Grade 6: Geometry and Spatial Sense **Written by:** Shawn Lajeunesse

The Tasks

Students will make a 3-dimensional structure (bird house with a pentagon face) using two provided nets. The nets must be combined to create the house; the two nets are: a triangular prism and a rectangular prism. Students will name each of the respective shapes; measure the volumes and outside surface areas of the two three-dimensional shapes and then add them, the sum of which will be the volume and total surface area of the birdhouse. All measurements will be recorded, and an explanation provided that the house is a combination of 2 smaller shapes, in this case, a triangular and a rectangular prism.

Students will transform this concrete model onto an isometric grid; as the dimensions of the house will be too large, the students must choose a scale, for example 2:1, and then draw the triangular prism, rectangular prism, as well as the pentagon faced house onto the grid paper. Students will show all measurements, and tell the dimensions of the new house (the two-dimensional grid house).

Students will be provided with isometric grid paper and then be asked to perform the three types of rigid transformations on the house: reflection (flip), rotation (turn), and translation (slide). Students will be asked to record the volume and total surface areas of their three new houses, and asked to explain why their new houses and the original house have the same dimensions (e.g., rigid transformations do not involve a change in size or property, merely position).

Students will then be asked to perform a (non-rigid) transformation (dilatation) on their house. As the first task required a reduction, this time students will be asked to do an enlargement (i.e., to make a house for a bird that is 4 times as big as the original bird). Students will be asked to record the volume and total surface area of their new house, and asked to explain why it is bigger (e.g., non-rigid transformations, or dilatations involve changing the sizes).

The following are the curriculum' "overall expectations" that relate to these tasks:

By the end of Grade 6, students will:

- identify, describe, compare, and classify geometric figures (1) – this is because they have to name the shapes making up the house
- draw and construct three-dimensional geometric figures from nets (2) – this is because they have to make the house
- identify congruent and similar figures (3) – this is because they have to recognize that the pentagon is made up of two other shapes (does that make sense)
- explore transformations of geometric figures (4) – this is because they have to perform both rigid and non-rigid transformations on their house

- understand, apply, and analyse key concepts in transformational geometry using concrete materials and drawings (5) – this is because they are both drawing the house and making it
- use mathematical language effectively to describe geometric concepts, reasoning, and investigations, and coordinate systems (6) –this is because they have to be able to name all of the shapes; they must recognize the differences between the rigid and non-rigid transformations

During these tasks, students will work on the following selected "expectations in specific areas" from the Grade 6 curriculum:

Students will:

- identify nets for a variety of polyhedra from drawings by visualizing the two-dimensional faces of the three –dimensional figures (1)
- demonstrate an understanding of similar and congruent figures (7)
- demonstrate congruence of figures by measuring angles and sides and matching corresponding parts (8)
- use mathematical language to describe geometric ideas (13) (e.g., translations, transformations, dilatations)
- recognize and describe in mathematical language the occurrence and application of geometric properties and principles in the everyday world (14)
- discuss geometric concepts with peers and use mathematical language to explain their understanding of concepts (15)
- visualize and describe the effect of translations, reflections, and rotations (more than one transformation) (17)
- apply and analyse translations, reflections, and rotations in a variety of geometric contexts (18)
- demonstrate an understanding of coordinates in a Cartesian plane in the first quadrant and plot points (20)

Previous Learning Experiences :

It was suggested that before attempting these tasks, students should have had experience with the following:

- measuring height, width, and length of various polygons and polyhedra
- measuring the area and volume of various polyhedra
- identifying, describing, comparing, and classifying geometric figures
- producing two- and three-dimensional works of art that communicate a range of ideas(thoughts, feelings, experiences) for specific purposes and to specific audiences
- creating scales

The Process Used:

Introductory Activities: The teacher will review the previous learning experiences with the class (i.e., discuss the origami projects used in art class). Students will then participate in a grand conversation about the different structures that exist in their local area that house animals. Followed by this, the students are given a choice to research types of houses that are built for birds through the Internet and use of the resource centre. Once the collecting of information is completed, an information session will be shared in another grand conversation. This can be lead into the identification and review of the previous learning experiences by the teacher.

