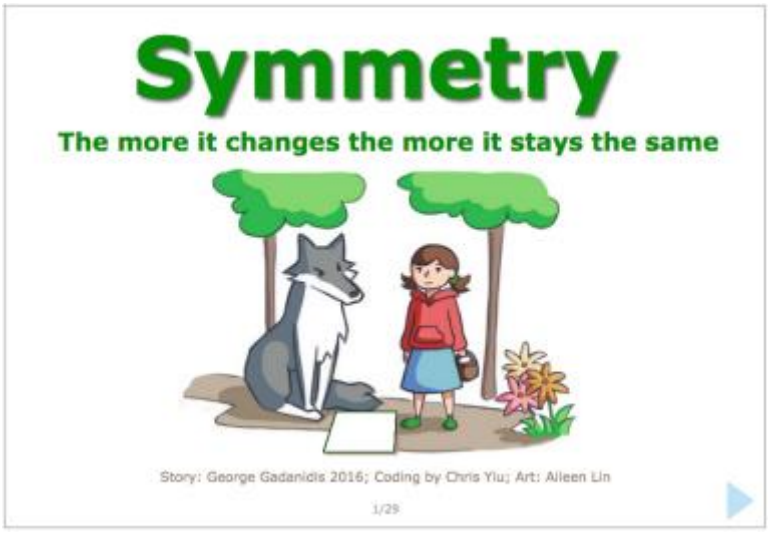
LESSON PLAN

STORY

Symmetry – the more it changes, the more it stays the same.

- researchideas.ca/sym/story.html



SEQUENCE (Questions, ideas, activities)

PART 1 (60 minutes)

Page 1

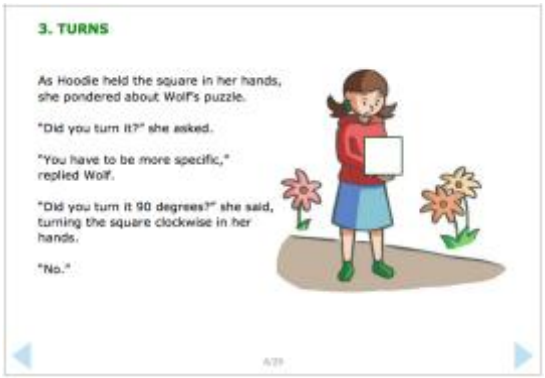
1. What do you know about symmetry?
2. What do you think this means: "The more it changes the more it stays the same"
3. Predict what might happen in this story.

Page 3

1. What would you do in Hoodie's situation? Why?

Page 4

1. Would you have closed your eyes? Why?
2. How might Wolf change the square?
3. How will you be able to tell how he changed it?

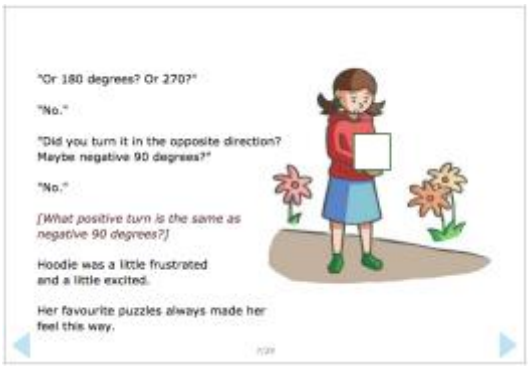


Page 6

1. Give a cardstock square to each pair of students.
2. How could you turn the square so that it looks unchanged?
3. Possible answers that connect to fractions: a quarter turn, a two-quarter turn or half a turn, a three-quarter turn, a four-quarter turn or a full/whole turn
4. If students don't know, tell them that 90 degrees is the same as a quarter turn.
5. How many degrees for a half turn? (180) A three-quarter turn? (270) A whole turn? (360)

