Finding a Balance: Skill Building vs. Contextual Problem Solving in a Multi-Level Math Classroom

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Introduction

Having difficulties in teaching mathematics, it is almost natural to resort to the one household name in secondary math education: Escalante. His fame spread quickly through his movie in which his skill as a teacher amazed audiences, displaying his ability to not only inspire inner city students, but also prove to many unbelievers the far-reaching extent of his students’ success. Escalante has dealt with a number of students who have had weak training in mathematics for all years of education prior to having him, and it is easy to look to him for inspiration. In The Jaime Escalante Math Program, Escalante (1990) shares his philosophical and pedagogical ideas, believing that his classroom atmosphere and accomplishments could be replicated. In reading this article and watching the movie, I was inspired to follow his path. It seemed that his only secret was motivating the students and holding the highest expectations for them. Despite his belief in how hard work from both teacher and student could achieve the same success, I now question how applicable his theories are to a first year teacher.

After reflections of my first year of teaching, I will unabashedly say that I thought I put in a lot of hard work. Needless to say, some of my students did the same. However, I cannot see us on the path to AP success. Similar to Escalante’s students, many of my high school students had low math skills that were not ameliorated, but rather manifested year after year of education. By the time these students reached me around the Algebra II level, their years of frustration had already deeply embedded some seed that spoiled their attitudes towards mathematics. Before I could start on my Escalante impressions and move on to pretending that my class was a team preparing for some major athletic competition, I had to resolve the issue of how to motivate the students to overcome their lack of skills.

Initially I looked at studying multiple intelligences, thinking that maybe my students, with their wide arrange of abilities, needed only a wide arrange of teaching styles to start them on their road to success. Moreover, I had to find some way to reach my limited English students because teaching verbally was not reaching them. Soon after, I became frustrated with the lack of good assessment and the difficulties of developing lesson plans that incorporated a variety of intelligences. However, in my attempts to develop more involved math problems that would interest more of my students, I discovered another barrier.
Why even worry about interesting my students with these problems when they
did not have the skills to do them?

I know that focusing on drilling my students’ skills is an instructional
method that is not currently supported. There is great pressure from the
administration and my own teacher training to provide my students with
instruction that would provoke their thinking to better conceptualize math. In this
way, they would have more success. Nevertheless, I could not find a way to
reach that realm of higher understanding of a system of equations when the
students were not strong on their multiplication skills. My goal then, with this
research, was to find some balance between teaching the students skills and
enhancing their conceptual understanding.

Background

In searching for textbooks, Escalante looks for one that provides a gradual
change in subject material to maintain his students’ confidence level as well as
provide a tremendous number of practice problems. He sees these two
components contributing most to the student’s math development. Evidently
there is the desire for a student to develop his skills completely, although not
necessarily for the entire instructional period. The need to allot time for drills that
improve the students’ skills is due to the sequential nature of learning
mathematics. With the basic principle of one skill stemming from another,
students who fail to grasp the first skill can easily get lost in math years later.
Furthermore, that is the reason for the difficulties in identifying true math learning
disabilities. Math is based on so many different concepts, it is a challenge to
accurately identify where a child needs assistance and provide him with the
proper teaching strategy.

In “Why is Mathematics Hard to Teach?”, Brignull expands on the different
theories of the pedagogy of mathematics throughout the years. Primarily though,
he explains the move away from Thorndike’s behaviorist approach, which is
simply drilling students on skills. Many saw problems in working on only
students’ skills: too superficial, no conceptual learning, students are dependent
on teachers to solve problems, rather than being innovative and turning to their
previous knowledge and experience to learn, lessons are too abstract, students’
interest wane due to the lack of concrete exercises and examples (Brignull, n.d.). The lack of major success with this theory has prompted the emergence of
other methods like constructionist (students discovering math skills on their own,
with a teacher serving only as a guide) and Papert’s ’matehetics’ (using previous
knowledge and experience to conquer a new or foreign concept). These and
many other theories attempt to deviate from the “traditional” classroom
environment and build the student’s conceptual understanding of mathematics
rather than their superficial understanding of skills.

