

Successful strategies from the revitalizing algebra project

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Abstract

The Revitalizing Algebra Project worked with teachers to improve the success rates of students, particularly those from underrepresented populations in math and science. The project worked in three areas: assumptions about race, gender, and culture and how those assumptions affect the classroom; using rich mathematical problems to teach the content of algebra; and key pedagogical issues for the teaching of algebra. The expected results are that participants in the workshop will explore one activity from each area in depth and will learn about other activities and the evaluation results of the project.

Key words: secondary mathematics education, teacher education, algebra, teaching practice, equity.

Introduction

The Revitalizing Algebra Project worked with three groups of teachers: preservice mathematics majors, inservice secondary school teachers, and mathematics graduate students who taught remedial algebra at the college level. All three groups met together 3 hours a week during the academic year and 6 hours a day for 15 days during the summer for a total of 135 hours. All of the participants were teaching algebra in secondary or college classrooms during the academic year. The purpose of the program was to improve the success rate of students, particularly those from underrepresented minority populations, and to prepare the teachers to work with their colleagues in the future.

The work with the teachers focused on three areas: assumptions about race, gender and culture and how those assumptions affect the classroom; using rich mathematical problems to teach the content of algebra; and key pedagogical issues for the teaching of algebra.

A few of the schools showed marked improvement in success rates and others showed none. One explanation of the difference came from our evaluator, who found a noticeable correlation between departments that were influenced by our philosophies and the improvement of success rates in algebra. At one high school where the largest minority groups are Filipino and Latino, the failure rate in algebra fell from 57% to 52%. At a second high school close to three-quarters of the students taking algebra are African-American. For African-Americans, the drop in failures was from 64% to 52%. That high school kept track of student absences per semester. For all algebra students the drop was from 14 per student to 4 per student; for African American students the drop was from 13 per student to 5 per student. At San Francisco State University the

overall failure rates in elementary algebra dropped from 23% to 15%. Particularly dramatic were the drops in African-American failure rates from 45% to 21%. (Hsu, 2009) Other explanations for the differences in success rates will be discussed at the end of the workshop.

Description of workshop

The proposed workshop would last for two hours. It could be in the morning or the afternoon. It will begin with a short introduction to the program. Then time will be devoted to each of the three aspects of the work with teachers: assumptions about race, gender and culture and how those assumptions affect the classroom; using rich mathematical problems to teach the content of algebra; and key pedagogical issues for the teaching of algebra. Those three part of the workshop are addressed below. After those presentation, there will be a short discussion of the lessons learned in our work and the results in the schools. The last ten minutes will be used to address questions from the audience.

Introduction

About 5 minutes will be spent introducing the prograam, its goals and the nature of the participants.

Assumptions about race, gender and culture

This forty minute session will begin by putting participants in groups of 4 around a table to play the card game Barnga. (Thiagarajan, 2005) Each participant will be given a page with the rules of the game. Unbenownst to participants, the rules given to each table differ slightly. So all partiipants believe they are playing by the same rules; however, they are not. Players are given time to play the game at their tables and discuss the rules. Then silence is imposed on the whole group and no one is allowed to speak until the end of the game except the leader. Each group plays silently for one round. Then the winners and losers at each table move to another group. Another round follows and again winners and losers move. Several more rounds are played in this way with winners and losers moving to another table. Silence is maintained throughout.

Much frustration is felt as players see that what thy believe are “the rules” are not being followed. Some participants become hostile, others withdraw. Some silently impose their rules on others and other participants try to “fit in”. After the last round, participants are given a minute or so to write their private thoughts about the experience. Then they are asked to discuss with their table what they observed. Then they are given a page from an essay by Delpit, “The Silenced Dialogue,” (Delpit, 1988). They read it to themselves. Finally each group discusses “What can teachers learn from this game about student behaviors in their classrooms?” and “How can teachers respond?” A whole group discuss follows.

A short description will be given of other activities from the project which relate to assumptions about race, gender and culture.

Using rich mathematical problems

This thirty minute session will focus on the use of rich mathematical problems with teachers. First, a rationale will be given for using such problems with students. Research has shown that such problems are more likely to engage students than ones that require little thought (NRC, 2004) and that working in cooperative groups and engaging in mathematical discourse enhance learning (Johnson, 1999; Kysh, 1999). In addition, such problems are more likely to

engage students (NRC, 2004) and this assignment will allow students to learn central ideas in depth while developing their ability to solve a multitude of other problems (Hsu, 2007a).

