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ICAPS

**PEDAGOGY AND ASSESSMENT
MODULE FOR
HIGHER ORDER THINKING SKILLS
IN MATHEMATICS
FOR PRIMARY SCHOOL
(DUAL LANGUAGE PROGRAMME)**





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Institute of Teacher Education Malaysia

NATIONAL EDUCATION PHILOSOPHY

Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious, based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards, and who are responsible and capable of achieving high level of personal well-being as well as being able to contribute to the harmony and betterment of the family, the society and the nation at large.

PEDAGOGY AND ASSESSMENT MODULE FOR HIGHER ORDER THINKING SKILLS IN MATHEMATICS FOR PRIMARY SCHOOL (DUAL LANGUAGE PROGRAMME)

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Preface

RECTOR
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Bismillahirrahmanirrahim
Assalamualaikum and Salam Sejahtera

Alhamdulillah, praise be to Allah The Almighty for His bounty and grace, the Teacher Education Institute (IPG), Ministry of Education Malaysia, has successfully produced Pedagogy and Assessment Module For Higher Order Thinking Skills in Mathematics for Primary School, to be used as a reference and support material for lecturers in implementing pedagogical teaching in mathematics education for teacher students. The publication of this module is relevant in contributing to the development of mathematical higher order thinking skills (HOTS) and problem solving among student teachers. Hence, they will then be able to implement more meaningful mathematical teaching and learning particularly in English for the Dual Language Programme.

This module provides activities based on the content and cognitive domains of mathematics by referring to international standardized assessment that is TIMSS. TIMSS assessment focuses on higher order thinking skills and problem solving. We aspire to become top one third in the PISA and TIMSS ranking in 2025. Therefore, HOTS and problem solving skills need to be enhanced in order to help improve the quality of primary school mathematics education as well as the recognition from international standards assessment. This is to realize one of the outcomes of the National Education Aspiration as stated in the Malaysian Education Blueprint (2012-2025) that all students can have access to quality education.

I hope this module will be fully utilized and able to assist lecturers in their effort to train teachers in planning and carrying out meaningful teaching and learning activities. Consequently, it will help improve the quality of primary school mathematics education. Finally, congratulations to all the panels and committee members on the development of the Pedagogy and Assessment Module For Higher Order Thinking Skills in Mathematics for Primary Schools. May Allah bless all these noble efforts.

Thank you.



Dr. Rusmini binti Ku Ahmad

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CONTENTS		PAGE
PREFACE		
MODULE WRITERS		
CHAPTER 1	INTRODUCTION	
	1.1 Aim	2
	1.2 Objective	2
	1.3 Rationale	2
CHAPTER 2	CONCEPTUAL FRAMEWORK	
	2.1 Polya's Problem Solving Model	3
	2.2 TIMSS Mathematics Assessment Framework	4
CHAPTER 3	ICaPS: ITEM CONSTRUCTION AND PROBLEM SOLVING	
	3.1 Introduction	5
	3.2 Item Construction (IC)	10
	3.3 Effective Questioning Skills	26
	3.4 Problem Solving (PS)	29
REFERENCES		

Pedagogy And Assessment Module For Higher Order Thinking Skills In Mathematics For Primary School

CHAPTER 1

INTRODUCTION

One of the five outcomes that the Malaysia Education Blueprint 2013-2025 aspires for the Malaysian education system is quality education. All children will have the opportunity to attain an excellent education that is uniquely Malaysian and comparable to the best international education system. The aspiration is for Malaysia to be in the top third performance of countries in international assessments, as measured by outcomes in Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) within 15 years.

TIMSS by International Association for the Evaluation of Educational Achievement (IEA) is a series of international assessments of the mathematics and science knowledge of students around the world. 60% of the thinking processes assessed in TIMSS consists of higher order thinking skills (HOTs). However, the TIMSS and PISA international assessment have demonstrated that our students struggle with higher order thinking skills. *Laporan Kajian Kebolehlaksanaan TIMSS 2019 Gred 4* (KPM, 2016), reported that teaching and learning activities using higher order thinking skills and teachers' readiness to prepare challenging tasks is still at the medium level. The report also mentioned that the number of teachers attending HOTs assessment courses is still low (50%).

With reference to TIMSS assessment, Pedagogy and Assessment Module for Higher Thinking Skills in Mathematics for Primary Schools is developed. This module provides information, activities and practices on Item Construction which focuses on the construction of Multiple Choice and Constructed Response Questions (MCQ and CRQ) with their respective scoring; effective questioning skills and Problem Solving. Item Construction (IC) and Problem Solving (PS) (ICaPS) are given focus in this module to help trainee teachers in enhancing their HOTs to be applied in their teaching and learning activities during their practicum and services. The module discusses the content and the cognitive domains of

TIMSS Mathematics Grade 4 assessment, teaching and learning activities incorporating HOTS, construction of assessment items and solving problems using Polya's model.

