Applying the Common Principles To Mathematics: Successes and Challenges

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In the mathematics department at Vanguard High School, we have taken on a mission to raise students' interest, skill, understanding, and performance in mathematics Over the past several years, we have wrestled with the implications of the achievement gap, a pressing fact for us, as students enter our school well below grade level. Our own belief in education as an act of social justice, our adherence to the Coalition's Ten Common Principles, and our response to external requirements from the city and state has produced a mathematics program characterized by some notable successes, strategies and ideas for the future, and a number of lingering puzzles.

Vanguard's Math Program

The Vanguard High School mathematics program requires students to enroll in four years of heterogeneously grouped classes, culminating in a senior portfolio class. Students also have the option to take several math electives, including Mathematical Games, Architecture, and Calculus. Over the past several years, we have moved away from instructor-designed classes into a more traditional sequence of courses (algebra, geometry, advanced algebra, and more) to increase consistency in our department and free up time to focus on helping students. Students work collaboratively in groups, and the curriculum comes primarily from College Preparatory Mathematics, a program that emphasizes conceptual problems and spiraled content. Classes are small, generally 15 to 20 students each.

The primary challenge our department has faced is how to support a set of high academic standards for a population that enters our school well below grade level. Two years ago, an internal drive to raise the level of mathematical rigor and achievement at the school, coupled with city, state and federal pressure to raise student achievement and rates of credit accumulation and graduation, prompted our department to re-examine our curriculum and pedagogy, our portfolio and graduation requirements, our assessment system, our academic supports, and our opportunities for advanced work.

More than five years ago, Vanguard lost its waiver from the Math A Regents, the high-stakes, standardized graduation requirement in the state of New York. In response, our school responded by taking steps away from the Common Principles; we wrote our own curriculum that focused on covering the breadth of topics on the Math A (which includes a rather broad and unconnected range of material) and spent a month of each semester on test preparation. Many classes featured teachers in a traditional role of "deliverer of instruction services," focusing in particular on the tricks and sometimes obscure content requirements of the Math A exam.

While we were able to improve students' standardized test scores, we hadn't developed strategies to actually improve students' mathematical understanding. As veteran teacher Rebecca Daczka says, "It seemed like students weren't really learning – they were just memorizing for the test." Our faculty became frustrated that we often had to teach much of the same content at each grade level: each course had students re learning how to solve simple equations, and our Senior Portfolios focused on linear and quadratic equations, a topic more traditionally seen in ninth grade mathematics.

Many teachers in the department felt frustrated by the amount of time it took to write curriculum to cover Math A topics and offer projects and exhibitions. Daczka says, "I'd find myself spending two hours a night writing lessons, and I didn't have time to really find what my students understood."

Vanguard teachers were also at a loss for useful student assessment and achievement data. For many years, the department kept detailed grade reports that focused primarily on student work habits describing

homework and class work completion, with commentary on exhibitions and projects. However, our assessment system did not provide some important information about our students. Many students failed our classes, and their grade reports often reflected poor work habits, especially regarding homework. However, during conversations and class time, we'd often find a number of these students really understood the material. On the other hand, students could have excellent grades given good work habits, diligence about tutoring, and seeking help from classmates, and yet have very weak mathematical skills and conceptual understanding. For instance, this past year our department watched a video of a student during his senior portfolio struggling with basic concepts and definitions that should have been addressed in the ninth grade. His impeccable homework habits and conscientiousness about seeking help, coupled with the high grades this produced, obscured the need for remediation until this portfolio presentation.

A Chance to Reflect

Over the past two years, a number of external accountability changes and inte rnal reflections have precipitated a chance to reflect on some of the challenges we have been facing. We received a new waiver from the Math A exam, but at the same time, we received demands from the city School Quality Review program to develop a system of interim assessments for the students called a Design-Your-Own Interim Assessment (DYO). While the waiver exempted students from the high-stakes aspect of the Math A exam, we still needed to offer the exam to meet federal No Child Left Behind requirements (the Federal government does not recognize a waiver, which was offered by the State of New York).

