

Unit Topic: Area, Surface Area, and Volume
Math 8

EDCP 342A Unit planning: Rationale and overview for planning a unit of work in secondary school mathematics.

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Topic of unit: Area, Surface Area, and Volume

Preplanning questions:

(1) *Why* do we teach this unit to secondary school students? Research and talk about the following: Why is this topic included in the curriculum? Why is it important that students learn it? What learning do you hope they will take with them from this? What is intrinsically interesting, useful, beautiful about this topic? (150 words)

Students will learn the basics of calculating how much space an object takes in a 2D plane and in a 3D plane. This unit will help students develop their spatial visualization and understand the net of a 3D prism through drawings or modelling. As an introductory unit to volume, simple prisms will be the primary focus of this unit. These simple prisms include right prisms (rectangular and triangular prisms) and cylinders. Cross-disciplinary connections between surface area and volume can be made with single-celled vs. multicellular organisms. Countless real-world applications can be applied to this unit, as understanding how to calculate surface area and volume allows you not to waste additional resources. Some of these real-world applications include calculating the surface area of a building to determine the amount of paint needed or the amount of liquid a given container can store. This topic can easily be applied to other units to help reinforce understanding and connection to the real world.

(2) A mathematics project connected to this unit: Plan and describe a student mathematics project that will form part of this unit. Describe the topic, aims, process and timing, and what the students will be asked to produce, and how you will assess the project. (250 words)

Students will explore the relationships between surface area and volume instead of writing a test. This project can be a cross-disciplinary topic where students will explore the reasoning behind why we are multicellular organisms and not a singular one. By giving the students a quick primer on cells in living organisms in case they forgot or haven't covered it in class, we treat a single cube manipulative as a single cell. Then, we combined them to make a giant single cell and asked the students to look at the surface area and volume and report their observations. Students are then asked to look at the surface area and volume of different right prisms and cylinders and report back. We then talked about why having a high surface area to volume ratio is essential for a cell and asked the students to find ways to increase the surface area of these shapes without changing the volume. (Can be done mathematically or explained using other sources.) Some examples would be to improve the SA to V ratio of rectangular prisms, cubes, triangular prisms, and cylinders. Then, we propose a single-celled human and ask how to improve their surface area to V ratio. (The expected answer would be to break up the human into many cells to improve the surface area to volume ratio.) Since we are Math 8 and the only volume and surface area we have explored, we are limited to cylinders, triangular prisms, and right prisms. Students will be given approximately three total classes, working in a visibly randomized grouping for the first 2. Scaffolding will be provided to the students to guide them with the exploration. Students will be graded on their findings and the different ways they explored surface area and volume ratio.

(3) **Assessment and evaluation:** How will you build a fair and well-rounded assessment and evaluation plan for this unit? Include formative and summative, informal/observational and more formal assessment modes. (100 words)

Summative Assessments: The class will be formally quizzed on area, prism nets, and surface area. Afterward, students will work on a project combining surface area and volume instead of a final unit test. During Thinking classroom students will self evaluate their group work and marked under communications for the curricular competency.

Formative Assessments: Thinking Classroom style observation for some lessons to help introduce a new topic and engage students with the unit. Thinking classroom problems will include using manipulatives to help students think about surface area and volume. There will be a couple of review classes to help wrap everything together and get everyone on the same page with a handout that needs to be handed in at the end of the lesson.

Elements of your unit plan:

a) Give a numbered list of the topics of the 10-12 lessons in this unit in the order you would teach them.

Lesson	Topic
1	Introduction to Area of 2D shape (review and introduction)
2	Introduction to 3D prisms and nets (Thinking Classroom)
3	Calculating Surface area using nets.
4	Application Questions of Surface Area (Thinking Classroom)
5	Recap and Review what was covered so far...
6	Review or Quiz depends on class.
7	Review or Quiz depends on class.
8	Introduction to Volume. (Thinking Class)
9	Review of Volume and more formal introductions (Handin formative)
10	Surface Area and Volume exploration (Thinking Classroom)
(11)	Class time (Thinking Classroom)
(12)	Class time (students should wrap up project)

b) Write a detailed lesson plan for *three* of the lessons which will *not* be in a traditional lecture/ exercise/ homework format. These three lessons should include at least three of the following six elements related to your mathematical topic. (And of course, you could include more than three!)

