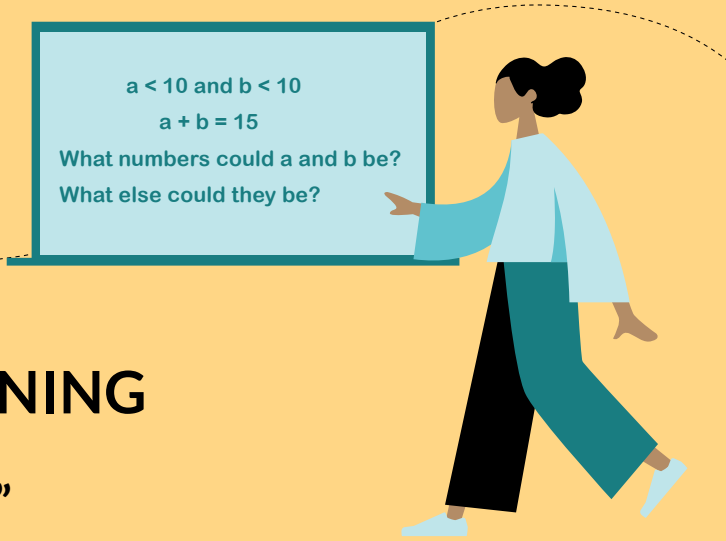
IEA
TEACHER
SNIPPETS XL



USING TIMSS TO TEACH MATHEMATICS WITH MEANING

Why "mathematics with meaning?"

Learners can only use mathematics if it makes sense to them, and they understand how it relates to the rest of their experiences. We call this "learning mathematics with meaning," and it is becoming increasingly important. In a data-rich and AI-enabled world, knowing *how* to carry out a mathematical procedure is no longer enough: learners need to know that the mathematics they learn makes sense, and that they can use it to interact with the world in empowering ways.

- Key to learning mathematics with meaning is successful engagement in mathematical reasoning and problem-solving, both underpinned by mathematical communication, whether spoken, written, digital, iconic, or embodied.
- This *Teacher Snippet* offers a practical route to achieving mathematics with meaning, using one freely available released assessment item from IEA's TIMSS (Trends in International Mathematics and Science Study) 2019. It shows how using (part or all of) TIMSS items can enrich lessons.

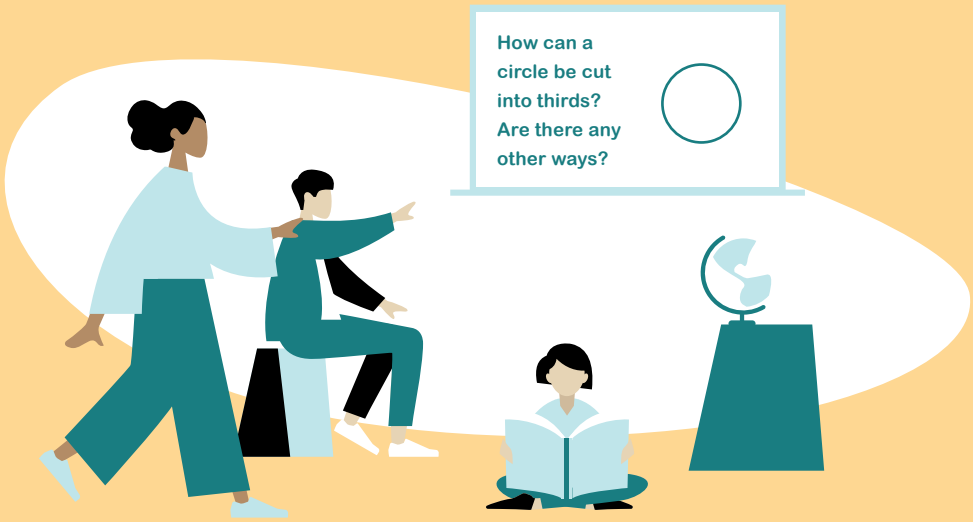
Practical starting points to foster reasoning, problem-solving, and communication using a task from TIMSS:

