN inquiries is a crucial undertaking in the continuous pursuit of enhancing mathematics instruction and promoting scholarly achievement among students.

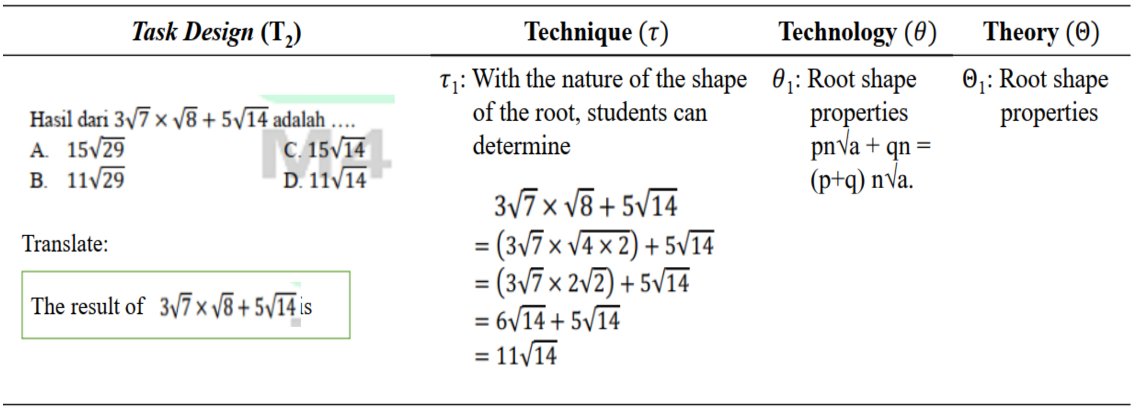
Table 11 - Task design (T_1) UN



Task Design (T_1)	Technique (τ)	Technology (θ)	Theory (Θ)
Nilai dari $(3\sqrt{3})^{-2}$ adalah .... A. -27 C. $\frac{1}{27}$ B. $-\frac{1}{27}$ D. 27 Translate: The value of $(3\sqrt{3})^{-2}$ is......	τ_1: With the properties of powers, students can determine $(3\sqrt{3})^{-2} = \frac{1}{(3\sqrt{3})^2}$ $= \frac{1}{9.3}$ $= \frac{1}{27}$	θ_1: Ranking properties $a^{-n} = 1/a^n, a \neq 0$.	Θ_1: Ranking properties

The last stage of finishing T_1 demonstrates a succinct yet crucial utilisation of mathematical principles, specifically focused on the characteristics of exponents. This challenge emphasises the importance of understanding basic mathematical ideas, as it only requires a single step. By utilising the property that states an exponentiated value to a negative power is equal to its reciprocal, specifically $a^{(-n)}$ =, where 'a' is a non-zero number, students skillfully navigate through the required algebraic manipulation to answer the equation. Utilising this characteristic, the expression $(3\sqrt{3})^{(-2)}$ produces th precise outcome of t numerator$\frac{1}{27}$ This is concise and accurate..ate. The solution showcases students' proficiency in using mathematical characteristics efficiently and emphasises the significance of comprehending fundamental principles in mathematical problem-solving. Incorporating these procedures at the C2 level signifies the essential essence of the expertise and abilities needed to effectively and confidently tackle algebraic difficulties.

