Lesson Plan # 1 – Linear and Exponential Functions Unit

Teacher Candidate: Timothy Paccione

Lesson Title: Exponential Decay

Grade Level: Algebra 1 (9th Grade)

Primary Subject Area: General Ed - Mathematics

Interdisciplinary Connections: English & Language Arts, Literacy

Lesson Duration: The lesson will span a full class period of 42 minutes.

Language Function:
Justify**:** Students will justify their answers to math problems using evidence of their understanding of Exponential Growth and Decay, and will explain why they believe their responses make sense mathematically and within context. They will do so in written form within their guided notes and independent tasks, and orally through discussion.

SETTING INSTRUCTIONAL OUTCOMES/ACADEMIC LANGUAGE

Enduring Understanding

Central Focus/Purpose Statement

The central focus of this lesson is for students to build on their understanding of Exponential Growth by interpreting Exponential Decay. Students will learn the differences between these two types of functions in both concept and notational elements and will be able to describe and analyze Exponential Decay models through both discussion and algebraic representations.

NYS Common Core Standards

CCSS.MATH.CONTENT.HSF.LE.A.1
Distinguish between situations that can be modeled with linear functions and with exponential functions.
CCSS.MATH.CONTENT.HSF.LE.A.1.C
Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
CCSS.MATH.CONTENT.HSF.LE.A.2
Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Objectives

- Students will describe and analyze Exponential Decay models.
- Students will understand that a growth factor of less than one results in a decreasing sequence of values.
- Students will use their understanding of Exponential Decay to justify their answers to word problems.

Academic Language
Content Specific Language: Function, Linear, Exponential, Sequence, Arithmetic, Geometric, Decay

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Process Terms: Describe, Analyze, Write, Determine
Syntax/Discourse: Students will recall the formula for geometric sequences ($a*b^{n-1}$) and will be given an opportunity to review and discuss what each part of the formula represents. Additionally, they will be provided with a suggested sequence of steps for solving Exponential Decay problems (E.g., First, identify *a* and *r*, then substitute and evaluate.)

Prior Learning/Prior Thinking

Students will need to draw on the previous two lessons in the unit which taught them the power of Exponential Growth and how to recognize it in real world contexts. They will need to apply the same methods of thinking in order to fully understand the concept of Exponential Decay. Students will compare the formula they used for Exponential Growth, specifically its inclusion of *(1+r)* to the element that replaces it in Exponential Decay, *(1-r)* and will need to comprehend why the exchange of those two elements makes sense logically.

MATERIALS/RESOURCES

Technologies and Other Materials/Resources:

Students receive a copy of a module titled *Exponential Decay*. The module was created by *EngageNY*, a New York State website that provides guidance to instructors that teach to *Common Core* standards. The module includes guided notes as well as practice problems for them to complete throughout the lesson. The classroom contains a Smart Board and the module has been converted into Smart Board format. It has also been altered and supplemented in order to accommodate the individual learners in my class. The Smart Board will also be used to display a video that has been edited using *Camtasia* software. The original video can be found on YouTube and is titled *Exponential Decay - why your fidget spinner won't spin for longer* (https://www.youtube.com/watch?v=G7hh42AgBlQ). Students will be provided with graphing calculators. Finally, students will be provided with an Exit Ticket before leaving the class session.

CONTENT AND PEDAGOGY

Anticipatory Set/Hook Elicit Prior Knowledge

To introduce the topic of Exponential Decay, I will show the students a video that discusses a device/toy called a "fidget spinner" that is popular with my students. It examines, using visuals and discussions of Exponential Decay, why it is difficult to increase the duration of sustained spins to any significant degree, as the speed of each successive spin decays exponentially. This video introduces the lesson's topic while connecting it to a real life situation that many of my students are familiar with. The video was edited from its original version in order to remove segments that are outside the scope of my lesson objectives and could potentially confuse the students. I also added text to the video to serve as a visual prompt for discussion.

After the video, I will show the students side by side graphic organizers showing the differences between Exponential Growth and Exponential Decay, including their graphs, formulas, elements, and behavior. This will allow students to connect their prior knowledge from the preceding lesson to the current one. Additionally, I will ask the students a discussion question in order to elicit their higher order thinking skills, "What happens to the output if the growth factor of the formula is equal to 1?"

Procedures

Next, I will have the students take out their modules and guided notes and ask them to follow along with

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my lesson on the Smart Board. The subject of the lesson is Exponential Decay, and the lesson is designed to build on their previous understanding of exponential behavior learned during the Exponential Growth lessons immediately preceding this one. In those lessons, students learned to modify the formula for a geometric function *($G(n) = ab^n$)* in order to incorporate a growth rate by replacing the *b,* the rate of change, with *(1+r),* where *r* represents the percentage by which the sequence or function is growing. For example, if a function is growing by 10%, *r* = 0.10 and *b* = (1+0.10), or 1.10. In this lesson, students will need to replace *b* with *(1-r)* and will need to understand that they are doing so because the rate is now one which decreases the values from term to term within their sequence. We will examine real life situations in which Exponential Decay exists, such as the decreasing value of a car and the decreasing concentration of medicine in a body after consumption. In each example, I will teach the students how to identify the elements of their geometric function, particularly the rate at which it decreases. The final piece of instruction will include the plotting of an Exponential Decay function on a graph.

As the lesson proceeds, the students and I will fill in the guided notes together. I will be interacting with the Smart Board to fill in the missing pieces of the guided notes in order to model for them what should be written on their own papers. The students will be given an opportunity to learn through auditory and visual means, by listening to oral instruction and by following along with the Smart Board presentation. This variation will provide opportunities for various types of learners to retain their new knowledge.