1.1 Aim

This module aims to enhance HOTS of trainee teachers in planning teaching and learning activities and assessment in mathematics for primary school.

1.2 Objectives

On completing this module, students will be able to:

- i. identify the cognitive and content domains of TIMSS Mathematics Grade 4 assessment;
- ii. construct mathematics assessment items for testing Year 4 pupils' mathematical skills;
- iii. create sets of effective questions to assist pupils to answer TIMSS Mathematics Grade 4 items; and
- iv. solve problems using Polya's Model.

1.3 Rationale

In order to prepare Year 4 pupils to sit for TIMSS assessment in year 2019, HOTS need to be developed among pupils. Trainee teachers' readiness to prepare challenging tasks and mastery of creating HOTS assessment items needs to be increased.

CHAPTER 2

CONCEPTUAL FRAMEWORK

The conceptual framework for this module focuses on two domains in TIMSS framework which are cognitive domain and content domain. Cognitive domain consists of knowing (40%), applying (40%) and reasoning (20%). The three content domains in Mathematics are Numbers (50%), Measurement and Geometry (30%) and Data (20%). These domains are used for TIMSS Grade 4 assessment.

The goals of this chapter are to outline and substantiate a broad conceptualization of what it means to think mathematically, and to understand mathematical thinking and problem solving. Lastly, this module gives a new direction in research, development and assessment with an emerging understanding of mathematical thinking and the goals for instruction.

2.1 Polya's Four Steps of Problem Solving

The following steps are extracted from the book *How to Solve It?* by George Polya.

Step 1: Understanding the Problem

You have to understand the problem. What is the unknown? What are the data? What is the condition? Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory? Draw a figure. Introduce suitable notation. Separate the various parts of the condition. Can you write them down?

Step 2: Devising a Plan

Find the connection between the data and the unknown. You may be obliged to consider auxiliary problems if an immediate connection cannot be found. You should obtain eventually a plan of the solution. Have you seen it before? Or have you seen the same problem in a slightly different form? Do you know a related problem? Do you know a theorem that could be useful? Look at the unknown! Try to think of a familiar problem having the same or a similar unknown related to yours and solved before. Could you use it? Could you use its result? Could you use its method? Should you introduce some auxiliary element in order to make its use possible? Could you restate the problem? Could you restate it differently? Go back

to definitions. If you cannot solve the proposed problem, try to solve first some related problems.

Could you imagine a more accessible related problem? A more general problem? A more special problem? An analogous problem? Could you solve a part of the problem? Keep only a part of the condition, drop the other part; how far is the unknown then determined, how can it vary? Could you derive something useful from the data? Could you think of other data appropriate to determine the unknown? Could you change the unknown or the data, or both if necessary, so that the new unknown and the new data are nearer to each other? Did you use all the data? Did you use the whole condition? Have you taken into account all essential notions involved in the problem?

Step 3: Carrying Out the Plan

Carrying out your plan of the solution, check each step. Can you see clearly that the step is correct? Can you prove that it is correct?

Step 4: Looking Back

Examine the solution obtained. Can you check the result? Can you check the argument? Can you derive the result differently? Can you see it at a glance? Can you use the result, or the method, for some other problems?

2.2 TIMSS Mathematics Assessment Framework

TIMSS Mathematics Assessment Framework is organized around two domains:

A Cognitive Domain

- Specifying the domains or thinking processes to be assessed (knowing, applying, and reasoning).
- The cognitive domains describe the sets of behaviours expected of students as they engage with the mathematics content.

A Content Domain

- Specifying the domains or subject matter to be assessed within mathematics (Numbers, Measurement and Geometry, Data).
- Has several topic areas.
- Each topic area is presented as a list of objectives.



**ICaPS ACTIVITIES TOWARDS STRENGTHENING DUAL
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CHAPTER 3

ICaPS: ITEM CONSTRUCTION AND PROBLEM SOLVING

3.1 INTRODUCTION

This section will provide information and practices on constructing items pertaining to the content and cognitive domains in Mathematics, with reference to TIMSS released items. Item Construction and Problem Solving (ICaPS) focuses on constructing Items namely Multiple Choice and Constructed Response Questions and their scoring methods. In addition, activities are also designed for students to improve their effective questioning skills which are relevant prior to applying steps of problem solving based on Polya's Model.

A. Objective

At the end of this section, students will be able to :

- i. compare TIMSS cognitive domains with Malaysian Mathematics Curriculum;
- ii. identify the cognitive domains in TIMSS items from the questions given; and
- iii. identify the content domains in TIMSS items from the questions given.

