Solving the Project-Based Math Conundrum: The Multidimensional Math Classroom

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This post is by Will Haase, Calculus and Math IV teacher at High Tech High International

Imagine walking into a math classroom. Everything is quiet, students are diligently writing and reading and thinking. You hear the rustle of paper, scratching pens, and the occasional student shifting in their seat; it seems like any other classroom except that the students are seated in groups facing each other. Then you notice that large pieces of paper cover the entire table and there are different colored markers in the center.

While you are taking it all in, the teacher announces that it is time for students to share their mathematical ideas with their group. The classroom erupts into activity and noise. Students begin discussing the math question they have been working on independently. Diagrams and equations start to dot the table papers. Students take turns sharing their thinking as group members challenge their logic and offer additional ideas. The energy and excitement in the room surprises you and for a while you lose track of whether there is even a teacher there at all. Creative and diverse ways of tackling the problem, some more likely to work than others, all get a place on the paper. Through cycles of questioning and discussion, the groups slowly develop a more coherent understanding of the mathematics involved in their problem. As the class draws to a close, students share their ideas with the larger group, drawing more questions, some praise, and further wonderings. This is a glimpse into the multidimensional math classroom, a conceptual project-based math vision I want to share with you.

Over the past decade I have had the privilege of working at one of the High Tech High schools located in San Diego, California. In that time, I have witnessed the impact a school focused on collaborative, project-based learning (PBL) can have on students. It has been inspirational to see first-hand how successful this model can be in addressing the needs of students. However, there has always been one discipline that didn't seem to fit in with this collaborative approach--math. In my hundreds of talks with other math educators across the project-based and deeper-learning network, there is a consistent frustration with math. Despite our best efforts, we have yet to create a clear vision of math in this innovative school context. Until now.

I believe that the model of math education that Jo Boaler presents in her ground breaking book *Mathematical Mindsets*, as well as on her **youcubed.org** website, is the missing piece for us in the project-based learning community. Of course we want students experiencing math in action and we should continue promoting applied math projects that cross over with science and engineering. But we also need to realize that conceptual fluency with math as a language is also important. These new practices that seek to unpack patterns and explore multiple solutions offer a new and exciting way to create projects with math that multiply entry points for all learners. A project where students are creating and exhibiting their own authentic math ideas. I believe that exploring and experimenting with how we can weave this vision into our own math programs would be transformational.

To clarify exactly what this multidimensional math experience is, I'd like to quote Jo Boaler directly from her **youcubed.org** website:

"So what is multidimensional mathematics? It is real mathematics. Let's consider the work of a mathematician: She first has to pose an

important problem, then map out a mathematical approach, she will probably collaborate with others on ideas, and engage in what Lakatos describes as a zig-zagging process of conjecturing, refining counter examples and proving. She has to form a mathematical model, apply methods, draw diagrams, connect ideas, reason about connections and communicate in different forms. The work is multidimensional. When math is taught as a multidimensional subject in classrooms students engage more, enjoy math more and achieve at higher levels."

In the multidimensional math class students wrestle with open ended problems and engage in a dialogic learning process. The low-floor and high-ceiling problems allow all students access to a starting point, but are also open enough that even the strongest student will be challenged and can delve into deeper levels of complexity. Throughout the learning experience the students propose ideas and act as skeptics for each other. Every student has a role to ensure that all ideas are heard and challenged. The work is creative, and most importantly gives every student a chance to develop their own mathematical understandings. Students craft their ideas and blend them together and then share them with the class. For me, this is a beautiful example of a truly conceptual math project. Students are authentically wrestling with difficult concepts and creating their own ideas about the math. Because the ideas are at the conceptual level they can be taken in many different directions and are not limited by a single "correct" answer. Students can go where their logic takes them and follow it as far as they want. Then when the group is finished they write up their ideas and share them publicly. I can imagine a gallery exhibition where students show off their creative mathematical questions and thinking.

The beauty of this approach is that by providing a framework for the development of conceptual math, it engages students in a more authentic way and has the potential to bring about more enjoyment of math. Now, I'm not suggesting we abandon teaching specific math skills or that we stop doing applied math projects. What I am suggesting is that a large and important part of the PBL math experience should be conceptual math learning and projects. That in both math and science classes students are mastering the language of math but in very different ways. In the science class students are focused using math as a tool, while in math students are engaged in the creation of the mathematics itself. In my time as a math educator, I have yet to encounter a more compelling vision that has the same potential to reinvigorate project based math across the country. I look forward to continuing this conversation and exploring how conceptual math projects can create deeper learning experiences for all students.

Photo by Mandalyn Kime

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