Should time permit, I will give the students an opportunity to get started on their homework, which will consist of exercises that provide independent practice in recognizing Exponential Decay in real world scenarios. The homework will serve as a formative assessment.

With five minutes left in the class, I will distribute an Exit Ticket to the students. The ticket will provide them with an opportunity to present their understanding of the lesson through a word problem and a reflective question. This will serve as a formative assessment that will allow me to gauge student comprehension before beginning the next day's lesson.

Procedures (Overview of your lesson)

Time # minutes	Instructional Strategies/Learning Tasks	Purpose
5 minutes	1. Video – Fidget Spinners and Exponential Decay	- Engage Students, Introduce topic.
33 minutes	2. Instruction of new material and Smart Board presentation	-Provide new knowledge and guided practice
5 minutes	3. Exit Ticket and Handout	-Provide Closure and formatively assess progress.

Differentiation

The video, slides, and oral instruction will provide students with material in both auditory and visual formats, providing different types of learners with multiple means of representation. The video I will provide was edited to accommodate the students in my class and their learning styles. The video topic was chose due to its cultural relevance with my students, as interest was expressed by them in previous class sessions.

At the end of the lesson, students will complete an Exit Ticket that will give them an opportunity to present their knowledge in written form. This will benefit learners who are not as comfortable with problem solving as they are with reading and writing. The Exit Ticket will also give the gifted students in the class an opportunity to challenge themselves by employing their higher order thinking skills through reflection.

Throughout the lesson, I will be asking students probing questions in order to check for student

understanding and keep students engaged, particularly those who struggle to pay attention for extended periods. Accommodations for students including preferential seating for students who struggle concentrating and extra instruction time provided outside of the class session for those students who require it.

Closure

With five minutes left in the lesson, students will receive an Exit Ticket which will be completed and collected before they leave the classroom. This task will give the students an opportunity to reflect on their learning and provide closure before the next lesson. Additionally, it will provide a formative assessment that I will use to evaluate their understanding in anticipation of the next lesson. Students will also be given a handout containing the side by side comparison of Exponential Growth and Decay previously discussed.

STUDENT ASSESSMENT

Before the lesson

During the initial discussion and comparison of Exponential Growth and Decay, I will ask students to verbally summarize their understanding of the preceding lesson. I will ask probing questions and engage all of the students in my class in order to fully determine their understanding of exponential sequences, and will take notes if any students show a lack of comprehension so that I can follow up with them later on.

During the lesson

During the instructional portion of the lesson, students will be asked probing questions as we go through the examples in class. I will ask questions such as "Why does it make sense for us to use *(1-r)* instead of *(1+r)* when we are dealing with Exponential Decay?" in order to help the students understand the topic conceptually and engage their higher order thinking skills. If at any point during my instruction I notice certain misconceptions or misunderstandings being shared by multiple students, I will pause the instruction of new material and address the area being misunderstood. When students succeed and show full understanding of the concepts being taught I will recognize this verbally and provide them with positive feedback.

At the end of the lesson

Students will complete an Exit Ticket before leaving the classroom. These will be evaluated in order to determine whether or not students have achieved fluency, conceptual understanding and the ability to problem solve within the topic of Exponential Decay. If I do not find evidence of any of the three items being evaluated, I will address the lacking component before beginning the next day's lesson.

Students will be assigned a formative assessment in the form of a homework worksheet, which will require them to use the steps they learned within the lesson to complete practice problems. This homework will be collected on the day following the lesson and will be reviewed in order to determine individual student strengths and weaknesses within the concepts being taught. The homework will be used to assess whether or not the students gained the understanding set forth by the lessons objectives, as well as whether or not they are giving a proper effort within their mathematical practices. If I find they do not comprehend the concepts to a satisfactory degree, I will speak to them individually and will provide them with written feedback.

Lesson Plan # 2 – Linear and Exponential Functions Unit

Teacher Candidate: Timothy Paccione

Lesson Title: Why Stay with Whole Numbers?

Grade Level: Algebra 1 (9th Grade)

Primary Subject Area: General Ed - Mathematics

Interdisciplinary Connections: English & Language Arts, Literacy

Lesson Duration: The lesson will span a full class period of 42 minutes.

Language Function:
Justify**:** Students will justify their responses to discussion questions using their understanding of sequences and domains, and will explain why they believe their responses make sense mathematically and within context. They will do so in written form within their guided notes and independent tasks, and orally through discussion.

SETTING INSTRUCTIONAL OUTCOMES/ACADEMIC LANGUAGE

Enduring Understanding

Central Focus/Purpose Statement

The purpose of this lesson is to build on student understanding of sequences and their related functions by having them examine why our lessons have been limited, thus far, to functions involving whole numbers and integers. This lesson will ask them to consider situations wherein expanding their domain of inputs beyond those number sets may be appropriate.

NYS Common Core Standards

CCSS.MATH.CONTENT.HSF.IF.A.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of f corresponding to the input *x*. The graph of *f* is the graph of the equation *y = f(x).*

CCSS.MATH.CONTENT.HSF.IF.A.2
Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Objectives

- Students will use functional notation, evaluate functions for inputs and domains, and interpret statements that use functional notation within a specific context.
- Students will justify their interpretations of functions using contextual evidence.
- Students will create functions representing geometric scenarios and understand the relationship between functions and their graphs.

Lesson Plan # 2 – Linear and Exponential Functions Unit

Academic Language

Content Specific Language: Function, Linear, Exponential, Sequence, Arithmetic, Geometric, Inputs, Outputs, Domain, Range

Process Terms: Evaluate, Interpret, Create, Prove, Explain

Syntax/Discourse: Students will be supported in their understanding of functions and patterns using a graphic organizers in the form of pictures and graphs (E.g., $S(n) = n^2$ is shown as pictures of dots in perfect squares.)