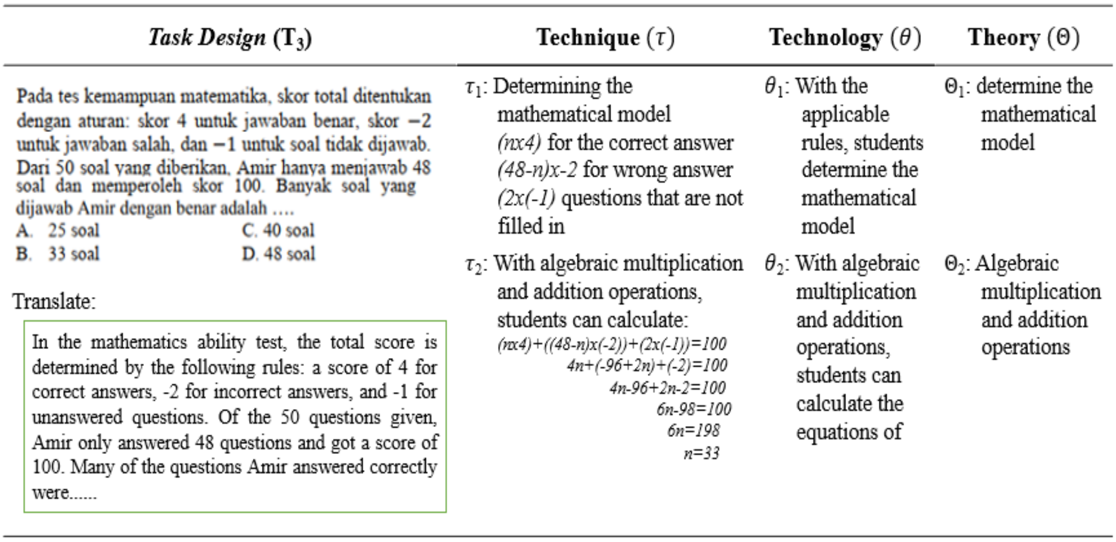
Table 12 - Task design (T_2) UN



Task Design (T_2)	Technique (τ)	Technology (θ)	Theory (Θ)
Hasil dari $3\sqrt{7} \times \sqrt{8} + 5\sqrt{14}$ adalah .... A. $15\sqrt{29}$ C. $15\sqrt{14}$ B. $11\sqrt{29}$ D. $11\sqrt{14}$ Translate: The result of $3\sqrt{7} \times \sqrt{8} + 5\sqrt{14}$ is	τ_1: With the nature of the shape of the root, students can determine $3\sqrt{7} \times \sqrt{8} + 5\sqrt{14}$ $= (3\sqrt{7} \times \sqrt{4 \times 2}) + 5\sqrt{14}$ $= (3\sqrt{7} \times 2\sqrt{2}) + 5\sqrt{14}$ $= 6\sqrt{14} + 5\sqrt{14}$ $= 11\sqrt{14}$	θ_1: Root shape properties pn√a + qn = (p+q) n√a.	Θ_1: Root shape properties

The ultimate phase in resolving T_2 involves a direct yet crucial utilisation of mathematical procedures, specifically about exponentiation. This challenge highlights the significance of understanding the fundamental rules that govern activities involving power. Students can do the math they need to solve the equation by using the power operation property, which says that the sum of powers inside a radical can be written as the power of the sum outside the radical. For example, $pn\sqrt{a} + qn = (p+q)\ n\sqrt{a}$. This concise technique emphasises students' ability to use mathematical properties proficiently, demonstrating their understanding of fundamental concepts necessary for solving algebraic problems. Incorporating these procedures at the level of comprehension (C2) exemplifies the essential essence of the knowledge and abilities required to effectively and accurately address mathematical difficulties.

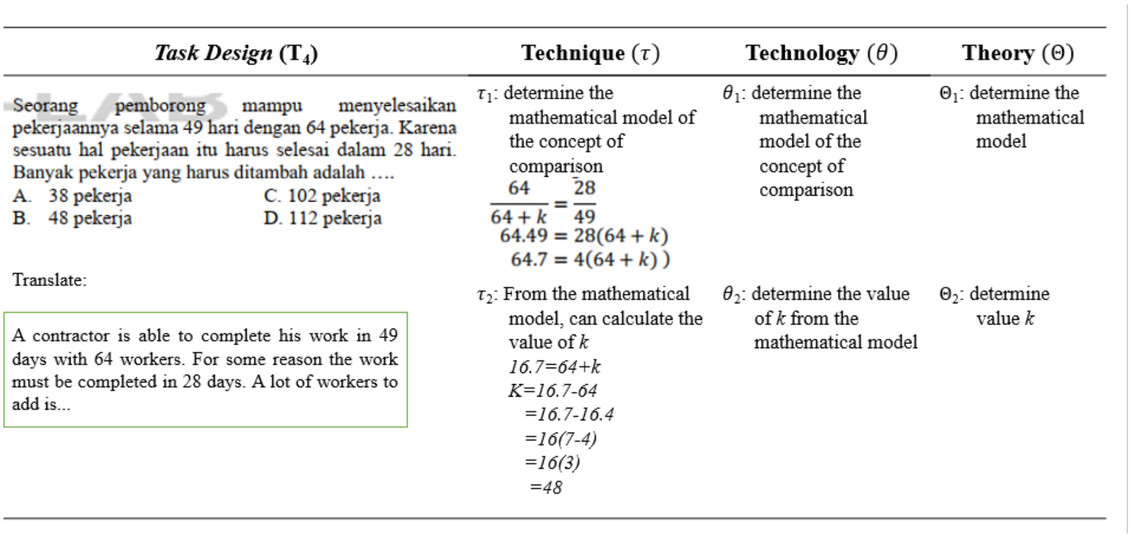
Table 13 - Task design (T_3) UN



Task Design (T_3)	Technique (τ)	Technology (θ)	Theory (Θ)
Pada tes kemampuan matematika, skor total ditentukan dengan aturan: skor 4 untuk jawaban benar, skor −2 untuk jawaban salah, dan −1 untuk soal tidak dijawab. Dari 50 soal yang diberikan, Amir hanya menjawab 48 soal dan memperoleh skor 100. Banyak soal yang dijawab Amir dengan benar adalah …. A. 25 soal B. 33 soal C. 40 soal D. 48 soal Translate: In the mathematics ability test, the total score is determined by the following rules: a score of 4 for correct answers, -2 for incorrect answers, and -1 for unanswered questions. Of the 50 questions given, Amir only answered 48 questions and got a score of 100. Many of the questions Amir answered correctly were......	τ_1: Determining the mathematical model *(nx4)* for the correct answer *(48-n)x-2* for wrong answer *(2x(-1)* questions that are not filled in	θ_1: With the applicable rules, students determine the mathematical model	Θ_1: determine the mathematical model
	τ_2: With algebraic multiplication and addition operations, students can calculate: $(nx4)+((48-n)x(-2))+(2x(-1))=100$ $4n+(-96+2n)+(-2)=100$ $4n-96+2n-2=100$ $6n-98=100$ $6n=198$ $n=33$	θ_2: With algebraic multiplication and addition operations, students can calculate the equations of	Θ_2: Algebraic multiplication and addition operations

