3 Act Math Task TEACHER NOTES

By Stella Hsu and Christina Reis

BC Mathematics Big Ideas:

Grade Level	Big ideas & Content	Curricular Competency
Math 6	Properties of objects and shapes can be described, measured, and compared using volume, area, perimeter, and angles.	• Use reasoning and logic to explore, analyze, and apply mathematical ideas • Develop, demonstrate, and apply mathematical understanding through play, inquiry, and problem solving • Engage in problem-solving experiences that are connected to place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures* • Estimate reasonably*
Math 7	The constant ratio between the circumference and diameter of circles can be used to describe, measure, and compare spatial relationships.	• Model mathematics in contextualized experiences • Explain and justify mathematical ideas and decisions • Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts
Math 8	The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.	• Model mathematics in contextualized experiences • Explain and justify mathematical ideas and decisions • Incorporate First Peoples worldviews and perspectives to make connections to mathematical concepts • Surface area and volume of regular solids, including triangular and other right prisms and cylinders • Construction, views, and nets of 3D objects
* Curricular Competency that applies to grade levels of Math 6, 7 and 8		

YouTube Link: https://www.youtube.com/watch?v=PXGQ1i1v61c

Act 1: The Intro

Below are some questions that we hope the students will be guided to. If students are struggling, teachers may give prompts to give them inspiration. The level of depth is dependent on grade level. Students may need to research or look up required information (like conversions) for reference.

Teacher Notes	Students: What did you notice?
Write down as many questions and points of what they noticed. Keep the time tight so that students are writing what comes to mind, rather than scrutinizing whether what they are asking is "correct". **Assumption**: students have some understanding of woodworking skills.	*Answers may vary, some notable mentions* • Different length boards available; conducted calculations; measured straight; used tools, wrote down numbers; 4 lines;
	Students: What questions did you have?
	• Why did she pick the piece of wood, but not others? • What are the different colors, shapes, and sizes of the wood? • Why was she taking the measurement? • What are the measurements for? • Why was she making notes after measuring the wood? • What was she writing on the paper? • How many lines were marked on the wood? And why? • What did she mark the lines?

Act 2: Wonder

Teacher Notes	What ELSE did you notice?
Q: Based on the predicted cuts, what shapes/options would be eliminated? *Not circular, not triangular, right angle cuts* Q: Why are straight cuts so important when it comes to building? *Joints need to be connected to close* Q: What is the shortest length of the nail? Why does it matter? *Needs to go through both boards* **Assumption:** Students should note there are **four 'walls' being built**.	*Answers may vary, some students may have more depth. The following points should be emphasized though.* • Did not break the wood; wood was cut (implied) • A certain type of nail was chosen, though there were ones of different lengths and thickness, grooves were available. • The depth of the wooden plank was considered • Lines need to be straight; Tools are used to ensure straight lines • Nails are placed only along the sides, not in the centre, they are spaced out evenly
	Why do you think the first 2 ideas were "bad"?
	• Breaking the wood would be jagged • Wouldn't be able to break along the drawn lines • Dangerous (lab safety violation)
	What could she possibly be making?
	Answers may vary Some realistic suggestions include a box, birdhouse, container, etc

Act 3: The Reveal

What is being created? *A wooden box*
What is the problem? *Which box can hold more (volume)?*

Teacher Notes	What MATH concepts do you need to solve this problem? Write down all formulas, values, conversions, etc that are relevant.
May not need all the formulas; encourage students to explore concepts that could relate to this potential problem. Ex: Surface Area = sum of all faces **Assumption:** Students should realize that units need to be the same → centimetres (cm). Imperial system is not officially taught but woodworking often integrates measurements in inches (Ex: "2 by 4", ⅛" blade saw, etc.	$Volume\ of\ rectangular\ prism = l \times w \times h$ **Other formulas for extensions, other possible questions** $Area\ of\ rectangular = l \times w$ $Area\ of\ square = l^2$ $Area\ of\ triangle\ (for\ handle) = \frac{b \times h}{2}$ $Area\ of\ circle\ (for\ handle) = \pi \times r^2$ **Conversions (may need assistance or further research)** $1\ cm = 10\ mm$ $1\ m = 100\ cm$ $1\ inch = 2.54cm$ $1\ ft = 12\ inches$
	What information do you need to accomplish this?
Some students may need to visualize this problem as a "flat board" to begin (Box A). As they build confidence using formulas → consider the thickness of the wood in calculations (Box B & C) and its impact on volume.	• length , width, height of boxes (Box A) • thickness of wood (Box B and C) Extensions/ Further Design skills • Different dimensions of boxes • Thickness of blade (when cutting the wood trim length of wood) • Amount sanded could impact length of original wood (though could be minimal)

