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Using Literature to Engage Students Mathematically

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Using Literature to Engage Students Mathematically

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Abstract: *In this article, the authors share two lessons that incorporate children's literature with the Pythagorean theorem and area to engage preservice teachers (PSTs) mathematically. Sample responses, example texts, and future work are discussed.*

Keywords: *English language arts, children's literature, Pythagorean theorem, area*

1 Introduction

If typical mathematics lessons fail to capture the attention of your middle grades students, we encourage you to integrate children's literature into your daily routine. A quick stop to the children's section of any bookstore provides a wealth of resources that may be used to infuse mathematics lessons with characters and scenarios that will likely capture the imagination of even the most jaded middle-schooler. Don't feel pressured to use chapter books or dictionary-like page turners. Instead, consider grabbing a colorful, picture-filled kid's book and let your students' creative juices flow. Picture books not only reawaken the child in all of us but often include scenarios that encourage students to engage in thought-provoking tasks that inspire perseverance and problem solving that connect to the *Mathematical Practices* (2010) and NCTM's *Principles and Standards* (2000). In this article, we outline two 60-minute activities we gave preservice teachers (PSTs) to illustrate the integration of children's literature into mathematics instruction in the middle grades.

2 Itsy books

Sequential narratives featuring a main character on a journey—for instance, *Itsy Bitsy Spider* by Kate Toms (2009) and *Itsy Bitsy Pumpkin* by Sonali Fry (2014)— provide rich contexts for integrating mathematics and literature. The former, based on the famous nursery rhyme of the same name, details the struggles of a spider, Itsy, as he tries to make it up the water spout to get home. Along the way, Itsy gets flushed out of the pipe, bounces on a trampoline over a wall, lands on a clothesline, and is catapulted into a tree! *How will Itsy ever get home and how long will it take?* In the latter, Itsy is a pumpkin. He rolls past many objects including a ghost, goblin's feet, and a cornfield—eventually coming to a stop far from home. *How will Itsy get back?* The Itsy texts provide novel questions and fun scenarios for students to explore as they engage in the following mathematics standards: 8.G.B.7: *Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions* and MP4: *Model with mathematics*.

In our class, PSTs sat in groups of 2–4 to complete the Itsy activities. Both lessons were structured similarly, with candidates using grid paper to determine the distance Itsy needed to travel to get home. Investigating Itsy's predicament from *Itsy Bitsy Pumpkin*, they drew the spider in the lower left corner and his final stop in the upper right. We asked PSTs to: (a) draw a picture of what they thought happened to Itsy in the story, (b) describe Itsy's path in words using directions (e.g., right/left/north/south with appropriate units), (c) sketch two unique paths for Itsy to get back home, and (d) calculate the total length of each route. A classroom-ready handout supporting this investigation is provided in Appendix A. PSTs constructed one path consisting of only vertical and horizontal line segments (see Figure 1) and another path including slanted (i.e., oblique) line segments (see Figure 2).

