



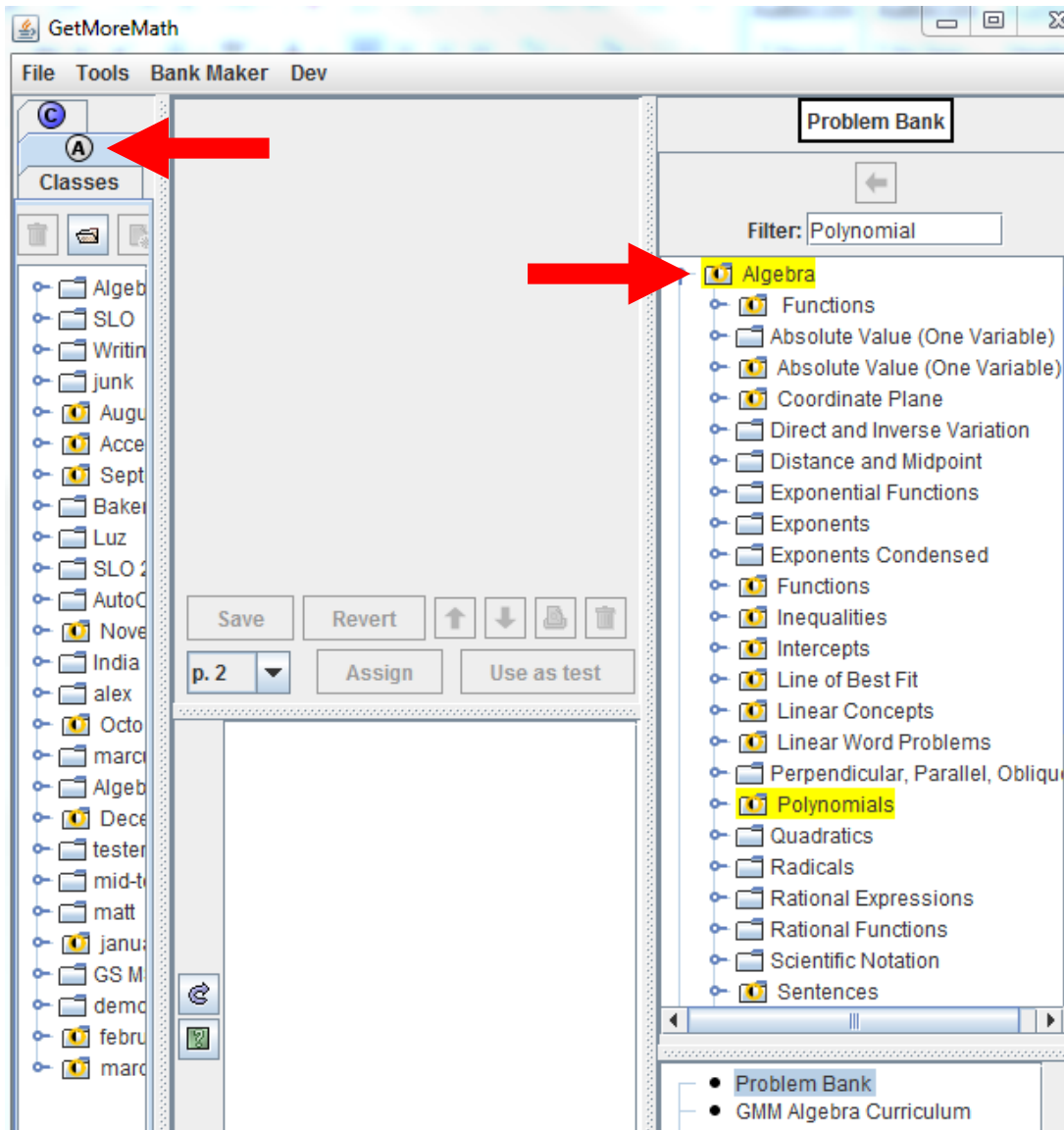
## Polynomials

Get More Math has a lot of polynomial problem types. Here is a guide for choosing ones that suit your needs. You may also get some insight into some GMM features and organization.

### Finding Problems

There are two main ways to find polynomial problem types. They are listed in the **Problem Bank** and the more selective collection, **GMM Algebra Curriculum**.

To find either source of problems, first select the **A** tab. **Problem Bank** is selected by default. Type 'Polynomial' in the filter, then follow the highlighting:



You will find many polynomial skills in **Problem Bank**. Click them to see examples in the bottom middle of the screen.