- **Flexible use:** A good task can be the focus of a whole lesson or a smaller part.
- **Let curiosity lead:** Respond to your learners' interests, and take into consideration what they find meaningful, as well as the areas where they need more experience, such as reasoning or problem-solving.
- **Assess what students understand and what they need:** Give learners a small set of related tasks to explore their strengths and areas for development. Talk about them and analyze responses to plan next steps.
- **Support mathematical talk:** Purposeful, mathematics-related talk with the teacher or other learners is key in mathematics learning, but needs to be planned. Encourage learners to explain their reasoning clearly.
- **Build a strategy toolkit:** As a class, explore different approaches learners use, and talk about what is useful in each.
- **Cross-curricular links:** Adapt task contexts to connect with other parts of mathematics or the wider curriculum.
- **Rethink a focus on "answers":**
  - Ask learners to explain their process and justify their thinking.
  - Value and explore "wrong" answers in order to learn from the underlying thinking.
  - Encourage learners to solve a problem in at least two different ways and record those. Can they find more? Which do they think is the best approach, and why?
  - Flip the task: Give learners the answer and ask them to come up with possible questions.
  - Leave out the numbers ("numberless word problems"), so that learners have to focus on the structure of the question. They can then make, and answer, their own questions by using numbers of their choice, or their neighbor's choice—often opening up new possibilities for mathematical learning.
- **Collaborate and share:** Work with colleagues to adapt items, trial them in different ways, and share what works.

Start small: Such teaching is ambitious, especially where classes are large or learners come with very mixed mathematics backgrounds. The skills needed to develop approaches that support "learning mathematics with meaning," with stronger mathematical reasoning, problem-solving, and communication skills, are complex. Their **development is a long-term process.**

Why use TIMSS items?

A great deal of work goes into developing and piloting TIMSS items to ensure they reliably assess both mathematics content and processes. Many items go beyond simple recall, requiring reasoning, problem solving, understanding of mathematical notation and vocabulary, and sometimes needing written explanations, so they are a good springboard for challenging and engaging work in classrooms: the classroom focus becomes learning mathematics for deep meaning-making and problem solving, rather than simply achieving a closed route to an answer.



Classroom task

A teacher wants to put 30 children in groups so that:

- each group has the same number of children, **and**
- each group has an odd number of children.

Find two different ways the teacher could make the groups

Way 1:

Number of groups: _____

Number of children in each group: _____

Way 2:

Number of groups: _____

Number of children in each group: _____

This grade 4 task focuses on the structure of number 30, especially its factors.

In 2019, on average, only 24% of learners in TIMSS 2019 completed it correctly.

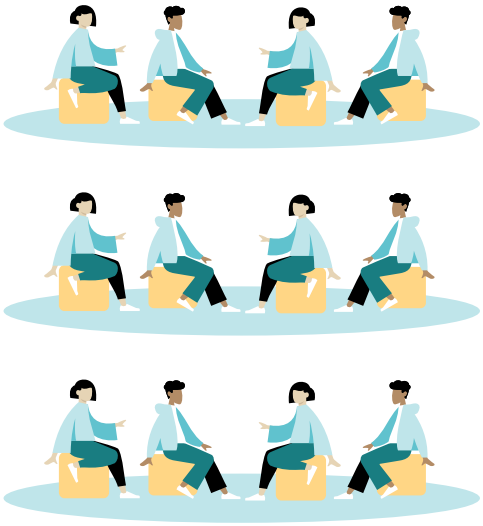
What does a learner need to know in order to work with this task with meaning?

This task needs learners to be secure in knowing, exploring, and using the factors of 30 (so as to make equal groups), and also confident in identifying and using odd numbers. These both relate to number structure, which underpins not only number confidence and flexibility, but is also important for later work in algebra.