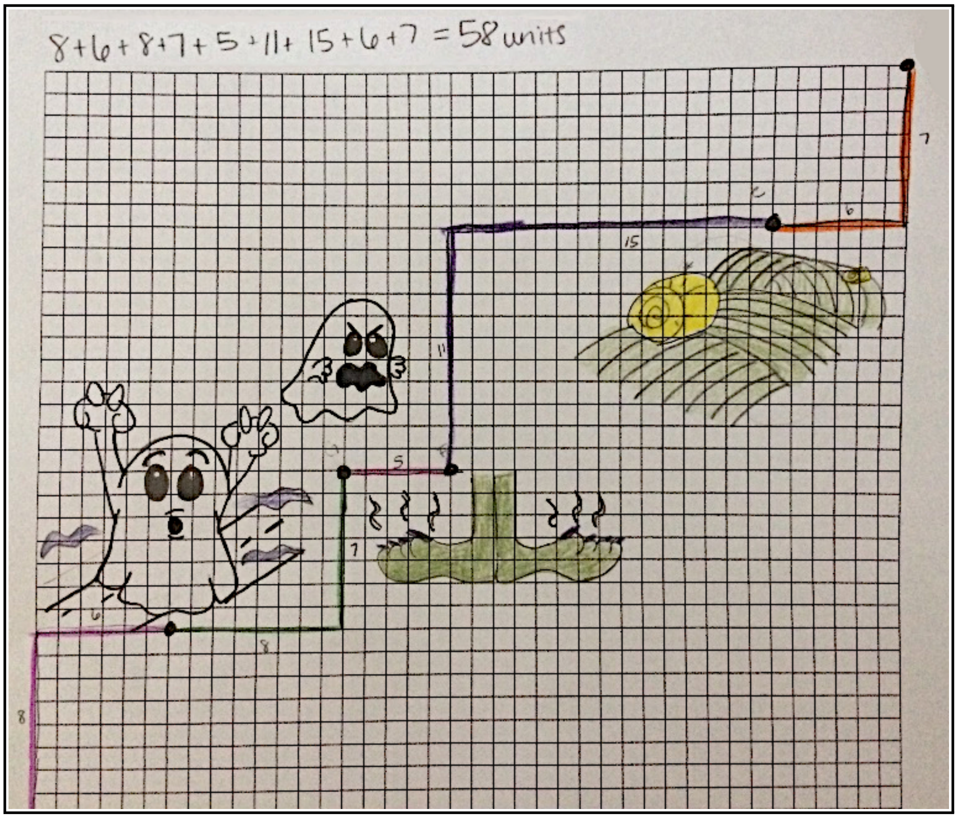

Fig. 1: *Sample work including vertical/horizontal path.*

The work samples in Figures 1 and 2 show a vertical/horizontal path of length 73 units, contrasted with a slanted path with a total distance of about 53.4 units. Not surprisingly, PSTs found it easier to calculate the length of first path (although work in Figure 1 does include a computational error—do you see it?). The second path included more advanced calculations that involved utilizing the Pythagorean Theorem. For instance, the sample work in Figure 2 highlights four applications of the theorem on the left along with a summation of these lengths at the top.

The activity led to interesting small group discussions about possible routes home (e.g., short ones, straighter ones, intricate ones that covered the entire grid) and how to calculate distances using the Pythagorean theorem. Many PSTs loved the openness of the activity since they were able to draw their own paths and use their artistic skills to make routes their own. Others preferred more prescriptive questions that forced them to create a specific path, with everyone calculating the same values so that they could more easily check their answers with their peers.

