Inquiry-Based Learning at a Summer Math Program

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Abstract:

This Thesis consists of three components related to inquiry-based mathematics learning. The first component is a literature review detailing what inquiry-based learning is, how it is commonly used, and the benefits of this type of instruction. The second part is a collection of math lesson plans for elementary age students. The third component was my experience teaching these lessons and other activities at a math program I ran through the Boys & Girls Club. I was responsible for planning and executing an eight-week long math program for K-5th grade students. This experience and what I learned about inquiry-based learning methods in an educational summer-program setting was presented at my Honors Presentation and Defense.

Introduction

In recent years education has begun to shift from a traditional learning approach in the classroom to a student-centered approach. One framework that shifts away from traditional methods is Inquiry-based learning (IBL). Inquiry-based learning has most commonly been implemented in upper-level science courses. However, there is evidence that this way of teaching can be effective across grade levels and academic content areas. The research stated here examines what IBL is, how it is most frequently used, and the effects of IBL on student success.

What is Inquiry-Based Learning?

Inquiry-based learning (IBL) is a teaching method that reverses the order of a traditional lesson. In the traditional classroom teachers present the information, then students practice, and the lesson ends with answering big picture questions. A key component of IBL is that the lesson begins by posing a question, then students work collaboratively to solve it (Ernst et. al., 2017). Ideally, this question is engaging and sparks curiosity among students. In the traditional classroom, the teacher is the one who possesses all necessary knowledge, and they are responsible for passing this knowledge to their students (Khalaf & Mohammed Zin, 2018). However, in a classroom that implements IBL, the students take much greater responsibility for their learning. This does not mean that students are left on their own throughout the learning process. Instead, the teacher serves as a guide to lead students through their learning while allowing them to ask questions as they discover new information (Keys & Bryan, 2001). Inquiry-based learning encourages students to ask questions and use critical thinking skills to solve a problem (Duran, & Dökme, 2016). Giving more power to students allows them to be deeply engaged in the material and provides them the opportunity to experience productive struggle before arriving at the answer (Ernst et. al., 2017). Research has shown that another key aspect of

inquiry-based learning is that it is a collaborative process. Students collaborate with their classmates through discussions and group projects (Ernst et. at., 2017).

IBL serves as the overarching framework for teaching, but it may look different for a particular class depending on the age, ability, and needs of the students in that class (Ernst et. al., 2017). The origin of inquiry-based learning can be traced back to the work of John Dewey. Dewey was influenced by other educational philosophers who saw the importance in learners gaining knowledge through questioning, experimentation, and deep thinking through reflection (Artigue & Blomhøj, 2013). In contrast, the traditional teaching method is based on the Behaviorism learning theory (Khalaf & Mohammed Zin, 2018). This theory states that students learn behaviors due to their interaction with the environment.

How is Inquiry-Based Learning Commonly Used?

My research across the majority of these studies found that inquiry-based learning is most prevalent in science courses (Khalaf & Mohammed Zin, 2018; Sever & Guven, 2014; Duran & Dökme, 2016). Many of these were upper-level courses, such as high school and college classes (Khalaf & Mohammed Zin, 2018). However, there are ways to implement IBL in elementary classes. For example, the books in the "Mindset Mathematics" series are full of lessons, research, and activities that promote student thinking through inquiry-based learning with younger students.

The author, Jo Boaler, gives suggestions on how to take an existing lesson and change it to make it more inquiry-oriented. The primary way this goal is achieved, is by modifying the lesson so that it begins with a question or problem for students to solve (Boaler, 2022). Another way to modify tasks is by asking students to draw pictures to show their thinking (Boaler, 2022). This encourages them to be reflective about their learning and conceptualize the mathematical process they are using to solve a problem. "Opening" a task so that it is a "low floor, high ceiling" task also makes it more inquiry-oriented (Boaler, 2022). Low floor, high ceiling activities are ones that are made accessible to all students regardless of skill levels. Typically, they are open

ended and have multiple ways to solve them (Boaler, 2022). This means that all students can participate in different ways and still come to meaningful conclusions. Another way to modify a task to make it inquiry-oriented is having students' reason with their answers by showing why it is true (Boaler, 2022). This encourages students to think through their answers and logically defend them using mathematical concepts and reasoning.

Teachers and IBL

Some of the studies I researched focused on teachers and their viewpoints and experiences with inquiry-based learning. Research has found that when teachers have more experience with inquiry-based learning as a preservice teacher, they are more likely to use these methods in the future (Magee & Flessner, 2012). Challenges facing teachers that can have a negative impact on student learning include teachers not believing in the benefits of IBL, lacking knowledge about how to correctly implement IBL in their own classrooms, and teachers not having enough practice with IBL to effectively use it with students (Keys & Bryan, 2001).

Effects of IBL

Inquiry-based learning has been found to provide students with many educational benefits such as promoting flexible thinking, making connections to real-life events, and improving students' critical thinking and problem-solving skills. Inquiry-based activities promote flexible thinking because students are invited to ask questions throughout the learning process. This requires them to add to their knowledge and make adjustments as they gain new information (Jansen, 2011). IBL positively enhances students' problem solving and critical thinking skills as well (Duran & Dökme, 2016). Inquiry-based learning has also been found to increase student's motivation in school (Sever & Guven, 2014). A study conducted in 2002 researched the effects of IBL on long-term learning and the attitudes of middle school students towards science. In order to learn more about this, data was collected on middle school students who went to summer camp. The group of

students who attended summer camp that used inquiry-based learning methods had the best outcomes for comprehension and attitudes toward learning (Gibson & Chase, 2002).