These elements should be thoroughly integrated into the lessons (i.e. not an add-on that the teacher just tells!)

- a) History of this mathematics
- b) Arts and mathematics
- c) Indigenous perspectives and cultures
- d) Social/environmental justice
- e) Open-ended problem solving in groups at vertical erasable surfaces ("thinking classroom")
- f) Telling only what is arbitrary, and having students work on what is logically 'necessary'

Be sure to include your pedagogical goals, topic of the lesson, preparation and materials, approximate timings, an account of what the students and teacher will be doing throughout the lesson, and ways that you will assess students' background knowledge, student learning and the overall effectiveness of the lesson. Please use a template that you find helpful, and that includes all these elements.

(See BELOW)

Unit Rationale: Students will learn the basic of calculating how much space an object takes in a 2D plane and in a 3D plane. This unit will help students develop their spatial visualization as well as understand the net of a 3D prism with drawings or modeling. Many real-world applications can be applied to this unit as understanding how to calculate surface area and volume can allow you to not waste additional resources.

Big Idea: The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships.

Curricular Competencies

- Use logic and patterns to solve puzzles and play games.
- Model mathematics in contextualized experiences.
- Communicate mathematical thinking in many ways.
- Connect mathematical concepts to each other and to other areas and personal interests.

Content

- surface area and volume of regular solids, including triangular and other right prisms and cylinders.
- construction, views, and nets of 3D objects

Unit Objectives: (SWBAT)

- Students will be able to calculate the area of 2D shapes. (Circle, Triangular, and Rectangular)
- Students will be able to create and identify the nets of 3D prisms.
- Students will be able to use nets of prisms to calculate the surface area.
- Students will be able to understand the relationship between 2D shapes and 3D shapes.
- Students will be able to solve the volume of simple right prism and cylinders.
- Students will be able to find a relationship between surface area and volume.

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Unit Duration: 10-12 lessons

Unit Outline

Lesson Title	Specific Objectives (Students will be able to...)	Activities (hook, body, closure)	Resources	Assessment
Lesson 1: Introduction of Perimeter and Area of 2D shapes (75 mins)	• Calculate the area of circles, triangles, and rectangles. • Understand what makes a circle, triangle, and a rectangle.	Introduction (15 mins) • Work through math warm-up questions and logic puzzles. • Quick run down on the unit with the class so everyone has a general understanding of the quiz dates and project due dates. Body (50 mins) • Define Circle, Rectangle and Triangle to the class. • Go over the mathematical definition of Area and Perimeter. • Give some examples of application. • Work on a couple of examples.	• Handout • Whiteboard • Area notes	Formative: Students are asked to submit the last page of the handout into the box for me to look at. (Used to gauge the progress of the class) Observation on student's progress will be noted.

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		- Let class work on the remaining one, walk around class to observe if anyone is struggling. Closure (10 mins) - Let class relax and talk with each other. - Encourage them to know everyone as I will introduce group learning to the class soon.		
Lesson 2: Introduction to 3D prisms and nets (75 mins)	- Identify the names of 3D prisms. (Cylinders, Triangular Prism, and Rectangular Prism) - Generate the Nets of the 3D prisms.	Introduction (10 mins) - Warmup/Logic Puzzle - Handout scissor, tape/glue, and net outlines to student. - Tell students that these nets when folded will form a 3D prism, ask them to guess the name of the prism. Body (50 mins) - Introduce the 3D prisms to the class and their name. (Ask students to	- Net hand in - Net cutout 3D prism models - Scissor - Glue/Tape	Formative: Students are asked to submit a worksheet. Observation on student's progress will be noted.