Our department viewed this as a chance to think about our graduation requirements and portfolio assessment system. We expressed the need to develop new performance assessments suitable for every grade level. We also decided to raise the level of rigor in the higher grades, while acknowledging a need to improve our curriculum to spiral content and increase conceptual understanding. We focused on improving our assessment and remediation strategies to discover student weaknesses and attempt to fix them systematically.

These last two years have been a time for reflection, and we have developed a number of strategies to address our challenges, described below in terms of some of the CES Common Principles.

"Learning to Use One's Mind Well"

The first step in raising the level of our graduation requirements was to define what we meant by rigorous mathematics, or, in the language of the Common Principles, what did it mean for our students to use their minds well? Our department chose to return to Vanguard's Habits of Mind, which focused on the need for students to learn the process of thinking well. This process requires students to reason with evidence, offer conjectures, seek significance, make connections, consider viewpoints and think about their learning.

Of course, this process is in service of learning particular content. Our department adapted a curriculum called College Preparatory Mathematics that focuses on grade-level standards, fewer, more conceptual questions, skill practice spiraled throughout the years and cooperative learning. We have begun to rewrite the content expectations of this textbook series in terms of our habits of mind, resulting in a list of understanding goals. For instance, one of our understanding goals comes from a tenth grade unit on Quadratic Equations, and it requires "students to make connections between verbal, tabular, graphical and analytical representations of quadratic situations and reason with evidence about how to go from one representation to another."

"Less is More, Depth over Coverage"

We selected a curriculum that spirals content, revisiting major topics many times over four years with increasing depth, and standardized understanding goals in terms of our habits of mind. As we started this process, we noticed that we've developed a set of expectations that emphasizes deep thinking. For instance, an eleventh grade understanding goal concerning Quadratic Equations requires "students make connections between verbal, tabular, graphical and analytical representations, including standard, factored and vertex forms, of quadratic situations"; students often revisit the same understanding goals in different years, simply with greater depth and newer material.

Furthermore, an emphasis on writing standards in terms of a few habits of mind pushes students to employ fewer, more generative ways of thinking rather than memorizing a plethora of mathematical facts, rules and tricks. An understanding goal from Calculus also requires students to make "connections between verbal,

tabular, graphical, and analytical representations," but this in service of understanding derivatives.

"Goals Apply to All Students" and "Personalization"
In writing these understanding goals, we have begun to write standards that apply to all students. In previous years, our department often had difficulty expecting the same understanding from all students. While all students had exposure to the same material, we tended to alter our goals for our performance assessments for our weaker students. While we made these adjustments to ensure all students had a chance to pass our courses, we failed to offer those "students not yet at appropriate levels of competence … intensive support and resources to assist them quickly to meet [our] standards," primarily because we did not have a system to identify the source and nature of students' individual difficulties.

Currently, our department is in consultation with Vanguard's Instruction Support Services team to identify those core understanding goals that will mark the heart of our mathematics experience, those goals that will apply to all students. Additionally, we are working to develop scaffolds and adaptations. Finally, we are designing our assessment system to maximize personalization of learning and teaching; students attempt to demonstrate mastery of understanding goals whenever they are ready, not just on test days or at the end of a unit. Students certainly appreciate this level of personalization; sophomore Evelyn Santiago says, "[Understanding checks] changed my way of thinking about math a lot because now I think you can keep trying until you understand something."

"Demonstration of Mastery"
This Common Principle suggests "multiple forms of evidence, ranging from ongoing observation of the learner to completion of specific projects, should be used to better understand the learner's strengths and needs, and to plan for further assistance. Students should have opportunities to exhibit their expertise before family and community." As such, we have developed a number of different assessment vehicles through which students can demonstrate their understanding.

Beyond written tests of the understanding goals, which we offer several times a semester as a part of our DYO interim assessment system, we have developed individual oral defenses, roundtable discussions and individual assessment interviews. In the oral defense, which we have expanded to the tenth and twelfth grades, students individually present and defend their knowledge through an explanation of an authentic mathematical task, followed by intense question and answer time. In a roundtable discussion, students work in small groups to tackle a new and novel situation; at the end of the roundtable, there can be an opportunity for evaluators to interview students to reflect on the process and develop a fuller sense of the student's understanding. Finally, assessment interviews provide an alternative to written tests for those with test anxiety or language difficulty; students are evaluated during a live interview instead of through a written test.