Conclusion:

Inquiry-based learning is a framework in which students work collaboratively and think creatively in order to solve a problem or answer a question. It has most frequently been used in science classes but has benefits for students of all ages across multiple subjects. Some of these benefits include strengthening students' problem-solving skills and critical thinking ability. It has also been found to increase students' motivation and attitudes toward school. These benefits provide a rationale for implementing inquiry-based learning in the classroom.

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Boxes of Pencils – Place Value with 10s and 1s

Grade Level: 1st	Time Requirement: 45 minutes
Oklahoma Academic Standards for Mathematics	
Standards	1.N.1.2 Use concrete representations to describe whole numbers between 10 and 100 in terms of tens and ones. Know that 10 is equivalent to 10 ones and 100 is equivalent to 10 tens.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	Students will determine how many groups of tens and ones are in a two-digit number. This will strengthen their knowledge of place value.	1. Formal: As you give students cards with numbers of pencils on it, assess how they determined how many boxes of ten and loose ones there are. 2. Informal: During the discussion, ask students how they made the groups to gain a better understanding of their thinking.

Prior Academic Knowledge:

Students need to be able to sort objects into multiple groups with ten objects in each group.

Materials:

- Box of 10 pencils, to display for class (this could be changed to a box of 10 candies or any other container with 10 objects).
- Snap cubes for each pair of students
- Index cards with two-digit numbers written on them (

Engage/Introduction:

Show the class the box of 10 pencils and tell them that pencils are frequently packaged with 10 pencils in each box. Tell students that today they are “working” in a pencil factory.

Ask students, “If we know how the total number pencils we have, how could we figure out how many packs of 10 and how many extra pencils we would have?”

Have students turn and talk to their neighbor about possible answers to this question.

Explore/Main Activity:

Give each set of partners an index card that has a two-digit number written on it, as well as some snap cubes for them to represent their work with. Have students work with their partner to determine how many packs of 10 they can make and how many extra “loose ones” they will have. Ask students to write down or draw their thinking and counting process.

Continue to give students new cards with different two-digit numbers on them when they find the answer to their first card.

Explain/Discussion:

After students have had time to work with their partner to make boxes of 10s and loose ones, bring the class together for a whole group discussion.

Have partners share how they determined how many boxes of ten and how many loose ones they had for their numbers. Then, ask students what patterns they noticed. The goal of this part of the discussion is for students to see that, for example, the 3 in the number 34 represents 30, or 3 packs of ten.

Possible Extensions:

- Give students index cards with three-digit numbers on them. This can be seen as more challenging for students. It also expands their understanding of place value to include three-digit numbers (in the low hundreds).

Notes:

This lesson is from Mindset Mathematics Grade 1

I did this lesson with students the summer before they started 1st and 2nd grade. Some students really struggled with the activity, but others got the hang of it once they were given a few different numbers (index cards). As they got quicker with making the boxes and loose ones, I would give students cards with higher numbers on them. They viewed it as a challenge, and it made the activity more fun and engaging. It was also helpful for some of the groups to be given numbers just above 100, I also think it helped build their understanding of place value. I think it would have been better to have enough snap cubes for each partnership to have their own set to work with, because the physical manipulatives were helpful, but I did not have enough in my classroom.

Calculating Area Using Square Tiles

Grade Level: 3rd	Time Requirement: 30 minutes
Oklahoma Academic Standards for Mathematics	
Standards	3.GM.2.2 Develop and use formulas to determine the area of rectangles. Justify why length and width are multiplied to find the area of a rectangle by breaking the rectangle into one unit by one unit squares and viewing these as grouped into rows and columns. 3.GM.2.4 Find the area of two-dimensional figures by counting the total number of same-size unit squares that fill the shape without gaps or overlaps.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	Students will measure the area of a rectangle with square units. Students will make connections between measuring area by counting the total number of square tiles that the object takes up and measuring area using the standard formula Area = length x width.	1. Informal: The assessment for this activity will take place as you observe and question students while they find the area of their papers. 2. Formal: This lesson could be followed up with a more formal assessment through a worksheet about area.

Prior Academic Knowledge:

2.GM.2.1 Explain the relationship between the size of the unit of measurement and the number of units needed to measure the length of an object

Materials:

- Copy paper, large note cards, other sizes of paper
- Square tiles for measuring

Engage/Introduction:

Show students a piece of copy paper and one plastic square tile. Ask them to estimate how many tiles they think you could fit in the piece of paper. Record some of the estimations on the board. Tell students that they will be answering this question today!

Explore/Main Activity:

For the Explore, students will work with partners to determine the area of a piece of copy paper. They will do this by filling in the whole paper with square tiles.

After students have found the area of their paper, give them a different size of paper to find the area of.

Once pairs have found the area of their papers, ask them to try to think of a quicker way to calculate the area of their pieces of paper. This should lead them to use the standard formula for area (length x width). However, if they do not come to this conclusion on their own, that is okay. Allow them time to explore and try out their own ideas before correcting them. In the explain you have a class discussion about how to use the formula for area.

Explain/Discussion:

Bring students together for a whole class discussion about how they found the area of their pieces of paper. Some questions to ask are:

- How did your group first find the area of your paper?
- Did you think of a way to find the area in a quicker way than filling in the whole rectangle?
- Did you use any other strategies to find the area?
- What was the most challenging part of calculating the area?