Participants will be put into new random groups and given the problem, “What numbers can be written as the difference of two squares?” The question is somewhat vague and participants will be asked to interpret it as they choose. After they have worked on it for 15 minutes, some groups will be asked to make short presentations on what they found. The presentations will be chosen to show a number of different approaches. Some are likely to be geometric while others are algebraic.

Next, participants will be asked what they think teachers can gain from working on such problems. If the following parts of a rationale are not given by participants, the leader will discuss them. Teachers see that they experimented and failed productively, and see other problem solvers weren’t just ‘better’ or ‘worse’. These are lessons teachers must learn about their students. They need to realize that failing is a part of learning and that their students aren’t simply ‘good’ or ‘bad’ at math. The teachers learn from each other and not only the instructor. Students can learn from each other in a classroom. Teachers enjoyed doing mathematics, which many of them had not done in the past. It is important for them to realize that their students can enjoy doing mathematics beyond “getting the correct answer.” Finally, our project found that working on mathematics problems together built a sense of trust and respect among the teachers. Once this community spirit was established, more sensitive issues such as race and cultural differences could be discussed. (Hsu, 2010)

Key pedagogical issues

Before working with teachers, we visited their classrooms and found that they were tightly structuring activities, or scaffolding them, for students. How much scaffolding or structure is effective? By restricting the choices and creativity of students, in principle a teacher could gain

1. more certainty of the mathematics being used and less complexity of managing different groups working in different ways;
2. more control over any resulting whole class interaction and greater ease of grading student work;
3. more student confidence as they succeed at tasks their teacher thinks they can accomplish;
4. more student confidence as they feel certain which “direction” their thinking should go.

On the other hand, by providing less structure, one might gain

5. student creativity, flexibility, active problem solving, and the sense that mathematical struggle is an essential part of math and not something to be ashamed of;
6. student motivation to engage in mathematical discourse;
7. student exploration, and pride of ownership of their solutions;
8. student belief that math is more than a small number of computations to be done quickly and a large number of problems whose solution methods must be memorized; and
9. student engagement and interest in the mathematics!

Our concern was that most of the low-track algebra classrooms, which were mostly serving minority students, displayed none of the gains (1) - (4) of more rigid structure and

lacked all of the benefits (5) - (9) of less structure. We saw students who were unsure of themselves and unable to take any risks. The goal was to be right, not to learn through multiple attempts to solve the problem. Students would hide their work from each other and give up when they didn't find answers quickly. Classes were boring and students were not engaged.

We tried to help teachers see the benefits of making lessons less structured and more open. Participants in this section of the workshop will first work on an open activity. They will be told that the Statue of Liberty's nose is 1.48 meter's long and ask to find the approximate length of her arm. After a short discussion of their work, they will be given a step by step method of carrying out the same problem. They will then discuss advantages of each approach.

Finally, the results of our work with teachers in the area of structuring will be discussed. (Hsu, 2009). This section will last about 30 minutes.

Closure

About 5 minutes will be spent discussing the results of the program and the reasons that some schools were more successful than others. (Hsu, 2009, 2007b). The last 10 minutes will be spent responding to questions from the audience.

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Appendix A

General Information

Table 1

<i>General Information</i>	
Title of Workshop	Successful strategies from the revitalizing algebra project
Names of Authors	Diane Resek and Judy Kysh
Institution of Authors	San Francisco State University
Country of Authors	United States of America
Convenient Length	2 hours
Proposed Education Level	Secondary
Maximum Number of Participants	24
Required Audiovisual	Overhead projector or computer and projector for PowerPoint Presentation

Appendix B

Activity Guides

The following activity guides are included:

Rules for Barnga

Selection from *The Silenced Dialogue*

Readings on Cultural Differences

Statue of Liberty problem unstructured

Statue of Liberty problema structured

Rules for Barnga

- **NO TALKING. NO WRITING.** Gestures are allowed.
- Players are dealt 5 cards each. The dealer can be anyone at the table, the person who plays first will be to the **right** of the dealer.
- The first player for each trick may play **ANY** suit. All other players must take turns going **clockwise** and “follow suit” (play a card of the same suit). For each round, each player plays one card.
- If a player does not have that suit, a card of any suit must be played. The “trick” (the round) is won by the person with the **HIGHEST** card of the **ORIGINAL** suit, **UNLESS there is a card of TRUMP suit played. In this case, the person with the HIGHEST card of TRUMP suit wins the trick.**
- The winner of a trick plays the first card of the next round.
- Aces are the **highest** card.
- **Spades** are the trump suit.
- The winner of the table will be the player who has won the most tricks by the end of the allowed time, and the loser of the table will be the player with the least tricks. Play as many rounds as you can before time runs out.
- In all cases, ties are resolved by rock, paper, scissors.

The Silenced Dialogue

LISA D. DELPIT

1. *Issues of power are enacted in classrooms.*

These issues include: the power of the teacher over the students; the power of the publishers of textbooks and of the developers of the curriculum to determine the view of the world presented; the power of the state in enforcing compulsory schooling; and the power of an individual or group to determine another's intelligence or "normalcy." Finally, if schooling prepares people for jobs, and the kind of job a person has determines her or his economic status and, therefore, power, then schooling is intimately related to that power.

2. *There are codes or rules for participating in power; that is, there is a "culture of power."*

The codes or rules I'm speaking of relate to linguistic forms, communicative strategies, and presentation of self; that is, ways of talking, ways of writing, ways of dressing, and ways of interacting.

3. *The rules of the culture of power are a reflection of the rules of the culture of those who have power.*

This means that success in institutions—schools, workplaces, and so on—is predicated upon acquisition of the culture of those who are in power. Children from middle-class homes tend to do better in school than those from non-middle-class homes because the culture of the school is based on the culture of the upper and middle classes—of those in power. The upper and middle classes send their children to school with all the accoutrements of the culture of power; children from other kinds of families operate within perfectly wonderful and viable cultures but not cultures that carry the codes or rules of power.

4. *If you are not already a participant in the culture of power, being told explicitly the rules of that culture makes acquiring power easier.*

In my work within and between diverse cultures, I have come to conclude that members of any culture transmit information implicitly to co-members. However, when implicit codes are attempted across cultures, communication frequently breaks down. Each cultural group is left saying, "Why don't those people say what they mean?" as well as, "What's wrong with them, why don't they understand?"

Anyone who has had to enter new cultures, especially to accomplish a specific task, will know of what I speak. When I lived in several Papua New Guinea villages for extended periods to collect data, and when I go to Alaskan villages for work with Alaskan Native communities, I have found it unquestionably easier—psychologically and pragmatically—when some kind soul has directly informed me about such matters as appropriate dress, interactional styles, embedded meanings, and taboo words or actions. I contend that it is much the same for anyone seeking to learn the rules of the culture of power. Unless one has the leisure of a lifetime of "immersion" to learn them, explicit presentation makes learning immeasurably easier.

And now, to the fifth and last premise:

5. *Those with power are frequently least aware of—or least willing to acknowledge—its existence. Those with less power are often most aware of its existence.*

For many who consider themselves members of liberal or radical camps, acknowledging personal power and admitting participation in the culture of power is dis-

tinctly uncomfortable. On the other hand, those who are less powerful in any situation are most likely to recognize the power variable most acutely. My guess is that the White colleagues and instructors of those previously quoted did not perceive themselves to have power over the non-White speakers. However, either by virtue of their position, their numbers, or their access to that particular code of power of calling upon research to validate one's position, the White educators had the authority to establish what was to be considered "truth" regardless of the opinions of the people of color, and the latter were well aware of that fact.



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The Statue of Liberty in New York City has a nose that is 4 feet 6 inches long. What is the approximate length of one of her arms?

The Statue of Liberty in New York City has a nose that is 4 feet 6 inches long. What is the approximate length of one of her arms?

1. How long is the Statue's nose in inches?
2. Estimate how long your nose is, in inches.
3. What is the ratio of the length of the Statue's nose to your nose?
4. Estimate how long your arm is.
5. Multiply the answers from (4) and (3). What is the relationship between this number and the length of the Statue of Liberty's arm?
6. Write down a brief explanation of why you gave the answer you did in (5)