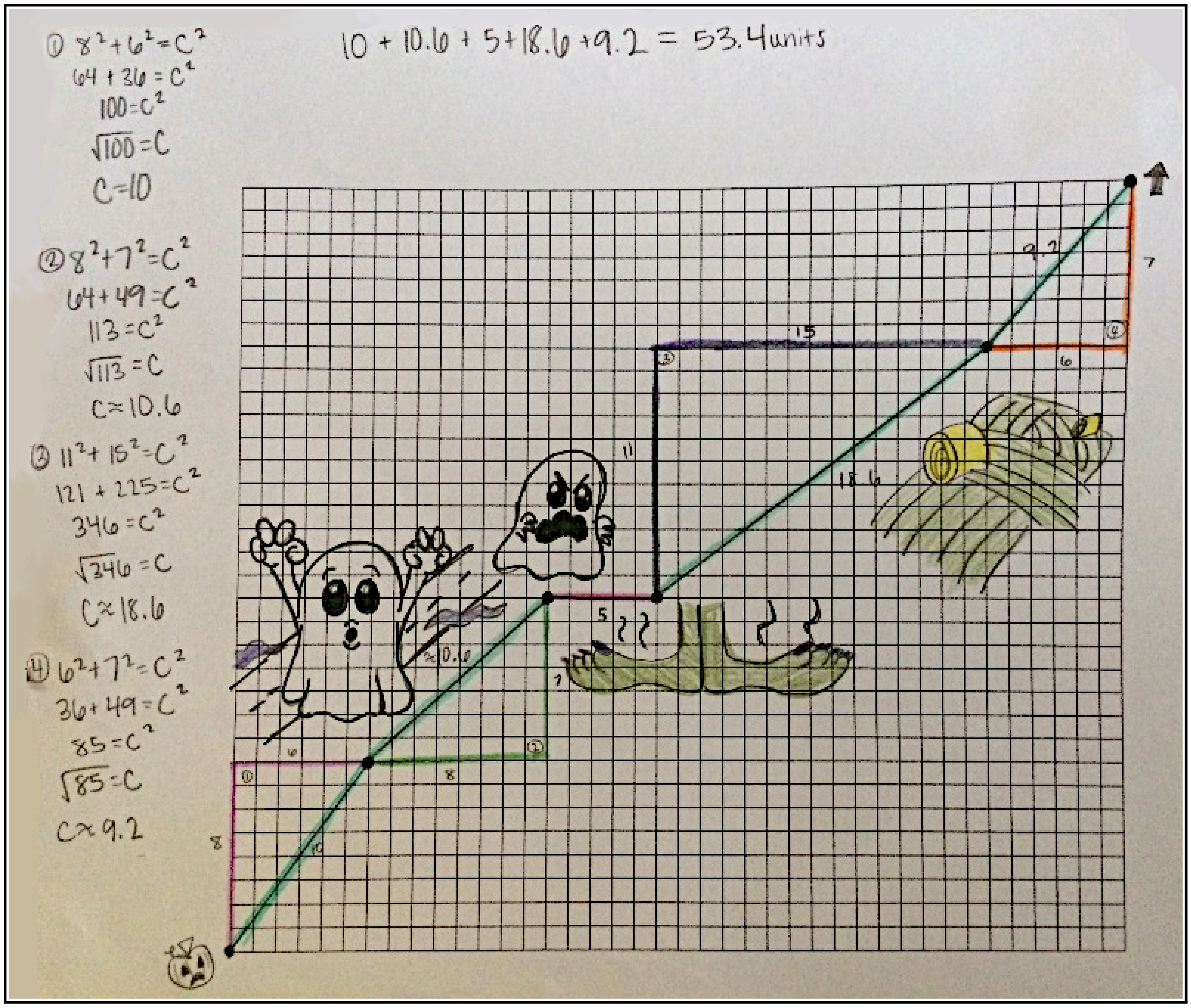

Fig. 2: *Sample work including slant path.*

Some groups were initially unsure how to calculate distances of slanted paths. Discussing possible strategies ultimately resulted in deeper understanding of the formula and greater confidence with its application. Having PSTs color code their paths helped them organize their work as they applied the Pythagorean formula and calculated total distances.

Some found the directional aspects of the activity challenging, struggling to describe their paths in words (e.g., "Itsy traveled north 8 units and east 5 units"). As teachers, we believe that helping students communicate mathematical ideas in words is at least as important as the ability to compute distances. To help students, teachers can model Itsy's movement on the grid while students describe this motion out loud and then in written form. If there are discrepancies between the two, students more readily see the errors in their logic using this approach.

We asked PSTs who finished early to determine the speed at which Itsy should travel to get home in 4 hours. Adding this extra question was a great way to engage them with standard 6.EE.A.2: *Write, read, and evaluate expressions in which letters stand for numbers*, while emphasizing the mathematical practice MP8: *Look for and express regularity in repeated reasoning*. As Figure 3 suggestions, groups approached this task differently, depending on what units they chose to answer the question (e.g., units per hour, units per minute).