Prior Learning/Prior Thinking

Students will need to retain and recall their understanding of discrete versus continuous functions. They will also be asked to identify explicit, recursive, geometric, and arithmetic functions, all of which were learned earlier in the current unit. Finally, they will need to utilize their general understanding of algebraic expressions in order to recognize the sequences in the example set.

MATERIALS/RESOURCES

Technologies and Other Materials/Resources:

Students will receive a copy of a module titled *Why Stay with Whole Numbers?* The module was created by *EngageNY*, a New York State website that provides guidance to instructors that teach to *Common Core* standards. The module includes guided notes as well as practice problems for them to complete throughout the lesson. The classroom contains a Smart Board and the module has been converted into Smart Board format. It has also been altered and supplemented in order to accommodate the individual learners in my class. Students will be provided with graphing calculators.

CONTENT AND PEDAGOGY

Anticipatory Set/Hook Elicit Prior Knowledge

Before beginning the lesson, students will complete a short Pre-Assessment that will assess their prior knowledge of the three essential elements of a function. The results of this Pre-Assessment will be used to plan the following day's lesson.

The lesson will begin with a partner activity in which the students will work together to examine the sequence of perfect squares (1,4,9,16,25,…). They will be assigned to partners randomly and will be asked to discuss the sequence and answer provided questions. They will be presented the sequence in two forms, both as a numerical set and in the form of square diagrams consisting of an increasing number of dots. The students will draw on their understanding of functions in order to define the sequence explicitly. After the students have defined their sequences with a function we will discuss whether or not we can use anything but whole numbers for our term numbers.

Procedures

After the opening exercise is completed, I will move on to the instruction of new material. Students will follow along, using their copies of the module with the identical slides that I have on the Smart Board. We will continue to discuss examples of sequences in which whole numbers must be used for terms. We will explore together why it is that we can only use positive whole numbers in our example functions. For instance, we will discuss that if our function represents the area of a square and the input, x, represents its side length, it would not make sense to have a negative value for x, as the length of a square cannot be negative. We will

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review the various number systems that exist in mathematics (E.g., Integers, Rational Numbers, etc.) At this point, I will introduce a new academic vocabulary word, Domain, which is the set of possible inputs and will point out that this word can be used to describe precisely what we have been discussing thus far in the lesson. After the students have seen a number of examples, I will reintroduce the concepts of discrete and continuous functions and ask them to identify various situations as one or the other. Finally, we will examine graphs that show the two types of functions and compare their similarities and differences.

As the lesson proceeds, we will fill in the guided notes together. All the while, I will be interacting with the Smart Board to fill in the missing pieces of the guided notes in order to model for them what should be written on their own papers. After the instruction of new material is complete, I will give the students a set of problems to work on independently. As they are completing this task, I will circulate the room and check for individual understanding and comprehension. Should time permit, I will also give the students an opportunity to get started on their homework, which will consist of exercises that provide further practice in the exploration of functions and their inputs. The homework will serve as a formative assessment.

With a few minutes left in the class, I will call the students to attention and present a summary of the key points of the lesson on the Smart Board, including that formulas that represent sequences have a set of inputs and those inputs represent a term number, while the outputs are the numbers in the sequence. I will also reiterate that the set of numbers available for the inputs depends upon the situation, and that sometimes whole numbers are all that is appropriate, but that other times that is not the case.

Procedures (Overview of your lesson)

Time # minutes	Instructional Strategies/Learning Tasks	Purpose
5 minutes	1. Pre-Assessment	-Assess for Next Lesson
7 minutes	2. Partner activity	-Activate Prior Knowledge / Engage Students / Collaborate
20 minutes	3. Instruction and Completion of Guided Notes	-Provide new knowledge and guided practice
5 minutes	4. Problem Set	-Independent practice / Individual assessment
5 minutes	5. Key points summary	-Provide Closure and formatively assess progress.

Differentiation

Students will be allowed to work partners at the beginning of the lesson in order to include collaborative learning within the instruction. This will enable students to complement each other's skillsets, with weaker students receiving help from students with stronger understanding of the material. This will also allow the more gifted students to engage in the higher order thinking skills required to demonstrate learning and teach content to another individual. Students will also be able to work independently later in the lesson, giving them an opportunity to practice individual problem solving skills.

Throughout the lesson, I will be asking students probing questions in order to check for student understanding and keep students engaged, particularly those who struggle to pay attention for extended periods. Accommodations for students including preferential seating for students who struggle concentrating and extra instruction time provided outside of the class session for those students who require it.

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Closure

With five minutes left in the lesson, students will be brought to attention and we will discuss the key takeaways from the lesson, including what their understanding of sequences and functional notation should be at this point in the unit and why we have been using whole numbers for our term placements. We will also discuss why we may not always use whole numbers going forward. I will ask the students to lead this discussion in order to ensure they are able to verbalize their thoughts and fully comprehend the material.

STUDENT ASSESSMENT

Before the lesson

Before the instruction of new material begins, the students will complete a partner activity involving the sequence of numbers that are perfect squares. As they complete this task, I will circulate around the class and check in with the pairs of students to see how they are progressing and take written notes of observations. This will formatively assess their understanding of previous lessons on arithmetic and geometric functions as well as their ability to create an explicit formula that models a sequence. Students will work in partners and when they are finished will discuss their findings with the class. I will also use this opportunity to fill in any gaps in knowledge that I perceive, in order to enable the strongest possible understanding of upcoming new material. If any of the students find the activity particularly challenging, I will make a note to follow up with them later in the lesson, when appropriate.