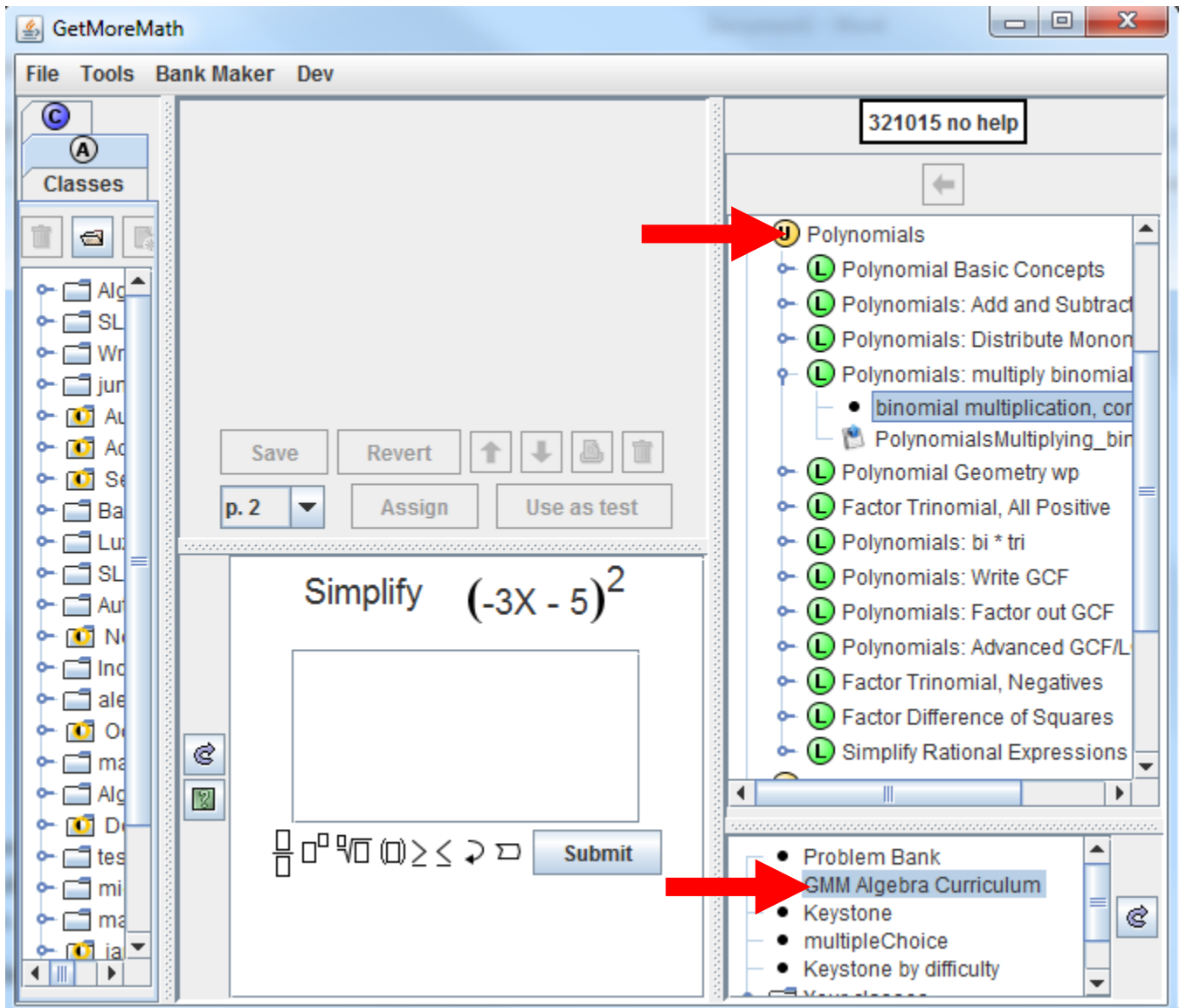
The screenshot shows a software interface for a polynomial problem. On the left, there is a control panel with buttons for 'Save', 'Revert', and 'Assign', along with a page indicator 'p. 2' and a 'Use as test' button. Below this, the problem is titled 'Factor' and displays the polynomial  $X^3 - 2X^2 - X + 2$ . A large empty rectangular box is provided for the student's answer. At the bottom of the problem area, there is a 'Submit' button and a set of mathematical symbols for input.

On the right side of the interface is a 'Problem Bank' list. The list is organized into categories: 'Polynomials', 'Concepts', 'Factor', 'Operate', and 'Operate Sophisticated'. Under the 'Factor' category, there is a long list of specific skills. A red arrow points to the skill 'factor by grouping: answer is', which is highlighted in blue.

- Polynomials
  - Concepts
    - Write polynomial in 'standard
    - Write polynomial in 'standard
    - Identify degree (chance of 'nc
    - Identify lead coefficient (chan
    - Identify monomial/binomial/tr
    - Polynomial concepts conden
  - Factor
    - write gcf
    - factor out gcf
    - factor quadratic, a = 1, b not 0
    - factor quadratic, a = 1, b not 0
    - factor quadratic, a = 1, b = 0 (
    - factor scrambled quadratic, a
    - factor quadratic, b = 0 (diffe
    - factor quadratic, a = 1 to 10, c
    - factor quadratic, a = 1 to 10, c
    - factor quadratic, a <> 1, all po
    - factor quadratic, a <> 1, b <> 0
    - factor quadratic, a <> 1, b <> 0
    - factor quadratic, a <> 1, b <> 0
    - factor out common binomial
    - factor out similar binomial: o
    - factor by grouping: answer is
    - factor by grouping: answer is
    - factor out gcf, then factor usin
    - harder (better) write gcf
    - write lcm
    - C gcf, lcm condensed
    - C factor quadratic, a = 1 to 10
- Operate
- Operate Sophisticated

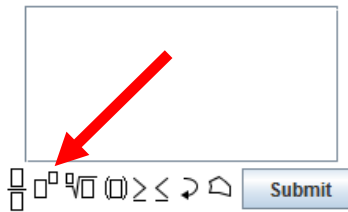
Our intent is to provide you with choices so you can tailor your GMM use to your curricular needs. However, you should *not* use all of these! That would take up too much screen real estate and also hinder student progress.