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		identify the 2D shapes they see) • Ask them to cut the nets out from the paper and fold and glue/tape them so they look like the 3D prisms. • Students now works on a worksheet that asks them to draw the net of the 3D prisms. Closure (15 mins) • Let students to relax and do whatever they want.		
Lesson 3: Surface Area of prisms using nets. (75 mins)	• Calculate surface area with the net and without the net	Introduction (10 mins) • Warmup/Logic Puzzle • Talk about what surface area is. Body (30 mins) • Ask the students to calculate the area of 2D shapes. • Slowly add complexity by making it a composite 2D shape	• Surface Area hand out • Surface area formative hand in	Formative: Students will submit a hand in on surface area. Students' engagement and work will be noted.

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		• Ask students to calculate the surface area of a 3D prism (no instructions) • Observe students and see that they relate the composite 2D shapes to the same as the nets. • Encourage them to talk with their neighbour and drop hints when needed. • Ask a few students (if they are willing to explain how they calculated the surface area of a prism) Wrap-up (20 – 30 mins) • Ask students to work on formative hand in. Closure • Let them relax and chat with friends.		
Lesson 4: Application of surface area. (75 mins)	• Solve word problems related to surface area.	Introduction (10 mins) • Split class up into groups of 3 as detailed in BTC. • Work on warmup/logic puzzle Body (40 mins)	• Whiteboard • Whiteboard pens • Group Evaluation form	Formative: Students will be observed throughout the activity.

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(Thinking Classroom)		- Students will be given a total of 4 application questions of surface area. In increasing difficulty. - They are asked to solve it themselves and I will provide hints as they work on it as needed. Closure (25 mins) - Students will also do an assessment on their group's work. - Students will be given a handout with more question to work on as well as a sample solutions to the questions presented today.	Additional questions and Solutions handout.	Summative: Group assessment will fall under the CC of communication, students will honestly evaluate their group's work and if there is something very wrong I will address it with the group.
Lesson 5: Recap of this week's lesson (Review for Quiz)		Introduction (10 mins) - Warmup/Logic Puzzle Body (35 min) - Recap Area, Perimeter, 3D prism, 3D prism nets, surface area, word problems.	Review worksheet	Formative: Observe Students working on the review worksheets

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		- Answer any questions and go over how the quiz might look like. Closure (30 min) - Students are given time to work on review questions.		
Lesson 6/7: Area and Surface Area Quiz.		Another Review Day or Quiz Day depends on my observation of students. (Students will be told quiz is this day but I can always move it forward.)		Summative Quiz
Lesson 8: Introduction to Volume. (Right prisms) (75 mins) (Thinking Classroom)	- Understand what volume is in mathematical terms and in terms of everyday life. - Solve volume for right prisms (single and composite)	Introduction (10 mins) - Split class up into groups of 3 as detailed in BTC. - Work on warmup/logic puzzle (Warmup on a old topic) Planned requiz after project. Body (40 mins) - Students will be given a total of 4 Volume questions of increasing complexity. - They are asked to solve it themselves and I will	- Whiteboard - Whiteboard pens - Group Evaluation form	Formative: Students will be observed through out the activity. Summative: Group assessment will fall under the CC of communication, students will honestly evaluate their group's work and if there is

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		provide hints as they work on it as needed. Closure (25 mins) Students will also do an assessment on their group's work.		something very wrong I will address it with the group.
Lesson 9: Continuation of volume. (Cylinders) (75 mins) (Thinking Classroom)	Solve volume for right prisms and cylinders (single and composite)	Introduction (10 mins) - Split class up into groups of 3 as detailed in BTC. - Work on warmup/logic puzzle (Warmup on a old topic) Planned requiz after project. Body (40 mins) - Students will be given a total of 4 Volume questions of increasing complexity. - They are asked to solve it themselves and I will provide hints as they work on it as needed. Closure (25 mins)	- Whiteboard - Whiteboard pens - Group Evaluation form	Formative: Students will be observed through out the activity. Summative: Group assessment will fall under the CC of communication, students will honestly evaluate their group's work and if there is something very wrong I will address it with the group.

