"How Do I Know That They Got It?"

Questions that assess mathematical understanding

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Have you ever taught a lesson that seemed successful, only to discover later that your students didn't grasp the material as well as you thought? Ever conducted a class that you thought went great, but at the end of the class a student asked you the most basic doubt that made you wonder if they understood anything at all in that session? We've all been there - and this happens due to a variety of factors, such as gaps in communication, differing learning styles, or even moments of distraction that can leave students struggling to grasp key concepts, despite our best efforts in the classroom.

When we introduce a concept, the examples (and non-examples) that we use play a crucial role in the understanding of the concept for a student. For example, showing a triangle always as an equilateral triangle with an upright orientation may lead to the over-generalisation among students that a triangle needs to look that way and that any other orientation or size does not qualify it to be a triangle (Figure 1). Using different examples for triangles, and providing some non- examples too (curved lines, open figures) will help build a proper understanding of triangles.

Similarly, while writing the expanded form of a number, we always tend to split it from left to right the way the digits appear, i.e., 3409 is 3 thousands + 4 hundreds + 0 tens + 9 units. A lot of students don't pay attention to the place name or place value but only notice the order of the digits- 3, 4, 0 and 9. And when you change the order in which the places are called out, they make an error. For instance, 3 tens + 2 units + 8 hundreds will most likely be written as 328, instead of as 832 by these students. Changing the order for the expanded form of a number while dealing with the topic can help in such cases. Of course, the teacher should use his/ her discretion to decide at what stage in the learning they'd like to bring in these additional points.

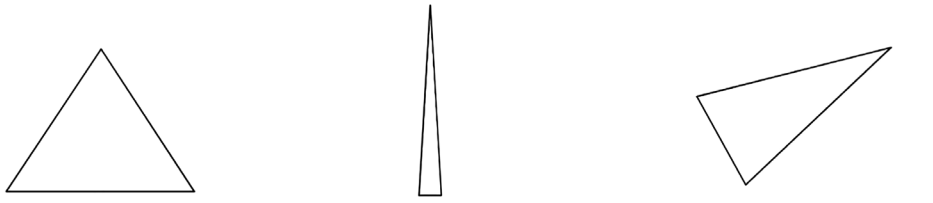

Figure 1

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Consider a few more examples

When we deal with subtraction of whole numbers, we say that we cannot subtract a bigger number from a smaller number, and yet when we move to integers, we teach them how to do exactly that! Also, we say that a zero has no value and yet 10 and 100 are different numbers and so are 1.02 and 1.2. (A lot of students when comparing decimals will say 1.02 and 1.2 are the same or equal because "zero has no value".)

While in the examples of the triangle and expanded form, misconceptions arise because we have not covered all cases, in the rest of the examples, what we say and want them to believe no longer holds true when they move to other topics or advanced lessons. This creates a cognitive conflict in their mind which, for some, takes a while to go away. Being aware of this and knowing how a student is likely to think can help us intervene when required, or prevent the alternative conceptions from forming in the first place.

Once we have incorporated the relevant points in our teaching, a good way to assess if our students have understood a concept in its entirety is to frame the right questions that test their understanding. Well-crafted multiple-choice questions (MCQs) with plausible distractors help identify student misconceptions by presenting incorrect options that reflect common misunderstandings. When a student selects one of these distractors, it provides insight into the specific area or concept they are struggling with (rather than a random guess), enabling targeted feedback and instruction. This is useful because it allows teachers to:

- **Diagnose misconceptions** instead of just checking recall.
- **Differentiate between partial understanding and complete misunderstanding.**
- **Target instruction more effectively,** since the wrong answers reveal patterns in student thinking.

Given below is an example of an MCQ, with the item stem, and the options, also known as distractors, labelled.

Add and choose the right answer:

374
+826
_____

(a) 11910
(b) 1200*
(c) 1191
(d) 1190

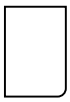
The item/ question stem: This conveys the question to the student.