During the lesson

During the instructional portion of the lesson, students will be completing practice problems at each step. I will ask them to volunteer to help me through the examples we complete as a class, and will use this time to gauge how well the class is comprehending the lesson as a group. In addition, the example problems and scenarios we discuss will provide an opportunity for students to show understanding of the real world scenarios in which whole numbers would be appropriate.

If at any point during my instruction I notice certain misconceptions or misunderstandings being shared by multiple students, I will pause the instruction of new material and address the area being misunderstood. When students succeed and show full understanding of the concepts being taught I will recognize this verbally and provide them with positive feedback.

At the end of the lesson

Students will be assigned a formative assessment in the form of a homework worksheet, which will require them to use the steps they learned within the lesson to complete practice problems. This homework will be collected on the day following the lesson and will be evaluated in order to determine individual student strengths and weaknesses within the concepts being taught. The homework will be used to assess whether or not the students gained the understanding set forth by the lessons objectives, as well as whether or not they are giving a proper effort with their mathematical practices. If I find they do not comprehend the concepts to a satisfactory degree, I will use time in the next class period to reinforce key concepts. In addition, I will provide written feedback on their homework before returning them to students in order to provide them with my assessment of their progress within the learning segment. If any individual student is found to be particularly struggling, I will arrange a time to speak to them directly.

Lesson Plan # 3 – Linear and Exponential Functions Unit

Teacher Candidate: Timothy Paccione

Lesson Title: The Three Essential Elements of a Function

Grade Level: Algebra 1 (9th Grade)

Primary Subject Area: General Ed - Mathematics

Interdisciplinary Connections: English & Language Arts, Literacy

Lesson Duration: The lesson will span a full class period of 42 minutes.

Language Function:
Justify**:** Students will justify why they believe given scenarios represent functions by providing evidence of domain, range, and correspondence. They will do so in written form within their guided notes and independent tasks, and orally through discussion.

SETTING INSTRUCTIONAL OUTCOMES/ACADEMIC LANGUAGE

Enduring Understanding

Central Focus/Purpose Statement

The central focus of this lesson is an explanation and discussion of the three essential parts of a function, including a set of domain values, a set of range values, and a method for assigning each element of the domain to exactly one element of the range, or correspondence. Students will evaluate these parts of a function through the use of notation and by interpreting real life situations through context.

NYS Common Core Standards

CCSS.MATH.CONTENT.HSF.IF.A.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of f corresponding to the input *x*. The graph of *f* is the graph of the equation *y = f(x).*

CCSS.MATH.CONTENT.HSF.IF.A.2
Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Objectives

- Students will understand that a function has three essential elements, including the domain set, the range set, and a method for assigning each element of the domain to exactly one element of the range.
- Students will evaluate functions in the both notation form and through interpretation of context and will recognize the three essential elements of a function in both.
- Students will justify their evaluation of a function using their understanding of its three essential elements.

Lesson Plan # 3 – Linear and Exponential Functions Unit

Academic Language

Content Specific Language: Function, Linear, Exponential, Sequence, Arithmetic, Geometric, Inputs, Outputs, Domain, Range, Correspondence

Process Terms: Match, Define, State, Write, Express, Describe, Explain

Syntax/Discourse: Students will be supported in their understanding of functional notation and what each symbol represents in the English language (E.g., $f:\{x\} \rightarrow y$ represents "The function *f* such that *x* maps to one and only one *y*.")

Prior Learning/Prior Thinking

Students will need to recall and understand the preceding day's lesson which taught them to identify when it would be appropriate to use whole numbers as inputs for a function, and that we interpreted that as Domain. That understanding will be expanded as we discuss the three essential elements of a function including domain, range, and a method for assigning the domain set to exactly one term in the range set.

MATERIALS/RESOURCES

Technologies and Other Materials/Resources:

Students will receive a copy of a module titled *Representing Naming, and Evaluating Functions*. The module was created by *EngageNY*, a New York State website that provides guidance to instructors that teach to *Common Core* standards. The module includes guided notes as well as practice problems for them to complete throughout the lesson. The classroom contains a Smart Board and the module has been converted into Smart Board format. It has also been altered and supplemented in order to accommodate the individual learning styles within my class. Students will receive a "Do Now" worksheet upon entering the classroom and another worksheet summarizing key points. Students will be provided with graphing calculators.

CONTENT AND PEDAGOGY

Anticipatory Set/Hook Elicit Prior Knowledge

When the students enter the classroom, they will receive a worksheet describing a "Do Now" activity that they will need to complete. There will be two versions of this activity distributed at random to students, with the difference being slightly modified content within the activity. The versions will also be color coded to provide clear distinction between them. Students will be asked to perform a matching activity in which they match pictures to text labels. For example, one version will have pictures of animals and ask the students to match them with a corresponding word. Students will be asked to complete their task and share their findings with the class. This activity is designed to show students that they already possess the ability to match elements from one set to another set given a method of doing so. This will allow them to connect their prior understanding to the current lesson.

Procedures

After the opening exercise is completed, I will move on to the instruction of new material. Students will follow along, using their copies of the module with the identical slides that I have on the Smart Board. I will introduce the three essential elements of a function to the students, including the domain set (or inputs), the range set (or outputs) and the criteria or method for which an element of the domain set can be assigned to exactly one element of the range set. I will refer to the opening exercise to help student understand that they

already comprehend these concepts but are just being given names for them as well as new ways to apply them. We will go through examples of real life situations in which domains and ranges exist and the third element can be determined. We will also go through non-examples in which an element in the domain set can be assigned to more than one element of the range set, meaning the situation does not represent a function. I will model for them the proper way to use functional notation in order to describe relationships where a function exists. For example, we will define *f* to assign each student in the school a unique ID number which can be written in functional notation as *f:{ students in school} → {whole numbers}.* Students will spend the last portion of class working either independently or in small groups on a set of practice problems.