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		Students will also do an assessment on their group's work.		
Lesson 10: Surface Area and Volume exploration (Thinking Classroom) (75 mins)	- Understand the relationship between surface area and volume. - Connect science and math and how certain topics covered in science can develop because of mathematical understanding.	Introduction (10 mins) - Split class up into groups of 3 as detailed in BTC. - Work on warmup/logic puzzle (Warmup on a old topic) Planned requiz after project. Body (30 mins) - Students will be given a prism and asked to calculate the surface area and volume. Students are then given a similar prism and do the same thing. Students are asked to note any differences. Closure (20 min) - Discuss with students what they have found. Connect this to cells as discussed in science 8 (or review/go over it)	- Whiteboard - Whiteboard pens - Group Evaluation form	Formative: Students will be observed through out the activity. Summative: Group assessment will fall under the CC of communication, students will honestly evaluate their group's work and if there is something very wrong I will address it with the group.

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		- Look at how this might be important for box makers as we can smaller SA with same volume. End (15 mins) - Students are introduced to the task and to start thinking about it.		
Lesson 11: Work Period for project (75 mins)		Introduction (10 mins) - Split class up into groups of 3 as detailed in BTC. - Work on warmup/logic puzzle (Warmup on a old topic) Planned requiz after project. Body/Closure (65 mins) - Students will be with their group to bounce idea's off each other and provide guidance. - Students will work on the project until class ends.		
Lesson 12:	ONLY IF NEEDED.	Introduction (10 mins)		

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Work Period for project (75 mins)		• Split class up into groups of 3 as detailed in BTC. • Work on warmup/logic puzzle (Warmup on a old topic) Planned requiz after project. Body/Closure (65 mins) • Students will be with their group to bounce idea's off each other and provide guidance. • Students will work on the project until class ends.		
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Date: March 2024

Title: Lesson 2: Introduction to 3D prisms and nets (Math Art)

Lesson Duration: 75 min	Material: Net hand in, Net cutout, 3D prism models, Scissor, Glue/Tape			
Curriculum Learning Standards (Big Ideas, Competencies and Content)	• 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. • Construction, views, and nets of 3D objects			
Learning Objectives	Students will be able to create and identify the nets of rectangular prisms, triangular prisms, and cylinders. For students who are extending they will also connect the creation of nets to the idea of calculating the surface area of a prism.			
Plan Activities				
Elements of the Lesson	Estimated Time (min)	What the teacher says/does	What the students do	Notes
Warm-Up	10 to 15 mins	*Assist any students who have questions	Students will review how to calculate the area of a variety of shapes and play around with a logic puzzle.	Student will review previous content on Area. See warmup handout.
Introduce 3D prisms	10 mins	Ask students to describe the shapes they see on the prisms (Rectangular, Triangular and Cylinder)	Students will describe what 2D shapes they see in the prisms	Have 3D prisms created to assists students in visualizing the 2D shapes
Introduce Nets and Construction of 3D prisms	20 - 30 mins	Provide students with the nets printed out. Provide hints to students if they have some issues.	Students will construct the 3D prisms by cutting out the NETS of the objects. They will fold and play	Will require scissors, glue and nets.

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			around until they are able to create the prisms.	
Formative Handin Worktime	15 – 25 mins	I will circle around aiding students when they seem to be struggling.	Students will draw out the nets of the 3D prisms and label the side lengths	
Wrap-up Class	10 mins		Let students converse with each other and relax	Students should relax in class.
Extra Notes				
Student Assessment	Assessment will be a hand in they submit at the end of class. This hand in is formative and I will use it to gauge the student's understanding on drawing of nets. Note will be made if students are struggling excessively.			
Extension	Encourage student to think about how we can use nets to calculate the surface area of an object.			
Differentiation and Adaption	One to one help to students in the class by walking around and checking out their work. Used visual aids to bring students attention to certain topics. Students will create the 3D prisms using the nets. ELL students have visuals to use to connect words to mathematical language. (Objects to Prism names)			
Reflections				

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Date: March 2024

Title: Lesson 3: Surface Area of prisms using nets. (Arbitrary and Necessary)