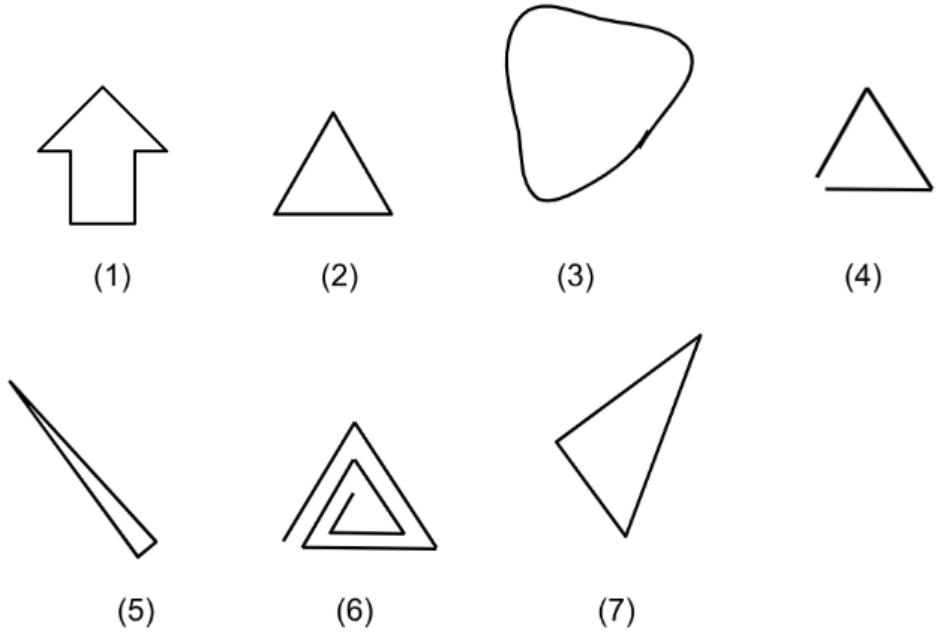
Options/ distractors:
The student marks one of these as their answer. There is a rationale behind each distractor added here. Can you figure it out?

*: Right answer

Here are a few sample questions that you can try in class and see if any of the expected misconceptions emerge. Questions like these have been designed to test the understanding of students across the world, irrespective of their socio-economic background, gender, teacher's experience or expertise. The likely logic for choosing each option is provided, so that it helps you as a teacher plan your remediation to address it. They have been mapped to learning outcomes mentioned in the NCERT documents *(Learning Outcomes at the Elementary Stage, NCERT, 2017* for Grade 3 LOs and *Learning Outcomes at the Foundational Stage, NCERT, 2025* for Grade 2 LOs), and give an indication of what outcome can be checked for (either directly or eventually leading to) through the questions asked.

Multiple Choice Question 1			
Topic: Addition of 2-digit numbers with regrouping		**Grade:** 3	**Learning Outcome:** Solves simple daily life problems using addition and subtraction of three-digit numbers with and without regrouping, sums not exceeding 999.
Testing objective	To check the complete understanding of the addition algorithm. In particular to find a missing digit, necessitating the use of subtraction.		
Question	Find the missing digit in this addition problem. 7 6 + □ 9 1 2 5		
	Distractors	**Probable reason for choosing the distractor**	
Distractor 1	20	Added 6 and 9 in the units place to get 15, and then added the 1 ten carried from 15, to 7 and 12 in the answer, to get 20.	
Distractor 2	19	Added 7 and 12 'seen' in the tens place to get 19.	
Distractor 3	5	Solved for 7 + ____ = 12 in isolation to arrive at 5.	
Distractor 4	4	The right answer. (76 + 49 = 125)	

Multiple Choice Question 2			
Topic: Identify 2D shapes (rectangle in particular)		**Grade:** 2, 3	**Learning Outcome:** • Identifies 2D shapes by their names (for example, square, rectangle, triangle and circle) and describes their observable characteristics (for example, the pages of a book are rectangular and have 4 sides, 4 corners) (Grade 2) • Describes 2D shapes by the number of sides, corners and diagonals (Grade 3)
Testing objective	Identify a rectangle		
Question	Select all the rectangles.		
	Distractors	**Probable reason for choosing the distractor**	
Distractor 1		"Looks" like a rectangle. Fails to see that the image is open, or may not know that rectangles are closed figures.	
Distractor 2		Fails to see the curves or does not realise that a rectangle has 4 corners and is made of 4 straight lines.	
Distractor 3		The right answer. (A reason for not choosing this may be that it is too "thin" to be a rectangle.)	
Distractor 4		Believes the orientation and size is right for it to be a rectangle. Misses or ignores the curve.	
Notes	Students are used to identifying objects that "look" like a rectangle, and sometimes miss the properties that make it (in the mathematical sense) a rectangle. We may have also, without realising, shown rectangles to appear a certain way, which makes them believe that a change in the orientation or a "thin" looking rectangle is not a rectangle at all.		

