

This learning progression is for an Algebra II class. The vast majority of the students are juniors but there are students of all grade levels. The lessons most generally use worksheets from Kuta Software to help facilitate the learning of the students; however, the class does have the Holt McDougal, Common Core Edition from 2012 that they use every now and again as the math department usually collaborates and creates their lesson plans with math tasks and activities to help engage the students. For this learning progression the students will be learning how to simplify rational expressions, multiply and divide rational expression, add and subtract rational expressions, solve rational equations, and solve radical equations. The standards that are applied to this unit plan are:

- CCSS.MATH.CONTENT.HSA.APR.D.6
Rewrite simple rational expressions in different forms
- CCSS.MATH.CONTENT.HSA.REI.A.2
Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise

The Mathematical Practice Standards that are applied to this unit are as follows:

- CCSS.MATH.PRACTICE.MP1: Make sense of problems and persevere in solving them
- CCSS.MATH.PRACTICE.MP3: Construct viable arguments and critique the reasoning of others.
- CCSS.MATH.PRACTICE.MP6: Attend to precision.
- CCSS.MATH.PRACTICE.MP7: Look for and make use of structure.

A teaching strategy that will be used during this learning progression is group work and collaboration. Students will be able to work in groups in order to work in groups of three or four. In a classroom set up such as this, the teacher will be able to facilitate to more students throughout the class period and guide the lesson rather than use direct instruction. The teacher will continuously monitor the students and listen in on the group conversations to hear where the students tend to be struggling and to answer questions that the students might have. The only thing that the students will be doing separately will be the five-minute exit slip at the end of class; these will not be used every class period as students might be doing an engaging activity or they may be having a lot of group conversation which I will be able to listen in on and gauge the students' understanding.

Lesson 1 – Simplifying Rational Expression:

In this first lesson students will be learning on how to simplify rational expressions. At the end of this first lesson they will be able to do this not only with values but also expressions. Students will need to factor polynomials both in the numerator and the denominator and simplify. I will introduce this topic by first showing a few simple fractions, such as $\frac{3}{9}$, $\frac{5}{10}$, and $\frac{20}{100}$ and ask the students if we are able to simplify these fractions into something smaller. The students will be able to easily notice that

HSA.APR.D.6

MP7: Look for and make use of structure.

these simplify down to $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{1}{5}$. What I will point out to the students is that what they were doing, without realizing it, was that they were pulling out a “one” that simplified the fraction, like this $\frac{3}{3} \times \frac{1}{3}$, $\frac{5}{5} \times \frac{1}{2}$, $\frac{20}{20} \times \frac{1}{5}$. We all know that any number divided by itself (except for zero!) is one, thus if we multiply by such as fraction we make a fraction with bigger numbers without changing the actual value! It goes to be the same with variables, $\frac{x}{x}$, and expressions, $\frac{(x-2)}{(x-2)}$! I will set the students to work in their groups on 4 sets of expressions that they need to simplify with 3 problems in each set. The first set will be simple fractions of just values, the next set will be values with one variables, third set will be values with multiple variables and powers, and the fourth set will be polynomials. As the students’ progress in the sets the problems will become more and more challenging. I will monitor the students as they are working on the problem sets and help with any misconceptions or questions that the students might come across. The students’ exit slip for this lesson will be “Why do we simplify fractions?” In asking this questions I hope to see how the students use mathematical reasoning to justify *why* they are learning to simplify rational expressions and not just *how*.

Lesson 2: Multiplying/Dividing and Adding/Subtracting Rational Expressions

This lesson will take a few days to get through since the students will be learning on how to do four different operations with rational expressions. With this lesson they will be using their knowledge on how to simplify rational expressions in order to make all four operations easier and less complicated. By eliminating the “ones” they will have something that will be easier to perform all four operations.

The students will first start with learning on how to multiply and divide rational expressions. What they will recognize is that they want to be able to simplify first. When multiplying/dividing rational expressions you’re allowed to cancel/simplify terms from one expression and the other expression, such as $\frac{3x}{y^2} \times \frac{5}{3x}$. Since here we are multiplying rational expressions and we have a $3x$ in the first numerator and a $3x$ in the second denominator those to terms simplify to “one” and our final

MP7: Look for and make use of structure.

MP6: Attend to precision

MP1: Make sense of problems and persevere in solving them

HSA.APR.D.6

MP7: Look for and make use of structure.

expression is $\frac{5}{y^2}$. We will also have a brief group discussion on the rules of exponents as they will come into play during this lesson. The students will have a Kuta Software worksheet to perform practice problems in their group to help them sharpen their skills.

The following day we will go over adding/subtracting rational expressions. To keep things a little familiar we will work with the same rational expressions we saw while multiplying/dividing. Here we will discuss finding a common denominator and why we have to find a common denominator before adding rational expressions. The students will work on the simpler rational expressions and creating a common denominator and then work their way onto the more challenging problems.

The formative assessment for this lesson will be assessing them while they are doing the activity Ticket Time, found here <http://ccssmathactivities.com/wp-content/uploads/2016/09/Ticket-Time-Instructions.pdf>.

The students will be in groups of two and there will be 6 tickets that the students will have the whole period to tackle. The students will have 7 minutes at each ticket to solve as a team. Since they are working as a group and have twice the brain power the problems will be more challenging. I will be able to monitor the students as they work in their teams and listen to the student voice to evaluate where their depth of knowledge is at.

Lesson 3: Solving Rational Equations and Radical Equations

This lesson will take a few days to conclude since the students will be working on two different types of equations that require completely different steps. However, in both equations the students will be needing to determine any extraneous solutions. The students will be using all of their previous knowledge of adding/subtracting and multiplying rational expression towards solving rational equations and they will be using inverse operations to solve radical equations.

The students will learn that with the rational equations they will have to find the common denominator for all three components of the equation. They will also need to do this by multiplying by that “one”, as we did in the first lesson. Once the students have the common denominator they will be able to eliminate the denominator and solve using the

MP3: Construct viable arguments and critique the reasoning of others.

MP6: Attend to precision

MP1: Make sense of problems and persevere in solving them

HSA.REI.A.2

MP6: Attend to precision

numerators. The students will be using a Kuta Software worksheet to practice their skills in solving rational equations. We will do the first 4 as a whole class; I will do the first one by instructing them on the steps on how to solve the rational equation and through the next 3 I will have the students instruct me on what to do. The students will then work in their groups and work on the remaining problems. I will be monitoring the class to listen in on the student conversations to see where their depth of knowledge is and to answer/correct any questions or misunderstandings. The next day the students will be working on rational equations where they will need to check and see if their answers are extraneous.

After rational equations, the students will be moving on to radical equations. Students will have to use inverse operations (additive/multiplicative inverse, etc.) in order to solve for the variable. The beauty in having this be the last portion of the unit is that it is much simpler than solving rational equations! The students will receive a Kuta Software worksheet that I will use to introduce the new topic. We will go over the first 2-4 equations together and then the students will focus on the remaining problems in their groups. The students will need to also ensure that all of their answers are not extraneous; they will do this by plugging the value back into the equation and solving. I will be monitoring the class to listen in on the student conversations to see where their depth of knowledge is and to answer/correct any questions or misunderstandings.

MP3: Construct viable arguments and critique the reasoning of others.

HSA.REI.A.2

MP6: Attend to precision

In conclusion, this learning progression builds on the students' knowledge of performing operations on fractions and expressions, to combining expressions, solving rational equations, and solving radical equations. Students were able to solve linear equations before this unit but afterwards they will be able to solve more complex equations and combine rational expressions.