Lesson Duration: 75 min	Material: handouts			
Curriculum Learning Standards (Big Ideas, Competencies and Content)	• 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. • Construction, views, and nets of 3D objects • surface area and volume of regular solids, including triangular and other right prisms and cylinders			
Learning Objectives	Students will explore surface area by slowly solving more complex area of composite 2D shapes			
Plan Activities				
Elements of the Lesson	Estimated Time (min)	What the teacher says/does	What the students do	Notes
Warm-Up	10 to 15 mins	*Assist any students who have questions	Students will review how to calculate the area of a variety of shapes and play around with a logic puzzle.	Student will review previous content on Area. See warmup handout.
Ask students to now calculate the area of a slightly more complex 2D composite until it looks like the net	10 mins	We work on slightly larger and more complex shapes	Students will slowly recognize that surface area is just the area of the net which is a composite 2D shape.	
Ask students to solve the surface area of some prisms	20 mins	I watch them work on it and assist students in trying to figure it out.	Students will attempt to understand what surface area is and hopefully understand it. (Finding out the	Encourage students to talk with their friends if they are stuck (NOTE be

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		Drop hints related to NETS and the area of composite 2D shapes.	logically necessary with given arbitrary help.)	aware of any students alone)
Ask students to explain their thinking. (Include a brain break)	10 mins	Identify some students and ask them to help me solve the surface area of a prism. Provide a lot of help so students do not feel nervous.	Students will be brought up to speed if they struggled.	
Formative Handin	20 min	Let students work on it.	A quick 2 question formative handin.	Used to gauge where the students are at with surface area.
Extra Notes				
Student Assessment	Main Assessment will be formative with the hand in at the end. Very short, used to gauge students progress with the topic.			
Extension	Encourage student to think about surface area with composite shapes.			
Differentiation and Adaption	One to one help to students in the class by walking around and checking out their work. Used visual aids to bring students attention to certain topics. ELL students have nets to guide understanding. Hope is that understanding is built from adding on to area of 2D shapes.			
Reflections				

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Date: March 2024

Title: Lesson 10: Surface Area and Volume exploration (Thinking Classroom)

Lesson Duration: 75 min	Material: Handout			
Curriculum Learning Standards (Big Ideas, Competencies and Content)	• cell theory and types of cells • The relationship between surface area and volume of 3D objects can be used to describe, measure, and compare spatial relationships. • Connect mathematical concepts to each other and to other areas and personal interests • surface area and volume of regular solids, including triangular and other right prisms and cylinders • numerical proportional reasoning (rates, ratio, proportions, and percent)			
Learning Objectives	Students will connect to Science 8 on why we are multicellular organism, and not single cellular organism. Students will explore the surface area and volume ratio and why it is important for cells. This exploration have students comparing a large cell vs many small cells that add up to the same volume. We will then explore the best way to maximize surface area while keeping volume the same. Looks at it in terms of multiple different shapes and see the relation.			
Plan Activities				
Elements of the Lesson	Estimated Time (min)	What the teacher says/does	What the students do	Notes
Put groups in "Randomized Groupings"	5 mins	Randomize groups (making sure we do not have groups of friends together)	Start of thinking classroom	Randomize groups with card draws
Review content	10 mins	Review Science 8 content, Surface Area and Volume	Students will attempt to remember content learned in Science 8 and other content in class with groups	Need to check how many students have completed science 8 in term 1

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Introduce Project with questions	20 - 30 mins	Explain how it is important that we consider surface area and volume as surface area is how cells transfer nutrients.	See how having a high surface area to volume will allow for more efficient nutrients to flow through the cells	
Work on questions related to project	30 mins	I will circle around aiding students when they seem to be struggling.	Students will work on exploratory questions on the whiteboard with their groups, seeing how surface area can change when volume does not.	Need to have a detailed instructions for the questions
Wrap-up Class	10 mins	Conclude class, and update students on the when this is due.	Let students converse with each other and relax after wrap up.	Students should relax in class.
Extra Notes				
Student Assessment	The main summative assessment for this class. Students will explore surface area and volume of a variety of prisms and see how they change when the prisms get bigger, and the shape is modified a bit.			
Extension	Main project will take time to implement, I would encourage students to find the best prism to be our cell representation.			
Differentiation and Adaption	Connecting with a different subjects and manipulatives can be brought out for students to use. Depending on ELL students, they might be purposely put together or separated for the purpose of better understanding the problem.			
Reflections				