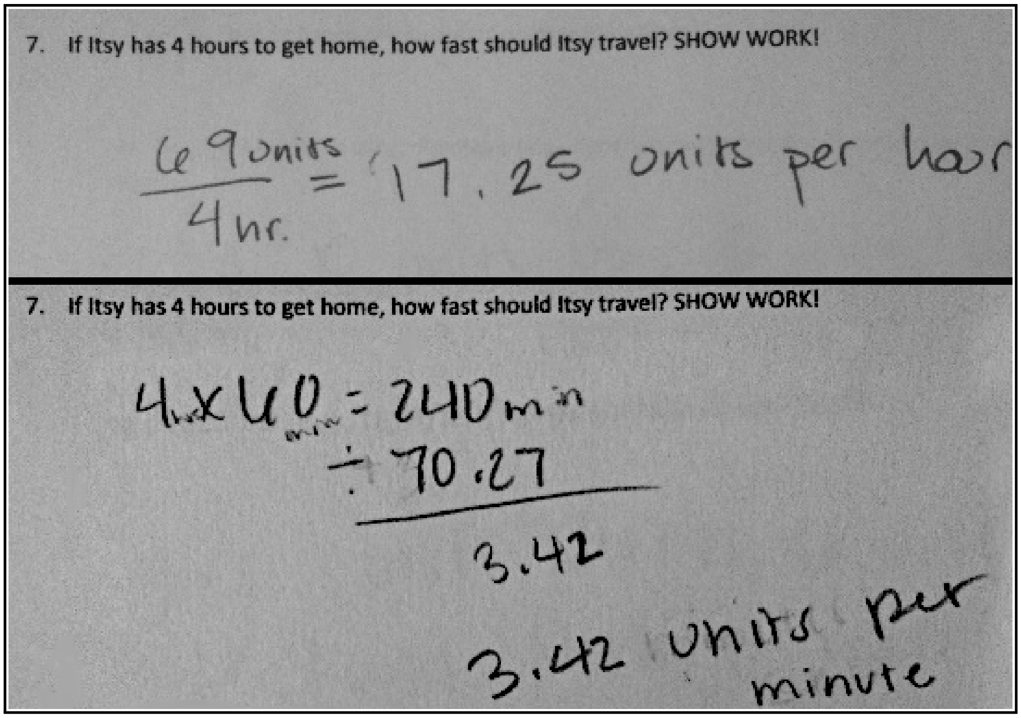

Fig. 3: *Sample written responses to Item 7.*

After the lesson, we asked PSTs to reflect on their work through a written reflection. We asked them to state what they liked and disliked about the activity, as well as what they might change. All PSTs stated that they loved the use of the Itsy books. Some commented that they found the openness of the problem to be challenging since we did not force them to select a certain route to draw, instead leaving it up to PSTs to use their interpretation of the story and their own creativeness to construct paths. One PST commented on connections to literature in the following manner:

> I loved, loved, loved the Itsy activity! I think this is so much more engaging than asking students to create a map from their house to school, et cetera . . . which is often used to address these standards . . . The book was a perfect way to incorporate listening skills, note-taking skills (listing the places on the worksheet), and directional awareness.

3 *Little Cloud* by Eric Carle

Eric Carle's picture book, *Little Cloud* (1996), provided PSTs with another compelling context for exploring mathematics. In the book, a little cloud turns into various shapes, such as a sheep, an airplane, and a clown. Our goal was to connect the book with middle grades mathematics through 6.G.A.1: *Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems*, with particular emphasis on the mathematical practice MP6: *Attend to precision*. We read the book to the class, let PSTs construct their own clouds out of cotton balls, and asked them to estimate the projected area (i.e., shadow) of their creations. PSTs traced their clouds onto grid paper worksheets representing the sky and then calculated area using the percentage of the outlined area of sky covered by the cloud, as shown in Figure 4.