Tips for implementing this task

- **Flexible, cross-curricular use:** Plan for learners to have previous informal experience of such equal (or unequal) grouping, as well as odd/even numbers, perhaps when lining up for playtime, or moving into groups or teams for any class. Be sensitive to the opportunity to talk about the numbers involved.
- **Approach this task as a physical activity if space allows:** Physically grouping 30 children (or objects) will enable them to develop a deep understanding of what it means to group. Start with a question with just the first condition. Constantly emphasize the mathematical language of creating groups of that number. With more children in a class, you could use another number (but preferably one with a good choice of factors, e.g., 36, 40, 45...).

- **Let curiosity lead:** Let learners suggest a group size to try and encourage learners to suggest approaches and reasons why that number will/will not work, as the grouping progresses. Why is it sometimes a good idea to have equal size groups? Which group sizes do they think would work well for a particular purpose?

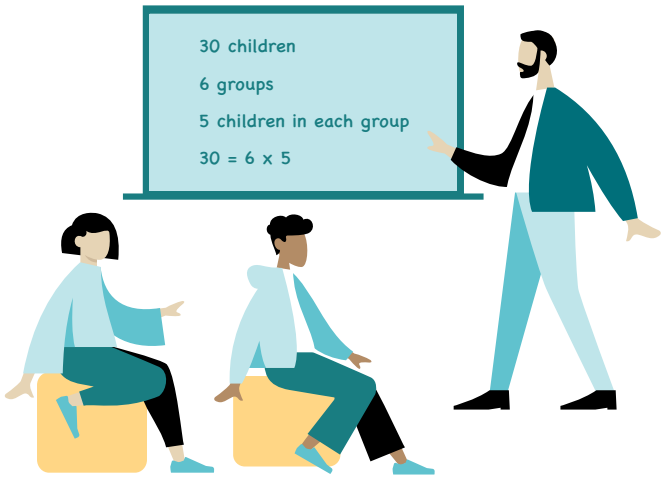


- **Encourage students to consider which equal groupings result in groups of an odd size.** Support learners to develop informal ways to record the different possibilities.
- **Assess what students understand and what they need ("formative assessment"):** Listen carefully to what learners say at each stage, as that indicates their confidence and security with the relevant ideas. Affirm and build on that.

- **Support mathematical talk:** If the number chosen by the class is a factor of 30 and equal grouping is possible, first discuss and then write (or draw) the number sentence:

  There were 30 children in all. We can put them into ▯ groups of the same size, with ▯ children in each group.

  Introduce the mathematical language: for example, explain that 5 is a factor of 30 because it divides into 30 exactly. If the number suggested is not a factor of 30 (e.g., 4) still work through the process to show that we cannot form a final equal group of the same size. You, and learners, can still use the mathematical language, for example, 4 not being a factor of 30 because 4 does not divide into 30 equally (there are 2 left over).



- **Build a strategy toolkit:** Reflect on the strategies the class has used. Are there other approaches they could have used? Which way is easiest/quickest? (That might differ by learner, or the particular numbers involved).
- **Rethink a focus on "answers":** In all these important approaches, notice the answers are only a small part: the meaning-making and mathematical thinking are the focus.

MORE INFORMATION

For more information about the topics covered in this *Teacher Snippet*, please see Volume 4 in the *IEA Research for Educators* series, *Teaching and learning mathematics with meaning: using and applying TIMSS*, by Jennie Golding and Rachel Marks, which explores these ideas more fully. The volume includes, as appendices, two freely downloadable classroom supplements of released TIMSS items and suggested related didactic approaches (for Grades 3 to 6 or Grades 6 to 10).

Since 1995, TIMSS has assessed learners' achievement in mathematics and science every four years, focusing on fourth and eighth grades.

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Berliner, D. C. (2004). Describing the behavior and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology & Society, 24*(3), 200–212. https://doi.org/10.1177/0270467604265535

Dunn T. G., Shriner C. (1999). Deliberate practice in teaching: What teachers do for self-improvement. *Teaching and Teacher Education*, 15, 631–651. https://doi.org/10.1016/S0742-051X(98)00068-7

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Scan the QR code to explore the classroom supplements, classroom examples, and the full publication.

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