The concluding stage of the T_3 project entails developing and implementing a mathematical model to encompass all conceivable eventualities under the guidance of the applicable regulations. This approach involves creating a mathematical framework that consists of three unique parameters: a correct response ($n \times 4$), a wrong answer ((48-n)(-2)), and an unsolved question (2x)(-1)). After establishing the mathematical model for a certain scenario, operations are performed on the model based on the specifications provided by the task. T_3 is a process that consists of two parts. However, its foundation lies in utilising a single notion of knowledge, which is subsequently extended and implemented in several scenarios. This analytical process, situated within the domain of the application level (C3) of thinking, highlights students' capacity to grasp mathematical concepts and proficiently employ them in various problem-solving scenarios. By employing this method, students exhibit their mastery of logical thinking in mathematics and display their ability to apply and utilise the knowledge gained to navigate intricate mathematical situations with accuracy and skill effectively.

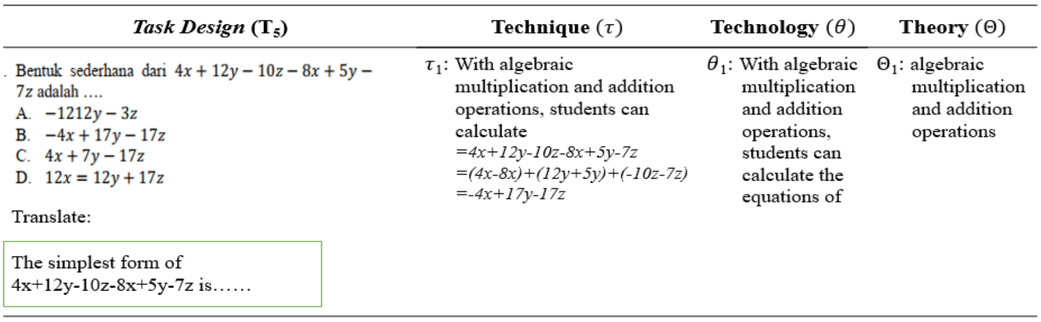
Table 14 - Task design (T_4) UN



Task Design (T_4)	Technique (τ)	Technology (θ)	Theory (Θ)
Seorang pemborong mampu menyelesaikan pekerjaannya selama 49 hari dengan 64 pekerja. Karena sesuatu hal pekerjaan itu harus selesai dalam 28 hari. Banyak pekerja yang harus ditambah adalah …. A. 38 pekerja B. 48 pekerja C. 102 pekerja D. 112 pekerja Translate: A contractor is able to complete his work in 49 days with 64 workers. For some reason the work must be completed in 28 days. A lot of workers to add is...	τ_1: determine the mathematical model of the concept of comparison $\frac{64}{64+k}=\frac{28}{49}$ $64.49 = 28(64+k)$ $64.7 = 4(64+k)\,)$	θ_1: determine the mathematical model of the concept of comparison	Θ_1: determine the mathematical model
	τ_2: From the mathematical model, can calculate the value of k *16.7=64+k* *K=16.7-64* *=16.7-16.4* *=16(7-4)* *=16(3)* *=48*	θ_2: determine the value of k from the mathematical model	Θ_2: determine value k

During the last stage of T_4, students create customised mathematical models for each provision while guided by the corresponding regulations. This approach involves developing a mathematical framework that includes multiple parameters determined by the specifications of the activity. After establishing these models for certain scenarios, students carry out operations on them under the needs of the work. T_4, albeit consisting of two processes, primarily focuses on applying a single knowledge notion, which is subsequently expanded and applied to various scenarios. This analytical process corresponds to the application level (C3) of thinking, focusing on students' proficiency in understanding mathematical concepts and skillfully applying them in diverse problem-solving situations. By employing this method, students display their logical thinking skill and capacity to adjust and apply the knowledge gained to solve complex mathematical situations with precision and effectiveness.

