10 000 Centicubes
Lesson 2: Devise

Australian Curriculum: Mathematics (Year 4)

ACMNA072: Recognise, represent and order numbers to at least tens of thousands.

ACMNA073: Apply place value to partition, rearrange and regroup numbers to at least tens of thousands to assist calculations and solve problems.

Lesson abstract

Students discuss what is meant by "best" container for an educational supplier to use to package 10 000 centicubes. They work in small groups to create a plan to make a suitable container (including giving all dimensions) before presenting their ideas for feedback.

Mathematical purpose (for students)

It is possible to package 10 000 centicubes in containers that are different sizes and shapes.

Mathematical purpose (for teachers)

MAB blocks help to visualise the total number of centicubes on the base layer and the dimensions of the base. Division is connected to multiplication when finding the number of layers required from the number of cubes in the base and the total (10 000). Constructive feedback focuses on the strengths and weaknesses of the mathematics used.

At the end of the Devise phase, students will be able to:

- Describe the shapes and base sizes they considered.
- Present planning ideas for feedback from others.
- Provide constructive feedback to others: seeking clarification, considering strengths and weaknesses of ideas or suggesting alternate pathways.

Lesson Length 90 minutes

Vocabulary Encountered

- best, suitable
- strength,
- volume,
- feedback,
- clarification

Lesson Materials

- Containers from previous lesson
- MAB (1000, 100, 10 blocks) sufficient for all groups
- grid squares (100cm^2) (optional)
- Student Sheet 1 - Planning Sheet (1 per group of 2 or 3 students) OR student workbook
- Scrap paper, calculators
- Metre rulers (2 or 3) (optional)

We value your feedback after these lessons via https://www.surveymonkey.com/r/CV2TXTT

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What Do We Mean By "Best"?

Inquiry Question: What is the best container to hold 10 000 centicubes?

Putting the inquiry question into context

1. Return to the inquiry question '*What is the best container to hold 10 000 centicubes?*' and focus on the word 'best'. Observe that different people might have different requirements, so what is best might vary. Review the problem context with students by thinking about educational suppliers who are planning to sell and distribute containers of 10 000 centicubes for classroom use.

2. Ask students to share with a partner attributes of a suitable container, then discuss as a class. **Record** suggestions on a class poster as students will revisit these ideas in the Develop and Defend Phases. Possible attributes might include:

    - Lightweight
    - Strong enough to hold that number of centicubes
    - Easy to carry - not too long, not too wide and not too high
    - Suitable shape to be packaged in the warehouse and delivery truck
    - Suitable shape to be stored on a classroom shelf or in a cupboard

    Summarise findings with the class: containers need to be a suitable size and shape.

3. Revisit some of the predictions of container sizes from the previous lesson (Discover Phase) and discuss their suitability of their shape. Do not focus on whether the volume is correct at this point.
For example, *Tom and John's container would be awkward to carry as it is quite long*.

    Acknowledge mass and strength as suitable attributes for the best container but focus this discussion on suitable size and shape. Mass and strength could be included as part of the justification for the best container in the Defend Phase.

Teacher Note

As students work through the Inquiry Phases, discussion may arise as to whether the container needs a lid. If it arises, address it. If not, allow groups to make this decision themselves and justify the inclusion as they present their solution in the Defend Phase.

Planning a Container

Thinking about length, width and height

4. Share and record (on poster or board) some of the number sentences and drawings for the possible base size and number of layers that students made at the end of the Discover Phase.

5. Ask the class how knowing the size of the base and how many layers can assist them to work out the dimensions (length, width and height) of their container. Help students to make the connection that a centicube and also an MAB 'one' is one centimetre long, one centimetre wide and one centimetre high.
So, if my base layer is made up of 10 rows of 100, how long will it be? (ANS: 100 centimetres long.)
How wide? (ANS: 10 centimetres wide.)
I would then need 10 layers of this base layer to make 10 000 cubes. So what height will my container be? (ANSWER: 10 centimetres high).

6. **Group** students (2 or 3 per group) and have them determine what they consider the 'best' container would look like (**shape** and **size**), perhaps using some of the suggestions recorded in Step 4

Group planning with open prompting

7. Allow 20-25 minutes for groups to plan ideas. Have groups record/draw their ideas using Q1 and Q2 on Student Sheet 1 - Planning Sheet or in their workbooks.

8. Move between groups, listening to students' thinking and providing open prompts if groups are only considering one option. Be mindful this is an initial plan that will be revised after feedback so avoid guiding groups too much. At this stage their container may be too wide, high or long. This will be addressed when groups share their work.

