**Lesson Plan: Numeric & Shape Patterns** (This lesson should be adapted, including instructional time, to meet the needs of your students.)

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| **Background Information** | |
| **Content/Grade Level** | Operations and Algebraic Thinking Grade 4 |
| **Unit/Cluster:** | 4.OA.C Generate and Analyze Patterns |
| **Essential Questions/Enduring Understandings Addressed in the Lesson** | * How can patterns help in problem solving? * How can multiple representations be used to express relationships? * How can expressions and equations be used to represent practical problems symbolically? * How can change be described mathematically? * Why are equations and inequalities useful? * What can we learn from studying patterns? * How can we use patterns to develop an understanding of our place value system? * What patterns are useful in computation? * Where are patterns in nature, architecture, music, words, and numbers? * What is the repeating and/or increasing unit in the pattern? * What strategies can be used to continue a sequence? * How does finding patterns help in counting and/or computation? * How is an equation like a balance scale? * How can relationships be expressed symbolically? * Why are variables used? * What strategies can be used to solve for unknowns? * Patterns enable us to discover, analyze, describe, extend, and formulate concrete understandings of mathematical and real world phenomena. * Algebraic representations are used to communicate and generalize patterns in mathematics. * Changes in quantities can be used to predict outcomes and solve problems. * Patterns can be found in many forms. * Patterns can grow and repeat. * Patterns can be generalized. * Mathematical expressions represent relationships. * Number patterns and relationships can be represented using variables. |
| **Standards Addressed in This Lesson** | * 4.OA.C.5 Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. *For example, given the rule “Ad 3” and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.*   It is critical that the Standards for Mathematical Practice are incorporated in ALL lesson activities throughout the unit as appropriate. It is not the expectation that all eight Mathematical Practices will be evident in every lesson. The Standards for Mathematical Practice make an excellent framework on which to plan your instruction. Look for the infusion of the Mathematical Practices throughout this unit. |
| **Lesson Topic** | Numeric and Shape Patterns |
| **Relevance/Connections** | * This unit builds on work done with numeric patterns in earlier grades. * This unit leads to work with functions in later grades, as well as graphing, and interpretation of graphs based on the patterns displayed. |
| **Student Outcomes** | * Generate a number pattern that follows a given rule. * Generate a shape pattern that follows a given rule. * Generate both growing and repeating patterns that follow given rules. * Identify various features that they see in the patterns generated. * Determine a future element in a repeating or growing pattern based on the portion of the pattern visible. |
| **Prior Knowledge Needed to Support This Learning** | * Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s. * Count within 1000; skip-count by 5s, 10s, and 100s. * Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. |
| **Method for determining student readiness for the lesson** | The Warm Up and Motivational activity will inform teacher of student readiness. |