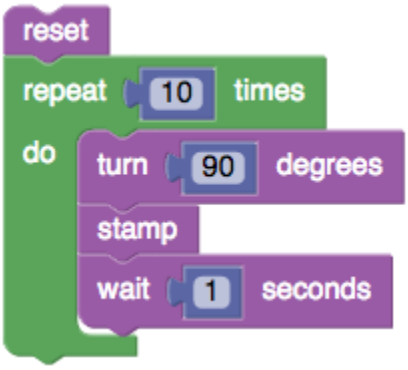
Page 7

1. What might negative 90 degrees mean?
2. Connect positive and negative turns to clockwise and counter-clockwise turns: negative 90 degrees can mean a quarter turn counter-clockwise.
3. What positive turn is the same as a negative 90 degree turn?

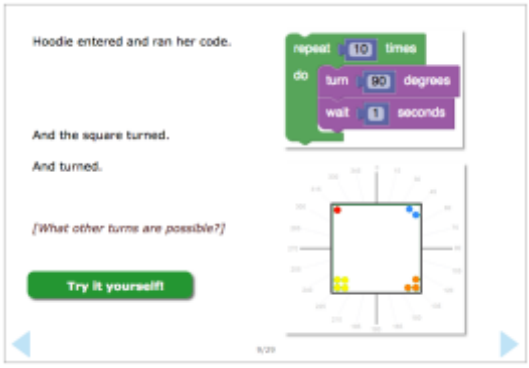


Page 9

1. Have students work in pairs for 10-15 minutes to turn the square using code at researchideas.ca/sym as shown on page 9.



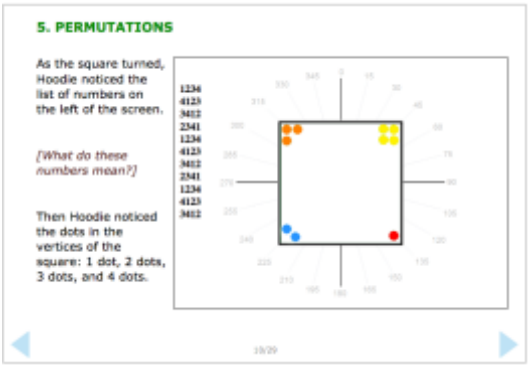
2. Prompt students to add the stamp feature, as shown at left. Why are there only 4 stamps recorded?
3. Prompt students to use negative 90 degrees.
4. Prompt students to notice the numbers at the left of the screen. What do these numbers mean? How many different numbers are there? (4) Why only 4? Why these 4?



5. In a whole class setting, share and discuss what was explored and what was learned.

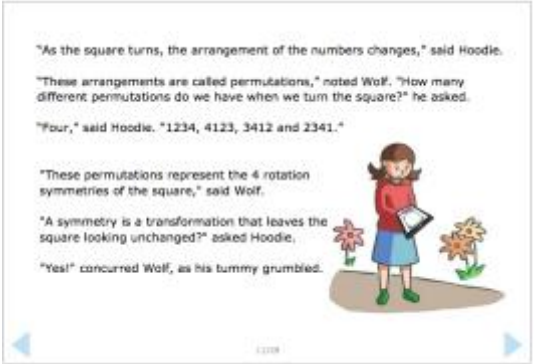
Page 10

1. Discuss the list of numbers on the left of the screen.
2. What do these numbers mean? How many different numbers are there? (4) Why only 4? Why these 4?

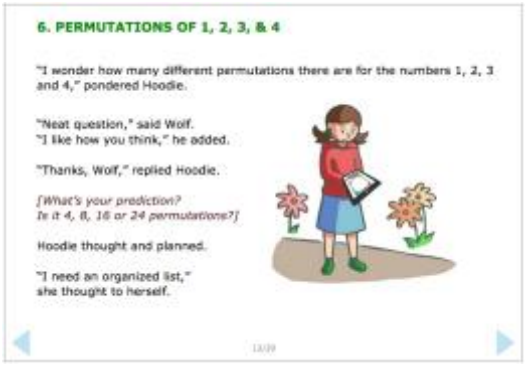


Page 11

1. The different arrangements of the numbers 1-4 are called permutations.
2. A symmetry is "a transformation that leaves the square unchanged." Ask students to explain what this means to them, with examples from their investigations, and to say this in their own words.
3. What are some examples of transformations of the square that are not symmetries of the square? Why?

