Translating Success: How Careful Planning Within a Problems-Based Curriculum Can Prepare Students to Enter College-Level Math Classes

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Amy Biehl High School (ABHS) is a charter high school located in downtown Albuquerque that serves students from Albuquerque and the surrounding communities. There is no "typical" ABHS student; our student body is as rich and diverse as the city itself. Despite our school population's differences in skills, special needs, socioeconomic class, race, culture, and English proficiency, we have one common goal for all our students: that they are able to succeed in college. In fact, we ask students to prove that they are on their way to achieving this goal while they are still at our school through concurrent enrollment, requiring that they take and pass two college level courses in their senior year.

Given the overall mission of our school, it makes sense that the mission of the math team at ABHS is for all students to succeed in a college level math class, and this goal is the lens through which we examine everything that we do. The curriculum that we use in our efforts to achieve this goal is the Interactive Mathematics Program (IMP). IMP helps to prepare our students for success in college by instilling a deep understanding of the generation and application of various mathematical concepts. It fosters critical thinking and independence. It teaches students the value of questioning and collaborating with others when faced with a difficult problem. All of these skills are invaluable once a student is in the college classroom. But how does IMP prepare students for the tests that permit or deny access to college classrooms in the first place?

Curriculum Translation

Almost all colleges and universities use some sort of standardized test as a means of placing students in math classes. One local university uses an ACT math score, and another administers a placement test specific to that school. While we may not agree with the methods that colleges and universities use to place students into math classes, we do not feel empowered to change them anytime in the near future. Ensuring that students succeed in college math classes means making sure they get there in the first place. And that means preparing them for success on standardized exams. But how does the type of mathematics learned in a context-rich, problems-based curriculum translate to the isolated skills that a student will encounter on such an exam? The key is in the idea of translation. It's as if our curriculum were written in one language and the tests in another. Our goal is for students to understand both languages.

Students can get all the skills they need to be successful college math students from the IMP curriculum. The problem comes when they have to take what they have learned in relation to a complex, weeks-long unit problem to the symbol-heavy and context-poor land of the standardized test. Though by now somewhat routine, it remains startling to watch a student struggle with a more "traditional-looking" problem just because of the way it appears, despite the fact that he or she has demonstrated to me an understanding of the concept repeatedly in the classroom. The task that faces us, then, is helping our students to be able to bridge the gap between the language of our curriculum and that different-looking "testing" language they will encounter as they transition from high school to college. We currently implement two strategies in an effort to help our students become better translators: one is the use of our own standardized exams, and the other is our outcomes-based grading system.

In-House Standardized Exams

One of the ways in which our team is working on bridging the gap is by giving our own standardized exam to all our students each year. These exams were created as a response to the need to better prepare students for the math portion of the ACT, which is the placement tool used by the local university that the majority of our graduates attend. Many of our students were not getting the required score of 22 that they needed on

the ACT in order to be placed into College Algebra, so our team decided that we needed a structure in place that allowed us to collect data on our students' performance on a similar type of test over the course of the four years that they are with us. We created four in-house standardized exams - one for each grade level - and began administering them twice a year, once at the beginning of the year and once again at the year's conclusion. The questions for the test come directly from various high school graduation and college entrance exams to be sure that the testing language is authentic. Students' scores then become data that we can use to make decisions about our own curriculum and assessment.

But just how does a biannually administered, in-house standardized exam assist students in translating from the language of our curriculum to the language of the test? First of all, we are exposing our students to this "testing" type of language. It is our hope that seeing this language year after year in this type of setting will increase students' comfort and confidence with testing language. But this is more of a side benefit than our actual goal in doing this testing. The primary benefit of this process lies in the data that is generated by these tests and the ways in which the data informs how we plan.

Analyzing how students are doing on particular questions allows us to see where the gaps and holes are in our four-year curriculum. We even group the problems into various categories, and understanding how students do within those categories (such as number sense or proportional reasoning) allows us to see the areas in which our curriculum is weak as well as the areas in which it is strong. All of the skills necessary for success on standardized exams and within college classrooms are contained within the IMP curriculum; sometimes it's just a matter of figuring out where they are. Since the skills are embedded in a problems-based context, it takes a little work to identify correlations.

For example, in the Year 1 unit, The Pit and the Pendulum, students use the idea of curve fitting to determine if the prisoner's escape in Poe's famous story is realistic by predicting how long it would have taken Poe's pendulum to make 12 swings. While students are exposed to different curves in an investigative activity called "Graphing Free-for-All," it is up to the instructor to determine how formally these curves are treated and how much emphasis is placed on finding equations for various curves. The standardized exams allow us to create a solid structure that we confidently feel contains all the skills a student needs. And they allow us to be deliberate, making sure students know exactly what it is they are learning as well as exposing them to the way a skill might look were it taken out of the context of the unit problem they are attempting to solve.

Outcomes-Based Grading

Another useful tool in ensuring that students can translate their knowledge and skills on a standardized exam is the outcomes-based grading system. The outcomes system is a way of assessing student learning that the team has been developing over the past year. It involves the teacher pinpointing and naming the specific skills that are embedded in a given unit and then helping students to focus on and sharpen those skills throughout the unit. The teacher carefully investigates a unit before the students begin it, and then names the mathematical skills (usually eight or nine) that the student is required to master by the completion of the unit. The outcomes are shared with the students at the onset of the unit and serve as a map of sorts, helping them to navigate the sometimes muddy (in other words, not mathematically obvious) processes they perform over the course of a unit. Students are then held accountable for demonstrating to the teacher that they have mastered the outcomes in various settings, such as homework assignments, in-class assignments, and quizzes. Their work is judged to be either highly proficient, proficient, or not yet proficient, and they can continue to work on skills and readdress outcomes as necessary throughout a unit. Outcomes help students to name the skills that they are learning, and this naming helps to ensure that the skills are more easily translated beyond the context of the unit problem. Some examples of outcomes from the Year 2 unit, All About Alice, include solving problems involving exponents, graphing exponential functions, and understanding and using laws of exponents.