B. Content

- i. TIMSS cognitive domains: Knowing, Applying, Reasoning
- ii. TIMSS content domains: Numbers, Measurement and Geometry, Data
- iii. Mathematical Ideas

C. Method

- i. Group work
- ii. Gallery walk
- iii. Power Point Presentation

D Learning Materials

- i. Power Point Slides
- ii. Multicoloured A4 Papers
- iii. Sticker Notes



- iv. Multicoloured Stickers
- v. Marker Pens
- vi. Flash cards
- vii. LCD Projector

ACTIVITY 1: TIMSS cognitive domains: Knowing, Applying, Reasoning.

1. Discuss to what extent the TIMSS cognitive domains match with Malaysian Mathematics Curriculum (Year 4 - 6).
2. Refer to Table 1: Identify the cognitive domains from the questions.

ACTIVITY 2: TIMSS content domains: Numbers, Measurements and Geometry, Data.

1. Determine to what extent of the TIMSS content domains match with Malaysian Mathematics Curriculum (Year 4 - 6).
2. Refer to Table 1: Identify the content domains from the questions.

Table 1: Identifying TIMSS Domains

No	Question	Cognitive Domain	Content Domain
1	Last year there were 92 boys and 83 girls in Kenny High School. This year there are 210 students, and 97 are boys. How many more/less girls are there this year than last year? Show your solutions.	Applying	Numbers
2	Don, Ray and Mimie walk home from school together. It takes them 25 minutes to walk to Mimie's house. Then it takes Don and Ray 10 minutes to get to Ray's house. From there it takes Don 5 minutes to walk home.		

No	Question	Cognitive Domain	Content Domain
	At what time must they leave school so that Don arrives home at 3.50 p.m?		
3	Neil buys a bag of 5 kg cat food. His cat eats 300g of food a day. For how many days will the bag of food last?		
4	Karen makes 2 liters of lemonade. Her brother drinks 1 glass of the lemonade Karen makes. If a glass can fill up to 250ml, how many glasses of lemonade does Karen make?		
5	Bill uses 57 craft sticks in an art project. Two fall off. Then he adds 10 more sticks. How many craft sticks are part of his final art project?		
6	Tom and his brother Peter received the same amount of money. Tom spent $\frac{1}{3}$ of his money on books. He spent $\frac{3}{5}$ of the remaining money to buy a new pair of shoes. Peter spent $\frac{3}{5}$ of his money to buy a new pair of shoes. Who spent more for shoes?		
7	Ahmad had the following scores out of 10 on his first 4 mathematics tests : 9, 7, 8, 8. Ahmad has 1 more test with a maximum of 10 points and says he wants to get an overall average of 9. Is it possible for him to do this? Explain your answer.		

ACTIVITY 3: Mathematical Ideas

1. Refer to Example 1: Identify the Mathematical Ideas.
 - Compare and discuss your findings.
 - Suggested activities – Gallery Walk or Power Point presentation.

Example 1: Identify the Mathematical Ideas.

A Problem Solving: Reading For Mathematics

Bonnie's school is having a play. 245 people come to the play the first night. 267 people come to the play the second night.
How many people come to the play in all?

Solution:

- i. What are the people doing?
- ii. What do you need to find out?
- iii. What details will help you find out?
- iv. How many people come to the play in all?
- v. Write a number sentence to show your thinking.

B Problem Solving: Story problems

1. Make up a story problem. Fill in the details.

Saturday was a fun day at the _____ . (name a place)

Adults and children _____ . (tell what they did)

All _____ adults had fun. (a number between 100 and 200)

All _____ children had fun. (a number between 200 and 300)

How many people had fun? _____

2. Trade stories with your partner by answering the questions below.

- a. What is the story about?
- b. What do you want to find out?
- c. What details will help you find out?
- d. How many people had fun?

C Problem Solving: Use the internet

- i. Go to <http://gg.gg/timssPS> or scan the QR code.
- ii. Explore the activity.
- iii. Why is the internet a good place to find information?



Answers

A Problem Solving: Reading For Math

- i. Coming to a play.
- ii. How many people come to the play in all.
- iii. 245 people come the first night; 267 people come the second night.
- iv. 512 people.
- v. $245 + 267 = 512$ or $267 + 245 = 512$.

B Problem Solving: Story problems

- 2.
- a. Answer will vary.
 - b. Number of people had fun.
 - c. Number of adults and children had fun.
 - d. Numbers vary but should equal to the sum of the two numbers used in the story.





**ICaPS ACTIVITIES TOWARDS STRENGTHENING DUAL
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3.2 ITEM CONSTRUCTION (IC)

A. Objectives

At the end of this section, students should be able to construct three cognitive domains of TIMSS items for each content domain.