As students answer these questions, the discussion should end with an explanation of why we use the formula length x width to calculate area. This is something that should be written and drawn on the white board. Students could also write this formula down in their math notebooks to refer to later.

Possible Extensions:

- Continue to give students larger pieces of paper once they are using the area formula.
- Ask students to think of other times when you need to calculate the area of a rectangle. Encourage them to think of real-life situations; this helps students to see why math is important and applicable in the real world.

Notes:

I taught this lesson as a review activity with students going into 4th and 5th grade. Even though this is a 3rd grade standard, I found that my students were still having some trouble with area. I did this lesson a few weeks after the "Measuring Area Using Nonstandard Units," so students were already familiar with calculating area. I chose to do this lesson because we were about to start a unit in which students would need to be able to calculate area quickly and understand the concepts behind area. However, this lesson could also be used to introduce the area formula.

Foot Parade (Adapted from youcubed)

Grade Level: Kindergarten	Time Requirement: 30 minutes
Oklahoma Academic Standards for Mathematics	
Standards	K.N.1.6 Read, write, discuss, and represent whole numbers from 0 to at least 20. Representations may include numerals, pictures, real-object and pictographs, spoken words, and manipulatives.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	Students will make combinations of numbers that equal 10.	1. Formal: Animal parade papers 2. Informal: Student conversation at the end of the lesson.

Prior Academic Knowledge:

PK.N.1.1 Count aloud forward in sequence by 1s to 20.

PK.N.2.1 Identify the number of objects, up to 10, in a row or column.

Materials:

- Foot Parade animal cards
- Scissors
- Glue sticks
- Crayons (or something to color with)

Engage/Introduction:

Show students the page with all the animals on it. Point to each animal and ask students how many feet each animal has. Then tell students they will be using the animal cards to make their own “parades” with these animals.

Show students the foot parade example or make your own foot parade to use as an example. As a class, count how many feet are in the parade (there should be 10). Explain to students that they will be making their own foot parade by coloring and cutting out the animals, then gluing them into a line to form a parade. They can use any combination of animals – but the total number of feet in the parade needs to equal 10. It might be helpful to have a class discussion to give students some ideas of how students can achieve this; 1 moose + 1 ostrich, 1 ladybug + 1 ostrich + 2 snails, etc.

Explore/Main Activity:

During the explore, students work individually to create their own foot parades with ten feet. They can color the animals and then cut them out and glue to a piece of paper or small poster board. Under each animal, have the students write the corresponding number of feet. For example, under the moose write a 4. Students can then decorate their papers or posters to look like a parade.

Explain/Discussion:

Once students have made their foot parades, have a class discussion so students can share their papers. During this time, you can lead a conversation about the different combinations of animals students used to make 10 feet.

Possible Extensions:

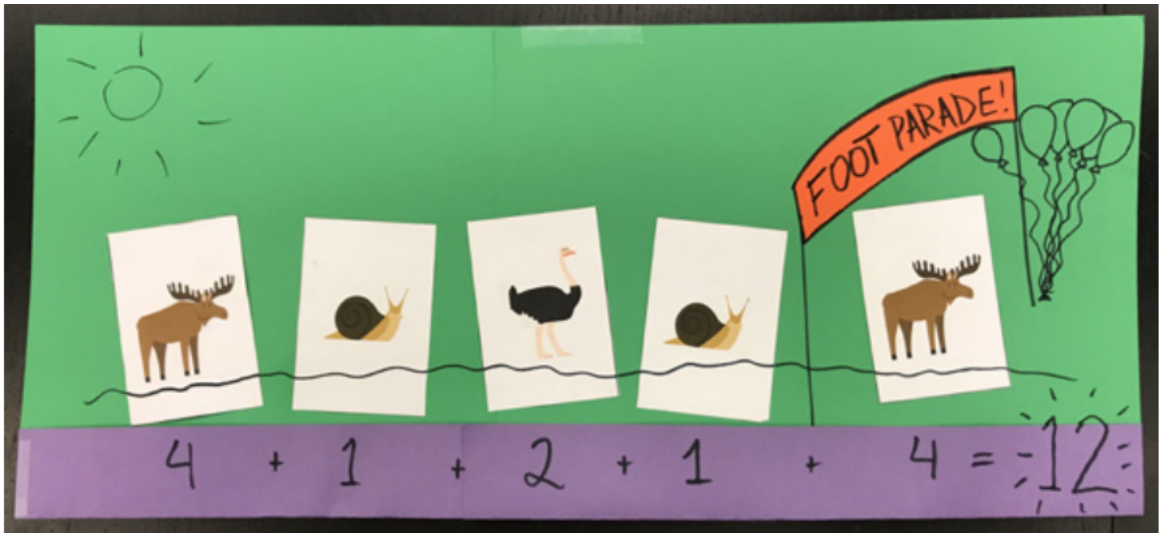
- Have students make foot parades with 20 feet in total (or a different number of your choosing)
- Ask students to make a different parade with the same number of total feet (10 or 20) but using a different combination of animals
- Challenge students to make a foot parade with a given number of total feet (10, 20, or other) by using either the LEAST number of animals possible or the MOST animals possible

Notes:

This lesson is adapted from youcubed

This lesson went well when I did it at the Boys and Girls Club with our youngest class – students going into K and 1st grade. They liked the coloring, cutting, and pasting (and these are important skills for kindergarten). I think they also liked that they got to make choices about which animals to use in their parade. Students wanted to make their own parades with random numbers of animal feet, so the extensions are a good way for students who finish early to continue working on the activity.