9. If groups are stalling, provide prompt questions to encourage them to:

    - Consider various options for the container. *What container sizes have you considered? Why do you think this size is best? Can you visualise how big this container will be? Can you make your container the same height but a different shape?*

    - Choose bases such as 1000 or 500 and count and tally to determine how many layers.

    - Seek assistance on possible ways to move forward. *What are you stuck on? Is there someone you could ask for help?*

    - Persevere through challenges. *I can see you are keen to use 15 layers. You know the whole (10 000) and one of the parts (15). Apart from multiplication, what else could you use to find the remaining part? How could you use a calculator do this? (division or repeated addition)*

    - Make connections between mathematical concepts and relationships. *You have worked out your hexagonal base uses 560 centicubes. Now you know one of your parts is 560. What else do you know? (whole 10 000) Is there a way we can use the part and the whole to work out how many layers? (ANSWER: division)*

10. Challenge more capable groups to consider a container that is not a rectangular prism (e.g. cylinder, hexagonal prism), finding dimensions and also considering whether it could be 'best'.

Providing and Receiving Feedback

Explain and model feedback

11. Position students so they can clearly hear what other groups have to share. Advise groups they will be sharing their plans (which may be incomplete) to:

    - explain what they have done
    - see how other groups have worked on the task
    - present any challenges they are having
    - ask for ideas to help them move forward

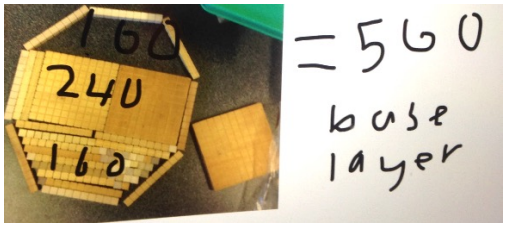
    Explain to students it is important to listen carefully as groups present and if they don't understand to ask clarifying questions. **Model** clarifying questions for students e.g. *You said your container was a rectangular prism and it had a base of 1250 centicubes. I did not hear how high it will be. Can you tell me the height of your container?*

12. As groups share their plans, model how to provide feedback that focuses on the mathematical strengths and weaknesses of their ideas. For example: *Your container is going to be 250 layers high and have a base layer of 400. I think your container will actually hold 100 000 centicubes. How did you work out your container would hold 10 000 centicubes?*

13. Encourage students to actively contribute to providing constructive feedback either through volunteering or being called upon.

14. **Look** for opportunities to deepen the mathematics during the sharing e.g. *Two groups have shown plans for a base layer of 400 centicubes with 25 layers. One group is using a square base with sides of 20 centicubes and the other group is using a rectangular base with a length of 40 centicubes and a width of 10 centicubes. Will both containers hold 10 000 centicubes even though they are different sizes and shapes? Why?*

15. Students may encounter unfamiliar mathematics (e.g. decimal remainders if they choose to work with a specific number of layers (e.g. 12) that is not a factor of 10 000). Rather than suggesting they try another option, help them make sense of the part *e.g. 17.789 is greater than 17 and less 18. Remember we need to construct a container that can hold 10 000 centicubes so should we choose 17 or 18 layers? Why?* (a container with 17 layers won't hold 10 000 centicubes, but a container can be larger so 18 layers would be needed). Some students may be able to calculate the number of centicubes in the partial layer.

Shared student work sample	Modelled Feedback
	*"I like the way you used MAB blocks to show how you worked out the number of centicubes on the base layer of your octagonal prism. If you had added a number sentence like 160 + 240 + 160 = 560 it would have been clearer than just telling us there were 560 on the base layer".*

Teacher Notes

Students need to develop the ability to provide constructive feedback that is based on mathematical understanding. Initially students tend to give surface and/or generalised responses, such as "*Your drawing of the container is nice*". Good feedback focuses specifically on the mathematics and addresses the application and use of mathematics, and its applicability to the context. Modelling this can assist students to analyse responses more closely, which has the potential to improve thinking and ideas.

Be patient as this is a skill that will need to be developed over time. Their feedback will slowly deepen as they gain experience.

Conclusion

16. Have students return to their groups and reflect on the feedback given to them. They need to decide whether it can help them improve their ideas and how to make any adjustments such as dimension labels and number sentences. At this stage they should also consider:

    - What their next step will be.
    - Whether they have seen a better idea they will use instead of continuing with what they have (e.g. using a more manageable height of 25 cm, more interesting container).

Planning Sheet

Name: _____

1. What shapes will you consider for your container?

2. What sizes for the base will you try?
   How many layers will be required to make 10 000?

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3. How will you construct your container? *Consider size and shape of each face, materials and construction method.*

Size(dimensions) and shape of each face	Construction
Base Sides	Materials required Method

4. Feedback: *Is there enough detail provided for you to construct this container? If not, what extra detail do you need?*