B. Contents

- i. Processes of TIMSS item construction and guidelines
- ii. Construction of TIMSS items

C. Methods

- i. Group work
- ii. Group presentation

D Learning Materials

- i. A4 paper
- ii. Marker pens
- iii. *Mahjong* papers
- iv. Masking tapes
- v. LCD projector

TIMSS ITEM CONSTRUCTION PROCESSES

Item Construction Processes and Guidelines

Points to ponder:

1. What should your pupils know?
2. What should your pupils be able to do?
3. Do consider:
 - the timing, grade appropriateness, difficulty level, potential sources of bias (cultural, gender or geographical).
 - item validity is not affected by factors that unnecessarily increase the difficulty of the item, such as unfamiliar or difficult vocabulary, grammar, directions, contexts or stimulus materials.
 - the possibility of unintentionally placing particular groups of pupils at an unfair disadvantage.
 - that diagrams and graphs are drawn accurately (to scale unless otherwise noted), and are correctly and fully labelled.
 - multiple intelligences among pupils.

Question Types and Scoring Procedures

- Two question formats - multiple choice question (MCQ) & constructed-response question (CRQ).
- Each MCQ is worth 1 score point.
- Each CRQ is worth 1 or 2 score points, depending on the nature of the task and the skills required to complete it.
- The choice of item format depends on the mathematics skills being assessed, and the format that best enables pupils to demonstrate their proficiency.

MCQ

A multiple-choice item asks a question or establishes the situation for a response. For the TIMSS 2015 assessments, this type of item includes four response choices, or options, from which the correct answer is selected.

Characteristics of MCQ Item



- **Stem** is the initial part of the item in which the task is defined
- **Options** refer to the entire set of labeled response choices presented under the stem
- **Key** is the correct response option
- **Distractors** are the incorrect response options

Guidelines of MCQ Item

- Ask a direct question with only one correct answer, and provide plausible distractors.
- The question must be able to stand alone, and be answerable without the response options.
- Do not include extraneous information that can confuse pupils.
- Avoid questions for which a wrong method yields the correct answer (e.g. a question about a circle with a radius of 2, since computing either area or circumference get 4π).
- Avoid writing items where students can work backwards from the response options to find the correct answer (e.g., solving for x in an equation).
(CRQ is more appropriate)

CRQ

For some desired outcomes of mathematics education, constructed-response items provide more valid measures of achievement than do multiple-choice items. The quality of constructed-response items depends largely on the ability of scorers to assign scores consistently and reliably within and across countries. Thus, it is essential that each constructed-response item and its scoring guide be developed together.

Type of CRQ Item

- Write a full credit answer in terms of the language, knowledge, and skills that pupils could be expected to possess and determine whether to allocate 1 or 2 score points.
- Develop a specific scoring guide. To ensure reliability, CRQ items need scoring guides with well-defined categories for allocating score points. It is also important



to collect information of value for educational improvement. Students' answers can provide insights into what they know and are able to do, including common misconceptions. The generalized scoring guidelines used for 1-point and 2-point constructed-response items are described in Table 1 and Table 2.

Table 1: Scoring guide for CRQ 1-point system

Score Points for 1-point system
<p>1 Point (Full credit) A one-point response is correct. The response indicates that the student has completed the task correctly.</p>
<p>0 Points (No credit) A zero-point response is incorrect, irrelevant, or incoherent.</p>

Table 2: Scoring guide for CRQ 2-point system

Score Points for 2-point system
<p>2 Points (Full credit) A two-point response is complete and correct. The response demonstrates a thorough understanding of the concepts and/or procedures embodied in the task.</p> <ul style="list-style-type: none"> Indicates that the student has completed all aspects of the task, showing correct application of concepts and/or procedures Contains clear, complete explanations, supporting work, or evidence when required
<p>1 Point (Partial credit) A one-point response is only partially correct. The response demonstrates only a partial understanding of the concepts and/or procedures embodied in the task.</p> <ul style="list-style-type: none"> Addresses some elements of the task correctly but may be incomplete May contain a correct answer but an incomplete explanation when required May contain an incorrect answer with an explanation or supporting work indicating a correct understanding of the concepts
<p>0 Points (No credit) A zero-point response is inaccurate or inadequate, irrelevant, or incoherent.</p>

Guidelines of CRQ Item

1. Pupils will not be allowed to ask the test administrator for clarification. Write questions in easily accessible language appropriate to the age and experience of the target population.
2. Use simple vocabulary and sentence structure, and avoid using complicated names for the subjects in the item. Make what is expected of students as clear as possible without compromising the intent of the item. Give an indication, where appropriate, of the extent, or level of detail, of the expected answer (e.g., “Give three reasons ...” rather than “Give some reasons ...”). Select real life problem settings that are likely to be “real” to pupils at the target grade levels, and that involve quantities that are realistic for the situations.
3. Avoid asking questions that could give rise to answers that cannot be scored strictly in terms of accuracy of mathematical or scientific understanding (e.g., “What are satellites used for?”).
4. Pupils should be able to complete the task in the time allocated for each constructed-response item, that is, a maximum of 3 minutes.
5. Write an appropriate answer to the question in terms of the language, knowledge, and skills that a good pupil at the target grade could be expected to possess. This tests the clarity of the question and is also an essential first step in producing a scoring guide for the item. It is also helpful for those who are reviewing the question.
6. Produce a scoring guide (as above). This action usually results in amendments to the item to clarify its purpose and improve the quality of information that can be obtained from pupils’ responses.