While students find the demands of mastery more difficult, many report appreciation for this way of learning and assessment. Student Jeffrey Rodriguez says, "I like to know that I am getting graded on how well I understand. It's harder, but we're proving that we know how to understand things."

"Student-as-Worker, Teacher-as-Coach"
To meet these standards, we've begun to share pedagogical strategies "to provoke students to learn how to learn and thus to teach themselves." Some of us have adopted a cooperative learning strategy developed by researchers at Stanford University called Complex Instruction, in which students are assigned roles and teachers work to provide group-worthy tasks and mitigate perceived status differences in students' abilities by valuing student questioning, skepticism and demands for evidence from fellow classmates. We have also started to implement study team strategies, such as participation quizzes, in which students are given a daily grade based on the quality of their conversations as recorded by the teacher on an overhead. We also utilize team tests, in which all students at a study team receive the same grade for a test, encouraging them to take ownership over their own learning.

"Democracy and Equity"
The changes and strategies listed above are part of a larger vision of democracy and equity: a belief in education and social justice that strives to offer an underserved, urban population of color educational opportunities that are equitable to those granted to wealthier suburban students. Our department has changed our exit requirements to focus on grade-level content, and we have developed a Calculus class for

students motivated to extend their study of mathematics. Students who once failed middle school mathematics are now successfully completing a course in calculus.

Lingering Puzzles

Our department has reached a few conclusions about our work. While we generally enjoy the increased rigor and consistency provided by our outside curriculum, we sometimes need to develop larger projects appropriate for our performance assessments. Each grade team spends part of every week collaborating on adaptations of the curriculum to meet our needs. In our department meetings, we have conversations about how to adapt the curriculum for our special needs children. We've also spent department meeting time working on analyzing our student performance information and assessment data, and we're trying to rearrange our staff to create additional math support classes based on what individual students need to know.

Though we are excited by the changes we've implemented over the past few years, a number of lingering puzzles remain. For instance, how can we use the information we collect on each student's understanding to better inform our remediation system? Currently, when students fail classes, they are placed in a generic night school or summer school program; how could we provide a more individualized experience so students learn what they don't understand? We also wonder how to write standards that truly emphasize deep, meaningful thinking and not just superficial knowledge. In working with our understanding goals, we've found some to be too procedural or obscure. How can we be sure our standards get at the heart of our subject matter? We also wonder how these strategies can translate into improving students' standardized test scores. Many of our students have difficulty scoring well on external metrics (although they have improved considerably on the Math A exam). What can we do as a school to promote success on these tests?

Finally, we want to know how we can use the information we collect about student achievement to inform our own practice. How can we reshape units based on our students' demonstrated understanding of topics? How can we work as a team to ensure students can demonstrate mastery of our goals?

Vanguard High School is a small Essential school located in Manhattan's Upper East Side in the Julia Richman Education Complex. Vanguard serves approximately 400 students, and is 92.6 percent students of color (60 percent Hispanic and 30 percent African-American). Only 11% of students who enter Vanguard meet the state reading standards and only 28 percent meet the state mathematics standards. An unusually large percentage of the student body receives special education services.

The Vanguard Habits of Mind

Working with students and staff with the intellectual focus on "using their minds well," our curriculum is developed stating the concepts, skills, knowledge and goals of year-long or semester-long thematic courses. We use the "Habits of Mind" to plan and implement curriculum. These are:

How well does the student use evidence to support his/her opinions or conclusions?

Does the student see other points of view?

Can the students see connections between different topics, areas and courses?

Is the student able to see the relevance of our studies?

Does the student see various factors in an argument and conjecture what would happen if they were changed?

In this process, students are expected to show and deepen their understanding of the five main "Habits of Work:" punctuality, organization, cooperation, revision, and focus.

Related Resource

In 2005, Vanguard High School and 27 additional schools belonging to the New York Performance Standards Consortium won a court ruling allowing a five-year waiver from the New York State Regents standardized exams. An overview of this legal victory in defense of performance based assessment, “Making the Pendulum Swing: Challenging Bad Education Policy in New York State,” by Ann Cook and Phyllis Tashlik, was published in Horace Volume 21, Issue 4, Fall 2005, www.essentialschools.org/cs/resources/view/ces_res/380

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