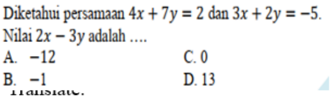
Table 15 - Task design (T_5) UN



Task Design (T_5)	Technique (τ)	Technology (θ)	Theory (Θ)
. Bentuk sederhana dari $4x+12y-10z-8x+5y-7z$ adalah …. A. $-1212y-3z$ B. $-4x+17y-17z$ C. $4x+7y-17z$ D. $12x=12y+17z$ Translate: The simplest form of 4x+12y-10z-8x+5y-7z is……	τ_1: With algebraic multiplication and addition operations, students can calculate *=4x+12y-10z-8x+5y-7z* *=(4x-8x)+(12y+5y)+(-10z-7z)* *=-4x+17y-17z*	θ_1: With algebraic multiplication and addition operations, students can calculate the equations of	Θ_1: algebraic multiplication and addition operations

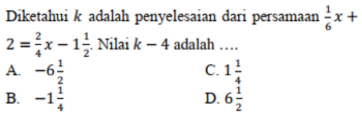
During the concluding phase of T_5, pupils are tasked with a singular step that entails solving algebraic addition and subtraction operations. Proficiency in algebraic operations is essential for this work, as students must utilise their knowledge and comprehension of these concepts to modify expressions with precision. Completing T_5 highlights the significance of having a strong understanding and grasp of algebraic operations, even if it only involves one step. These stages, categorised at the C2 level of cognitive complexity, demonstrate students' adeptness in utilising basic algebraic principles to solve problems. During this procedure, students not only display their proficiency in manipulating algebraic expressions but also exhibit their skill in using the knowledge gained to solve mathematical problems accurately and confidently.

Table 16 - Task design (T6) UN

Task Design **(T_6)**	**Technique (τ)**	**Technology (θ)**	**Theory (Θ)**
Diketahui persamaan $4x + 7y = 2$ dan $3x + 2y = -5$. Nilai $2x - 3y$ adalah …. A. -12 C. 0 B. -1 D. 13 It is known that the equations of 4x+7y=2 and 3x+2y=-5. The values of 2x-3y is…….	τ_1: determine the value of one of the variables by elimination $4x+7y=2$ |x3| $12x+21y=6$ $3x+2y=-5$ |x4| $12x+8y=-20$- $13y=26$ $y=2$	θ_1: eliminate one of the variables	Θ_1: variable elimination concept
	τ_2: determine the value of another variable by substitution$4x+7.2=2$ $4x+14=2$ $4x=2-14$ $4x= -12$ $x=-12/4$ $x=-3$	θ_2: substituting the value of one of the variables into one of the equations	Θ_2: substitution concept
	τ_3: determine value $2x-3y$ $=2(-3)-3.2$ $=-6-6$ $=-12$	θ_3: determine the value of the equation by substituting the values for x and y	Θ_3: algebraic operations

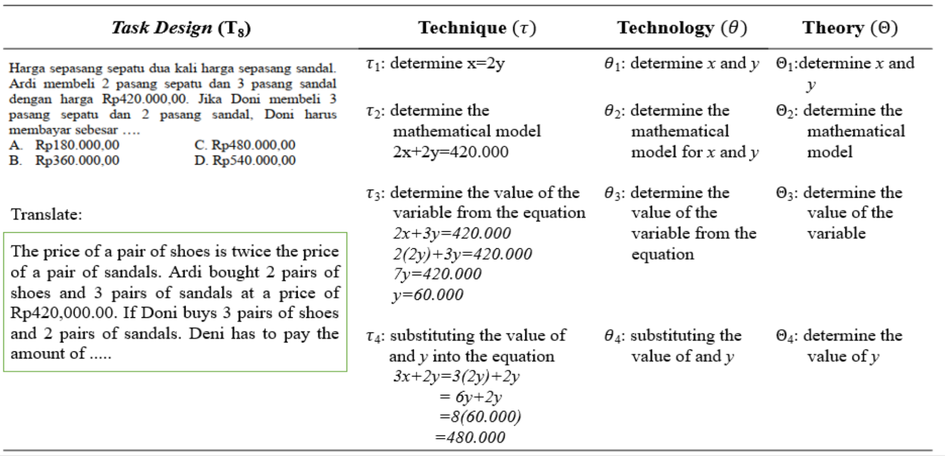
To address T6, the first step is to discover the value of y. Then, substitution is used to find the value of *x*. Isolating variables first and substituting known values to get more solutions emphasises the importance of approaching equations methodically. By precisely ascertaining the numerical values of *x* and *y*, pupils can subsequently assess the provided statement, such as *2x-3y*, with assurance. These methods combine algebraic manipulation with substitution techniques well and are equivalent to cognitive thinking at the application level (C3). By engaging in this analytical process, students exhibit mastery in solving algebraic problems and demonstrate their capacity to utilise their knowledge and abilities in resolving intricate equations with exactness and precision.