You can limit your view to only see the skills we use in our GMM classes. With the **A** tab still selected, in the bottom right corner click on **GMM Algebra Curriculum**. Click on the tiny handle next to the Polynomials unit, then you can see each 'lesson' we teach. Open a lesson to access the GMM skills for that lesson, as well as the PowerPoint we use for it.



## Entering Polynomial Answers

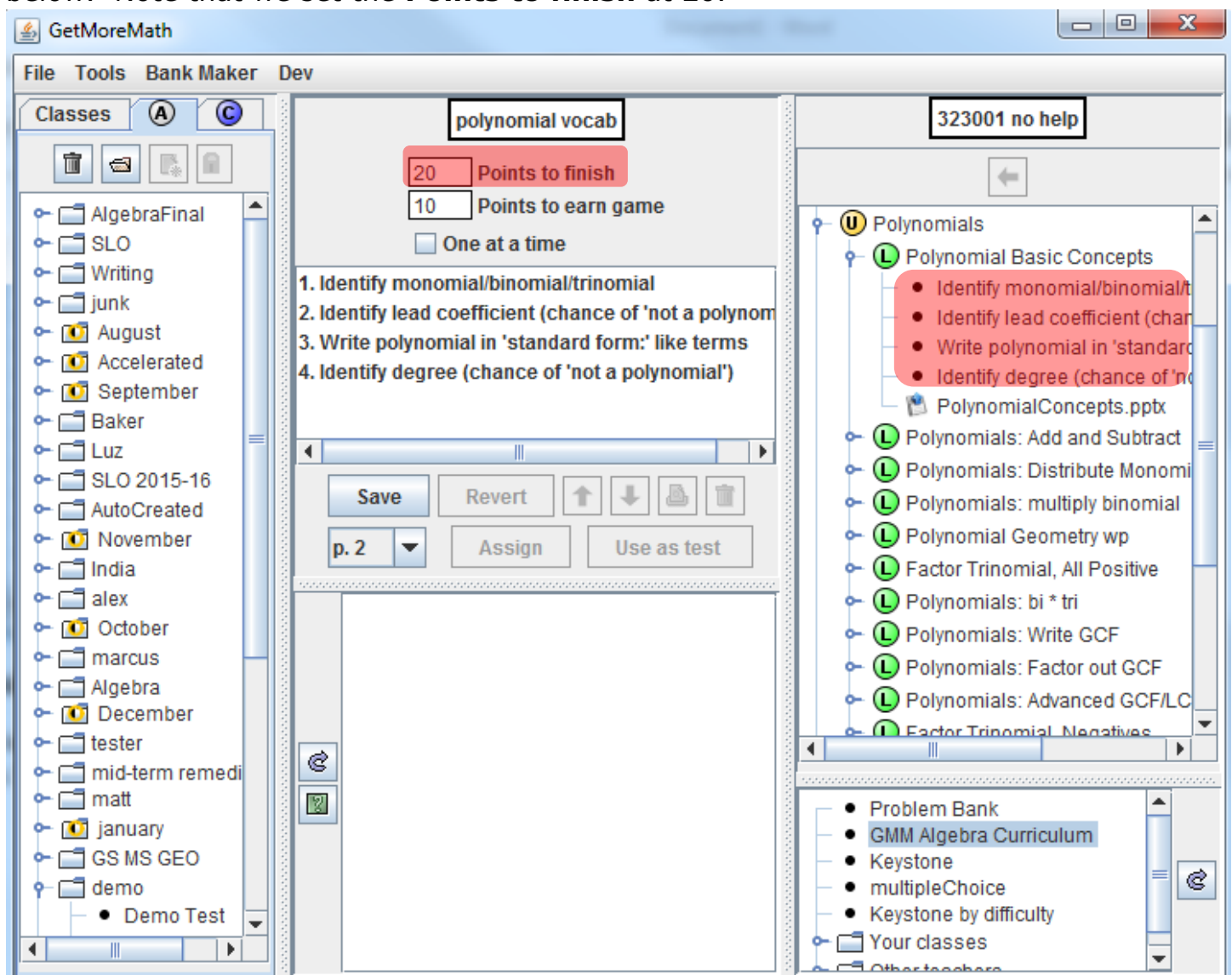
You can use the mouse to click on the power icon when you need to enter a power:



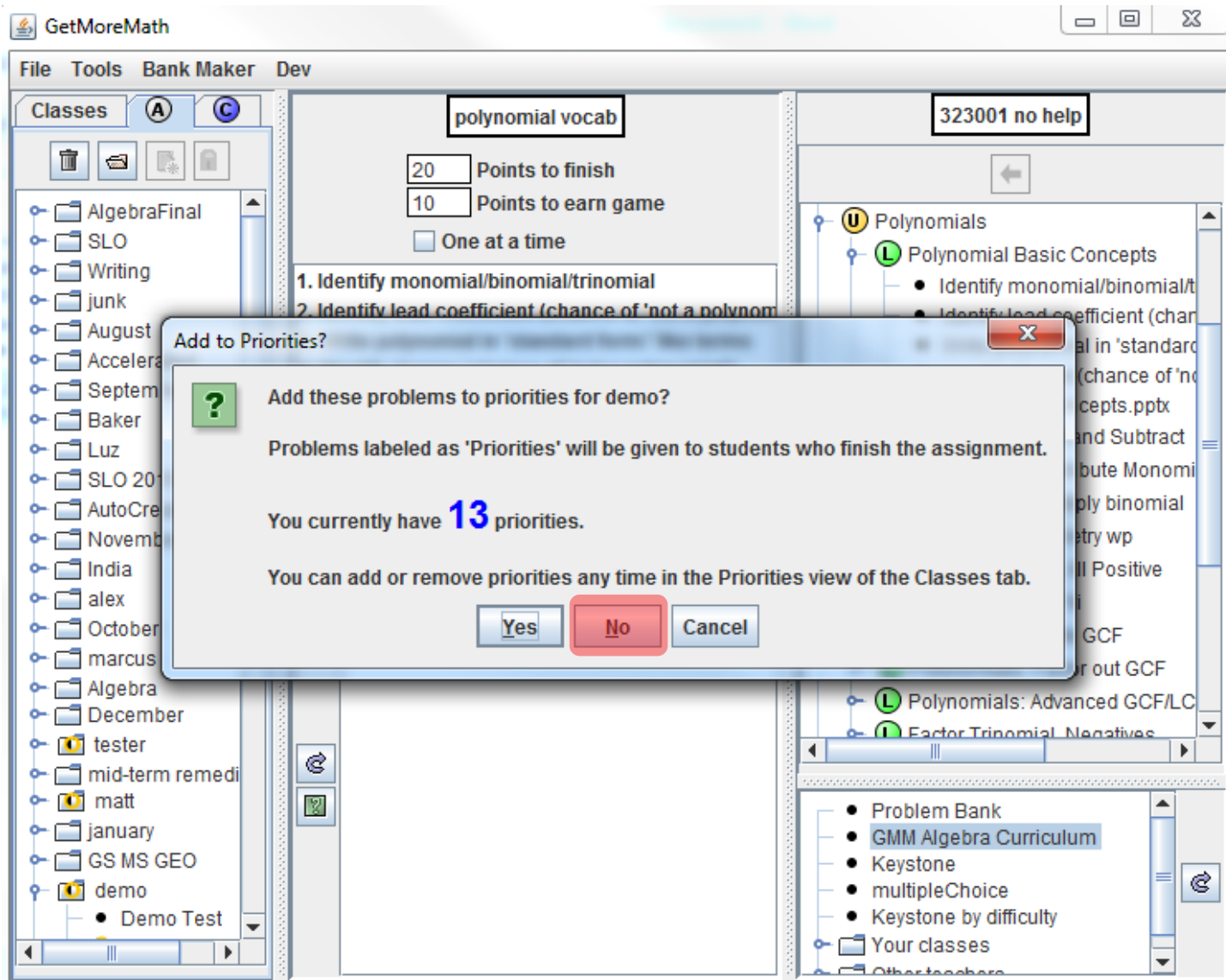
However, you can save a lot of time with hot keys. Use ctrl-p to enter a power, then the right arrow to move back down out of the power.

## Polynomial Vocabulary

Our first lesson covers polynomial vocabulary skills. They are listed in the lesson named "Polynomial Basic Concepts." We usually make an assignment with the skills shown below. Note that we set the **Points to finish** at 20.

A screenshot of the GetMoreMath software interface. The window title is "GetMoreMath". The interface is divided into several sections. On the left is a "Classes" sidebar with a tree view of folders and files, including "AlgebraFinal", "SLO", "Writing", "junk", "August", "Accelerated", "September", "Baker", "Luz", "SLO 2015-16", "AutoCreated", "November", "India", "alex", "October", "marcus", "Algebra", "December", "tester", "mid-term remedi", "matt", "january", "GS MS GEO", and "demo". The main area is titled "polynomial vocab" and contains a "Points to finish" field set to 20, a "Points to earn game" field set to 10, and a "One at a time" checkbox. Below this are four numbered tasks: "1. Identify monomial/binomial/trinomial", "2. Identify lead coefficient (chance of 'not a polynomial')", "3. Write polynomial in 'standard form:' like terms", and "4. Identify degree (chance of 'not a polynomial')". At the bottom of the main area are buttons for "Save", "Revert", "Assign", and "Use as test", along with a "p. 2" dropdown menu. On the right is a sidebar titled "323001 no help" showing a tree view of lessons under "Polynomials", including "Polynomial Basic Concepts" (which is highlighted with a red box and contains a list of tasks), "Polynomials: Add and Subtract", "Polynomials: Distribute Monomial", "Polynomials: multiply binomial", "Polynomial Geometry wp", "Factor Trinomial, All Positive", "Polynomials: bi \* tri", "Polynomials: Write GCF", "Polynomials: Factor out GCF", and "Polynomials: Advanced GCF/LC". At the bottom right is a "Problem Bank" section with a list of options including "GMM Algebra Curriculum", "Keystone", "multipleChoice", and "Keystone by difficulty".