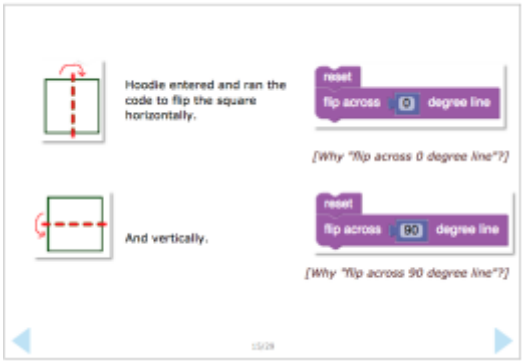


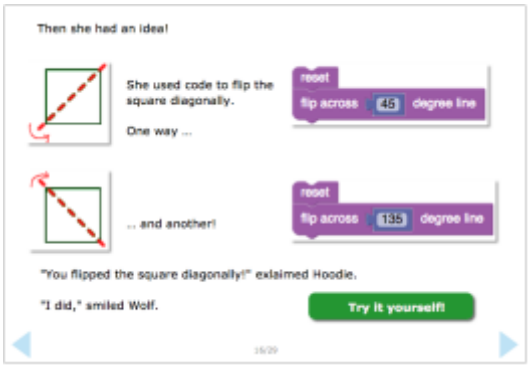
Page 12



1. Have students predict the number of permutations of the numbers 1-4.
2. With student input, start creating an organized list. For example, start by listing all the permutations that start with 1: 1234, 1243, 1324, 1342, 1423, 1432
3. How many permutations would start with 2? 3? 4?
4. How many permutations in total? (4 groups of 6 = 24)
5. Make a connection to probability, where we also need to know all the possible outcomes.
6. Have student volunteers circle the turn symmetry permutations (1234, 4123, 3412, 2341).
7. Why are the other permutations not possible with turns? When the square turns, its vertices do not switch places. All other permutations have some vertices switching places.
8. What can we do to the square so that vertices switch places?

PART 2 (60 minutes)





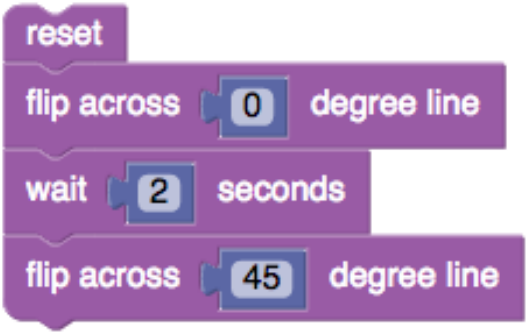
Page 15

1. Go to researchideas.ca/sym
2. In a whole class setting, explore the 2 flips on page 15.
3. Note: the reset code block is necessary after each flip so we don't combine flips (which we will explore on page 18).
4. What does it mean to “flip through 0 degree line”?
5. What does it mean to “flip through 90 degree line”?
6. What other flips are possible? What lines will we flip through? How can we tell what the degrees should be for the lines?
7. Model flipping through the 45 and 135 degree lines

Page 16

1. Have students work in pairs for 10-15 minutes to flip the square using code at researchideas.ca/sym as shown on pages 15-16.
2. Are there any other flips possible, that leave the square looking unchanged?