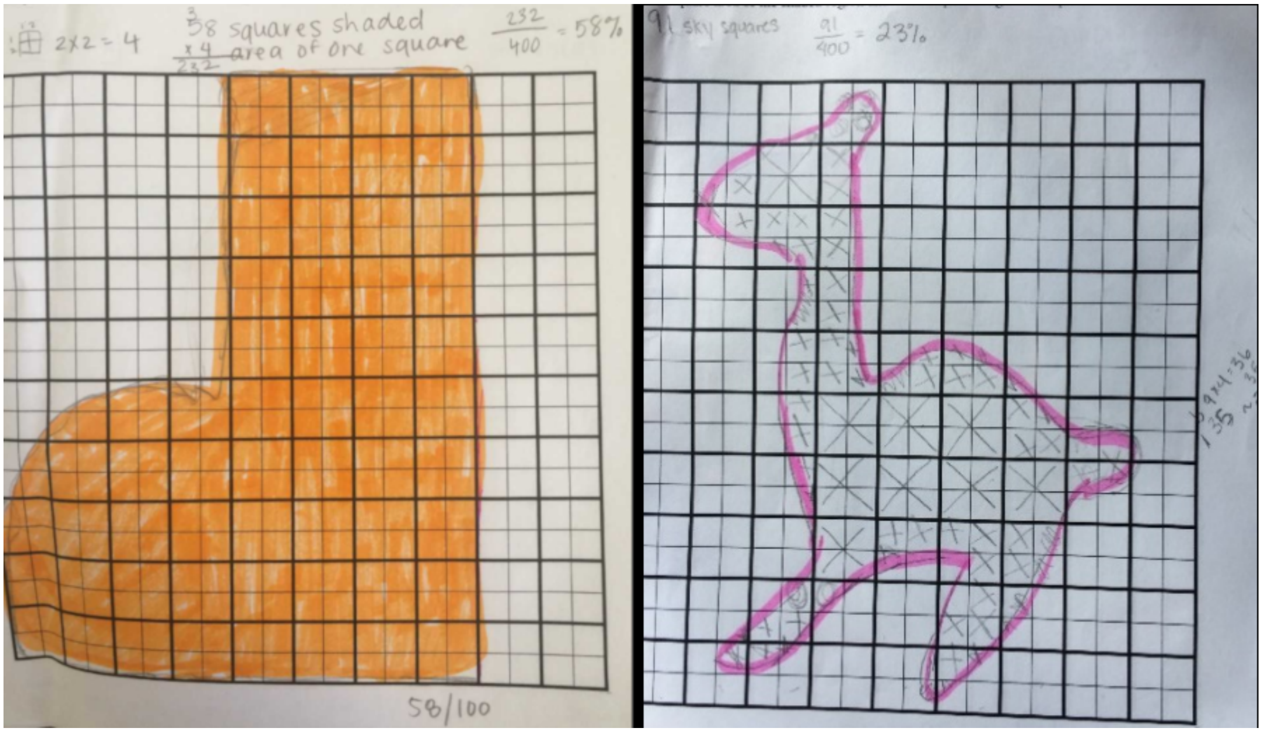

Fig. 4: *Sample responses to* Little Clouds *task.*

As Figure 4 suggests, separate groups took very different approaches to the problem. Some tried to create simple shapes to make their calculations easier, while others created more unique figures, decomposing them into simpler shapes to estimate area.

For example, to calculate the area of the boot-shaped cloud (Figure 4, left), PSTs used subpartions of the unit squares (note that each unit square is split into fourths). They counted 57 unit squares and 2 half outlined squares for a total of 58 square units, noting that the boot covered

$$\frac{58}{100} = 58\%$$

of the outlined sky. The PSTs also included the measurement of $\frac{232}{400} = 58\%$ to show that decomposing the sky into 400 quarter squares with 232 colored gave the same result:

$$\frac{232}{400} = \frac{58}{100} = 58\%$$

The work in Figure 4, right, illustrates how PSTs estimated the area of the animal-shaped cloud. They estimated that the cloud enclosed 91 quarter squares, with $\frac{91}{400} = 23\%$ of the outlined sky covered.