On my own:

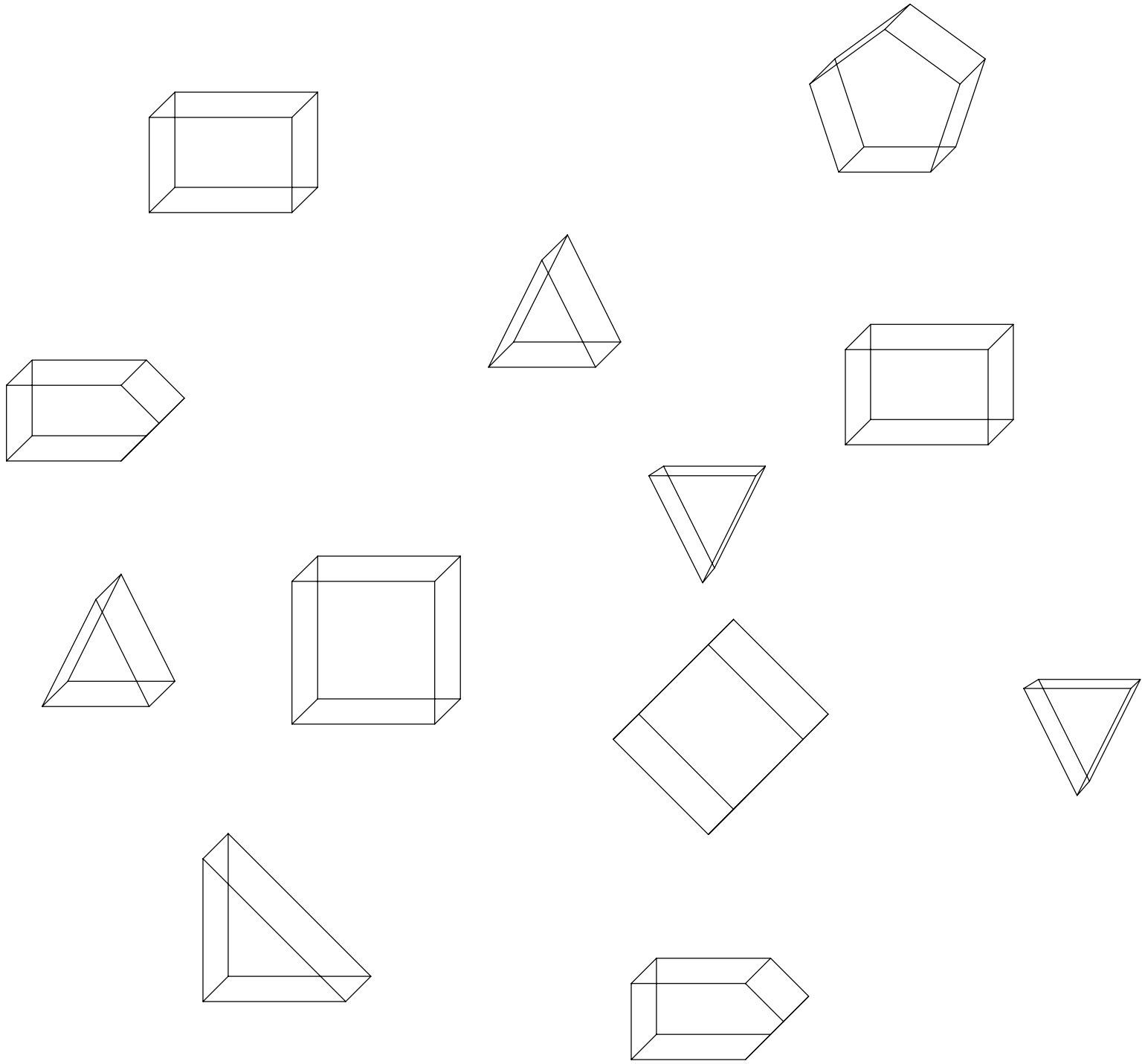
The students are informed of the task about to be handed out and the problem of the bird needing a home. They are given the time to complete each task throughout the scheduled mathematics period.

Evaluation:

A rubric will be used to asses the students' works.