Full lesson can be found here: https://www.youcubed.org/wim/foot-parade-1-2/



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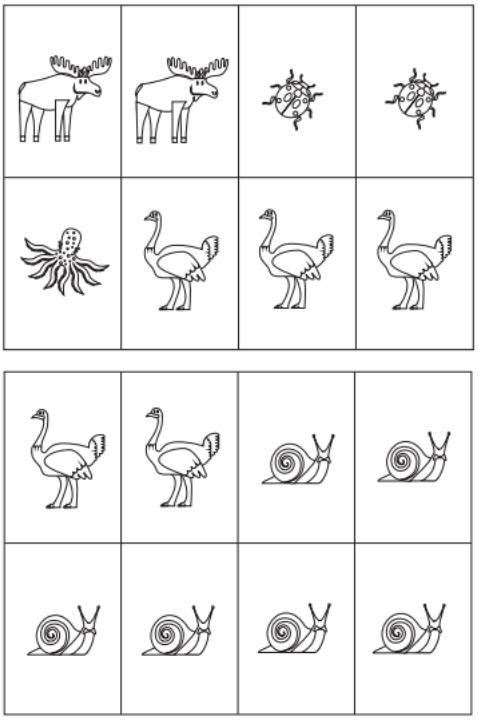

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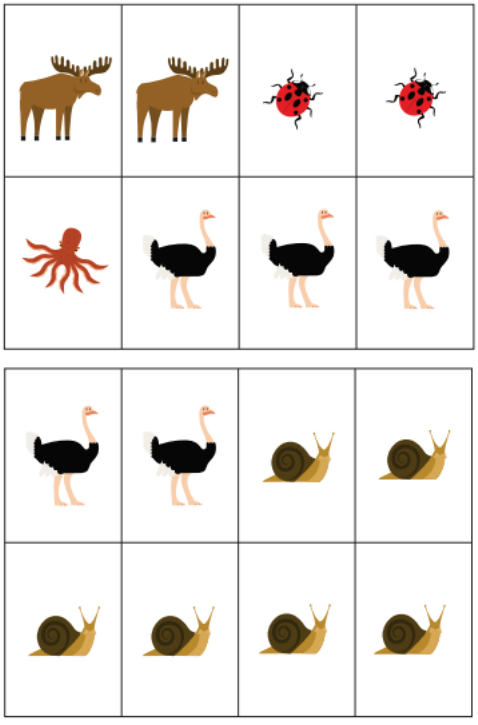


Measuring Area Using Nonstandard Units

Grade Level: 3rd	Time Requirement: 45 minutes
Oklahoma Academic Standards for Mathematics	
Standards	3.GM.2.2 Develop and use formulas to determine the area of rectangles. Justify why length and width are multiplied to find the area of a rectangle by breaking the rectangle into one unit by one unit squares and viewing these as grouped into rows and columns.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	- Students use nonstandard tools (in this case, paper) to measure area. - Students make connections between measuring area by counting the total pieces of paper that the object takes up and measuring area using the formula Area = length x width.	1. Formal: student recording sheet (have students write down how they are finding the area and all their calculations in a notebook). 2. Informal: As students work in groups to measure classroom objects, record what strategies they are using. A whole-class discussion at the end of the activity will also inform the teacher about the student's thought process while measuring area.

Prior Academic Knowledge:

2.GM.2.1 Explain the relationship between the size of the unit of measurement and the number of units needed to measure the length of an object

- Students need to be familiar with how to measure the length of an object. They do not need to know how to find the area of a rectangle yet.

Engage/Introduction:

For the "Explore" portion of this lesson, you need to select large classroom objects for students to measure. You also need to group students (partners or small groups) and give each group two classroom objects that they are responsible for measuring and determining which one has a larger area.

To introduce this activity, have the two objects each group is going to measure written on the white board. As a class, vote or discuss which object the students think will have a larger area. (At the end of the lesson, you will meet back as a class to see if the predictions were correct). Try to pair objects of a similar size together to make the predicting more difficult (it is also interesting to pick objects with a similar area, but different shape – such as a long, skinny rectangle and a short, wide rectangle.)

Explore/Main Activity:

MATERIALS: printer paper (or notecards if measuring smaller objects), tape

Once the predictions are gathered, have students use pieces of paper to measure the area of their objects (they may need tape as well).

During this time, you should walk around the room to observe how different groups are finding the area of their selected objects and offer help as needed.

Explain/Discussion:

Once all the groups are done measuring and have found the area of their objects, have the class come together to discuss their results/strategies.

NOTE: use your observations from the explore to select the order in which you want the groups to share their work. For example, you might want to have a group that counted each unit share first, then finish the discussion with the group that used multiplication (this is a more "advanced" and efficient strategy).

Questions to ask during the explain:

- "Tell me about what strategy your group used to find the area"
- "Did you use more than one strategy?"
- "Do you think your strategy was quickest, or do you think there is another way to find the area that might be easier/more efficient?"

After all groups have had a chance to share their work, make connections between the different strategies. This should lead to introducing the formula for area (Area = length x width).