Once again, we asked PSTs to reflect on their work and what they liked, disliked, or would change about the activity. They loved the use of literature. Many found calculating the area of irregular, two-dimensional clouds challenging. As one PST noted,

> You added literature to math again. LOVED IT! The activity enabled me to construct my own creation while finding the area of the “cotton ball creation.” This activity was important because it moved me from my comfort zone of making the area all equal—into making the squares unequal and finding the total area. You made us construct our knowledge on our own instead of a lecture or doing it for us.

4 Future work and example texts

As a future activity for this course, PSTs could select their own children's books and create their own creative mathematics tasks from the stories presented. We list several examples below along with relevant standards.

- **Example #1—Create your own treasure map and calculate the distance to your treasure!**
  - Dean, J. (2017). *Pete the Cat and the Treasure Map. New York: Harper Festival.*
  - 8.G.B.7: *Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.*
- **Example #2—Calculate what size raft Simba could use to save the mother giraffe.**
  - *Simba and the Big Flood* (1996). Copenhagen, Denmark: Egmont Gruppen.
  - 7.G.B.6: *Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.*
- **Example #3—Draw a picture that hides Sassoon five times throughout the coordinate plane. Create an answer key that shows his positions.**
  - Usher, S. (2011). *Can You See Sassoon?* London: Little Tiger Press.
  - 6.NS.C.6.C: *Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.*
- **Example #4—Draw a picture of Zoom Squirrel's tooth and perform different transformations with it. Label each transformation.**
  - Willems, M. (2018). *I Lost My Tooth!* New York: Hyperion Books for Children.
  - 8.G.A.3: *Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.*

Not only would this task encourage PSTs (and any students) to think "outside the box," the task might help them to become better problem-solvers and to look at books in a whole new light.

5 Conclusion

Through the use of literature, students of all ages can become engaged in mathematics in a whole new way. It just takes a little more effort by the teacher to try to find books (perhaps from earlier ages) that may inspire hidden mathematical tasks to unlock students' imagination, creativity, and problem solving skills to bring their natural appreciation for stories into mathematics class.

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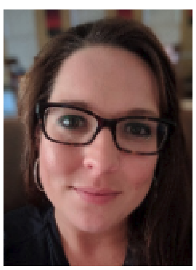


Holly Dybvig is a mathematics teacher in the Pilot Point Independent School District. Holly enjoys seeing the "ah ha" moments on students' faces as they begin to fully grasp a concept.

APPENDIX A: Handout accompanying *Itsy Bitsy Pumpkin*

The Itsy Bitsy Pumpkin's (Fry, 2014) Great Journey

Directions: Oh no! The Itsy Bitsy Pumpkin is so far from home! Help the Itsy Bitsy Pumpkin get back to home by drawing a possible path back home. Make sure to include all the places he visited along the way.

1. Places that Itsy visited:

2. Next, draw the above locations on your grid paper.

3. Now, draw the path between the locations on your grid paper.

4. Describe your path in words using directions (e.g., right/left/north/south) and appropriate units of measure.

5. Calculate the total distance Itsy traveled. Show your work below and include units.

6. Could Itsy have traveled a different path between locations? Compare the distance you got above with an alternate path. Include diagonals, if you did not have them above. SHOW WORK!