Each MCQ/CRQ Item contains:

- the content domain, topic area, and objective the item measures
- the cognitive domain
- the item number (1, 2, 3, etc.)
- the key (multiple-choice items only)
- the scoring guide



Example 1

Content Domain	Main Topic	Cognitive Domain
NUMBER	Fractions and Decimals	Knowing

Which of these fractions is larger than $\frac{1}{2}$?

- A. $\frac{3}{5}$
- B. $\frac{3}{6}$
- C. $\frac{3}{8}$
- D. $\frac{3}{10}$

Correct Response:

A

Example 2

Content Domain	Main Topic	Cognitive Domain
NUMBER	Whole Numbers	Applying

Georgia wants to send letters to 12 of her friends. Half of the letters will need 1 page each and the other half will need 2 pages each. How many pages will be needed altogether?

Answer: _____

SCORING

Correct Response

- 18

Incorrect Response

- 24
- 36
- Other incorrect (including crossed out, erased, stray marks, illegible, or off task)

Student Responses

Correct Response:

Answer: 18

$$\begin{array}{r} 12 \\ + 6 \\ \hline 18 \end{array}$$

Incorrect Response:

Answer: 36

$$\begin{array}{r} 12 \\ \times 2 \\ \hline 24 \end{array}$$

$$\begin{array}{r} 12 \\ + 24 \\ \hline 36 \end{array}$$

Example 3

Content Domain	Main Topic	Cognitive Domain
NUMBER	Whole Numbers	Reasoning

Three thousand tickets for a basketball game are numbered 1 to 3,000.
 People with ticket numbers ending with 112 receive a prize.
 Write down all the prize-winning numbers.

Prize-winning numbers: _____

SCORING

Correct Response

- 112, 1112, 2112

Incorrect Response

- 112, 1112, 2112 with additional incorrect
- One or two correct no incorrect
- Other incorrect (including crossed out, erased, stray marks, illegible, or off task)

Student Responses

Correct Response:

Prize-winning numbers: 112, 1112, 2112

112
 1112
 2112

Incorrect Response:

Prize-winning numbers: 112 212 312 412 512
 612 712 812 912 1,012
 2,012

ACTIVITY 1:

Construction of TIMSS items pertaining to three cognitive domains

1. Form three groups. Each group selects only **one** content domain (Number, Measurement and Geometry, Data).
2. Construct **three** different cognitive domains of TIMSS items. Construct the items using TIMSS Items Construction Format as shown in Table 3. You may use Example 1 and Example 2 of MCQ and CRQ Items Construction as a guideline.
3. Present your work using any collaborative learning strategies (Gallery walk, slide presentation, etc.).

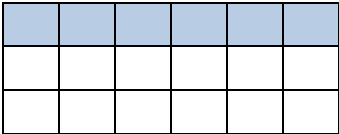


Table 3: Format of TIMSS Items Construction

Subject	Mathematics
Year	
Content Domain	
Main Topic	
Learning Standard	
Cognitive Domain	Knowing/ Applying/ Reasoning
Type of Question	MCQ/ CRQ
Question	
Scoring	
Scoring Guide	




Example 4: Format of MCQ Items Construction

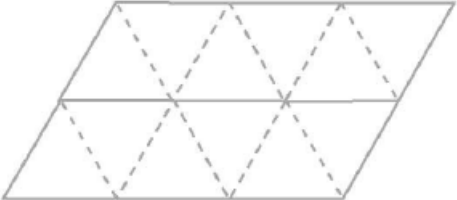
Subject	Mathematics
Year	4
Content Domain	Numbers
Main Topic	Fraction
Learning Standard	7.5 (i)
Cognitive Domain	Knowing
Type of Question	MCQ
Question	<p>What fraction of this rectangle is shaded? Are the unshaded parts considered as the whole parts?</p>  <p>A. $\frac{1}{4}$ B. $\frac{1}{3}$ C. $\frac{6}{12}$ D. $\frac{2}{3}$</p>
Scoring	<p>Maximum Points 1 point</p> <p>Key B</p>
Scoring guide	None

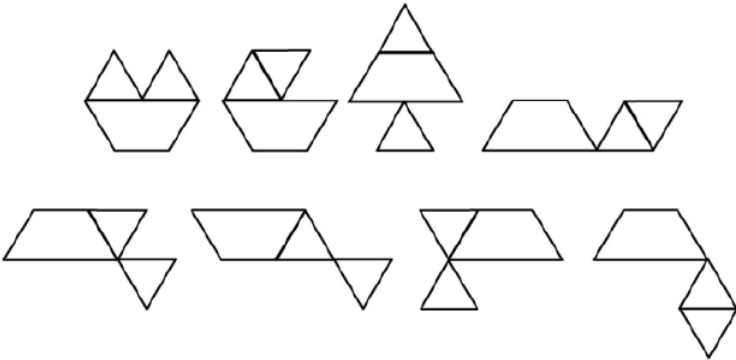
Example 5: Format of 1-Point CRQ Items Construction