Table 17 - Task design (T_7) UN

Task Design **(T_7)**	**Technique (τ)**	**Technology (θ)**	**Theory (Θ)**
Diketahui k adalah penyelesaian dari persamaan $\frac{1}{6}x + 2 = \frac{2}{4}x - 1\frac{1}{2}$. Nilai $k - 4$ adalah …. A. $-6\frac{1}{2}$ C. $1\frac{1}{4}$ B. $-1\frac{1}{4}$ D. $6\frac{1}{2}$ Translate: It is known that k is a solution to the equation $\frac{1}{6}x + 2 = \frac{2}{4}x - 1\frac{1}{2}$. The value of *k-4* is…………….	τ_1: determine the value of $x=k$ from the equation $\frac{1}{6}x + 2 = \frac{2}{4}x - 1\frac{1}{2}$ $2x + 24 = 6x - 18$ $2x - 6x = -18 - 24$ $-4x = -42$ $x = \frac{42}{4} = 10\frac{1}{2}$ $k = x = 10\frac{1}{2}$	θ_1: determine the value of x from the equation by algebraic operations	Θ_1: determine the value of x
	τ_2: : substitute the value of k to determine the value of k-4 $k - 4 = 10\frac{1}{2} - 4 = 6\frac{1}{2}$	θ_2: substituting the value of k to determine the value of *k-4*	Θ_2:substitute the value of k

To solve the problem in T_6, one must determine the value of variable *x*. After determining the value of x, it is next used to compute the value *k*-4. This process emphasises the significance of understanding fundamental algebraic concepts, specifically in solving equations and manipulating expressions. The completion of T_6, albeit consisting of several stages, relies on using fundamental algebraic principles. This task can be categorised as being at the level of comprehension (C2) in terms of cognitive thinking levels. Students exhibit proficiency in comprehending and applying mathematical principles by skillfully navigating through the stages of solving equations and evaluating expressions. During this process, students not only strengthen their comprehension of algebraic ideas but also improve their problem-solving abilities in mathematics.

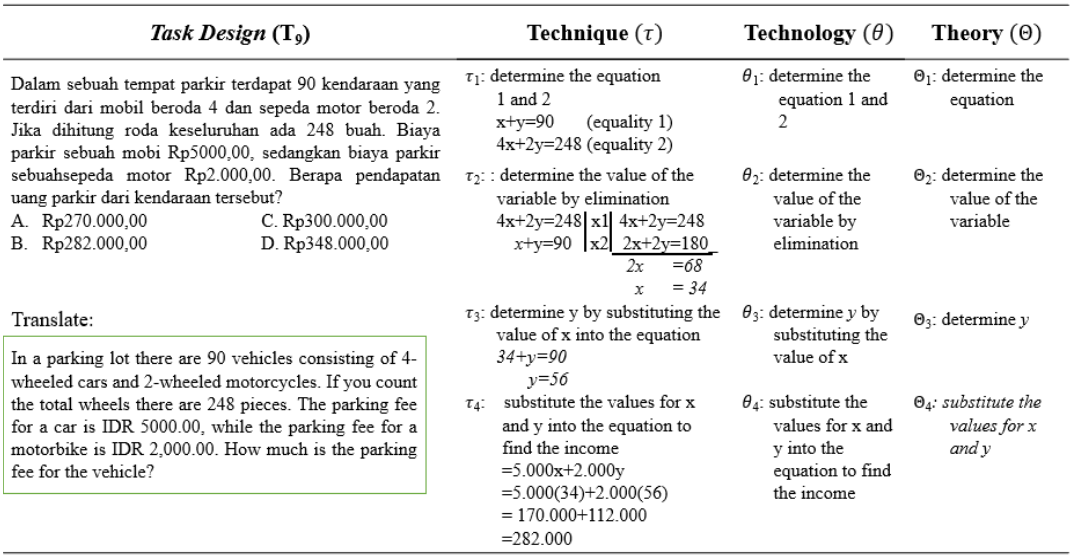
Table 18 - Task design (T_8) UN



Task Design **(T_8)**	**Technique (τ)**	**Technology (θ)**	**Theory (Θ)**
Harga sepasang sepatu dua kali harga sepasang sandal. Ardi membeli 2 pasang sepatu dan 3 pasang sandal dengan harga Rp420.000,00. Jika Doni membeli 3 pasang sepatu dan 2 pasang sandal, Doni harus membayar sebesar …. A. Rp180.000,00 C. Rp480.000,00 B. Rp360.000,00 D. Rp540.000,00	τ_1: determine x=2y	θ_1: determine x and y	Θ_1:determine x and y
	τ_2: determine the mathematical model 2x+2y=420.000	θ_2: determine the mathematical model for x and y	Θ_2: determine the mathematical model
Translate: The price of a pair of shoes is twice the price of a pair of sandals. Ardi bought 2 pairs of shoes and 3 pairs of sandals at a price of Rp420,000.00. If Doni buys 3 pairs of shoes and 2 pairs of sandals. Deni has to pay the amount of …..	τ_3: determine the value of the variable from the equation $2x+3y=420.000$ $2(2y)+3y=420.000$ $7y=420.000$ $y=60.000$	θ_3: determine the value of the variable from the equation	Θ_3: determine the value of the variable
	τ_4: substituting the value of and y into the equation $3x+2y=3(2y)+2y$ $= 6y+2y$ $=8(60.000)$ $=480.000$	θ_4: substituting the value of and y	Θ_4: determine the value of y