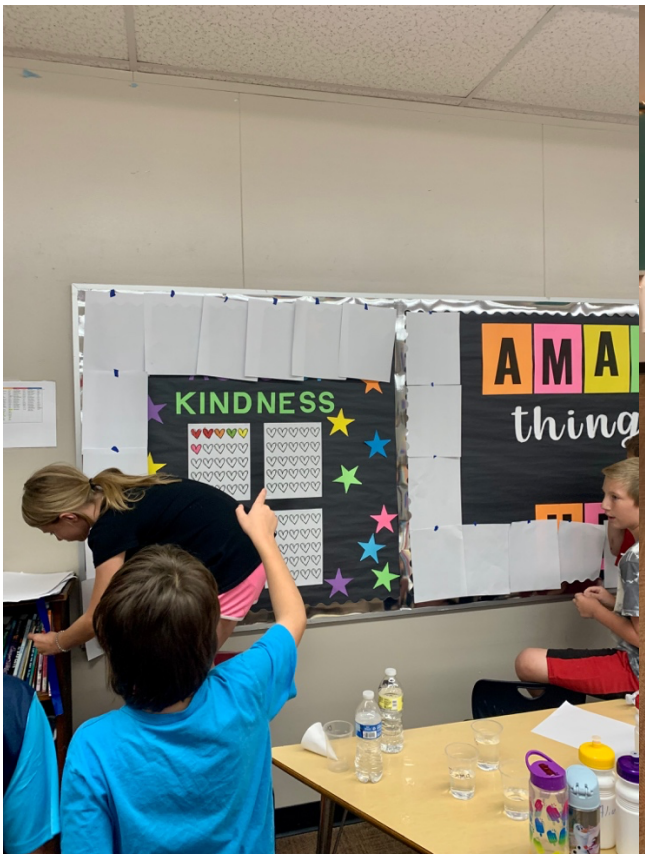
Possible Extensions:

- For the next lesson, have students measure the same objects using standard units and measuring tools such as a measuring tape.
- If you wanted to include perimeter in this lesson you could, but students would need to already be familiar with the formulas of area and perimeter/what makes them different. But finding the perimeter is an option for groups who finish the explore early.

Notes:

This lesson went well when I did it with 4th and 5th grade students. The only thing that caused some trouble was that some groups did not correctly measure the object with the paper. Students had trouble lining up the paper without gaps or overlapping parts. They also did not always tape the paper in straight lines. For me, this did not cause much concern because the goal of this lesson is for students to conceptualize what area means; however, I did have to help students try to make their measuring more standard and accurate.

I had students use sheets of copy paper as their measuring tool and I selected large classroom objects to measure (white board, chalk board, bulletin board, door, filing cabinet). I like this lesson because of how hands on and engaging it is. It is also a good way to introduce the concept of area to students before teaching them the formula. Students do not need to have any prior knowledge or experience with area in order to participate in this activity. Because of this, it is a great lesson to begin measurement unit/ more time spent on area and perimeter.



One Hundred Hungry Ants Literature Connection

Grade Level: 2nd	Time Requirement: 30 minutes
Oklahoma Academic Standards for Mathematics	
Standards	2.N.2.6 Use concrete models and structured arrangements, such as repeated addition, arrays and ten frames to develop understanding of multiplication.

	Learning Objective(s) Associated with Above Standards:	Assessment
	1. Students will represent multiplication problems in multiple ways through arrays.	1. Formal: Student recording sheets (The arrays they draw can be in a handout or a math notebook.) 2. Informal: Class discussion

Prior Academic Knowledge:

1.N.1.4 Count forward, with objects, from any given number up to 100 by 1s, 2s, 5s and 10s.

Materials:

- *One Hundred Hungry Ants* by Elinor J. Pinczes
- Manipulatives to create arrays of "ants"
- Students need paper to record their work

Engage/Introduction:

Read *One Hundred Hungry Ants* by Elinor J. Pinczes.

Tell students that in the book 100 ants went to the picnic in rows of 2, 4, 5, and 10. Today, we will be making our own rows of hungry ants marching to a picnic.

Explore/Main Activity:

For the main part of the activity, students will work with a partner to make arrays of ants using manipulatives.

Say: *At our picnic the ants are marching toward the food in a group of 24 ants. I want you to use the manipulatives at your table to make parades that have 24 "ants" in total. As you make your parade, record what it looks like on a piece of paper so we can talk about it later. Remember that rows go side to side and columns go up and down. Also, make sure your ants are in straight lines so you can count them easily. After you make your parade with the ants, use dots to sketch your parade on paper, just make sure that your drawing matches the one you made with counters. You can work with a partner to make your rows of ants. Once everyone has their rows made, and has recorded how they did it, we will share as a group.*

Explain/Discussion:

Have students join you for a whole class discussion.

During the Explain, you will share student strategies and introduce the academic vocabulary (array).

Say: *Great job making your parades of ants! In math, this type of organized group is called an array. An array is when objects are organized into rows and columns. Let's look at Student A's ant parade. In this array, the ants are in 2 rows and 12 columns. We can use arrays to help us with multiplication. This array could be written as the multiplication problem 2 x 12 = 24. Which means that when there are 2 rows, with 12 objects in each row, there are 24 objects altogether.*

Okay, now let's look at Student B's strategy. In this array we have 4 rows and 6 columns. If were to write that as a multiplication problem, it would be 4 x 6 = 24 because there are 4 rows and 6 objects in each row.

Remember that arrays are objects organized in rows and columns. They can be used to represent multiplication problems and they can also help us determine the total product of a multiplication problem.

Possible Extensions:

- Have students make an array with a larger number such as 48
- If you think students are ready to be introduced to more multiplication concepts, you can have students make arrays with numbers that they learn first in multiplication. For example, arrays of 5 (2 x 5 = 10, 3 x 5 = 15, 4 x 5 = 20) and arrays of 2 (2 x 3 = 6, 2 x 4 = 8).