Subject	Mathematics
Year	4
Content Domain	Numbers
Main Topic	Patterns and Relationships
Learning Standard	15.3
Cognitive Domain	Applying
Type of Question	CRQ
Question	<p>Cooney has to form figures 1 to 4 with matches.</p> <p>Figures 1, 2, and 3 are shown below.</p> <p>He needs four matches to form figure 1, seven matches to form figure 2, and ten matches to form figure 3.</p> <p>He uses the same rule each time to make the next figure in the pattern.</p> <p>How many matches will he need to form figure 4?</p> <p>Answer: _____</p>
Scoring	<p>Maximum Points 1 point</p> <p>Key See Scoring guide</p>
Scoring guide	<p>Correct Response (1 point) 13</p>

	<p>Incorrect Response (0 point)</p> <ul style="list-style-type: none">  Incorrect (including crossed out, erased, stray marks, illegible, or off task) <p>Nonresponse (0 point) Blank</p>
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Example 6: Format of 2-Points CRQ Items Construction

Subject	Mathematics						
Year	4						
Content Domain	Measurement and Geometry						
Main Topic	Space						
Learning Standard	15.3 (i)						
Cognitive Domain	Reasoning						
Type of Question	CRQ						
Question	<table border="1" style="width: 100%;"> <tr> <td>USE:</td> <td>2 Triangle Tiles and 1 Trapezoid Tile</td> </tr> <tr> <td>MAKE:</td> <td>A 7-sided figure</td> </tr> <tr> <td>SHOW:</td> <td>Draw it on the grid</td> </tr> </table> 	USE:	2 Triangle Tiles and 1 Trapezoid Tile	MAKE:	A 7-sided figure	SHOW:	Draw it on the grid
USE:	2 Triangle Tiles and 1 Trapezoid Tile						
MAKE:	A 7-sided figure						
SHOW:	Draw it on the grid						

<p>Scoring</p>	<p>Maximum Points 2 points</p> <p>Key See Scoring guide</p>
<p>Scoring guide</p>	<p>Correct Response (2 points) Makes a correct 7-sided figure, e.g. one of those shown below (in any orientation).</p> <div style="text-align: center;">  </div> <p>Incorrect Response (0 point) Incorrect (including crossed out, erased, stray marks, illegible, or off task)</p> <p>Nonresponse (0 point) Blank</p>

Example 7: Format of 2-Points CRQ Items Construction

Subject	Mathematics																
Year	4																
Content Domain	Number																
Main Topic	Whole Number																
Learning Standard	17.1																
Cognitive Domain	Applying																
Type of Question	CRQ																
Question	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Ingredients</th> </tr> </thead> <tbody> <tr> <td>Eggs</td> <td>4</td> </tr> <tr> <td>Flour</td> <td>8 cups</td> </tr> <tr> <td>Milk</td> <td>$\frac{1}{2}$ cup</td> </tr> </tbody> </table> <p>The above ingredients are used to make a recipe for 6 people. Sam wants to make this recipe for only 3 people.</p> <p>Complete the table below to show what Sam needs to make the recipe for 3 people. The number of eggs he needs is shown.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Ingredients</th> </tr> </thead> <tbody> <tr> <td>Eggs</td> <td>2</td> </tr> <tr> <td>Flour</td> <td>___ cups</td> </tr> <tr> <td>Milk</td> <td>___ cup</td> </tr> </tbody> </table>	Ingredients		Eggs	4	Flour	8 cups	Milk	$\frac{1}{2}$ cup	Ingredients		Eggs	2	Flour	___ cups	Milk	___ cup
Ingredients																	
Eggs	4																
Flour	8 cups																
Milk	$\frac{1}{2}$ cup																
Ingredients																	
Eggs	2																
Flour	___ cups																
Milk	___ cup																
Scoring	<p>Maximum Points 2 points</p> <p>Key See Scoring guide</p>																

Scoring guide	<p>Correct Response (2 points) 4 cups of flour and $\frac{1}{4}$ cup of milk</p> <p>Partially Correct Response (1 point)</p> <ul style="list-style-type: none">• Flour correct, milk incorrect• Flour correct, milk omitted• Milk correct, flour incorrect or omitted <p>Incorrect Response (0 point) Incorrect (including crossed out, erased, stray marks, illegible, or off task)</p> <p>Nonresponse (0 point) Blank</p> <p>SCORING</p> <p>Correct Response</p> <ul style="list-style-type: none">• 4 cups of flour and $\frac{1}{4}$ cup of milk <p>Partially Correct Response</p> <ul style="list-style-type: none">• Flour correct, milk incorrect• Flour correct, milk omitted• Milk correct, flour incorrect or omitted <p>Incorrect Response</p> <ul style="list-style-type: none">• Incorrect (including crossed out, erased, stray marks, illegible, or off task)
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Note

- Each of the items needs to contribute to the overall mathematics test.
- Some relatively easy items and some challenging items.
- Avoid items that almost all students or almost no students are able to answer correctly.

