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Math 499E

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edTPA Learning Progression

This Learning Progression will take place in a 12th grade Collection of Evidence class at the Excel High School in Ellensburg School district located in Black Hall on Central Washington University Campus. There is no scripted curriculum for this class and not content restrictions or goals set by the mentoring teacher. The content that is taught is decided by the instructor and the purpose is to prepare the students for entering the work force and having the math skills to be successful. These lessons will align with the mathematics content standards HSF.BF.B.3. The Learning Progression will also be aligned with the following mathematical practices: MP5 Use appropriate tools strategically, MP7 Look for and make use of structure, and MP1 Make sense of problems and persevere in solving them.

Students have spent the year learning various basic math skills that covers subjects from finding areas and volumes, to statistical analysis, and all the way to basic optimization problems. These were learnt to pass a test to ensure that the students would be able to graduate high school. Now that the tests are completed the student have little motivation to complete anymore content. The course content that was covered was expansive but did not rigorously cover each of the topics in depth. Therefore, this progressions goal is to take one of the subjects that was covered, specifically functions, and study it more in depth. The purpose of the focused approach is to create a new goal to work towards: a modeling project. The student will create a model that represents something that has meaning to them. To better understand how this model works they need to understand how functions work. So this progression will cover more complex concepts regarding functions. The students will build off of their basic understanding of functions and their basic algebra and graphing skills to understand function transformations, compositions, and inverses so that these can be tools that the students can use in making their models. Since their content understanding is limited, the depth of this discussion of functions will be limited to linear and quadratic functions.

To foster better learning and peer tutoring, the students will be exposed to a mix of cooperative learning and ability grouping. Students who are exceling, who are meeting expectations, and who are no meeting expectations will be grouped in equal amounts. This will give the opportunity for struggling students to get more help that what the teacher can provide individually and will allow the students who are meeting expectation and those who are exceling to tutor the struggling student to improve their own understanding of the materials being taught. This is particularly beneficial for students with exceptionalities and those who are bilingual or multi-lingual learners. These students can be grouped with more fluent students to practice their math skills as well as practice their speech.

**Build new functions from existing functions.**

**Lesson One**

CCSS.MATH.PRACTICE.MP7: Look for and make use of structure

CCSS.MATH.CONTENT.HSF.BF.B.3

“Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.”

To better scaffold this lesson, the students will start with a warm-up that includes the material they had been working on for the test involving functions. This includes graphing a function, using a X-Y table, and identifying linear and non-linear as well as understanding the concept of dependent and independent variables. After this brief warm-up the students will break up into groups of 3. There will be a discovery type of an activity. Each group will be given a slip of paper with 8 functions that have one parent function and functions that are that parent function shifted vertically and horizontally in addition to functions that have been stretched and flipped over the axis’s. The students will graph each of these and then be asked to look at the difference between the transformed function and its parent function. Their goal is self-identify the structure behind transformations to see if they can identify what in the transformed function equation causes the changes. There will be a brief discussion about what the students found followed by direct instruction about the general form of a transformed linear and quadratic function. There will also be a brief discussion of the vocabulary necessary to properly communicate. This will include: vertical shift, horizontal shift, stretch, squeeze, parent function, and reflection. The students will write the general formulas down so they can be referenced later. Next they will practice writing a function given a graph of the function and its parent with the parents explicit function written out. This activity will be a partner activity where each pair will be assigned a pair of functions and then they will need to find the explicit function to describe the transformed function. They will then present their function to the class and explained why they chose to write it that way.

The purpose of the Benchmark Assessment for this lesson is to show that students are able to apply the structure of transformations to creating functions given a parent function and a list of desired transformations. This will show that they can step-by-step create a function by compiling the individual transformations.

**Benchmark Assessment for the Lesson One:**

Write a function that represents the transformation.

1. Given , write a function that is shifted horizontally by 2, shifted vertically by -2, and faces downward.
2. Given , write a function that is stretched by a factor of 2 and shifted vertically by 3.

**Hinge question:** Are there two ways to write the same function?

**Lesson Two**

CCSS.MATH.PRACTICE.MP5: Use appropriate tools strategically

CCSS.MATH.CONTENT.HSF.BF.B.4

“Find inverse functions.”

