

5 Principles of Extraordinary Math Teaching (Math & PL)

We're just finishing up a massive project of creating a supplementary curriculum for Seattle's Summer School program. We realized that the spirit of the lessons was even more important than the content. To this end, we designed the activities to encourage students to own their mathematical experiences, to give kids an opportunity—and a reason—to fall in love with math.

So we introduce our lessons with this list of the 5 principles that you can use in your math teaching to make the classroom hum. We wanted to share the list here, even though school is almost out. Let us know if these principles speak to you, and if there's anything you think we're missing.

1. Give students time to struggle

Students learn by grappling with mental obstacles and overcoming them. Your students **MUST** spend time stuck on problems. The more a teacher steps in to solve a student's problems, the less the student learns. This is not to say you shouldn't be involved in their process at all. Learn how to identify when your students are productively stuck—i.e. unable to answer the question but still making progress by making various attempts at understanding the problem—and when they are unproductively stuck—i.e. giving in to despair and hopelessness about the problem.

Productively stuck students need little more than a bit of encouragement, reflection, or the occasional prompt from a teacher (best offered in the form of a question, such as "What have you done so far?" or "Have you tried ____?"). Unproductively stuck students need help scaffolding the problem, by rephrasing the question, identifying learning gaps, and possibly backing up to a more concrete or simpler problem. For both, time is critical: prioritize giving students the time required to let their perseverance flower.

2. Say yes to your students' ideas

Doing math is creative work. It requires making connections between distinct concepts, translating knowledge into new contexts, and making intellectual leaps into unexplored territory. These are the hallmarks of creative thinking, and this is exactly the kind of capacity we want our students to develop. Creative work is hard, though, and becomes especially hard when the process of creative work is received with skepticism and negativity. When a student is working on a hard math problem, they are in a delicate place full of uncertainty, and a lot of the time the ideas they will have are wrong, or at least not exactly right. Many teachers want to point this out immediately to a student who is tentatively putting forth what to them is a novel idea on how to make sense of a math problem. However, to have an idea shut down means the

student misses out getting to see why their idea might or might not work, and more importantly, they miss out on the exciting process of following wrong ideas into deeper understanding. We want our students to practice coming up with ideas and following them, even down rabbit holes, to see what they can discover.

As a teacher, one of the best ways to support the creative growth of students is to say yes to their ideas. That doesn't mean confirming the correctness of an idea, but it does mean refraining from pointing out the wrongness. Instead, encourage students to test out their ideas for themselves. Say yes to the creative act and respond "I don't know—let's find out!"

3. Don't be the answer key

Most students will avoid hard work if they suspect there is an easier way. (Most people do this too. It's an efficient strategy for handling a complex world with an abundance of information.) Unfortunately, there is no substitute for hard work when developing the mind. Students need to struggle with concepts themselves if they are going to understand or master them. They will not struggle if they believe that instead, they can ply the teacher for the answer. The teacher needs to avoid being seen as the source of all knowledge in the classroom.

Rather, the teacher is the orchestrator of the classroom, setting up learning opportunities in which the students come to possess their own knowledge through grit, patience, and hopefully joy. Instead of using your knowledge to confirm to students when they have answered a problem right or wrong, encourage students to reference their own understanding of the problem and the mathematics behind it. If they don't have the conceptual models at hand to check their understanding, help them build what they need.

4. Questions, questions, questions

Practice asking questions. Practice launching your lessons with questions and interacting with your working students by posing questions. Give your students opportunities to ask questions, and find ways to show them you value their questions. You can do this by using their questions to guide a lesson, having a special "Questions" board in the classroom, or making time for students to think of and write questions in a math journal.

Not all questions will be answered, and that's okay. (You are not the answer key, remember?) More important than answering all the questions is learning the practice of asking them in the first place. Students benefit from having the classroom be a place of questions. Questions keep the math classroom active, engaging, and full of surprises. For many students, developing the habit of asking questions about math, and seeing the teacher ask questions about math, marks the point in their elementary math lives when math truly comes alive.

5. Play!

Seriously. The more a teacher models a positive and excited disposition toward learning and especially mathematics, the more students will begin sharing in the fun. Find the parts of math that you love, and share your joy with the students. Look for opportunities to keep play at the center of the classroom: for example, introduce games to students by playing them (rather than just explaining them); give students an opportunity to play freely with math manipulatives; and be willing to play along when students try changing the rules of a game to invent their own variation.

Avoid false enthusiasm: students know the difference. Find out how to get excited about math, and give yourself permission to play. Maybe for you this means being attentive to patterns, or finding really juicy questions to start a lesson with, or spending time making your own mathematical discoveries (remember how good an aha! moment feels?). Develop your own relationship with math and your students will benefit.

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