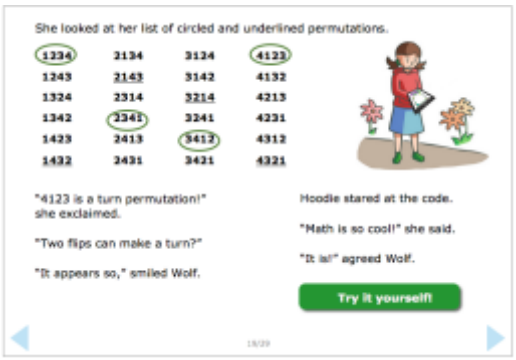
Page 18



1. Go to researchideas.ca/sym
2. In a whole class setting, enter and run the code on page 18.
3. Note that this code combines two flips.
4. Ask students to note the permutation that results (4123).
5. Have students think-pair-share.

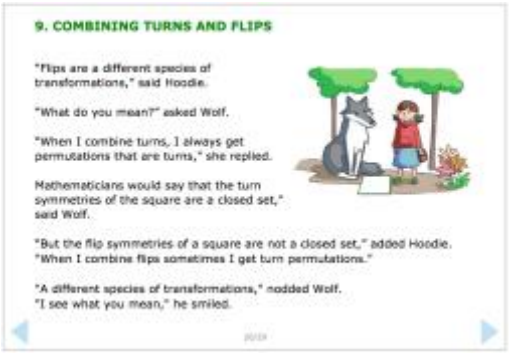
Page 19

1. Have students work in pairs for 10-15 minutes to flip the square different ways, as shown on pages 18, using code at researchideas.ca/sym
2. Ask students to try different combinations of flips and record results.
3. In a whole class setting, share and discuss what was explored and what was learned.



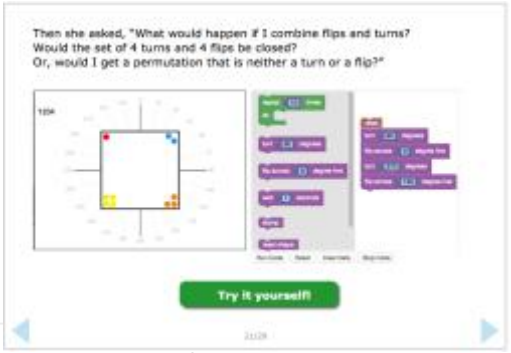
Page 20

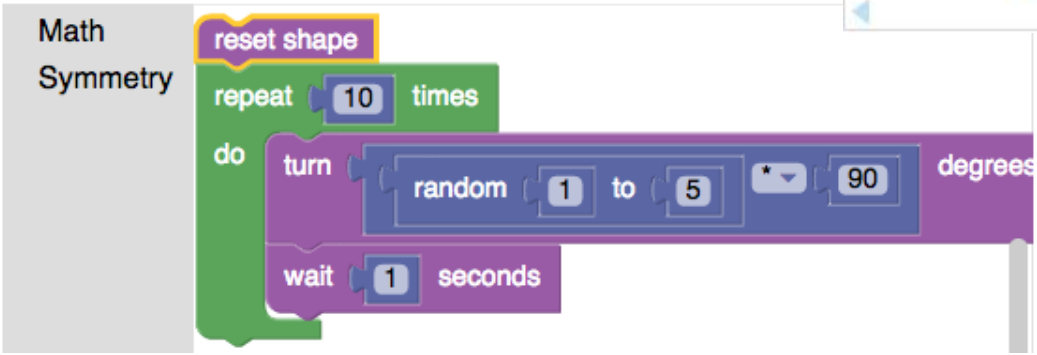
1. What does Hoodie mean by “a different species”?
2. Do you agree? Why?