WHOLE GROUP ACTIVITY

Have the students take out their origami birds previously created in Math/Art class. Explain to them that their bird needs a house for shelter. The shelter will also be made of paper. Based on the height, length, and width of the bird, have the students brainstorm, estimate, and do some rough calculations to determine the most suitable house size for their bird.



ON MY OWN

Assessment Criteria

- I estimate and measure the area, and volume of the birdhouse
- I name and record the names of all of the shapes that make up the birdhouse
- I represent the three-dimensional birdhouse on grid paper using a scale
- I record the new dimensions of the house
- On the grid paper, I flip, turn and slide the house
- I show my calculations
- I explain what I do

1. Look at the nets provided. Imagine what the birdhouse will look like when it is constructed. Considering the width, length, and height of the bird, do you think it will be large enough to house the bird? Explain your answer.

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2. Assemble the birdhouse using scissors, glue and the nets provided.

3. What **two** polyhedra make up the shape of the birdhouse? When put together, what polyhedron do they form?

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4. Estimate the surface area and volume of the assembled birdhouse.

Surface area: _____

Volume: _____

5. Using a scale of 1:1 draw the completed birdhouse on the graph paper provided. Label the measurements in centimeters (length, width and height).

6. a) Measure the **surface area** of the two polyhedron shapes that make up the birdhouse. Show your calculations in the space below.

b) Measure the **total surface area** of the birdhouse. Show your calculations below.

7. a) Measure the **volume** of the two polyhedron shapes that make up the birdhouse. Show your calculations in the space below.

b) Measure the **total volume** of the birdhouse. Show your calculations below.

8.a) Using the graph paper provided, draw a birdhouse that would house a bird **half the size** of your origami bird. Label its measurements.

b) Explain the scale and process you used to draw this birdhouse.

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9. Calculate the **total area and volume** of this birdhouse.

9. (continued)

10) Compare the **volume and surface area** of the two birdhouses you drew. What relationship do you see?

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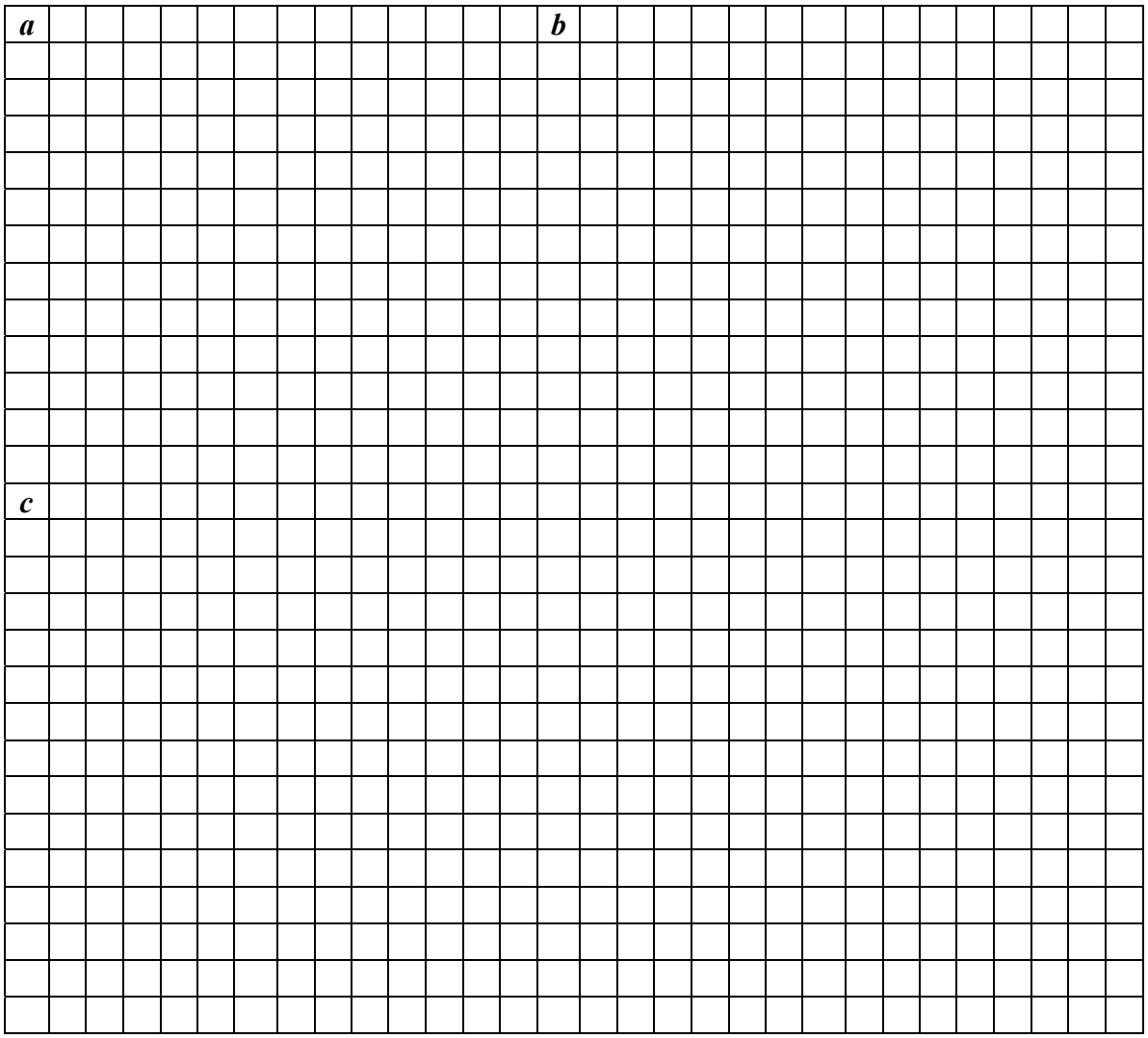
11. Using the graph paper below, perform the following **transformations** on the picture of the house:

a) Perform a reflection (flip)
b) Perform a rotation (a turn)
c) Perform a slide



12. a) Explain the effects of the various transformations performed in question 11 <u>on the dimensions of the house</u> (length, width, height)? How about the <u>area</u> of the house?

b) How do you think these transformations would affect the area and volume of the three dimensional birdhouse you assembled?

c) Explain how these transformations are different than the transformation you performed in question 8, when you drew a birdhouse for a bird half the size of your origami bird.

Achievement Levels: Mathematics — Geometry and Spatial-Sense - Grade 6

Categories	Level 1	Level 2	Level 3	Level 4
Problem solving	**The student:**			
	Uses a limited range of problem-solving strategies to solve a few simple problems	**Uses appropriate problem-solving strategies to solve some problems**	**Selects and uses appropriate problem-solving strategies to solve problems**	**Selects and uses appropriate problem-solving strategies or modifies strategies to solve problems**
Understanding of concepts	The student:			
	Provides some incomplete and some inappropriate explanations of 3- and 2-dimensional forms and transformations	**Provides appropriate but sometimes incomplete explanations of 3- and 2-dimensional forms and transformations**	**Provides accurate explanations of 3- and 2-dimensional forms and transformations**	**Provides accurate and complete explanations of 3- and 2-dimenstional forms and transformations.**
Application of mathematical procedures	The student:			
	Makes some major errors when measuring and calculating area and perimeter **Makes some major errors when constructing a 3-dimensional model** **Makes some major errors when producing transformations**	**Makes several minor errors when measuring and calculating area and perimeter** **Makes several minor errors when constructing a 3-dimensional model** **Makes several minor errors when producing transformations**	**Makes only a few minor errors when measuring and calculating area and perimeter** **Makes only a few minor errors when constructing a 3-dimensional model** **Makes only a few minor errors when producing transformations**	**Makes almost no errors when measuring and calculating area and perimeter** **Makes almost no errors when constructing a 3-dimensional model** **Makes almost no errors when producing transformations**
Communication of required knowledge related to concepts, procedures, and problem solving	The student:			
	Describes processes unclearly and imprecisely, using a limited range of mathematical terminology	**Describes processes with some clarity and some precision, sometimes using appropriate mathematical terminology**	Describes processes and strategies clearly and precisely, using appropriate mathematical terminology	**Describes processes and strategies clearly and precisely, extensively using appropriate mathematical terminology**