

Zero, Our Hero

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Abstract: Mathematical research is not just for college professors but for mathematics teachers at all levels. Spending the majority of their summer break involved in mathematical research had a profound impact on two elementary teachers. One teacher taught fifth grade math in an urban setting while the other taught seventh grade math in a rural setting. The article takes you on the journey with the teachers as they select a question that is pertinent to teaching both grade levels, understanding the art of academic research, putting understanding to their new knowledge, and finally how to use this new understanding to improve student knowledge. The teachers are given the opportunity to put this discovery to work with a group of volunteer students. The enthusiasm for the experience can be seen in the total immersion into the student lesson.¹

As mentioned in the initial article from the September, 2007, issue of the *LATM Journal*, the Departments of Mathematics at Louisiana State University and Southeastern Louisiana University partnered to provide professional development to four schools in the Baton Rouge and Hammond areas. This program afforded university faculty the opportunity to introduce participating teachers to the benefits of mentored mathematical research. Dr. Lou Schultz has previously given an overview of his work with two elementary teachers. In this continued coverage of the project, Ms. Kirkpatrick shares her experiences with the teachers she mentored.

Selecting a Research Question

In this group, we were working with two teachers whose teaching styles were very similar. They both incorporated a great deal of hands on investigation into their teaching. Although one taught fifth grade and the other seventh grade, they found that their students shared common questions and difficulties – fractions, decimals, understanding our number system, word problems, measurement and geometry. Coming into the project, they both had hopes of increasing their own conceptual understanding of

¹ This manuscript is a continuation of the description of a university/middle-school mathematics project. Refer to *Using Mathematical Research as a Professional Development Technique*, *LATM Journal*, September, 2007.

mathematical concepts that were of interest not only to them but also to their students. Into which mathematical concept should they delve?

They discussed questions their students had posed during the previous year for which they felt their answers had been incomplete. They wanted to formulate a research question that would give them the deeper insight needed to explain these mathematical concepts more thoroughly. The seventh grade teacher was particularly interested in the role zero plays in our number system and how that role has evolved over time. After much discussion and deliberation the two concurred on a research question: “What difference does it make if a numeration system has or does not have zero or an equivalent?”

Researching the Question

How and where should they start? Puzzled by this question the teachers met with their faculty advisor and together decided to spend a large part of the first two weeks at the SLU library. With the assistance of one of Southeastern’s librarians, they explored the various resources available in Southeastern’s library on campus as well as materials offered on the Internet. This in itself was a learning experience and a bit overwhelming at first. The two persevered and found a great deal of reading material to keep their interest kindled. The faculty member lent support, guidance and a friendly ear as they bounced off ideas.

They delved into various numeration systems of the past, exploring the limitations of each and the eventual realization of the role of zero. As they researched each system they began to formulate plans for incorporating some of their findings into their classes. They were excited about having the students attempt to work simple arithmetic problems

using some of these ancient systems, feeling certain that the students would discover, as they had, the true role and necessity of zero in a positional number system.

Analysis of Research

Although the teachers were quite proficient at using zero in mathematical operations, they now began to appreciate the need to “see behind the scenes”. In their research, they acquired a deeper appreciation for our base-ten number system and the entire concept of place-value. These two teachers experienced the limitations, both in the representation of numbers and day-to-day computations, when a number system lacks zero. Their research led to a better understanding and appreciation of a positional system such as ours and its’ efficiency. Their hope was to pass this on to their students through the study of other systems.

Presentation of Findings

In reporting to the larger group, the teachers referred to zero as the “Rodney Dangerfield of numbers” because it “gets no respect”! They proceeded to give a brief history of number systems they had researched and how zero first came to be accepted by mathematicians. The two went on to explain that even though these number systems of the past are evidence that you can have a working number system without zero, the absence of zero truly limits the system. The lack of zero makes it harder to identify numbers and requires more symbols to represent numbers. Without zero, math can be very time consuming and much more difficult for the general public. Zero gives meaning to place value and allows for a positional system that is much easier to use in computations.

Incorporating New Knowledge into a Lesson

For the next three weeks these two teachers worked together under the guidance of the faculty mentor to develop two lesson plans that they could take back to their classrooms. In the upcoming year one would be working with fifth graders and the other, with seventh graders. They each wanted to find something that would work for their individual teaching styles as well as their different grade levels. The students from one school were accustomed to the various antics of their dynamic teacher. The other teacher regularly incorporated storytelling and singing in math class. The two picked each other's brains and creativity as well as that of the mentor and came up with ideas for two unique lesson plans.

At the next group meeting, the teachers discussed their ideas with the other participants. They listened to suggestions and words of encouragement. They then spent the remaining time refining their individual lesson plans.

Testing the Lesson with Students

The seventh grade teacher was unable to attend the last meeting when the lessons were actually presented to seventh and eighth grade volunteers. Her lesson was to begin with a story about a Cajun gator farmer who is having difficulty accounting for all of his "livestock". This intriguing story written by one of her co-workers explored the use of a tally system and the eventual development of a base-ten number system. Following the story she planned to divide the class into "Romans" and "Egyptians". The students would then research and explore the number systems of their respective ancient societies and report to the class. A discussion and comparison of the two systems to each other and to our own system would eventually lead to the discovery of the absence of zero in

these ancient systems. This in turn would lead the students into a realization of the role of zero.

The fifth grade teacher, dressed in a toga and sandals, presented his lesson on the Roman Numeral System. He stressed the absence of zero in that system and had the students explore the limitations of having such a system. He had them compare it to our Arabic system and explain the advantages of having zero. The students ended the lesson by working in small groups to develop their own number systems and sharing these with other groups. Some were told to develop a system with a symbol for zero and others without one. The student volunteers found this more challenging than they had expected.

Critiquing the Project

This project was an eye-opener for both the classroom teachers and the university faculty involved. All were amazed at the new found depth of understanding and the resulting flexibility it afforded our teacher participants as they prepared for the upcoming school year. The teachers investigating zero left with greater confidence, renewed excitement about learning and teaching and the anticipation of incorporating research as a new teaching tool in their classrooms. The concepts of discovery, exploration and questioning are now more deeply embedded in their teaching of both mathematics and science. All have come away from the project as winners – the university faculty, the in-service teachers and most importantly, the students.

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