Also note that when we **assign** this assignment to a class, we do NOT add to Priorities (see below). While we care enough about these concepts to ensure a basic early understanding via a one-time assignment, we do not rate them as long-term 'Priorities.' We will use polynomial vocabulary in class discussions from this point forward: that should be enough ongoing review.



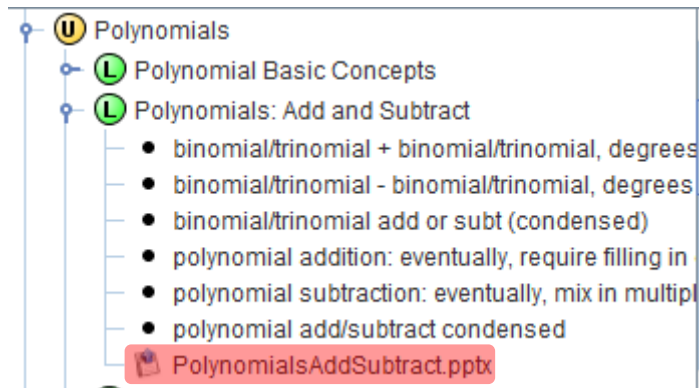
\*\*\* If this is the FIRST assignment you've ever given, you should choose YES when you see the above message!

# Adding and Subtracting Polynomials

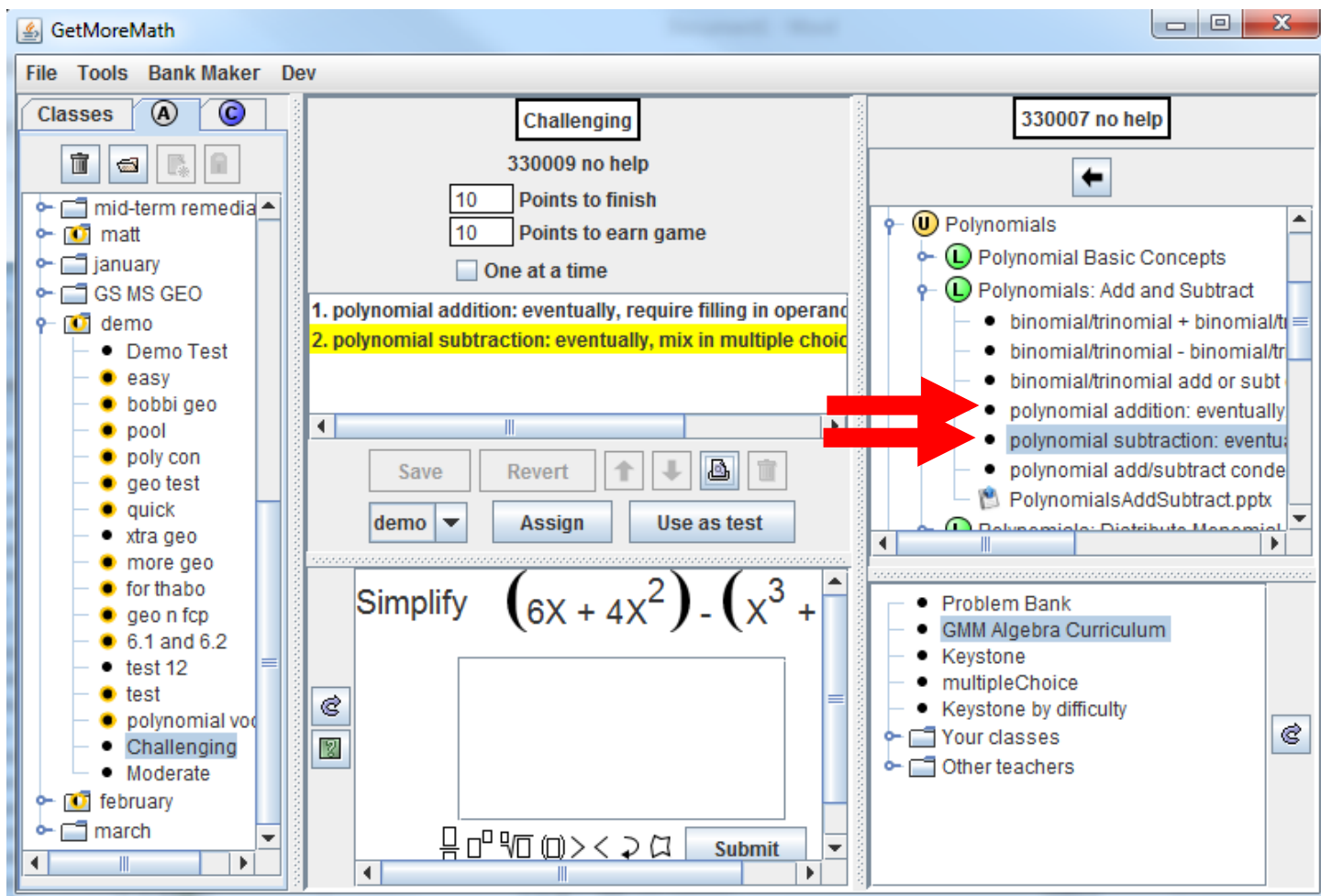
We have three paths for teaching addition and subtraction of polynomials. Each path targets a different level of student.