| **Learning Experience** | | |
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| ***Component*** | ***Details*** | ***Which Standards for Mathematical Practice(s) does this address? How is the Practice used to help students develop proficiency?*** |
| ***Warm Up*** | Ask: Where have you seen patterns? Is anyone wearing a pattern? Does anyone see a pattern in the classroom?  (As students share, have them explain each pattern explicitly.) | SMP 4: Model with mathematics - Students are discussing real-world examples of patterns.  SMP 6: Attend to precision - Students share their patterns using appropriate mathematical vocabulary. |
| ***Motivation*** | Materials Needed:   * Resource Sheet 1: Multiplication Chart (for display and one for each student)   Directions:  Refer to multiplication chart – patterns (should have been done in 3rd)  Display Resource Sheet 1: Multiplication Chart or distribute copies to students.  What patterns do you see?   * All rows and columns that has an even factor will produce an even product. * Rows & columns for 5 – all products end in 0 or 5. * Rows & columns for 10 – all products end in 0. * No columns or rows have all odd numbers – why is that? When will you get an odd product? (E x O) * Diagonally from top right to bottom left – all perfect squares * A square number is a result of a number times itself (1 x 1, 2x2, etc.) * Look at where the square products fall on the table and identify where the next square number in the sequence will fall. | SMP 7: Look for and make use of structure - Students look for patterns in the multiplication chart. |
| ***Activity 1***  UDL Components   * Multiple Means of Representation * Multiple Means for Action and Expression * Multiple Means for Engagement   Key Questions  Formative Assessment  Summary | Materials Needed:   * Resource Sheets 2A&B: Using a Chart to Reason about Numeric Patterns (one copy for each student)   Directions:  Say: Today we will be exploring more number patterns.  Distribute Resource Sheets 2A&B: Using a Chart to Reason about Numeric Patterns and guide students through this activity.  Part A models how to use a chart to record and extend a numeric pattern. This can be done as a Think-aloud by the teacher.  Part B provides students with an opportunity to practice what they have just learned. Allow students to work in pairs and encourage student discussion as they work through the problem.  Discuss solutions before moving to Activity 2.  As students are working, note which students are still struggling with the concept and might need more time/support.  Also note which students might need enrichment. | SMP 1: Make sense of problems and persevere in solving them - Students make sense of a problem and how they can use patterning to solve the problem.  SMP 4: Model with mathematics - Students apply what they know about patterns to solve a real world problem.  SMP 6: Attend to precision - Students express numeric answers appropriate to the problem.  SMP 7: Look for and make use of structure - Students apply rules to a pattern. |
| ***Activity 2***  UDL Components   * Multiple Means of Representation * Multiple Means for Action and Expression * Multiple Means for Engagement   Key Questions  Formative Assessment  Summary | Materials Needed:   * Resource Sheets 3A&B: Using a Diagram to Reason about Shape Patterns (one copy for each student)   Directions:  Say: We are now going to explore a shape pattern.  Distribute Resource Sheets 3A&B: Using a Diagram to Reason about Shape Patterns to each student and guide them through Activity 2.  Part A models how to use a diagram to interpret and reason about a shaper pattern. This can be done as a Think-aloud by the teacher.    Part B provides students with an opportunity to practice what they have just learned. Allow students to work in pairs and encourage student discussion as they work through the problem. Discuss solutions before moving to Activity 3.  As students are working, note which students are still struggling with the concept and might need more time/support. Also note which students might need enrichment. | SMP 1: Make sense of problems and persevere in solving them - Students make sense of a problem and how they can use patterning to solve the problem.  SMP 4: Model with mathematics - Students apply what they know about patterns to solve a real world problem.  SMP 6: Attend to precision - Students express numeric answers appropriate to the problem  SMP 7: Look for and make use of structure - Students apply rules to a pattern. |
| ***Activity 3***  UDL Components   * Multiple Means of Representation * Multiple Means for Action and Expression * Multiple Means for Engagement   Key Questions  Formative Assessment  Summary | Materials Needed:   * Resource Sheets 4 A&B: Apply What You Have Learned   Directions:  Part A:  Students apply what they have learned. Students may work alone or in partners to work on questions 1-2. This activity may be used as a formative or summative assessment, depending on student readiness. | SMP 1: Make sense of problems and persevere in solving them - Students make sense of a problem and how they can use patterning to solve the problems.  SMP 4: Model with mathematics - Students apply what they know about patterns to solve a real world problem.  SMP 6: Attend to precision - Students express numeric answers appropriate to the problem.  SMP 7: Look for and make use of structure - Students apply rules to a pattern. |
| ***Closure*** | Use Part B for the closure. Depending on student readiness, question 3 could be used as an exit slip or as a basis for class discussion.  In addition, students could create their own shape patterns and share with classmates. When students share, they need to explain their pattern numerically. | SMP 1: Make sense of problems and persevere in solving them - Students make sense of a problem and how they can use patterning to solve the problem.  SMP 4: Model with mathematics - Students apply what they know about patterns to solve a real world problem.  SMP 6: Attend to precision - Students express numeric answers appropriate to the problem.  SMP 7: Look for and make use of structure - Students apply rules to a pattern  SMP 8: Look for and express regularity in repeated reasoning - Students understand the broader application of patterns and see connections within mathematics. |