Notes:

I did this literature connection with 1st and 2nd grade students at a summer program. Some of them knew what an array was, and others did not, but it was still helpful to do the activity first and then introduce the vocabulary. As I gave directions for the explore, I made notes on the white board about rows and columns. I reiterated this in the explain along with the term array. Some students had trouble keeping the manipulatives and dots (in their drawings) in straight rows. This is something I had to correct as I walked around the room while they worked.

Organizing and Counting a Collection (Mindset Mathematics)

Grade Level: 1	Time Requirement: 45 minutes
Oklahoma Academic Standards for Mathematics	
Standards	1.N.1.4 Count forward, with objects, from any given number up to 100 by 1s, 2s, 5s and 10s.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	Students will use manipulatives to count a collection of objects by organizing the objects into groups.	1. Formal: Student recording sheet, checking student work when they have finished counting a collection 2. Informal: Discussion at the end of the lesson, observation of student strategies as they work.

Prior Academic Knowledge:

Materials:

- Collections of objects. These can be math manipulatives such as snap cubes and counters, they can also be classroom materials like crayons or blocks.
- Tools to help students keep track of their counting. Bowls, cups, and paper plates work well.
- A student worksheet or math notebook entry for recording student work (if desired).

Engage/Introduction:

Show students some baskets containing a large group of classroom objects and tell them that their job is to figure out how many objects are in each group. Encourage students to find ways they can organize the objects so that they are better able to accurately count their given collection. Tell students that you are going to give them some

resources to help them organize the objects as they count. These are things like extra bowls, cupcake liners, paper for recording their work, small white boards, etc.

Explore/Main Activity:

Pair students up before beginning the explore.

Partners work with their collection of classroom objects to organize and count how many they have. Encourage students to try many different strategies to count their collection, but do not explicitly give them ways to do this. As students work, walk around the room and offer help as needed – direct students to organizing the objects by 2s, 5s, then 10s.

Give partners additional collections when they finish counting a group of objects.

Explain/Discussion:

Once all partners have had a chance to organize, count, and record their work for a collection (or multiple collections) bring the class together for a discussion. Have partners share how they organized and counted their groups. Have them share what strategies worked well and which ones were more confusing or time consuming. The discussion should end with all students making the connection that sorting objects into groups – especially 2s, 5s, and 10s is a helpful way to count a large set of objects.

Possible Extensions:

- Ask students to organize by 10s and 1s and then make a chart with how many 10s and 1s they have. This helps kids understand place value.

Notes:

This was one of my most engaging lessons at the Boys & Girls Club summer math program. I used this lesson with 1st graders, as well as with 2nd and 3rd grade as a hands-on review of counting and organizing. With each increase in grade and ability level, I increased the number of objects in the collection (for some of the partners I had collections with over 100 objects). They all really enjoyed this lesson! I mostly used math manipulatives for the collections and gave the older classes small white boards to record their work on. They love any opportunity to use the white boards, so this was a good addition to the lesson. It encouraged students to record their work and use the boards for written computation if that was more comfortable for them.


100
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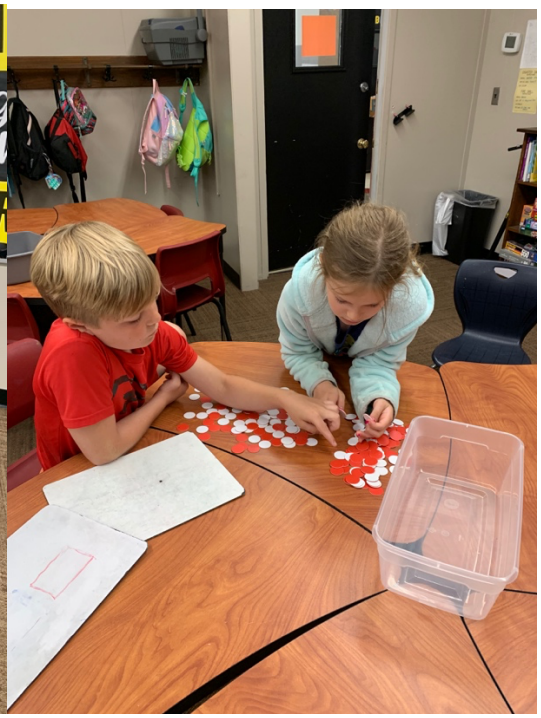



things
happen
HERE!

Pattern Bugs Literature Connection

Grade Level: 1st	Time Requirement: 30 minutes
Oklahoma Academic Standards for Mathematics	
Standards	1.A.1.1 Identify, create, complete, and extend repeating, growing, and shrinking patterns with quantity, numbers, or shapes in a variety of real-world and mathematical contexts.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	- Identify patterns found in the book *Pattern Bugs*. - Create their own growing patterns.	1. Formal: Assess the picture students create of their pattern bug and the other patterns they added to their drawing. 2.Informal: Listen for what patterns students identify as you read *Pattern Bugs.*

Prior Academic Knowledge:

K.A.1.2 Recognize, duplicate, complete, and extend repeating, shrinking and growing patterns involving shape, color, size, objects, sounds, movement, and other contexts.

- Students may not be creating patterns until 1st grade, but in order to be ready for this lesson, they should be familiar with the pattern skills listed in the kindergarten standard.

Engage/Introduction: Read Aloud

- Read aloud *Pattern Bugs* by Trudy Harris.
- Have students identify patterns they find in the pictures and words. (This can be done as you read, by pausing the end of each page to talk as a group, or you can wait to discuss until the end of the story.)