Multiple Choice Question 3		
Topic: Identify 2D shapes (triangle in particular)	**Grade:** 2, 3	**Learning Outcome:** • Identifies 2D shapes by their names (for example, square, rectangle, triangle and circle) and describes their observable characteristics (for example, the pages of a book are rectangular and have 4 sides, 4 corners) (Grade 2) • Describes 2D shapes by the number of sides, corners and diagonals (Grade 3)
Testing objective	Identify a triangle	
Question	Which of these are triangles?  	

	Distractors	**Probable reason for choosing the distractor**
Distractor 1	(2), (4), (6)	They "look" like an equilateral triangle in an upright position.
Distractor 2	(2), (5), (7)	The right answer. [A reason for not choosing this may be that (5) is too "thin" to be a triangle and/or (7) is not in the right orientation.]
Distractor 3	(2), (3), (4), (7)	They have 3 "sides". (The fact that a triangle has 3 straight sides or is a closed figure is missed.)
Distractor 4	(1), (2), (4), (6)	They 'look" like triangles, even when the number of sides is more than 3, or it is an open figure.

Multiple Choice Question 4			
Topic: Standard expansion of a 2-digit number		**Grade:** 2, 3	**Learning Outcome:** Applies the understanding of place value of numbers while grouping & recognising them.
Testing objective	Check the understanding of expansion of 2-digit numbers		
Question	3 Ones + 5 Tens = _____		
	Distractors	**Probable reason for choosing the distractor**	
Distractor 1	35	Writing the digits in the order in which they appear.	
Distractor 2	53	The right answer.	
Distractor 3	350	3 ones is 3 and 5 tens is 50. Writing them in that order gives 350 (three and fifty).	
Distractor 4	503	3 ones is 3 and 5 tens is 50. Writing the tens first, you get 503 (fifty and three).	
Notes	We always tend to write the expanded form starting from the highest place (say, hundreds, then tens and then units) while writing from left to right. Some students build a strategy to write the digits in that order from left to right to form the number, without observing or understanding what the place value is.		

Multiple Choice Question 5			
Topic: Subtraction with regrouping		**Grade:** 2	**Learning Outcome:** Solves daily life situations based on subtraction of two digit numbers.
Testing objective	To check if the student is able to subtract with regrouping		
Question	Solve. 83 – 67 ——		
	Distractors	**Probable reason for choosing the distractor**	
Distractor 1	26	Subtract 7 from 13 to get 6, and without accounting for the "borrowed" ten, subtract 6 from 8 to get 2.	
Distractor 2	24	7 – 3 in the units place and 8 – 6 in the tens place.	
Distractor 3	20	0 in the units place and 8 – 6 = 2 in the tens place.	
Distractor 4	16	The right answer.	
Notes	Students choosing Distractor 2 are looking at two separate calculations with the order of the digits not mattering ("Always subtract the smaller number from the larger number"). Those choosing Distractor 3 may think that a larger number cannot be subtracted from a smaller number in the units place and so add a 0 there and then proceed to subtract 6 from 8 in the tens place to get 2.		

Multiple Choice Question 6			
Topic: Expanded form of a 3-digit number		**Grade:** 2	**Learning Outcome:** Reads and writes numbers up to 999 using place value.
Testing objective	To check if the student is able to identify the expanded form of a 3-digit number		
Question	What is the expanded form of 461?		
	Distractors	**Probable reason for choosing the distractor**	
Distractor 1	4 + 60 + 1	Focus on the order of the digits- 4, 6 and then 1, without looking at place value OR Reading the number as "four sixty-one".	
Distractor 2	40 + 6 + 1	461 is seen as forty six and one.	
Distractor 3	60 + 1 + 400	The right answer.	
Distractor 4	4 + 1 + 6	461 is 4, 6 and 1.	
Notes	This is a simple question that checks the understanding of the standard expansion of a 3-digit number. There is an implicit understanding of place value, face value and place name.		

By asking the right questions, teachers can move beyond mere rote memorization and instead foster a deeper understanding of mathematical concepts. By incorporating a combination of both non- MCQs (open-ended, probing questions), as well as MCQs with careful thought out distractors, we can gain valuable insights into our students' thought processes, identify areas of misconception, and adjust our instruction to meet the diverse needs of our students. Here we have explored the MCQs specifically. Ultimately, these approaches enable teachers to create a more supportive and effective learning environment, where students can develop a strong foundation in mathematics and build confidence in their problem-solving abilities.

Teachers interested in trying any of these questions in their class can fill this short form by clicking or scanning the given QR code so that we can brief you on the next steps on how you can incorporate this in class. Tips for possible remediations will also be provided.

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