As the lesson proceeds, we will fill in the guided notes together. I will be interact with the Smart Board to fill in the missing pieces of the guided notes in order to model for them what should be written on their own papers. Through the different parts of the lesson I will give the students the opportunity to work independently, collaborate with fellow students, listen to oral instruction, and take in content visually. This variation will provide opportunities for various types of learners to retain their new knowledge.

Should time permit, I will give the students an opportunity to get started on their homework, which will consist of exercises that provide further practice in the lesson's learning objective. The homework will serve as a formative assessment.

With five minutes left in the class, I will hand out a worksheet that summarizes the key points of the lesson and we will read through it together as a class. I will ask for volunteers to explain to the class what they feel they learned in the day's lesson, and will ask them to justify their explanation using evidence (E.g., If a student says that they learned how to identify a function, I will ask them to explain how they are able to do so).

Procedures (Overview of your lesson)

Time # minutes	Instructional Strategies/Learning Tasks	Purpose
7 minutes	1. "Do Now" activity	-Activate Prior Knowledge / Engage Students
25 minutes	2. Instruction and Completion of Guided Notes	--Provide new knowledge and guided practice
5 minutes	3. Problem Set	-Independent Practice / Collaborate
5 minutes	4. Key points summary	-Provide Closure and formatively assess progress.

Differentiation

Students will be allowed to work within groups during the opening exercise and practice problems portions of the lesson in order to include collaborative learning within the instruction. This will enable students to complement each other's skillsets, with weaker students receiving help from students with stronger understanding of the material. This also allows the more gifted students to engage in the higher order thinking skills required to teach another individual new knowledge. Students will also be able to work independently, giving them an opportunity to practice individual problem solving skills.

Throughout the lesson, I will be asking students probing questions in order to check for student understanding and keep students engaged, particularly those who struggle to pay attention for extended periods. Accommodations for students including preferential seating for students who struggle concentrating and extra instruction time provided outside of the class session for those students who require it.

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Closure

With five minutes left in the lesson, students will receive a graphic organizer detailing the key points of the lesson and will be asked to discuss them as a class. This task will give the students an opportunity to reflect on their learning and provide closure before the next lesson. Additionally, it will provide a formative assessment that I will use to evaluate their understanding in anticipation of the next lesson.

STUDENT ASSESSMENT

Before the lesson

During the preceding lesson, the students completed a pre-assessment which assesses their pre-existing understanding of the three essential elements of a function. This assessment provided me with information regarding which areas required more focus within the lesson and which did not. For example, most of the students showed a strong understanding of the vertical line test, but were not able to extend that understanding to non-algebraic relationships.

Before the instruction of new material begins, the students will complete a "Do Now" in the form of a matching activity. This will formatively assess their understanding of previous lessons on functions as well as their ability to apply criteria to real life situations. Students will work independently or as a group and will discuss their findings with the class. I will also use this opportunity to fill in any gaps in knowledge that I perceive, in order to enable the strongest possible understanding of new material. If any of the students find the activity particularly challenging, I will make a note to follow up with them later in the lesson, when appropriate.

During the lesson

During the instructional portion of the lesson, students will be completing practice problems at each step. I will ask them to volunteer to help me through the examples we complete as a class, and will use this time to gauge how well the class is comprehending the lesson as a group. In addition, the example problems and scenarios we discuss will provide an opportunity for students to show understanding of the real-world applications of functional notation and its essential elements. When the students work independently on their problem set, I will check in with each individually to check for understanding and their ability to identify domain, range, and correspondence within given relationships.

If at any point during my instruction I notice certain misconceptions or misunderstandings being shared by multiple students, I will pause the instruction of new material and address the area being misunderstood. When students succeed and show full understanding of the concepts being taught I will recognize this verbally and provide them with positive feedback.

At the end of the lesson

Students will be assigned a formative assessment in the form of a homework worksheet, which will require them to use the steps they learned within the lesson to complete practice problems. This homework will be collected on the day following the lesson and will be evaluated in order to determine individual student strengths and weaknesses within the concepts being taught. The homework will be used to assess whether or not the students gained the understanding set forth by the lessons objectives, as well as whether or not they are giving a proper effort with their mathematical practices. If I find they do not comprehend the concepts to a satisfactory degree, I will use time in the next class period to reinforce key concepts. Students will have their homework returned to them prior to the next lesson with written feedback included.

Lesson Plan # 4 – Linear and Exponential Functions Unit

Teacher Candidate: Timothy Paccione

Lesson Title: Representing, Naming, and Evaluating Functions

Grade Level: Algebra 1 (9th Grade)

Primary Subject Area: General Ed - Mathematics

Interdisciplinary Connections: English & Language Arts, Literacy

Lesson Duration: The lesson will span a full class period of 42 minutes.

Language Function:
Justify**:** Students will justify whether algebraic expressions represent functions (whether they are true or false) by determining whether their inputs map to one and only one output. They will do so in written form within their guided notes and orally through discussion.

SETTING INSTRUCTIONAL OUTCOMES/ACADEMIC LANGUAGE

Enduring Understanding

Central Focus/Purpose Statement

The purpose of this lesson is to give students an opportunity to become more comfortable when using a formula to define a function. Within this unit, students have used recursive and explicit formulas mostly to represent discrete functions, and this lesson will allow them to apply those skills to algebraic expressions in which variables are used to represent any number in the Real Number ($\mathbb{R}$) set.