Explore/Main Activity: Drawing

- Watch Pattern Bugs Lesson (YouTube video by Rachel Fortenberry) starting at 4:30. Have students draw their pattern bugs along with the video, pausing as needed to catch up with the drawing instructions.

NOTE: this can easily be adapted to have the teacher lead the drawing activity instead of using the video – just watch the video beforehand and lead your class in a similar process of creating a pattern bug and then adding as many additional patterns as possible.

Explain/Discussion:

- Have students share their drawings and discuss what patterns they added.

Possible Extensions & Modification:

Extensions:

- Ask students to label the patterns on their drawing (ABC, ABC, ABC)
- Have students create their own patter bug (or other animal) on their own if the finish the pattern bug drawing quickly
- Ask students to determine what future segments of this pattern would be (Example: what would the 25th segment of your pattern be?)

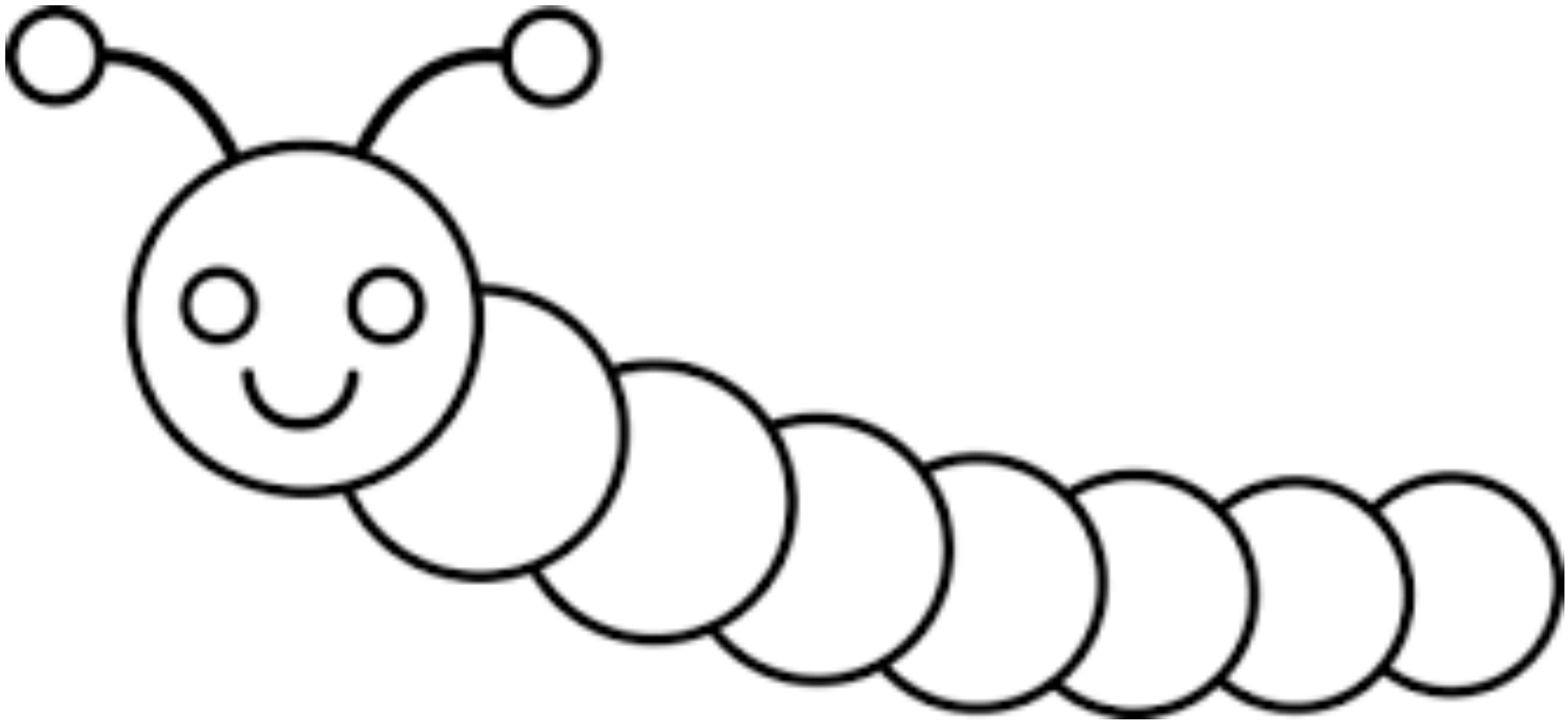
Modifications:

- Draw an outline of the pattern bug and make copies so students can just fill it in with patterns, instead of trying to draw their own circles for the body. Or use one from the internet, like the one on page 3.

Notes:

Overall, this lesson went well when I taught it at the Boys & Girls Club. I think it was best suited for 1st grade but could be adapted for slightly younger or older grades. I used it as a review lesson about patterns; I would not recommend teaching it when first introducing patterns because it relies heavily on students having some experience identifying and creating patterns. It is also a great way to incorporate both literature and art into the math lesson.

Name:_____



Pete the Cat and the Missing Cupcakes Literature Connection

Grade Level: Kindergarten	Time Requirement: 45 minutes
Oklahoma Academic Standards for Mathematics	
Standards	K.N.1.2: Compose and decompose numbers up to 10 with objects and pictures. K.N.1.5: Count forward, with and without objects, from any given number up to 10.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	Students will use counting back and counting on strategies to compose and decompose numbers up to 10 with objects arranged in a ten-frame.	1. Formal: Students will fill out the recording sheet. 2.Informal: I will listen to student's discuss while they work. I will ask probing questions to learn more about their thinking.