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| **Supporting Information** | |
| **Interventions/Enrichments**   * Special Education/Struggling Learners * ELL * Gifted and Talented | Special Education/Struggling Learners   * Provide manipulatives for students to physically model the patterns * Physically create the model using desks and chairs * Frontload specific vocabulary such as *level* and *sequence* * Allow students to work in small groups and/or partners   ELL   * Frontload specific vocabulary such as *level, sequence,* and *pattern* * Allow students to work in small groups and/or partners   Gifted and Talented   * Have students extend patterns beyond classroom expectation * Students can design their own shape patterns and use a chart to record the patterns numerically |
| **Materials** | * Resource Sheet 1: Multiplication Chart * Resource Sheets 2A&B: Using a Chart to Reason about Numeric Patterns * Resource Sheets 3A&B: Using a Diagram to Reason about Shape Patterns * Resource Sheets 4A&B: Apply What You have Learned |
| **Technology** | See Unit Plan Technology Link for websites. |
| **Resources**  (must be available to all stakeholders) | See Unit Resources Link for various resource materials. |

Resource Sheet 1 **Multiplication Chart**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **x** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **1** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| **2** | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| **3** | 0 | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 27 | 30 |
| **4** | 0 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 |
| **5** | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
| **6** | 0 | 6 | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 |
| **7** | 0 | 7 | 14 | 21 | 28 | 35 | 42 | 49 | 56 | 63 | 70 |
| **8** | 0 | 8 | 16 | 24 | 32 | 40 | 48 | 56 | 64 | 72 | 80 |
| **9** | 0 | 9 | 18 | 27 | 36 | 45 | 54 | 63 | 72 | 81 | 90 |
| **10** | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |

Resource Sheet 2A **Using a Chart to Reason about Numeric Patterns**

**LEARNING HOW TO USE A CHART TO REASON ABOUT NUMERIC PATTERNS**

Eli gets $5 a week for his allowance. Eli is saving all of his allowance so he can buy a sport’s jersey that costs $42. He wants to know how many weeks it will take to save the amount he needs.

We can use a chart to represent the total amount Eli has each week.

|  |  |
| --- | --- |
| Week | Total $ Saved |
| 1 | 5 |
| 2 | 10 |
| 3 | 15 |
| 4 | 20 |
|  |  |
|  |  |
|  |  |
|  |  |

Look at the relationship between the two numbers in each row. (The week and the total saved for that week). We can see that if you multiply each week by 5, you get the total amount of money saved. So we can see that the rule is to multiply the week times 5. If we let *m* represent the week, we can write the rule as *m* x 5.

We can use this rule to calculate the amount saved at different weeks without filling out the entire chart. For example, at 10 weeks we can see that 10 x 5 = 50 which is more than Eli needs. At 9 weeks, we can see that 9 x 5 = 45 which is a little more than what Eli needs. At 8 weeks, Eli will only have $40, which isn’t quite enough. (8 x 5 = 40)

Resource Sheet 2B **Using a Chart to Reason about Numeric Patterns**

**PRACTICE USING A CHART TO REASON ABOUT NUMERIC PATTERNS**

Kris is making cookies for a bake sale. She agreed to make 5 dozen cookies. She can fit 8 cookies on each cookie sheet. She is wondering how many batches of cookies she will have to make.

