Problem Solving with Laser Precision

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Engaging all students in mathematics has been an age-old challenge that has become increasingly difficult in the twenty-first century. Remarkable new technologies—smart phones, tablet computers, and video games—have further eroded students’ attention spans. The traditional method of a teacher-centered classroom with students plugging away on endless activity sheets is a thing of the past. Creating a student-centered, inquiry-driven classroom is essential to reinvigorating students so that they can actively engage in learning mathematics.

To prepare students to succeed in the future by simply memorizing formulas and algorithms would be a disservice. Since the world is ever changing, those students who learn problem solving as well as interpersonal skills and critical-thinking skills will be the most successful. How, then, are teachers to prepare students to be successful problem solvers and critical thinkers?

Within a student-centered classroom, the teacher acts as a facilitator of learning as opposed to a dictator of knowledge. Lessons are developed around a central problem or question, thus allowing students to work cooperatively toward a solution. By taking a problem-solving approach, students are building not only interpersonal skills but also critical-thinking skills (Hmelo-Silver 2004). As students progress, they will have a context with which to apply mathematical reasoning, and mathematics will become purposeful.

CREATING A PURPOSE

With a solid foundation in proportional reasoning and similar figures, my students were ready to tackle the concept of indirect measurement. In years past, I have done what many other teachers have done: Write an example problem on the board and assign countless problems from the textbook and assorted activity sheets. I noticed that my students would become successful at completing the activity sheets with astounding accuracy, but their understanding was weak.

Within a week or two, the memorized skill was forgotten because it had been taught out of context. That is when it clicked for me: If I wanted my students to understand mathematics, I would need to provide a purpose and a context.

To engage the students, I directed a laser pointer at a mirror on the floor, with the reflection hitting the 12 on a clock positioned above the classroom door. I posed the simple question, “Who can explain what is happening?” Knowing that my students had just completed a unit on the electromagnetic spectrum and light in science class, I was confident that this would be a conversation starter. As a class discussion progressed, students expanded on one another’s ideas, with each student adding more and more detail to the science and mathematics behind this relatively basic phenomenon. By the end of the discussion, the students had made a drawing on the board, showing how light reflected off the mirror forming two similar triangles.

GUIDING INQUIRY

Students were then divided into groups of three or four and given a mirror, laser pointer, and meterstick and asked to measure the heights of flags hanging along the ceiling in the school gymnasium. Students were given minimal instruction and asked to devise and execute a plan to determine the measurements. Most groups jumped at the opportunity and asked to measure the height of the soccer goal. Once the group established the ratio of height to width of a soccer goal was 1:3. Using this fact, the students then reflected on what could have been done differently to get a more accurate answer in the future.

Providing Freedom to Learn

To further develop my students’ understanding of indirect measurement, I assigned an additional task: Find the width of the soccer goal outside our school. Having the students brainstorm solutions and then actually go outside and implement their ideas provided a context to engage even the most difficult-to-reach students. The only materials they could use included an empty paper towel roll, a ruler, and a trundle wheel. Again, students would have to explain how they solved the problem as well as reflect on their accuracy after the project’s completion.

The students’ solutions to this problem were both creative and feasible. One group proposed using the Pythagorean theorem (see fig. 2). Another group of students knew that the ratio of height to width of a soccer goal was 1.3. Using this fact, the students then developed a method using shadows from the sun and similar triangles to calculate the height of the goal. Since the group established the height, students determined that they could set up a proportion to solve for...
the width of the goal (see fig. 3). Although these solutions were reasonable and had addressed the given problem, they did not include the paper towel roll. I wanted to expand on my students’ problem-solving abilities so I encouraged them to look through the paper towel roll and develop a possible relationship between the size of the roll and what they saw when looking through it. After posing some guiding questions and encouraging creative thinking, most groups proposed the relationships shown in figure 4.

As I moved among the students, I heard many different proposals. In one magical moment, I realized that every student was actively engaged. They were grappling with an activity that fostered problem solving, critical thinking, and interpersonal skills. By creating a student-centered, inquiry-driven classroom, students had become re-engaged with learning math.

In years past, my students would have easily completed ten times the number of practice problems as compared with the current year. However, now my students have a much deeper understanding of not only the mathematical concepts at play but also the real-world contexts with which to apply the skill.

**REFERENCE**


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Mathematical Modeling

The focus on college and career readiness and the adoption of the Common Core State Standards for Mathematics have made paramount the ability for students to construct, interpret, and use mathematical models. Students can use mathematical models to analyze, predict, and resolve issues “arising in everyday life, society, and the workplace” (CCSSI 2010, p. 7). Modeling applications span various middle-grades subjects. In science, students might use graphs and tables to model water quality over time; in social studies, students might address social justice issues by analyzing map projections for distortions of national boundaries.

Mathematical modeling can engage students in writing, using multiple representations, making conjectures, applying mathematics to real-world contexts, and assessing error. The Editorial Panel of *MTMS* invites authors to share ideas and classroom experiences with mathematical modeling in grades 5–9. *MTMS* is especially interested in manuscripts that include classroom-tested activities supported by examples of student work. Manuscripts that address one or more of the following questions are encouraged:

- What strategies support students’ development of mathematical modeling in the curriculum?
- How can professional development opportunities support inclusion of mathematical modeling in the math curriculum?
- What activities, lessons, or modules exemplify mathematical modeling as well as other mathematical practices? How do you find and choose quality tasks or lessons that involve mathematical modeling?
- How might a focus on mathematical modeling be reflected in assessment and classroom discourse?
- In what ways does mathematical modeling offer opportunities for interdisciplinary learning, possibly through teacher collaboration?
- In what ways can technology be used effectively to enhance student learning in the context of mathematical modeling?
- How can the use of mathematical modeling help develop students’ habits of mind as they work toward mathematical sophistication?

The manuscript should be no more than 2500 words, not counting references and figures. To submit manuscripts, access mtms.msubmit.net. On the tab titled “Keywords, Categories, Special Sections,” select the 2015 call from “Departments/Calls.” The due date is January 6, 2014.