Prior Academic Knowledge:

K.N.1.2: Recognize that a number can be used to represent how many objects are in a set up to 10.

Materials:

- *Pete the Cat and the Missing Cupcakes by* Kimberly & James Dean
- Manipulatives (counters or square tiles)
- Recording Sheet

Engage/Introduction:

I will read the book *Pete the Cat and the Missing Cupcakes.*

Explore/Main Activity:

Have students practice an example with you.

- Go to the page where Pete lost the first two cupcakes. Have students discuss how they could figure out how many cupcakes Pete has if he started with 10 and lost 2. Encourage discussion and different strategies for solving this problem.

Pass out the recording sheet and manipulatives. Put students with partners. Tell students that one of them is going to be Pete and one is going to be Toad. Go over the directions on the recording sheet together. If students need more practice, solve the first question or two together before they work with their partners.

Encourage students to use the manipulatives as cupcakes and physically act out what would happen if they were Pete and Toad and were trying to figure out how many cupcakes were left.

Explain/Discussion:

After students have completed the recording sheet, bring the class together for a discussion. Ask students how they solved the problems. Ask them about the manipulatives and make connections between different strategies that partners used.

Possible Extensions:

- I would only select one recording sheet for the whole class to work on; however, I would have additional sheets printed to give to students who finish early.

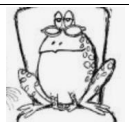
Notes:

This lesson was based on a lesson we did in SMED 3153.

Teaching this lesson with the book made it engaging for my students. They enjoyed acting as Pete and Toad and the manipulatives were helpful because it was a concrete representation of the math.

Pete the Cat and the Missing Cupcakes (A)

Directions: Each row tells you how many cupcakes Pete the Cat baked, and either how many cupcakes grumpy toad ate or how many cupcakes were left after grumpy toad ate some. Figure out the missing information.

	 baked ___ 	 ate ___ 	___  left
Day 1	10	4	
Day 2	10	3	
Day 3	10		5
Day 4	10		8
Day 5	10		2
Day 6	10		9
Day 7	10		4
Day 8	10		3
Day 9	10		0

Pizza Factory

Grade Level: K-1st	Time Requirement: 45 minutes
Oklahoma Academic Standards for Mathematics	
Standards	K.N.1.6 Read, write, discuss, and represent whole numbers from 0 to at least 20. Representations may include numerals, pictures, real-object and pictographs, spoken words, and manipulatives. K.GM.1.1 Recognize squares, circles, triangles, and rectangles. 1.N.3.1 Partition a regular polygon using physical models and recognize when those parts are equal.

	Learning Objective(s) Associated with Above Standards:	Assessment
1	Students will identify a variety of shapes. Students will count objects up to 20. Students will partition regular polygons and circles.	1. Formal: "Pizza Factory" recording sheet 2. Informal: Asking questions as students make their pizzas.

Prior Academic Knowledge:

PK.GM.1.1 Identify circles, squares, rectangles, and triangles by pointing to the shape when given the name.

PK.N.2.2 Use one-to-one correspondence in counting objects and matching groups of objects up to 10.

Materials:

- Scissors
- Glue sticks
- "Pizza Factory" recording sheet

- Pencils and crayons for recording sheet
- Colored construction paper for cutting pizza toppings
- Paper plates (if desired)

Engage/Introduction:

I will put an example pizza on the board and invite students to notice and wonder.

Anticipated noticing/wonders:

- Shape of pizza
- Shape of toppings on pizza
- Colors of toppings
- Number of toppings
- Pieces of the pizza (fraction it is divided in, ex. fourth)

Explore/Main Activity:

Tell students that today they will be working in a pizza factory and designing their own pizza with partner!

Pass out materials and partner students (if you want them to work in groups). Explain to students that they will be making their own pizza. This means that they get to decide what shape the pizza is, what toppings are on it, and how many pieces they are splitting it into. As students make their pizzas, they will be recording information about them on the recording sheet. This sheet will be used for the class discussion and later turned in as an assessment.

Explain/Discussion:

Once students have finished creating their pizza, bring the class together for a discussion.

Have partners show their pizza to the whole class and talk about the shapes, colors, and numbers they used when making their pizza. Ask groups how many people could share their pizza if each person got one piece.

(This could also be done with table groups instead of presenting to the whole class.

Possible Extensions:
- Focus on the partitioning by giving student a number of people that need to share the pizza. (For example, "Four people want to share this pizza. How could we cut the pizza so they each get one piece?")

Notes:

This lesson helps students identify shapes, colors, and practice partitioning a regular polygon. It is also engaging and encourages students to be creative because they are thy ones who are making the decisions when it comes to their pizza. This lesson could be easily modified for a variety of grade levels and depending on the skills you want to focus on. For example, this lesson is made for kindergarten and 1st graders because it includes partitioning and fair sharing which is a higher-level task. This was also practical for me because I had combined grade levels at the Boys & Girls Club. When I did it with Pre-K students, I focused more on shape identification, colors, and counting. For Pre-K students it was also good practice with cutting and pasting. With younger students, I also provided more structure and gave them the types of toppings to use, rather than letting them make the decisions fully on their own.

Name:_____

Pizza Factory

1. What is the shape of your pizza? Draw it here:

2. Draw the shape and color in the toppings you used here:

○ Circle	Rectangle	△ Triangle	Other

3. How many toppings did you use in total?

4. How many people could eat your pizza if they each get 1 piece?