Students can see clearly the benefits of having an outcomes-based grading system. "With IMP, it's hard to know what exactly you're being taught because of how the assignments are set up," states Bethany Trujillo, a tenth grader at ABHS currently taking the second year of IMP. "Having outcomes it gives a clearer point of what we're doing, and also helps to show that we know and are capable of doing the work." Outcomes are solid and tangible; they are something that the student can go back to when they need to be reminded of the purpose of an assignment. Outcomes allow a student to connect the concepts they are learning with some sort of larger mathematical picture. Aine Brazil, a ninth grader taking IMP 2, says, "Before outcomes, I

didn't know what was expected of me for each assignment, but now it is clear that each outcome is a skill that is important to learn to keep moving forward academically." Each outcome becomes a link in the chain, and seeing this allows students to transcend the contextual nature of IMP and connect their knowledge in new and innovative ways to spaces outside of the classroom. This, in turn, improves students' ability to retain and use skills in an unfamiliar setting, such as a standardized test.

In addition to helping students use skills in new ways, outcomes prepare students by naming skills and reinforcing those names so that students can recognize the name and then recall the skill in a new context. Because IMP is structured so differently from traditional math curricula, the book is not divided into discrete processes with the name of a particular process in bold letters at the top of the page. Math in context is rich and powerful in that it gives students an understanding of the need for the mathematical concepts they are learning. But sometimes the names can get lost in the context. For example, an IMP student might feel quite comfortable finding the area of a rectangular lot with a length of x + 3 and a width of x + 4, but might have no idea what was being asked of him or her if a problem said "multiply two binomials." Outcomes allow students to become familiar with the names of concepts and skills and thus increase the likelihood that a student will accurately interpret the directions of a problem on a standardized exam. Students are thus equipped to more accurately and easily translate from a contextual setting to more formal mathematical language and back again.

Opening the Gates

The ABHS math team does not propose that simply teaching to the test prepares students for success in college, though these translation skills have value beyond the various gatekeeping standardized tests that students will encounter as they move from ABHS to their next educational steps. Preparing students for the more formal language of standardized tests also prepares them for success in the college classroom where that more formal language is typically employed. But the unfortunate reality is that students have to have access to a class before they can succeed in the class. It is our sincerest hope that someday a new system will come into place that determines the classes in which students belong based on a careful examination into the mathematical background of each student. But in the meantime, we believe that our mission is best achieved by working to prepare students to succeed on these tests and pass through these gateways. We haven't changed what we teach. We've just been careful to expose students to what the skills they are already learning might look like in a different context. We believe that familiarizing students with the more formal and rigorous language of mathematics that they will encounter in their post-secondary studies allows them to translate the deep and useful learning that occurs in a curriculum like IMP to this new setting.

Sample Problems in Translation

Algebra

Solving basic equations is traditionally taught in the ninth grade in an Algebra I class. In IMP, it is covered at the beginning of Year 2 in the unit Solve It!

Solving Equations: IMP

There are 8 mystery bags of equal weight and 10 ounces of lead weights on one side of a pan balance, and 4 mystery bags and 30 ounces of lead weights on the other side. How much does each mystery bag weigh?

Solving Equations: Standardized Exam

Solve for x: $8x + 10 = 4x + 30$

Exponential Functions

Graphing exponential functions is sometimes covered in a ninth grade Algebra 1 course, but usually does not get taught intensively until Algebra 2. In IMP, graphing exponential functions gets covered at the end of Year 2 in the unit All About Alice.

Graphing Exponential Functions: IMP

Alice's height doubles for every ounce of cake that she eats. Find out what Alice's height is multiplied by when she eats 1, 2, 3, 4, 5, or 6 ounces of cake. Then make a graph of this information.

Graphing Exponential Functions: Standardized Exam
Graph the exponential function y = 2x

Trigonometric Ratios
Using trigonometric ratios to find missing side lengths in a right triangle is typically covered in a Geometry course, which most students take in their sophomore year. This topic is covered toward the end of Year 1 in IMP in the unit Shadows.

Using Trigonometric Ratios: IMP
Shredding Charlene is out surfing and catches the eye of her friend, Dave the Dude, who is standing at the top of a vertical cliff. The angle formed by Charlene's line of sight and the horizontal measures 28°. Charlene is 50 meters out from the bottom of the cliff. Charlene and Dave are both 1.7 meters tall. They are both 16 years old. The surfboard is level with the base of the cliff. How high is the cliff?

Using Trigonometric Ratios: Standardized Exam
A right triangle has a hypotenuse with a length of 12 feet and an acute angle that measures 27°. What is the length of the leg opposite the 27° angle?

Related Resource

For more on Amy Biehl High School, please read "Small School, Big Influence: Amy Biehl High School Tells Its Story" in Horace Volume 21, Issue 4, Fall 2005, www.essentialschools.org/cs/resources/view/ces_res/381

Founded in 1999, Amy Biehl High School is located in downtown Albuquerque, New Mexico. A CES Mentor School, ABHS is a year-round school with 200 students in grades nine through twelve.

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