NYS Common Core Standards

CCSS.MATH.CONTENT.HSF.IF.A.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of f corresponding to the input *x*. The graph of *f* is the graph of the equation *y = f(x).*

CCSS.MATH.CONTENT.HSF.IF.A.2
Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Objectives

- Students will understand that if *f* is a function and *x* is an element of its domain, then *f(x)* represents the output of *f* corresponding to the input *x*.
- Students will evaluate functions in both notation form and through interpretation of context and will recognize domain elements as inputs and range elements as outputs.

Academic Language

Content Specific Language: Function, Linear, Exponential, Sequence, Arithmetic, Geometric, Inputs, Outputs, Domain, Range, Correspondence

Process Terms: Study, Assign, Determine, Justify, Explain, Write, Evaluate, Find

Lesson Plan # 4 – Linear and Exponential Functions Unit

Syntax/Discourse: Students will be provided with various representations of equivalent functions in varied forms (tables, notation, sequences, graphs, diagrams) in order to support their understanding of the academic vocabulary being discussed (domain, range, correspondence).

Prior Learning/Prior Thinking

Students will need to draw on the previous lesson discussing the three essential elements of a function. We will be building on that information in order for students to understand how to name, write, and evaluate functions algebraically. Students will need to be able to recognize a set of inputs as a domain, a set of outputs as a range, and a correspondence as a method of mapping individual inputs to one and only one output.

MATERIALS/RESOURCES

Technologies and Other Materials/Resources:

Students will receive a copy of a module titled *Representing Naming, and Evaluating Functions*. The module was created by *EngageNY*, a New York State website that provides guidance to instructors that teach to *Common Core* standards. The module includes guided notes as well as practice problems for them to complete throughout the lesson. The classroom contains a Smart Board and the module has been converted into Smart Board format. It has also been altered and supplemented in order to accommodate the individual learning styles within my class. When students enter the classroom, there will be an activator problem on the classroom white board. Students will also be provided with a printout summary of the lessons key points. Students will be provided with graphing calculators.

CONTENT AND PEDAGOGY

Anticipatory Set/Hook Elicit Prior Knowledge

When the students enter the classroom, there will be an activator problem on the classroom whiteboard that reviews the previous lesson concerning the three essential elements of a function. Students will be allowed to work together or independently in order to solve the problem and answer the related questions. This task is designed to activate their knowledge of the preceding lesson so that we can build on it in the current class period. Students will need to understand the three essential elements of domain, range, and correspondence in order to name, represent, and evaluate functions.

Procedures

After the opening exercise is completed, I will move on to the instruction of new material. Students will follow along, using their copies of the module with the identical slides that I have on the Smart Board. We will begin by looking at the sequence {1,2,4,8,16,32} in five different formats, including in a table, written in functional notation, defined as a recursive sequence, shown in a diagram, and plotted on a graph. Students will compare the representations and discuss socratively what the differences between these function formats are and what each tells us about the original expression. I will ask students if each format has the same essential elements as discussed in the preceding lesson. We will identify the domain, range, and method for assigning domain to range before proceeding.

Next, we will discuss when expressions can be considered “false” (for example, when their solution involves dividing by x, then the function is false when x = 0) and how this can affect our domain and range. We will talk about how multiple functions can have the same domain value map to a common range value, and that it

Lesson Plan # 4 – Linear and Exponential Functions Unit

does not necessarily mean they are equivalent. For example, $x^2 - 7$ and $-3x + 11$ both contain the point (3, 2) within their solution set, but are vastly different functions. We will review set notation including how to use both types of brackets to indicate inclusion or exclusion of a value. Finally, I will review the language functions of "substitute" and "evaluate" in order to ensure students know what is expected of them when they see them within a word problem.

As the lesson proceeds, we will fill in the guided notes together. I will use the Smart Board to fill in the missing pieces of the guided notes in order to model for them what should be written on their own papers. Through the different parts of the lesson I will give the students the opportunity to work independently, collaborate with fellow students, listen to oral instruction, and take in content visually. This variation will provide opportunities for various types of learners to retain their new knowledge.

Should time permit, I will give the students an opportunity to get started on their homework, which will consist of exercises that provide further practice in the lesson's learning objective. The homework will serve as a formative assessment.

With five minutes left in the class, I will distribute a printout of the key points from the lesson to the students. I will have students take turns reading the key points out loud to the class and check for understanding after each one. Students will be asked probing questions and be required to justify their understanding of key objectives using their own words. For instance, if a student expresses that they understand how to use set notation, I will ask them to provide me with evidence in the form of an example. Along with their homework, this will serve as a formative assessment that will allow me to gauge student comprehension before beginning the next day's lesson.

Procedures (Overview of your lesson)

Time # minutes	Instructional Strategies/Learning Tasks	Purpose
5 minutes	1. Activator problem	-Activate Prior Knowledge / Engage Students / Collaborate
22 minutes	2. Instruction and Completion of Guided Notes	--Provide new knowledge and guided practice
10 minutes	3. Homework Problem Set	-Provide opportunity for practice and assessment.
5 minutes	4. Lesson Summary	-Provide Closure and formatively assess progress.

Differentiation

Students will be allowed to work within groups at the beginning of the lesson in order to include collaborative learning within the instruction. This will enable students to complement each other's skillsets, with weaker students receiving help from students with stronger understanding of the material. This will also allow the more gifted students to engage in the higher order thinking skills through the act of teaching their knowledge to their peers. Students will also be able to work independently, giving them an opportunity to practice individual problem solving skills.