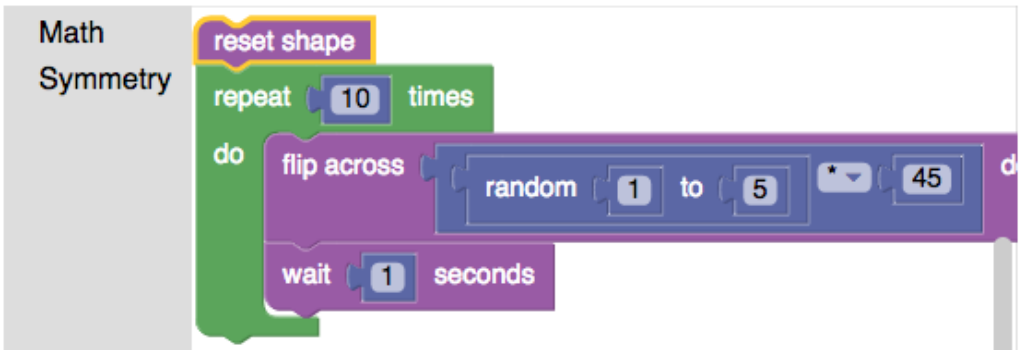


Page 21

1. Have students work in pairs for 10-15 minutes to turn and flip the square using code at researchideas.ca/sym
2. Have students combine flips and turns to see if they can find new permutations – ones that are not part of the 8 circled or underlined permutations shown on page 19.
3. In a whole class setting, share and discuss what was explored and what was learned.
4. Guide students to use the Random code block, to create random turns and flips. For example:



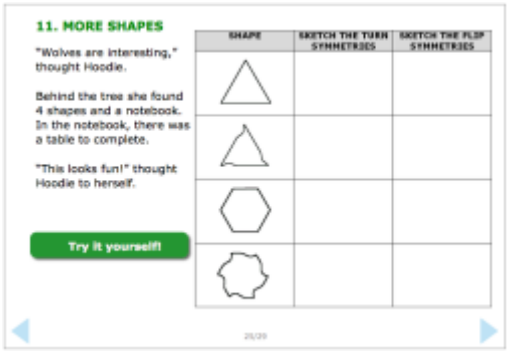




Page 22

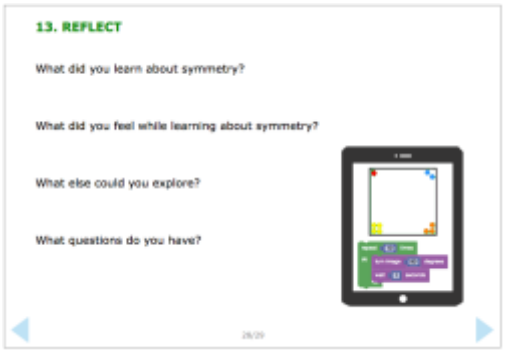
1. Discuss the idea that a symmetry is a transformation that leaves an object unchanged.
2. Recall the subtitle of the story: "The more it changes the more it stays the same." What does this mean?

PART 3 (60 minutes)



Page 25

1. Have students work in pairs for 20-30 minutes to explore symmetries of other shapes using code at researchideas.ca/sym
2. Notice that not all shapes are regular. Note: all shapes with have rotational symmetries; but not all will have reflection symmetries.
3. In a whole class setting, share and discuss what was explored and what was learned.



Page 28

1. Have students work individually for 5 minutes to record answers to the questions on page 28.
2. Share and discuss in a whole class setting.

Page 29

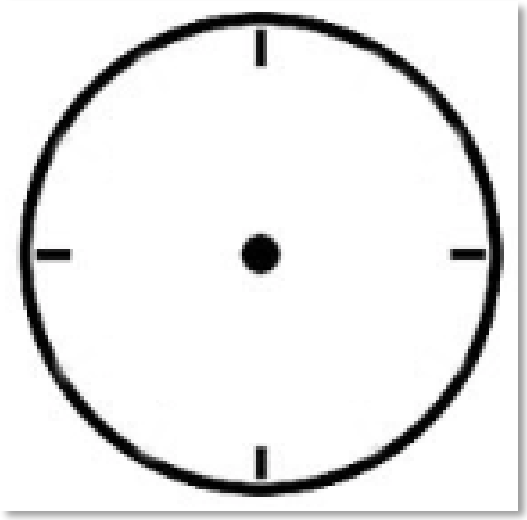
1. Give students opportunities to practice how they will share their learning at home.
2. Have students read the story and share their learning at home.
3. Ask parents to complete and return their answers to the questions on page 29.