Use the chart to help solve the problem.

|  |  |
| --- | --- |
| Number of cookie sheets | Total number of cookies |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

What rule represents this problem? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How many batches did she have to make? \_\_\_\_\_\_\_\_\_\_\_\_\_

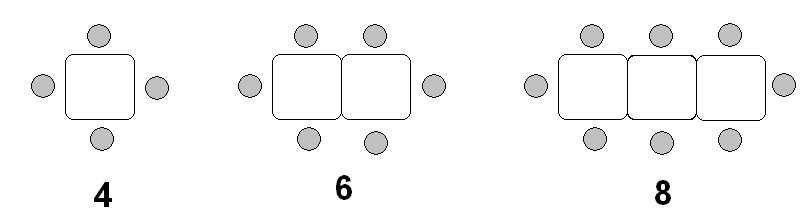
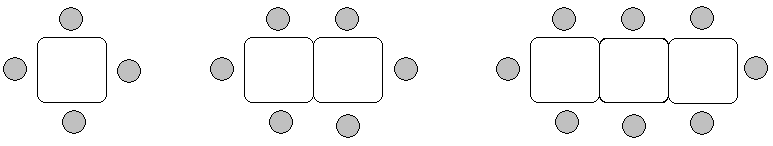
Did she have any cookies left over? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What should Kris do with the left over cookies?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Resource Sheet 3A **Using a Diagram to Reason about Shape Patterns**

**LEARNING HOW TO USE A DIAGRAM TO REASON ABOUT SHAPE PATTERNS**



Look at the table arrangement below. Each represents a chair and each represents a table.

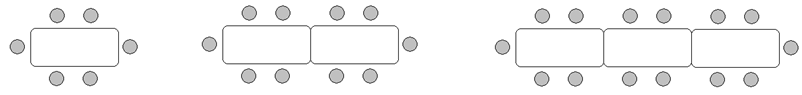
What do you notice about the number of chairs related to the number of tables? Start by writing the number of chairs below each set of tables.

You should notice that even though the number of tables doubles and then triples, the number of chairs does not. For example, one table has 4 chairs but two tables only have 6 chairs, not 8. Three tables have 8 chairs, not 12. Why is that? You should notice that when tables are pushed together, there are sides where no one can sit.

Resource Sheet 3B **Using a Diagram to Reason about Shape Patterns**

**PRACTICE USING A DIAGRAM TO REASON ABOUT SHAPE PATTERNS**

Look at the following table arrangement.



1. How many chairs are added each time a table is added? \_\_\_\_\_\_\_\_\_\_\_\_\_
2. How many tables are needed to seat 22 people? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Resource Sheet 4A **Apply What You Have Learned**

**Solve each problem and show all your work in the space provided.**

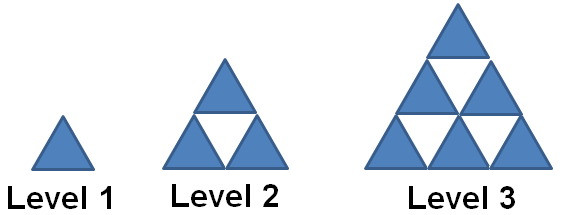
1. Riley makes $7 an hour babysitting. She is saving money to go on a trip to Kings Dominion. She decides she needs at least $80 for the trip.   
   How much money would Riley make if she babysat for 3 hours? \_\_\_\_\_\_\_\_\_\_\_\_\_

How much money would Riley make if she babysat for 5 hours? \_\_\_\_\_\_\_\_\_\_\_\_\_  
  
Riley babysat 6 hours on Saturday and 2 hours on Monday.

How much money will she make over the two days of babysitting? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How many more hours of babysitting before she has at least $80? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Look at the pattern of blue triangles below.



How many blue triangles are in each figure? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Think about the pattern you see. How many blue triangles will be in the 5th level? \_\_\_\_\_\_\_\_\_\_\_

Resource Sheet 4B **Apply What You Have Learned**

**Solve each problem and show all your work in the space provided.**

1. John represented the pattern above with the numbers 1, 4, 9.   
   Explain what pattern John is seeing. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  
  
How many triangles would be in the 5th level, according to John? \_\_\_\_\_\_\_\_\_\_\_\_\_\_