Throughout the lesson, I will be asking students probing questions in order to check for student understanding and keep students engaged, particularly those who struggle to pay attention for extended periods. Accommodations for students including preferential seating for students who struggle concentrating and extra instruction time provided outside of the class session for those students who require it.

Lesson Plan # 4 – Linear and Exponential Functions Unit

Closure

With five minutes left in the lesson, students will receive a printout of the key takeaways from the lesson that will be tied to the learning objectives. Students will be asked to read them aloud and after each one is read I will check for both individual and group understanding. The reading of these key points will provide closure for the lesson for the students and it will provide a formative assessment that I will use to evaluate their understanding in anticipation of the next lesson.

STUDENT ASSESSMENT

Before the lesson

Before the instruction of new material begins, the students will complete an activator task in the form of a word problem activity. This will formatively assess their understanding of previous lessons on the three essential elements of a function. Students will work independently or as a group and will discuss their findings with the class. I will also use this opportunity to fill in any gaps in knowledge that I perceive, in order to enable the strongest possible understanding of new material. If any of the students find the activity particularly challenging, I will make a note to follow up with them later in the lesson, when appropriate.

During the lesson

During the instructional portion of the lesson, students will be completing practice problems at each step. I will ask them to volunteer to help me through the examples we complete as a class, and will use this time to gauge how well the class is comprehending the lesson as a group. In addition, the example problems and scenarios we discuss will provide an opportunity for students to show understanding of the real world implications of functions, and when to use the various methods of representation.

If at any point during my instruction I notice certain misconceptions or misunderstandings being shared by multiple students, I will pause the instruction of new material and address the area being misunderstood. When students succeed and show full understanding of the concepts being taught I will recognize this verbally and provide them with positive feedback.

At the end of the lesson

Students will be assigned a formative assessment in the form of a homework worksheet, which will require them to use the steps they learned within the lesson to complete practice problems. This homework will be checked for completion on the day following the lesson and will be reviewed in order to determine individual student strengths and weaknesses within the concepts being taught. The homework will be used to assess whether or not the students gained the understanding set forth by the lessons objectives, as well as whether or not they are giving a proper effort with their mathematical practices. If I find they do not comprehend the concepts to a satisfactory degree, I will use time in the next class period to reinforce key concepts. When the homework is returned, it will contain written feedback detailing my assessment of their progress within the learning objectives.

Lesson Plan # 5 – Linear and Exponential Functions Unit

Teacher Candidate: Timothy Paccione

Lesson Title: Practice with Functions

Grade Level: Algebra 1 (9th Grade)

Primary Subject Area: General Ed - Mathematics

Interdisciplinary Connections: English & Language Arts, Literacy

Lesson Duration: The lesson will span a full class period of 42 minutes.

Language Function:
Justify**:** Students will justify their understanding of six different topics by providing evidence and examples of the concepts in context. They will do so through discussion with their peers and instructors and in written form within their packets.

SETTING INSTRUCTIONAL OUTCOMES/ACADEMIC LANGUAGE

Enduring Understanding

Central Focus/Purpose Statement

The purpose of this lesson is to provide students with an opportunity to practice and further explore the concepts they have learned in the preceding lessons within this learning segment, and to review the prior learning segment for their upcoming summative assessment. The focuses of six stations include: Sequences, Recursive Formulas, Exponential Growth and Decay, Compound and Simple Interest, The Three Essential Elements of a Function, and Evaluating Algebraic Functions.

NYS Common Core Standards

CCSS.MATH.CONTENT.HSF.IF.A.1
Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f(x)* denotes the output of f corresponding to the input *x*. The graph of *f* is the graph of the equation *y = f(x).*

CCSS.MATH.CONTENT.HSF.IF.A.2
Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

CCSS.MATH.CONTENT.HSF.BF.A.1
Write a function that describes a relationship between two quantities.

Objectives

- Students will be able to describe their understanding of a function's three elements (domain, range, method for assigning elements) in both oral and written forms.
- Students will be able to identify and define domain and range sets in real life situations.
- Students will justify their oral and written responses using evidence of conceptual understanding.

Lesson Plan # 5 – Linear and Exponential Functions Unit

Academic Language

Content Specific Language: Function, Linear, Exponential, Sequence, Arithmetic, Geometric, Inputs, Outputs, Domain, Range

Process Terms: Study, Assign, Determine, Justify, Explain, Write, Evaluate, Find

Syntax/Discourse: Students will communicate their understanding of the preceding lessons through a stations activity which will involve discussions with both their peers and their instructors. They will be given the opportunity to ask clarifying questions, as well as reflect on their knowledge.

Prior Learning/Prior Thinking

Students will need to enter the lesson with understanding of the previous three lessons, dealing with inputs, domains, ranges, function relationships, and how to represent, name, and evaluate functions. They will also need to recall lessons from a prior learning segment that include recursive functions, simple and compound interest, and how to represent sequences. All of those skills will be practiced in this lesson during a stations exercise in which they will have to complete different learning tasks with and without the help of their instructor.

MATERIALS/RESOURCES

Technologies and Other Materials/Resources:

Students will receive a graphing calculator upon entering the classroom. They will also receive a six page packet with the tasks they must complete at the six stations. In addition, I created flash cards for each station that have the question numbers on the front and answer on the back. Desks will need to be prearranged in groups of four around the room. The Smartboard will be used briefly to display the groups that will be randomly assigned for the lesson. I will also employ a timer to help with time management.