## Challenging

For our strong students, we teach an adding and subtracting lesson with a few basic examples. For the curious, you can access the exact examples on the PowerPoint.



We create an assignment that uses the two types of skills shown below:



Here is the beauty of these skill variants. After a few simple add/subtract problems, GMM will sporadically include alternately worded questions such as the following. We do NOT show any examples like this ahead of time. It is up to the students to independently figure out how to apply the new ideas in these alternately phrased situations.

Gretta started with this polynomial:  $4X^3 - X^2 - X$

She added another polynomial.

The sum was:  $4X^3 + 4X^2 - 3X - 1$

What was the second polynomial?

Finn started with this polynomial:  $2X^2 + X + 3$

He subtracted another polynomial.

The difference was:  $5X^2 + 3X + 6$

What was the second polynomial?

- $3X^2 - 2X + 3$
- $3X^2 + 2X + 3$
- $-3X^2 - 2X - 3$
- $-3X^2 - 2X + 3$



## Moderate

For students who may need a little more preparation before they hit problems like the ones shown above, we teach the same lesson, but then give an assignment that covers only basic variants.

The screenshot shows the GetMoreMath software interface. The main window is titled "Moderate" and contains the following elements:

- File Tools Bank Maker Dev** menu bar.
- Classes** sidebar with a tree view of folders including AlgebraFinal, SLO, Writing, junk, August, Accelerated, September, Baker, Luz, SLO 2015-16, AutoCreated, November, India, alex, October, marcus, Algebra, December, tester, mid-term remedia, matt, and january.
- Moderate** difficulty level label.
- Input fields for **10 Points to finish** and **10 Points to earn game**, with a checkbox for **One at a time**.
- Two problem descriptions:
  1. binomial/trinomial + binomial/trinomial, degrees 0 to 3
  2. binomial/trinomial - binomial/trinomial, degrees 0 to 3
- Buttons: **Save**, **Revert**, **Assign**, and **Use as test**.
- Problem preview area showing: **Simplify  $(-2X^3 - 3X^2 + X) - ($**
- Bottom right sidebar with a tree view of curriculum categories: **Problem Bank**, **GMM Algebra Curriculum**, **Keystone**, **multipleChoice**, **Keystone by difficulty**, **Your classes**, and **Other teachers**.

Two red arrows point from the second problem description in the main window to the "binomial/trinomial - binomial/trinomial" item in the curriculum tree on the right.



At a later time (maybe a day, maybe a week) we might remove those two types from Priorities, and then assign the assignment shown in the Challenging section, above. When we did this, we would monitor student progress to see which students are able to independently figure out the new 'tough ones.' After a while, we would teach a lesson to the students who could not work them out on their own. The students who could work them out independently would stay at their computers (skip the lesson). We love not wasting student time!

## Lower Ability

With our lowest students, we would start with the same assignment as the one shown above in the Intermediate section. However, before eventually transitioning to the harder variants (the Challenging assignment), we would explicitly prepare the entire class with an additional addition/subtraction discovery-based lesson. We would provide lots of support and practice so that we knew all students were well-prepared before we sent them to computers for the harder types. Otherwise we would be in for a train wreck (lots of stuck kids, penalties, and frustration).

## OR

With a very weak group, we might never introduce the harder variants.

**Condensing** (You'll need this when you are more experienced. Read now for exposure.)

Eventually (a month or two later) we remove the adding and subtracting skills from Priorities and add the single skill that condenses those two. For any group that has had the challenging problems, here is what that would look like. Choose the **Classes** tab, then click on the small 'handle' next to a class, then click on Priorities:

The screenshot shows a software interface with a 'Classes' tab selected. On the left is a tree view showing a hierarchy: Settings, All Students Online, demo, p. 1, and p. 2. Under 'p. 1', there are several items including 'Priorities', which is highlighted. On the right, a notification box says '59 Priorities for p. 1'. Below this is a table with columns 'Date Added', 'Prioritize', and 'Description'. The 'Prioritize' column has checkboxes, and the 'Description' column contains text like 'WP ineq system: write system then ...' and 'C fractional coefficient, condensed'. A red box highlights a 'C' icon in the table header, and a blue box highlights the notification box.