PART 4 (extension) – Adding hours on a quarter-hour clock (10 minutes)

Complete the addition table, for minutes on a quarter-hour clock.

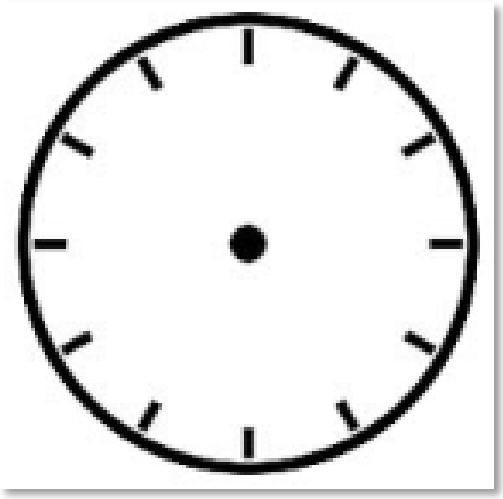
- What patterns do you notice?
- Use crayons to identify patterns.
- How many rotational symmetries does a quarter-hour clock have?
- What geometric shape would have the same number of rotational symmetries? Why?

	15	**30**	**45**	**60**
15			60	15
30				
45				
60				



PART 5 (extension) – Adding hours on a 12-hour clock

(20 minutes)



Complete the addition table, for hours on a 12-hour clock.

- What patterns do you notice?
- Use crayons to identify patterns.
- How many rotational symmetries does a 12-hour clock have?
- What geometric shape would have the same number of rotational symmetries? Why?

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1	2	3										
2			5									
3												
4												
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6					11							
7							2	3				
8												
9												
10										8		
11												
12												

NOTES

PART 6 (extension) – Do the rotation symmetries of the square form a group? (20 minutes)

The square has 4 rotation symmetries:
Turn 0 degrees, Turn 90 degrees, Turn 180 degrees, Turn 270 degrees

We can be more concise and write them like this:
T0, T90, T180, T270

Do the 4 rotation symmetries of the square form a group?

A set of elements form a group if they meet these conditions:

1. There is an inverse (or undo, or opposite)
- What is the inverse of T0? _____
- What is the inverse of T90? _____
- What is the inverse of T180? _____
- What is the inverse of T270? _____

2. There is an identity (do nothing)
- Is there a symmetry of the square that does nothing? _____

3. The result of any combination of the 4 symmetries is one of the 4 symmetries
- If you combine the symmetries of the square, can you get a result that is not one of the 4 symmetries? Explain.

4. Grouping combinations of the 4 symmetries different ways does not make a difference (this is also called the associative property)
- Is this true? For example, do the two different groupings below have the same result? Remember that what's in the brackets is done first.
    - (T90 followed by T270) followed by 180
    - T90 followed by (T270 followed by 180)

PART 7 (extension) – Do the reflection symmetries of the square form a group? (20 minutes)

The square has 4 reflection symmetries:
Flip through 0 degrees, Turn 90 degrees, Turn 180 degrees, Turn 270 degrees

We can be more concise and write them like this:
T0, T90, T180, T270

Do the 4 rotation symmetries of the square form a group?

A set of elements form a group if they meet these conditions:

5. There is an inverse (or undo, or opposite)
- What is the inverse of T0? _____
- What is the inverse of T90? _____
- What is the inverse of T180? _____
- What is the inverse of T270? _____

6. There is an identity (do nothing)
- Is there a symmetry of the square that does nothing? _____

7. The result of any combination of the 4 symmetries is one of the 4 symmetries
- If you combine the symmetries of the square, can you get a result that is not one of the 4 symmetries? Explain.

8. Grouping combinations of the 4 symmetries different ways does not make a difference (this is also called the associative property)
- Is this true? For example, do the two different groupings below have the same result? Remember that what's in the brackets is done first.
    - (T90 followed by T270) followed by 180
    - T90 followed by (T270 followed by 180)