Table 4: Checklist for MCQ Item

Item Characteristic	Yes	No
Is the mathematics/science correct?		
Task clear to students?		
Free of cultural, gender, or geographical bias?		
Seems to be OK for translation?		
No unfamiliar factors contributing to difficulty?		
Negative stem avoided (or negative word highlighted if used)?		
One (only) correct response?		
Distracters plausible but demonstrably incorrect?		
Options parallel in structure?		
Words in stem NOT repeated in options?		
Content classification correct?		
Cognitive classification correct?		

Table 5: Checklist for CRQ Item

Item Characteristic	Yes	No
Is the mathematics/science correct?		
Task clear to students?		
Free of cultural, gender, or geographical bias?		
Seems to be OK for translation?		
No unfamiliar factors contributing to difficulty?		
Clear expectations for full-credit response?		
Task can be completed in a reasonable time?		
Scoring guide has appropriate number of score points?		
Scoring guide descriptors clear?		
Content classification correct?		
Cognitive classification correct?		



**ICaPS ACTIVITIES TOWARDS STRENGTHENING DUAL
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3.3 EFFECTIVE QUESTIONING SKILLS

A. Objective

At the end of this section, students will be able to :

- i. identify different types of question;
- ii. stimulate creativity in constructing question; and
- iii. construct a set of effective questions to answer each TIMSS item.

B. Content

- i. ICaPS: Items Construction and Problem Solving
- ii. Self Reflection

C. Method

- i. Group work
- ii. Workshop
- iii. Power point presentation
- iv. Discussion
- v. Reflection

D Learning Materials

- i. Power point slides
- ii. Handouts
- iii. Toolkits
- iv. TIMSS Released items



E Materials

- i. Laptop
- ii. Wifi
- iii. Projector LCD
- iv. White Board
- v. Marker Pens
- vi. A4 Papers
- vii. *Mahjong* Papers

F Evaluation

- i. Continuous observation
- ii. Gallery Walk

G Summary/ Reflection

Based on the analysis of evaluation result

ACTIVITY 1: Different types of question

1. Self reflection.

What do you know about the different types of question?

What do you want to know about the different types of question?

Refer to [Appendix A: Toolkit 3.2.1 KWLH form](#). Fill out the first two columns.

2. Share your work.
3. Revise your knowledge on different types of question by referring to [Appendix B](#).

ACTIVITY 2: Video presentation.

1. Watch the video presentation ([Appendix C](#)) on different types of question.
2. By using think-pair-share strategy, discuss the different types of question.



ACTIVITY 3

1. You are given questions to answer on Numbers, Measurement and Geometry, Data. Refer [Appendix D: Toolkit 3.2.2](#).
2. In groups of four, complete [Toolkit 3.2.2](#).
(List all the suitable questions for the given items)

ACTIVITY 4

1. In groups of four, construct a set of suggested questions to answer items on Numbers, Measurement and Geometry, Data with suitable questions.
2. Using *mahjong* paper, post your group work and carry out gallery walk. Give your constructive comments.
3. Complete the third and fourth columns of [Toolkit 3.2.1: KWLH form](#).



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3.4 PROBLEM SOLVING (PS)

A. Objectives

At the end of this section, students will be able to:

- i. identify different types of problem solving strategy; and
- ii. solve TIMSS questions by applying suitable strategy.

B. Module Content

Problem solving using Polya's Model.

C. Method

- i. Group work
- ii. Group presentation

D Learning Materials

TIMSS Released items

ACTIVITY 1: Problem Solving Skills

1. Refresh your knowledge on Problem Solving Strategies:
 Refer to [Appendix E: PS Strategies With Polya's Model](#)
2. Study the following questions with guided answers given.

Question 1

CONTENT DOMAIN

Numbers

LEARNING STANDARD: 11.6 (i)

COGNITIVE DOMAIN

Reasoning

Don, Rob and Lynn walk home from school together. It takes them 25 minutes to walk to Lynn's house. Then it takes Don and Rob 10 minutes to get to Rob's house. From there it takes Don 5 minutes to walk home. At what time must they leave school so that Don arrives home at 3.50 p.m.?

SOLUTION: Steps in Polya's Model

1. UNDERSTAND THE PROBLEM. Pose these questions to yourself.

- a. Where are those children?
- b. What are they doing?
- c. What the question asks you to do?