When students tackle T_8, they engage in a complex problem-solving process that involves multiple steps. Despite its complexity, the primary notion employed centres around algebraic addition in a novel environment. The first stage entails ascertaining the values of variables x and y, which is essential for resolving the provided equation: $3x+2y=3(2y) + 2y$. Students establish the groundwork for tackling the more extensive mathematical problem posed in T8 by accurately ascertaining these values. This technique demonstrates students' ability to apply their expertise in solving complex equations and highlights the importance of using algebraic principles in unfamiliar scenarios. Incorporating these procedures into the cognitive level of thinking (C3) emphasises students' proficiency in effectively integrating and implementing acquired mathematical principles. By employing this analytical methodology, students strengthen their comprehension of algebraic operations and enhance their ability to solve problems, empowering them to effectively tackle various mathematical difficulties with assurance and accuracy.

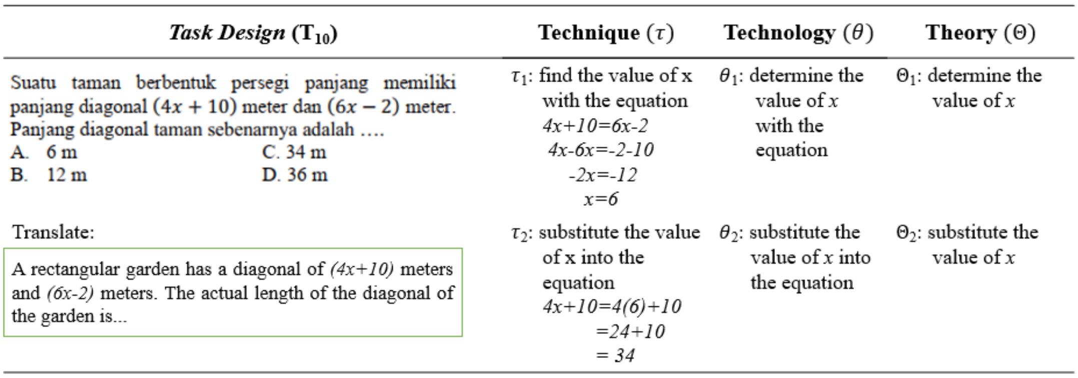
Table 19 - Task design (T_9) UN



Task Design **(T_9)**	**Technique (τ)**	**Technology (θ)**	**Theory (Θ)**
Dalam sebuah tempat parkir terdapat 90 kendaraan yang terdiri dari mobil beroda 4 dan sepeda motor beroda 2. Jika dihitung roda keseluruhan ada 248 buah. Biaya parkir sebuah mobi Rp5000,00, sedangkan biaya parkir sebuahsepeda motor Rp2.000,00. Berapa pendapatan uang parkir dari kendaraan tersebut? A. Rp270.000,00 C. Rp300.000,00 B. Rp282.000,00 D. Rp348.000,00	τ_1: determine the equation 1 and 2 x+y=90 (equality 1) 4x+2y=248 (equality 2)	θ_1: determine the equation 1 and 2	Θ_1: determine the equation
	τ_2: : determine the value of the variable by elimination $\begin{array}{r\|l\|l} 4x+2y=248 & x1 & 4x+2y=248 \\ x+y=90 & x2 & \underline{2x+2y=180} \\ & & 2x \quad =68 \\ & & x \quad = 34 \end{array}$	θ_2: determine the value of the variable by elimination	Θ_2: determine the value of the variable
Translate: In a parking lot there are 90 vehicles consisting of 4-wheeled cars and 2-wheeled motorcycles. If you count the total wheels there are 248 pieces. The parking fee for a car is IDR 5000.00, while the parking fee for a motorbike is IDR 2,000.00. How much is the parking fee for the vehicle?	τ_3: determine y by substituting the value of x into the equation $34+y=90$ $y=56$	θ_3: determine y by substituting the value of x	Θ_3: determine y
	τ_4: substitute the values for x and y into the equation to find the income =5.000x+2.000y =5.000(34)+2.000(56) = 170.000+112.000 =282.000	θ_4: substitute the values for x and y into the equation to find the income	Θ_4: *substitute the values for x and y*

When students work on T_9, they encounter a complex problem-solving process that consists of multiple stages. Each level requires a sophisticated application of algebraic principles. Although intricate, the underlying principle involved centres around algebraic addition, albeit in a unique situation. The primary task involves ascertaining the values of variables *x* and *y*, utilising elimination and substitution techniques to do this task efficiently. Students establish the foundation for solving the more comprehensive mathematical equation by accurately determining these numbers, such as $5{,}000x + 2{,}000y = 282{,}000$. This comprehensive method emphasises the importance of applying algebraic concepts in real life by showing students' capacity to solve complex problems.. Incorporating these procedures within the cognitive level (C3) of thinking highlights students' proficiency in integrating and implementing acquired mathematical principles with skill. By engaging in this analytical process, students strengthen their comprehension of algebraic processes and improve their problem-solving abilities, empowering them to approach various mathematical issues with accuracy and assurance.