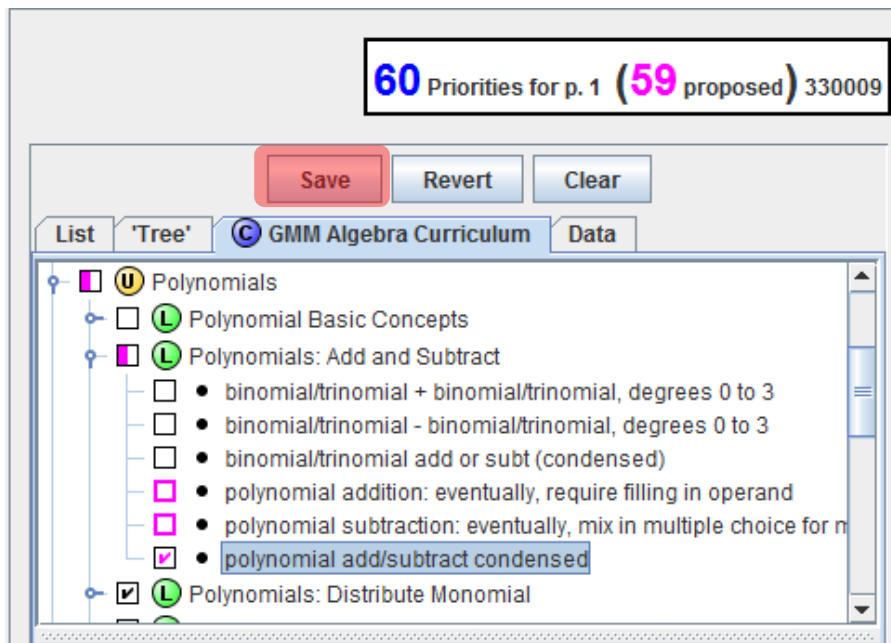
Date Added	Prioritize	Description
Jan 12, 2016	<input checked="" type="checkbox"/>	WP ineq system: write system then ...
Jan 7, 2016	<input type="checkbox"/>	WP ineq system: click on correct sha...
Feb 1, 2016	<input checked="" type="checkbox"/>	C fractional coefficient, condensed
Feb 3, 2016	<input checked="" type="checkbox"/>	C Solve proportion with expressions
Sep 28, 2015	<input type="checkbox"/>	Type 2, given m and b, two question...
Feb 8, 2016	<input checked="" type="checkbox"/>	Graph on numberline
Oct 20, 2015	<input checked="" type="checkbox"/>	Type 6 Given graph of wp, write and ...
Dec 3, 2015	<input checked="" type="checkbox"/>	Given graph which number is not in

Next, click on the **C** tab near the middle of the screen (see above).

Click on **Click to Load Curricula**, then click on the small 'handle' next to the word **Curricula**. Navigate to **Britton, Josh** and then select **GMM Algebra Curriculum**.

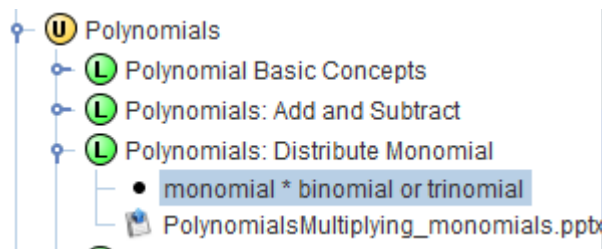
The screenshot shows a software interface with a left sidebar and a main content area. The sidebar, titled 'Classes', contains a tree view with folders for 'demo' and 'p. 1', and 'p. 2'. Under 'p. 1', there are several items, with 'Priorities' highlighted. The main content area has a header with '59 Priorities for p. 1' and buttons for 'Save', 'Revert', and 'Clear'. Below this are tabs for 'List', 'Tree', 'GMM Algebra Curriculum', and 'Data'. The 'GMM Algebra Curriculum' tab is active, showing a list of units: Relationship Basics, Relationships 2, Relationships 3, Systems, Numberline Inequalities, Linear Programming, and Polynomials. Below this list is a section titled 'Curricula' with a tree view showing folders for 'Allen, Lisa', 'blose, blose', and 'Britton, Josh'. Under 'Britton, Josh', there are several items, with 'GMM Algebra Curriculum' highlighted.

Navigate to the Polynomials unit, deselect the addition and subtraction skills, and select the condensed version. Then click **save**.



## Multiplying Polynomials

We like to start with a monomial times binomial or trinomial lesson:



When we teach the concept, we only do 'vanilla' examples (regardless of level), but be warned: after a few successful problems, students will encounter the same concept in an alternate format. We prefer to encourage them to sort this out for themselves, rather than rely on teacher explanation. However, we usually find in our lower groups that a subgroup cannot decode the alternate format problems. We teach this group separately, either one-on-one or in a break-out lesson (while everyone else stays at computers).