Another method for teaching math has been based on research that has
found a positive correlation between verbal and math ability. That means for
limited English students, conceptualizing mathematics is more difficult because
their grasp of the English language is still developing. Due to suggestions that
students can enhance their understanding of math through talking, it seems that
those with weak verbal skills are at more of a disadvantage. Were their English skills stronger, many limited English students could be strengthening their math skills by working with partners and discussing homework or quizzes. Word problems and multi-task problems are already difficult for students when given in the primary language. Therefore, Cocking & Chipman (1988) suggest the best method for limited English students to acquire abilities to solve these problems is through increased exposure. The more experience students have with these problems, the more it will lead to greater achievement in math.

Methods

I used my linear programming lessons in my attempt to find a balance between drilling students on skills and understanding the concepts behind those skills. Linear programming relies on many skills: math modeling, defining variables and constraint equations, graphing inequalities, and locating the vertices of the feasible region to discover the most optimal solution. It is also interesting because there are a variety of real-life applications for the method.

When I tried a more involved math problem-solving project with linear programming, there were many problems and methods to choose from. I had found a project on the web that provided step-by-step instructions for one question. Also, the numerous problems in the textbooks provided great practice for the students that could be done in groups or by themselves. I attempted all three.

Before I introduced the lesson, I reviewed the students on their ability to graph inequalities and locate vertices. I knew the hardest part for them was translating from the word problem to math. Therefore, I spent the next day with a worksheet of many problems and all they had to do was come up with equations. They did not have to solve anything. Finally, I spent another class performing an entire problem as a class example. As homework, I gave the students a worksheet that provided step-by-step instructions in order to walk the students through the problem. There was a lot of guidance, but I hoped they could do the problem on their own. The next day in class, I broke them up into groups of two or three to solve different linear programming problems. They were allowed to use their notes, but I wanted them to rely more on one another. Finally, I attempted to assess how well they had ingrained the concepts with a quiz.

Reflection

The biggest success out of this lesson was the group work. I was very pleased with how much the students knew. For once, they were very comfortable and many relied more on one another and their notes than on me. That may have been the first success I had with group work. I was able to see how the students work very differently when they feel more confident with the skills. Unfortunately, when it came time to do the quiz there was not as much success as I had hoped. Only a few students who were struggling before showed improvement. Many of my weak students, who did perform well during class exercises only did well on the quiz with much guidance from me.
The poor grades on the quiz meant that there was little conceptual understanding of the process and that was due to a variety of reasons. Yes, some students do not study and therefore it is still difficult for many to not depend on their notes. They were not strong enough to remember many skills on their own. With my modeling of methods to solve the problems, I did not allow the students the opportunity to develop their own problem solving skills – a way for them to retain the skills better.

Then, there were problems with the examples I had chosen for class. I probably needed more examples that were not so abstract. Even though I gave them an involved word problem that touched on many different math lessons, they were still only using their skills. There was little conceptualization or application because the problem did not deal with anything around their daily lives.

The success with my limited English students was mixed. These problems involved a lot of reading. Some noticed a pattern for the translation of equations from the sentences and therefore did well because they understood the rest of the math concepts. Again, when I did change the format of the questions, English did become a major factor. One teacher at my school has developed the practice of preparing his students for quizzes by giving them review sheets that are essentially duplicates of the exam. The only difference lies in the numbers. There are issues with how challenging this is for the students. However it does allow the limited English students to overcome the challenge of translating the word problem into math and be graded more on the math concept than their English skills. I have to decide what it is I want my students to do.

In conclusion, I spent maybe a little too much time on linear programming. It was thrilling to see my students build up their confidences, but in the end I realized it was only skill-based learning. For the future, I know I need to find some problems that the students develop the solution on their own. In order to do that, I must start off teaching the class methods on how to develop problem-solving strategies. It is important for the students to develop this skill to lead to greater conceptual understanding. It would also be beneficial to work on problems that the students could more easily relate to. Perhaps then, the students will be able to pass these quizzes without any guidance and keep the information for a longer length of time.

References
Brignulla, H. (n.d.). Why is Mathematics Hard to Teach?