CONTENT AND PEDAGOGY

Anticipatory Set/Hook Elicit Prior Knowledge

When the students enter the classroom, they will see their names listed on the Smart Board in one of three groups. Each group will be assigned a station (1, 2, or 3) and the students will be directed to sit at that station and await further instructions. At two of the stations, a teacher will be waiting (either myself or my mentor teacher) and at one of the stations the students will rely on their written instructions. I will bring the class to attention and explain the following to them: "We will be taking part in a station activity, where you will have five minutes to complete the questions of your station. There will be six rounds of stations, and after each five minute period you will rotate to the next station, regardless of whether you completed the current set of questions. Each station will have a different focus. Four of the stations will have an instructor to help guide you towards the correct responses to your questions. The other two stations will be independent and your group will have to work together to find the answers. Once you believe you have the correct answer to a question, flip over the corresponding, color-coded flash card to determine if you are correct. Fill out your packets with the correct responses as you go."

Procedures

Students will report to their assigned stations and receive their stations packet. Each station consists of four questions that cover the topic of the station. The first is independent and contains four questions that review their knowledge of sequences, including the parts they need to identify to build a formula, a comparison of geometric and arithmetic sequences, and an evaluation between the two types, with

Lesson Plan # 5 – Linear and Exponential Functions Unit

justification of their responses required. The group at the second station will be with me, and will cover recursive formulas, including the general formula for arithmetic and geometric sequences, the notation [$f(n+1)$], a real life word problem, and evaluation between the two types, with justification required. The third group will be with my mentor teacher and their questions will be regarding exponential growth and decay, including the elements of $f(n) = ab^n$, interpretation of growth versus decay with justification required, and two word problems.

After five minutes have passed, students will be rotated to another station and asked to complete the tasks there, and after another five minutes, students will repeat the process. Once each group has been at all the first three stations, I will flip the station numbers to four, five, and six and the same process will take place with three new subjects. At station four, students will work independently as a group to solve questions regarding compound and simple interest, including the symbols required (P, r, and t), the explicit formulas for simple and compound interest, and a word problem comparing two banks who offer various rates and account types over different time periods. The second group will be at station five with me and we will be discussing the three essential elements of a function, and students will be required to identify domain, range, and correspondence (mapping each input to one and only one output), identification of the elements in a real world scenario, identification of the elements in an algebraic expression, and whether various examples represent a true function. The group at the sixth and final station will be with my mentor teacher, and they will be asked to evaluate algebraic functions. Their questions will involve substituting and evaluating various inputs, determining the domain and range for various functions, and functional notation using multiple functions together [E.g., $g(x) + f(x)$]

After thirty minutes, students will have completed all of the stations and at that point I will hand out an answer key to the stations packet. We will use the remaining time in the class period to discuss the various elements. Students will be given the opportunity to ask questions in areas where they have lingering confusion and I will also ask them to reflect on whether or not they found the activity worthwhile and if it helped them better understand the preceding lesson learning objectives. As the students contribute their thoughts orally, I will write them down on the classroom whiteboard.

Procedures (Overview of your lesson)

Time # minutes	Instructional Strategies/Learning Tasks	Purpose
2 minutes	1. Explain stations activity to students	-Set expectations for lesson
30 minutes	2. Stations exercise	-Opportunity for independent practice and varied levels of guided practice. Students will collaborate as well.
10 minutes	3. Lesson Summary discussion	-Provide Closure, formatively assess progress, give opportunity for discourse.

Differentiation

The stations activity presents a unique opportunity for differentiation, as it provides students with varied levels of attention from the instructor and academic independence. Students will be required to work on their own at times, work with classmates at others, and work with their teachers at yet others. In addition, the group work and action of rotating from station to station will help keep students engaged who struggle to do so in the traditional classroom environment and structure. The discussion element will allow students who prefer to show evidence of their understanding verbally an opportunity to display comprehension.

Lesson Plan # 5 – Linear and Exponential Functions Unit

As some students in the class exhibit anxiety, I will make sure to explain the situation thoroughly before beginning and to let the students know that the lesson is designed for them to explore their understanding and is not a test of their learning that will be graded. Students with medical concerns will be given an opportunity for seating at each station, so no extra strain will be put on them when compared to a normal class period.

Closure

With ten minutes left in the lesson, the students, my mentor teacher, and I will engage in a discussion about the activity and the concepts contained within it. Students will reflect both on the increased understanding they gained through the stations activity as well as whether or not they preferred the format itself. This discussion will give them closure on both the activity and the preceding three lessons concerning the topics involved in the stations.

STUDENT ASSESSMENT

Before the lesson

As there is no new material in the lesson, all topics have been formatively assessed at some point in the learning segment or preceding it. Students will have received formative assessments in each of the previous lessons concerning the topics covered in this lesson, and will therefore have been provided feedback on those assessments before the activity begins.

During the lesson

Students will have varying levels of attention from instructors within the lesson. In the stations in which my mentor teacher or I are located, we will take notes on the progress of individual students and use those notes to follow up with the students later should time not allow for immediate feedback. I will prepare blank assessment sheets ahead of time for this purpose. In addition, the station packets will serve as a self-assessment for the students, as they will serve as a review of all the topics they will need to master for an upcoming summative assessment. Students can use the packet and answer key to study the areas in which they have lingering confusion or where they struggled within the station activity.

Lastly, the student discussion that takes place in the last ten minutes of the class period will serve as an assessment of student learning, their confidence in their understanding of the topics covered, and how well the activity was designed to meet their needs and the learning objectives of the lesson. Students will be asked probing questions designed to engage their higher level thinking skills and promote engaging discussion.

At the end of the lesson

Students will be asked to review and complete any of the problems from the two collaborative stations that they were not able to finish for homework. I will offer them the opportunity to review individual packets for feedback if they desire during a free period or after school, but will not collect the packets so that they can use them to study for their upcoming summative assessment. If students do arrange for extra time, I will review each section and offer feedback where appropriate.