### Vanilla

Simplify  $3X^4(3X^3 - 5 + 7X^2)$

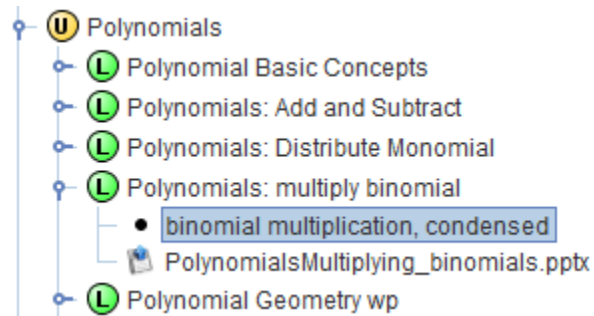
### Alternate

For which value of Y will the following be true:

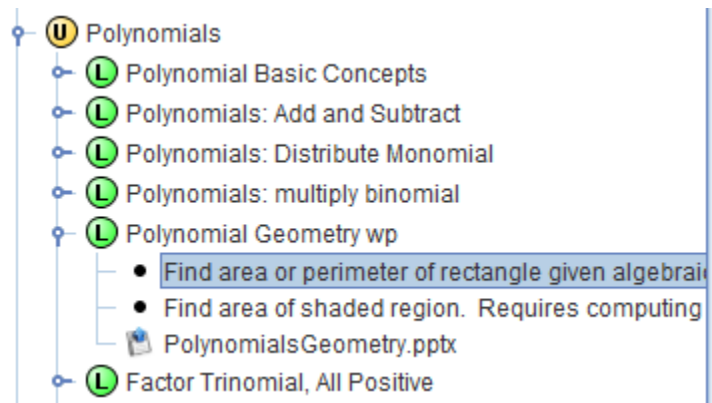
$$-4X^Y(7X^2 + 4X^3) = -16X^7 - 28X^6$$

- 1
- 2
- 3
- 4

Our next lesson covers binomial times binomial, using this problem type:



Next, we spend a few days on 'Polynomial Geometry.' This is really just a chance to nurture early polynomial operations questions with alternate formats. As with the prior lessons, we find that many students are capable of mastering these two skills without ANY teacher talk or formal lesson. Sometimes we say: "A new type of problem is about to show up on your screen. See if you can figure out how to handle it. If you can't, come over here for a lesson." Here's where to find the problems and what they look like:



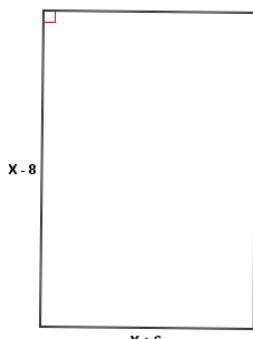
**Day 1**

The dimensions of a rectangle are:

$x - 3$  and  $-2x - 6$

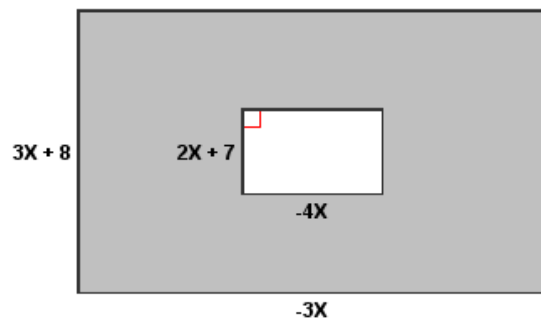
Write the simplified expression for the rectangle's area.

Write the simplified expression for the rectangle's perimeter.



**Day 2**

Write a simplified expression for the shaded area.



# Factoring

The next few paragraphs are not really about GMM. Skip them if you just want the nuts and bolts.

Next, we plunge into factoring. In our opinion, it is possible to 'teach' factoring trinomials without ever formally teaching to about 90% of our students. They figure it out for themselves!

Here's how I (Josh) get that to happen. First, I have them do an assignment on GMM with about 4 multiplying binomials problems. They learned this skill several days earlier. Once everyone is done (all students have been shifted to Priorities), I tell them we have a pop quiz on multiplying binomials, but to make it a little easier they can take the quiz as partners.

While announcing the quiz, I get out a stack of small posters clearly marked 'ANSWERS' on one side. I make sure they can see that word, but also that I can't, so they have the impression that I am mistakenly about to show them a bunch of answers. Then when they have numbered a blank paper and are ready for the quiz, I turn around the first poster and pretend to be surprised to find a trinomial answer there. "OOOPS!" I frantically look around for the quiz questions, but can't find them!!! Then I suggest that since the quiz is ruined, maybe they can help me rebuild it. I leave the first answer trinomial where they can see it and simply say: "I got this when I made the quiz this morning. I multiplied two binomials, and this was the answer. What were the binomials?"

That is ALL I ever have to do to get almost every student up and running successfully with factoring!

There are a lot of factoring skills listed in GMM. Here are the three we use. We don't get to the second and third until several days after the first.

- Polynomials
  - Polynomial Basic Concepts
  - Polynomials: Add and Subtract
  - Polynomials: Distribute Monom
  - Polynomials: multiply binomial
  - Polynomial Geometry wp
  - Factor Trinomial, All Positive
    - factor quadratic,  $a = 1$  to 10
  - Polynomials:  $bi * tri$
  - Polynomials: Write GCF
  - Polynomials: Factor out GCF
  - Polynomials: Advanced GCF/LC
  - Factor Trinomial, Negatives
  - Factor Difference of Squares
  - Simplify Rational Expressions

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  - Polynomials: Write GCF
  - Polynomials: Factor out GCF
  - Polynomials: Advanced GCF/LC
  - Factor Trinomial, Negatives
  - Factor Difference of Squares
    - factor quadratic,  $b = 0$  (differe
  - Simplify Rational Expressions