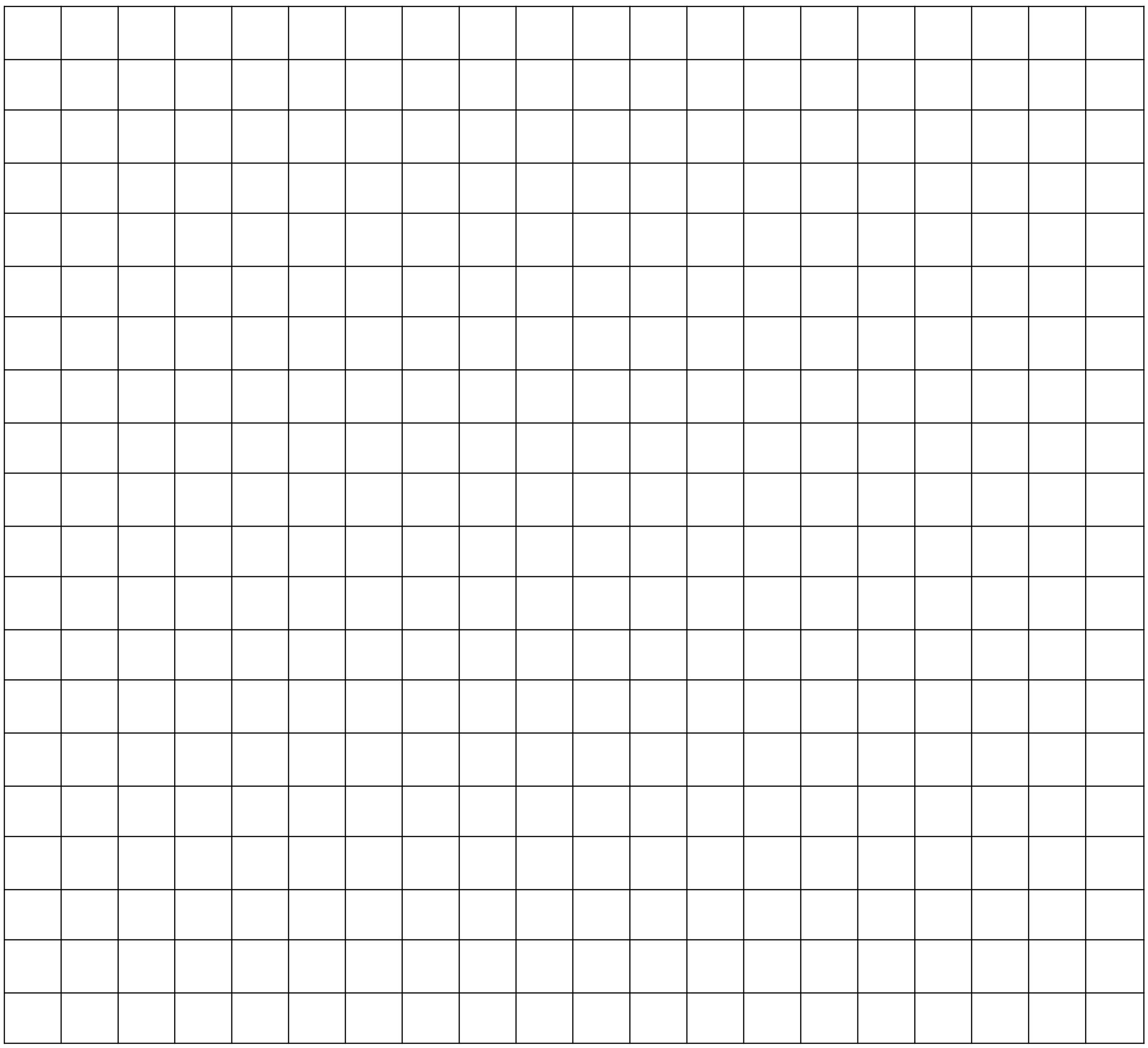
7. If Itsy has 4 hours to get home, how fast should Itsy travel? SHOW WORK!

Reference: Fry, S. *Itsy Bitsy Pumpkin*, Little Simon, 2014.

APPENDIX B: Handout accompanying Eric Carle's *Little Cloud*

Little Cloud (Carle, 1996)

Directions: Place your cotton balls on the graph to create your very own cloud! Using your pencil, trace your cloud. After your cloud is traced, remove the cotton balls and shade in the area. Calculate the area of the shaded region and the percentage of the grid that is covered by your cloud.



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