2. PLAN THE STRATEGY TO USE



3. CARRY OUT THE STRATEGY

Arrival time 3.50 pm. To solve the problem, you need to subtract the times taken to arrive at Don's house from the arrival time.

$$3.50 \text{ pm} - 5 \text{ mins} = 3.45 \text{ pm}$$

Now you are at Rob's house.

Subtract the time taken to arrive at Lynn's house from Rob's.

$$3.45 \text{ pm} - 10 \text{ mins} = 3.35 \text{ pm}$$

Now you are at Lynn's house.

Subtract the time taken to arrive at the school from Lynn's.

$$3.35 \text{ pm} - 25 \text{ mins} = 3.10 \text{ pm}$$

Therefore, the children must leave school at 3.10 pm in order for them to arrive at Don's house at 3.50 pm.

Note:

You may pose several different situations to enhance students' skill in solving this type of question. Example is given below.

Examples:

- i. If the children start their journey at 2 pm, what time will they arrive at Don's house? (their final destination is Don's house)
- ii. If they arrive at Don's house at 3.00 pm, what time do they start their journey? (guide pupil to apply subtraction when arrival time is given)

4. CHECK YOUR ANSWER

$$3.10 \text{ pm} + 25 \text{ mins} + 10 \text{ mins} + 5 \text{ mins} = 3.50 \text{ pm.}$$

This is the arrival time given in the question.

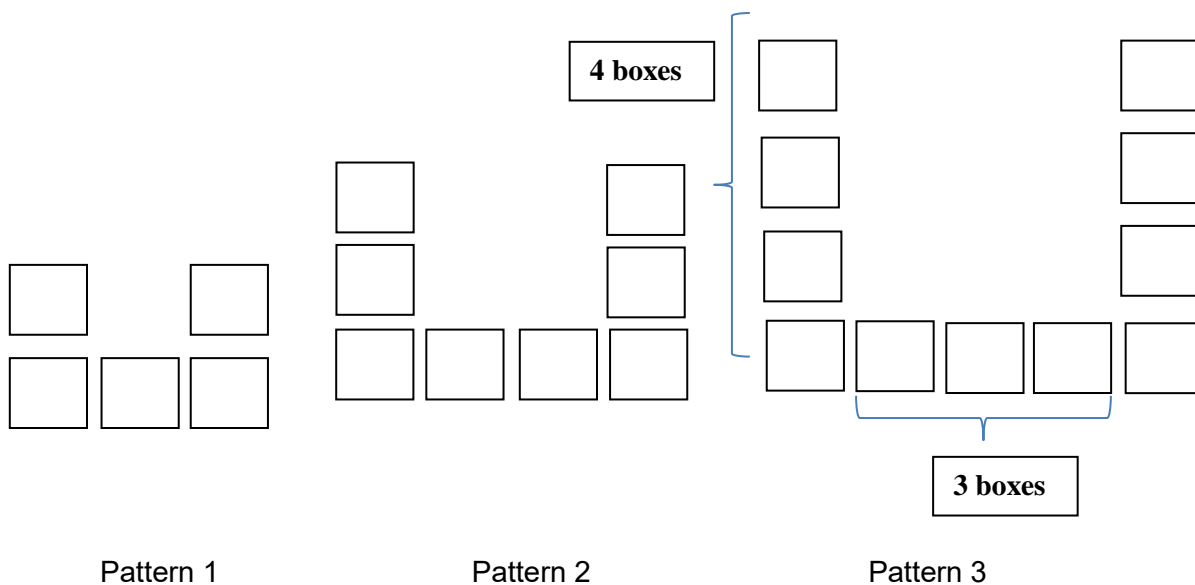
Explanation:

Applying addition to get the total of time used/spent in travelling from one place to another place. Applying addition to get the arrival time (forward). Applying subtraction to get the starting time when the arrival time is given (backward).



Question 2

As shown below, there will be _____ boxes in Pattern 19.



SOLUTION: Steps in Polya's Model

1. UNDERSTAND THE PROBLEM. Pose these questions to yourself.

- What is the difference in the number of boxes between pattern 1 and 2?
- How about the difference between Pattern 2 and Pattern 3?

2. PLAN THE STRATEGY TO USE.

Strategy: Look for a Pattern

3. CARRY OUT THE STRATEGY

Guiding pupils to build up the relationship of all the information they could see in the problem.



ACTIVITY 2

1. Form groups of three. Choose one question from each Content Domain: Numbers, Measurement and Geometry, Data from [Appendix F: Sample of TIMSS Released Items](#).
2. Apply Polya's Model to solve the questions chosen by using any suitable strategy.

ACTIVITY 3: Presentation of Solutions to the Problems

1. Group representative present the solution.
2. Perform class discussion for any different strategies suggested for the solution presented.

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