Math Exemplar (Guided Practice):

Teacher Notes	**Which box can hold the most? Using the Guided Exemplar provided by your teacher, solve the problem.**
$volume = l \times w \times h$ $= 8 \times 9 \times 5$ $= 360\,cm^3$ **Assumption:** there is no "third dimension" to the THICKNESS of the board.	Find the **volume (V)** of the following shape: a) The measurement of the following rectangular prism is 8cm, 9cm, and 5cm  Should students consider this type of calculation accurate? *NOT accurate because it would hold LESS than the calculated volume.*
$Volume = l \times w \times h$ $=(10\text{-}1\text{-}1)\times(10\text{-}1\text{-}1)\times(4\text{-}1\text{-}1)$ $= 8\times8\times2$ $= 128\,cm^3$ Subtracting "1" accounts for the thickness of the wood on each side. **Assumption B & C:** Dimensions are measured from the outside INCLUDING the lid.	b) The measurement of the following rectangular prism is 10cm, 10cm, and 4cm, with the wood thickness of 1cm. 
$Volume = l \times w \times h$ $=(18\text{-}0.5\text{-}0.5)\times(10\text{-}0.5\text{-}0.5)\times(4\text{-}0.5\text{-}0.5)$ $= 17\times9\times3$ $= 459\,cm^3$ Integrates more complex concepts with decimals. This is realistic as boards often will not be in whole units.	c) The measurement of the following rectangular prism is 18cm, 10cm, and 4cm, with the wood thickness of 0.5cm. 

Follow up questions: Local Connection (Meadowridge)

Teacher Notes	Where do you think the wood comes from?
Prompt students to think the **length** of the original boards. How might the tree need to be cut in order to obtain this? *Vertically rather than horizontally.*	*Students can brainstorm based on the origins of the wood. Examples:* • Forests • Different types of wood have different colours, hardness, etc • Thickness of board associates with diameter of trees
	What are some differences between the types of wood that are available to us? Such as the color, the grain, the treatment, etc? How would this impact your cuts?
Natural wood contains 'knots' depending on the cut. Some students wish to keep these in their design, others may wish to cut them out.	*Answers may vary*
	Why do you think it is important to recycle or refurbish used materials, such as lumber?
Understand how many trees may have been sacrificed to provide the lumber; minimize waste; double-check calculations before cuts, reduce errors etc.	*Answers may vary*

***** For more information about tree logging and "bucking" see McBride (2020) and Esch (2018)*****

Extensions:
(Connections to First People)

One possible extension is that the Northwest Coast people have for many years created Bentwood boxes to store food, items, clothing, etc as well as ceremonial items. The traditional method of creating these beautiful indigenous pieces is complex and requires masterful craftsmanship; it is an art form that is making a revi. As students in our school are learning design and woodworking skills (rather than being masters), the modification of this project would allow them to understand the stories and significance of these boxes while recognizing the complexing and differences in technique. The boxes were traditionally made out of red cedar, yellow cedar, or spruce.

References:

"10cm Beechwooden box with lid" (2020). Absorbent Minds Montessori https://www.absorbentminds.co.uk/10cm-beechwood-box-with-lid.html

"Bentwood Boxes" (2019). Douglas Reynolds Gallery. https://douglasreynoldsgallery.com/bentwood-boxes/

Darice 9149-16 Wood Box with Lid, 3-1/2-Inch, 3.5" x 2.5" x 1.4", Natural (2012). "Darice 9149-16 Wood Box". Amazon. https://www.amazon.com/Darice-9149-16-Wood-Box-2-Inch/dp/B0054G6KBI

Esch, A. (2018) "How to Buck a Tree: Cutting logs for maximum yield". *The Balanced Small Business.* The Dot Dash Publishing. https://www.thebalancesmb.com/how-to-buck-a-tree-2218134.

Goldbelt Heritage Foundation. "Bentwood Box Math". US Department of Education. http://www.goldbeltheritage.org/wp-content/uploads/2014/03/Bentwood-Box-Unit.pdf

Good, J. (2021). "Making a Brentwood Box". NLPS Learns. YouTube. https://www.youtube.com/channel/UCPE5Tb3WDIeoktkdfky8jnA

"Grand Hall Tour: Bentwood Boxes" (2020). Canadian Museum of History. https://www.historymuseum .ca/cmc/exhibitions/aborig/grand/gh12eng.html

McBride, S. (2020). "Salvaging Trees for Lumber". *Fine Homebuilding.* The Taunton Press Inc. https://www.finehomebuilding.com/2020/04/08/salvaging-trees-for-lumber