CCSS.MATH.CONTENT.HSF.BF.B.4.A

“Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x-1) for x ≠ 1.”

CCSS.MATH.CONTENT.HSF.BF.B.4.B

“Verify by composition that one function is the inverse of another.”

CCSS.MATH.CONTENT.HSF.BF.B.4.C

“Read values of an inverse function from a graph or a table, given that the function has an inverse.”

“Produce an invertible function from a non-invertible function by restricting the domain.”

To better scaffold this lesson, the student will start with a warm-up that includes the topics covered in the previous lesson. This warm-up will be similar to the Benchmark Assessment from the previous lesson but the students will be taking functions and writing the transformations that occurred to create the function from the parent function. This will ensure that the entire class has enough understanding of functions and transformations to continue with the current day’s lesson. The instructor will then bring the class together to discuss the day’s new material. The students will be introduced to composition of functions and inverse functions. The instructor will go through examples to show that compositions of functions like and are not necessarily equal and maybe drastically different. There will be two activities regarding this content. The first activity will require that the students break up into groups and then they will do various compositions of functions. They will be given three functions and then they will be asked to do 5 different compositions. The second activity will require the same groups of students to compose functions to decide if the functions are inverses.

The purpose of the Benchmark Assessment is to test if student understand the concept of inverses and if they are proficient in calculating the composition of functions. This task tests these two elements of the lesson at once. In order to be able to decide if a function is an inverse of another they have two options: they could look at the transformations it took to get to those functions from the parent function and see if they cancel each other or they could use composition to determine it.

**Benchmark Assessment for Lesson Two:**

Are these functions inverses of each other?

Is the inverse of ?

Is the inverse of

**Hinge Question:** Is the inverse of a function unique? Can you write two functions that are the inverses of the same function?

**Lesson 3**

CCSS.MATH.PRACTICE.MP1: Make sense of problems and persevere in solving them

CCSS.MATH.CONTENT.HSF.BF.B.5

“Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.”

To better scaffold this lesson, the students will start with a warm-up. This task will be having the students find inverses of linear and quadratic functions. The purpose of the warm-up is to check the student’s understanding of inverses and the procedural understanding of finding inverses as well as practicing transformations. Then after the warm-up the students will be introduced to logarithms and exponentials. There will be direct instruction about the different log bases, the different exponentials, and then a brief discussion of the change of base formula. This is a relatively new concept for the students so the direct instruction portion will be elongated and contain student practice and example problems. The first portion of direct instruction will definitely include explanation of the logarithm rules, except for the inverse rule which will be explained later in the lesson. There will be two activities in the lesson. The first is converting exponential equations into logarithmic equation and then going the other direction. This will practice the conceptual understanding of the connection between the two and hint at the fact that they are inverses of each other. Additionally, this is good algebra practice and will give the students experience working with logarithms and exponentials and help them develop understanding of the procedures associated with them. After the first activity the instructor will have another portion of direct instruction where they explain the inverse relationship between inverse and logarithms. This will be phrased in terms of the questions that each is asking. Logarithms ask the question “a to what power gives you y?” and the answer is x. when it is posed in this context it is easier to see the inverse relationship because the exponential tells you “a to the x gives you y.” Then the instructor will transition into the next activity where the students will practice using the inverse properties of exponentials and logarithmic functions. The second activity will be a brief introduction to using logarithms and exponentials to solve problems. The students will be given a story problem and an equation that they know will model the situation and then are told to solve that equation for a specific value. This will employ their use of the inverse properties so they will get practice.

The purpose of the Benchmark Assessment is to see if the student actually understand the inverse relationship of the exponential and logarithmic functions. Although they have not been exposed to the relationship between and natural logarithms, they will be given problems where they will need to use their understand of basic logarithms to solve the problem. This will work on the conceptual understanding of using inverses to solve problems as well as practice the procedural fluency of the algebra behind it.

**Benchmark Assessment for Lesson 3**

Use inverse properties to solve for given the following equation: .

**Hinge Question:** What is equivalent to? How do inverses help in solving problems?