Table 20 - Task design (T_{10}) UN



Task Design (T_{10})	Technique (τ)	Technology (θ)	Theory (Θ)
Suatu taman berbentuk persegi panjang memiliki panjang diagonal $(4x + 10)$ meter dan $(6x - 2)$ meter. Panjang diagonal taman sebenarnya adalah …. A. 6 m C. 34 m B. 12 m D. 36 m	τ_1: find the value of x with the equation $4x+10=6x-2$ $4x-6x=-2-10$ $-2x=-12$ $x=6$	θ_1: determine the value of *x* with the equation	Θ_1: determine the value of *x*
Translate: A rectangular garden has a diagonal of *(4x+10)* meters and *(6x-2)* meters. The actual length of the diagonal of the garden is...	τ_2: substitute the value of x into the equation $4x+10=4(6)+10$ $=24+10$ $= 34$	θ_2: substitute the value of *x* into the equation	Θ_2: substitute the value of *x*

When students complete step T_9, they face a complex problem-solving procedure that relies on using algebraic addition in a new situation. Although the task is difficult, the core notion remains simple, focusing on adding algebraic expressions in a new context. The main goal is to ascertain the value of variable x, which is crucial for solving the provided equation. Through the systematic application of algebraic principles, students begin by substituting the given value for one variable (in this case, 6) into the equation. This process allows them to isolate and determine the value of x. Through this procedure, pupils solve the equation $4x + 10 = 34$. The use of algebraic addition and substitution techniques makes these steps stand out. They are categorised under the application level (C3) of cognitive processing. Students strengthen their comprehension of mathematical principles and improve their critical thinking and analytical abilities by effectively progressing through the problem-solving phases and utilising algebraic concepts. By engaging in such efforts, students acquire the skill and self-assurance necessary to address various mathematical problems effectively.

3.2 Discussion

Evaluating students' mathematical competence via standardised assessments such as TIMSS (Trends in International Mathematics and Science Study) and UN (National Examinations) reveals certain attributes influenced by pedagogical methodologies and educational objectives. Although the Indonesian curriculum has prioritised the implementation of higher-order thinking Skills (HOTS) since 2013, an analysis of the questions used in the UN exam shows a predominant emphasis on cognitive levels classified as C1 (knowledge) and C2 (understanding), with occasional inclusion of elements from C3 (application). The discrepancy between educational objectives and assessment methods highlights the necessity for thoroughly evaluating the congruity between curriculum goals and assessment approaches. This discourse examines the difference between educational goals and assessment methods in the Indonesian education system.

3.2.1 Work steps

The first phase of the TIMSS assessment procedure focuses on cultivating and assessing students' fundamental comprehension of mathematical principles. TIMSS questions are distinct from conventional exams as they incorporate many mathematical concepts into a single exercise rather than examining discrete ideas. This technique challenges students to comprehend individual topics and requires their capacity to make connections between them. Furthermore, the task formats included in TIMSS primarily focus on pattern-establishing activities, which encompass basic patterns and more intricate sequences that require numerous steps. TIMSS seeks to evaluate students' capacity to identify and utilise fundamental mathematical patterns in various situations by emphasising pattern identification and problem-solving abilities. The TIMSS assessment measures students' mathematical competency and develops their analytical thinking and problem-solving skills, which are crucial for success in mathematics.

Students participate in UN examinations that consist of standardized questions. These questions typically start with an introduction and are followed by specific inquiries. In contrast to the TIMSS exam, which frequently requires the integration of several mathematical concepts, the questions in the UN evaluation generally focus on individual mathematical topics. Consequently, students need to have a strong base of knowledge and comprehension in a particular mathematical field to tackle these questions efficiently. The task types included in UN assessments mainly include ordinary exercises that students typically experience in their regular learning process. These questions aim to assess students' proficiency in essential mathematical principles and their capacity to utilise them in standard situations. UN evaluations offer valuable insights into students' ability to accurately perform mathematical procedures and algorithms, with an emphasis on regular exercises. Nevertheless, these exams may provide only a restricted understanding of students' cognitive talents and capacity to solve complex problems, in contrast to assessments such as TIMSS, which emphasise activities involving pattern recognition and multi-step problem-solving.

3.2.2 Work strategy (heuristic)

The task type described is an open-ended problem-solving method, allowing students to address challenges in various ways. Students can utilise several methodologies, including systematic experimentation, guess-check revision, working backwards, specifications and generalisations, and analogies. This approach fosters students' critical and creative thinking by providing many methods for problem-solving. By adopting diverse tactics, students can enhance their higher-order thinking skills, enabling them to assess problems from different perspectives and generate creative solutions. By employing this methodology, students enhance their problem-solving abilities while fostering a mindset that values experimentation and creativity, which are crucial for achieving success in academic and real-life situations.

