**High School Algebra II**

[CCSS.MATH.CONTENT.HSA.SSE.B.3](http://www.corestandards.org/Math/Content/HSA/SSE/B/3/)

Write expressions in equivalent forms to solve problems.

HSA.SSE.B.3

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

CCSS.MATH.CONTENT.HSA.SSE.B.3.A

Factor a quadratic expression to reveal the zeros of the function it defines.

CCSS.MATH.CONTENT.HSF.IF.C.7.C

Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

CCSS.MATH.PRACTICE.MP1

Make sense of problems and persevere in solving them.

CCSS.MATH.PRACTICE.MP4

Model with mathematics.

CCSS.MATH.PRACTICE.MP7

Look for and make use of structure.

**Polynomial Division**

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This learning progression will be taught in a small town high school algebra II class with students ranging from tenth to twelfth grade. The Common Core State Standards (CCSS) domain and cluster for this learning progression is CCSS.MATH.CONTENT.HSA.SSE.B. The main standard that the students are learning is HAS.SSE.B.3.A. The math practices (MP) that will be used by students for this progression would be MP1, MP4, and MP7.

The textbook used in this class is the McDougall Litell Algebra II book. While teaching this lesson, we assume the students have worked with polynomials and understand that the roots mean the different zeros, along with being able to graph the zeros as in CCSS.HSF.IF.C.7.C. They will have done basic factoring throughout this curriculum and should get that when they take two separate factors, they are able to multiply them together and get the full polynomial. Likely, they have only worked with simple binomials and trinomials and would not know where to start with four terms in a polynomial.

This progression will be split up into three tasks which would probably be split up into three different fifty minute classes.

**Task One: Exploration**

**Learning Target** I can discuss ideas in finding different ways to find the factors of a polynomials

**Hinge Question** How do the different factors relate to the full polynomial?

Give the students a difficult problem and one factor and ask them to attempt to find the other factors.

Ex. Given x4-7x3+8x2+28x-48, and there is a factor of (x-4). Find more factors.

Task One: Explore different ways to find the factors of a polynomial.

L.T. I can discuss ideas in finding different ways to find the factors of a polynomials

To begin this lesson, I would start the students off by simply telling them we will be learning how to factor out polynomials in a different method and then having them work in groups to attempt. They will be given a large polynomial and one factor and after about five or ten minutes depending on their work they would be brought together to share with the class. If no ideas were thought of, I would share with them to attempt to use the fact that you multiply them back out, so you divide to get them separate.

The students are attempting to find different equivalent forms of the same expression which is what the CCSS is. They are using MP1 as they persevere in attempting to find new ways to get the different factors. They are not being given the answer and the way to do the work so they have to do their best. They also have to make use of the structure that they already understand in order to attempt to create and do the opposite structures. This is what is MP7 has the students do.

Task Two: Apply knowledge of polynomials and division to do Long Division

**Task Two: Long Division**

**Learning Target** I can use long division to find new factors given one factor and a polynomial

**Hinge Question** How do the different factors relate to the full polynomial?

Give the students a difficult problem and one factor and ask them to attempt to find the other factors.

Ex. Given x4-7x3+8x2+28x-48, and there is a factor of (x-4). Find more factors using long division.



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Learning Target I can use long division to find new factors given one factor and a polynomial

After the students have explored, they will be given instruction on how to do the division. It is pretty similar to normal long division and after giving the students the hint of division, likely a few of them will have figured out how to do it. A few problems will be done on the board and practiced in groups then they will play a game for formative assessment. This uses MP7 for the CCSS.HSA.SSE.B.3 so that they are doing their best using what they know about the structure to make sense of why the polynomial factors out correctly.

The formative assessment game used for this will be giving the students two cards, one of which is green and the other is red for them to choose whether they agree or not that a certain factor works for a polynomial. There will be examples up on the board and they will be given a factor. They must do the division then hold up the green card if it worked out nicely and the red if it doesn’t work.

Task Three: Use the shortcut of Synthetic Division to find factors of polynomials.

Learning Target: I can create new polynomial factors given a shortcut version of division

For this, they will also take all the factors and put them into a graph. They will know the different zeroes from the factors and hopefully can put that in a different setting by modeling (MP4) as a graph. This brings in the common core state standard HSA.SSE.B.3.A as they relate the polynomials the zeroes. They also from polynomials to factors are creating equivalent expressions.

There will be an exit ticket used as the assessment for the end of this lesson. For the students who are doing well, I would ask what they think it means if there is a remainder when they do a factor that doesn’t go in evenly. Otherwise, the way they were able to answer the questions correctly or incorrectly would affect whether the next day took the information another way or the ability to move on.

**Task Three: Synthetic Division**

**Learning Target** I can create new polynomial factors given a shortcut version of division.

**Hinge Question** How do the different factors relate to the full polynomial?

Give the students a difficult problem and one factor and ask them to attempt to find the other factors.

Ex. Given x4-7x3+8x2+28x-48, and there is a factor of (x-4). Find more factors using synthetic division.