This work type entails a well-organized series of formal inquiries that require a systematic approach to finding an answer. The nature of this work requires the use of regular tactics to complete the prescribed tasks. Consequently, students have restricted autonomy in choosing their response technique due to the questions' nature, which requires a more predetermined approach. This framework often coincides with standardised assessments or examinations where clarity and uniformity in problem-solving approaches are crucial. Although this technique may restrict students' independence in choosing solution methods, it provides a uniform structure for assessing and evaluating their work. By following routine completion tactics, students acquire expertise in efficiently carrying out specified procedures and algorithms, which are crucial abilities for successfully navigating standardised exams and academic settings. However, educators must augment such examinations with chances for students to explore multiple problem-solving approaches, supporting a more comprehensive development of their problem-solving and critical thinking abilities.

3.2.3 Stages of thinking

Examining the cognitive phases in TIMSS and UN evaluations reveals clear distinctions in problem-solving methodologies. The task type in TIMSS demonstrates a gradual increase in cognitive complexity, requiring a methodical approach to problem-solving. Students are encouraged to participate in a sequential and logical reasoning process, where each subsequent step is based on the preceding one. Furthermore, the prevalence of pattern-establishing assignments in TIMSS highlights the significance of students' capacity to create and distinguish patterns, promoting critical and innovative thinking in their responses. The focus on identifying patterns and employing methodical approaches to problem-solving fosters advanced cognitive skills in pupils, enabling them to examine challenges and generate inventive solutions comprehensively. Conversely, the UN assessments may prioritise mundane assignments, limiting students' freedom to choose problem-solving approaches. Both examinations are crucial for evaluating students' mathematical skills and promoting their cognitive growth, but they employ distinct methods for solving problems.

Unlike TIMSS, the UN evaluations involve a different activity consisting of a series of formal questions that need precise and straightforward answers. These questions mainly consist of common situations that require simple solutions. Consequently, students have restricted autonomy to develop knowledge or investigate other problem-solving methods. Nevertheless, the organised form of UN tasks underscores the significance of employing mathematical principles in various situations. The focus on utilising mathematical knowledge in practical scenarios corresponds to the level of thinking known as application, which is considered the highest cognitive capacity in UN assessments. UN evaluations evaluate students' ability to apply mathematical ideas to real-world situations, promoting the development of critical thinking and problem-solving abilities that are crucial for success outside of the classroom.

Examining TIMSS items uncovers a comprehensive method for addressing problems, including the algebra content and reasoning cognitive domains. Under this approach, students are encouraged to utilise various cognitive processes rather than favouring a single thinking capacity. In the Design Task, students must critically assess problems before participating in creative thinking to uncover new patterns. The emphasis on high-order thinking skills inherent in TIMSS questions highlights the promotion of pupils' cognitive growth and problem-solving ability. On the other hand, the UN questions mainly focus on the content domain of algebra. The analysis of these questions reveals that they primarily need higher levels of comprehension and the ability to apply knowledge. Nevertheless, the UN questions demonstrate a poor proficiency in higher-order thinking Skills (HOTS). This difference shows that the cognitive demands of the TIMSS and UN tests are different, highlighting how important it is to align assessment methods with educational goals to promote overall student growth.

Encouraging kids to engage in reasoning goes beyond simply memorising information and involves exploring the domain of critical inquiry and exploration. Students are prompted to investigate inquiries related to phenomena that require explanation instead of simply absorbing information about mechanisms. During this process, students are encouraged to engage in analytical and creative thinking, exploring several potential processes and determining the most appropriate methods for testing them. This methodology promotes a more profound comprehension of ideas and motivates pupils to cultivate their problem-solving aptitude. Through active participation in the reasoning process, students acquire knowledge and crucial cognitive skills such as critical thinking, analysis, and hypothesis formation. Therefore, promoting a culture of logical thinking in education improves students' comprehension of intricate phenomena and provides them with vital abilities to navigate the difficulties of a constantly changing environment.

4. Conclusions

This article thoroughly analyses algebraic questions found in both TIMSS and the Indonesian National Examination, offering valuable insights. By doing a praxeological analysis, we discovered significant differences in the patterns of questions between the two evaluations. Although the Indonesian curriculum places importance on developing higher-order thinking skills (HOTS), the evaluation techniques mostly rely on questions that fall under lower-order thinking skills (LOTS). The lack of concordance between the goals of the curriculum and the methods used to measure student learning reveals a notable inconsistency in educational approaches. Consequently, this finding gives birth to various significant ramifications. Firstly, the government must promptly implement measures to harmonise curriculum objectives with assessment instruments to ensure their alignment and efficacy. Furthermore, teachers have a crucial role in promoting HOTS among students. Therefore, they must emphasise including HOTS-type questions more regularly in their teaching methods. Finally, additional research is necessary to thoroughly investigate all types of questions employed in government evaluations, encompassing subjects outside of algebra, to precisely assess the academic accomplishments of Indonesian students in many areas. To improve the quality of education and foster comprehensive student development in Indonesia, officials and educators should address these consequences.

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Conflict of Interest

The authors declare no conflicts of interest.

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