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Thinking About the Preparation of Teachers of Elementary School Mathematics

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RECOGNIZING THE NEED

Numerous reports and studies published over the last decade have evidenced growing concern about the preparation of persons who teach mathematics in our nation's schools. Since the quality of school mathematics is contingent upon the quality of undergraduate programs, college and university mathematics departments are being exhorted to re-examine their own programs as well as their relationships with teacher preparation programs. Referring to undergraduate mathematics programs as "flawed models" the National Research Council states:

> Unfortunately, few university mathematics departments maintain meaningful links with mathematics in school or with the mathematical preparation of school teachers . . . Only when college faculty begin to recognize by deed as well as word that preparing school teachers is of vital national importance can we expect to see significant improvement in the continuity of learning between school and college (*Moving Beyond Myths*, 1991, p. 28).

A Carnegie survey of college faculty clearly reveals this perceived lack of continuity (National Science Board, 1996, p. 1-26). Faculty representing ten countries around the world agreed that pre-college students do not receive adequate preparation in mathematics and quantitative reasoning. The U. S. faculty ranked lowest in this perception with only 15% believing that students were adequately prepared for collegiate mathematics.

Unfortunately, mathematics faculty often fail to make the connection between the perceived lack of preparedness of pre-college students and their own undergraduate programs. High school mathematics teachers are the products of these programs. They not only teach what they learned to their students but also how they learned it. The Mathematical Association of America (1991) calls for colleges and universities to seriously rethink undergraduate mathematics instruction:

> . . . the teaching of collegiate mathematics must change to enable learners to grapple with the development of their own mathematical knowledge. As we rethink the collegiate curriculum in mathematics, we must be open to new ways of presenting mathematical ideas. The standard curriculum in place for the past several decades should give way to a curriculum that weaves mathematical strands together to create new courses and new approaches to the development of ideas (*A Call for Change*, p. 39).

SEIZING THE OPPORTUNITY

In the fall of 1997, several of us in mathematics and in teacher education at Mississippi University for Women began working in close concert to respond to the need for improved preparation of teachers of school mathematics. Our teacher education program requires students who are planning to teach in grades K-8 to take two 18 semester hour concentrations in content area courses. Very few students choose a focus in mathematics. We wanted to know why mathematics was not chosen and what we could do to promote that choice. This effort at understanding was funded by a small grant from the Exxon Education Foundation.

Our learning strategy consisted of a series of small group luncheon discussions with a dozen elementary education volunteers from the undergraduate math methods course. All of these students had taken at least 9 semester hours of undergraduate mathematics; only one was completing the 18 semester hour concentration in mathematics. All of the students were women and at least half were non-traditional older students. The discussions were purposely unstructured with the only parameter a persistent probing to understand the students' perceptions of mathematics and lack of enthusiasm for its pursuit.

THE EMERGENCE OF THEMES

As the students described their high school and collegiate experiences with mathematics, several disturbing themes began to emerge. The issue of continuity between pre-college and collegiate mathematics was particularly manifest in the attitudes of the students towards college algebra. Mississippi undergraduates are required to take a course in college algebra or above where "above" refers to a mathematics course that utilizes college algebra. All of the students had opted to take the college algebra course.

Those students who had a good high school background in Algebra I and II described themselves as inadequately challenged by college algebra because of the redundancy. One student, who had taken mathematics courses through calculus in high school, said that the college algebra course made her lose interest in mathematics and opted not to take courses beyond the basic math requirements. Those students who did not have a good high school background in Algebra I and II described themselves as overly challenged in college algebra and lost confidence. They experienced college algebra as a repeat of the frustration and sense of incompetence suffered in high school mathematics.

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For these twelve students their initial experience of collegiate mathematics in college algebra did not evidence a lack of continuity between high school and college, but just the reverse. The problem for these students was that their college algebra experience mirrored closely their high school algebra experience. A distinctly different initial experience of college mathematics was needed. If college algebra is deemed a mathematically significant experience for undergraduates, then the challenge is to present it in such a way that the significance is both visible and accessible to the students. Fortunately, mathematicians are revisiting college algebra. New approaches are emerging which emphasize the variety of applications in which algebra can be found and which make connections between the graphical and algebraic representations of functions. These approaches go beyond the traditional drill type problems to encourage the deeper conceptual questions that make mathematics meaningful.

The next theme to emerge in our conversations related to relevance. Initially the students talked about not seeing the relevance of college math requirements for teaching elementary school math. With continued conversation and probing, it became evident that these students did not experience the problem of relevance as much in other subject areas such as humanities and social sciences. While the meaningfulness of Beowulf and Chaucer for elementary teaching are no more evident than that of college mathematics, the students did not think of it in this way. In other disciplines they seemed to be more conscious of the connections within the disciplines and the connection between themselves and the disciplines. Learning seemed more natural to them in other disciplines. As one student expressed it: "Anyone can go into English and you know you can learn it; but the same is not true of math."

In elaborating on the absence of "connections" in and with mathematics, the students talked about the rigidity of mathematics. Unlike other subjects, mathematics did not seem to lend itself to interpretation. Students not only perceived a singular "answer" to mathematical questions but also associated fixed processes with mathematical solutions. They did not see that mathematics could draw upon the multiple modes of human thought which other subject areas draw upon.

This pattern of the perceived irrelevance of mathematics in the intellectual lives of those who will be teaching it may well be at the root of why significant reform in school mathematics has been so difficult to achieve. The students with whom we talked were not adverse to learning mathematics. Quite the opposite, they wanted to understand mathematics for themselves as well as for the sake of the children they would teach. They were frustrated that the world of mathematics felt so inaccessible and so foreign. With the exception of the mathematics courses designed specifically for prospective teachers, these students did not feel that their college mathematics courses, or for that matter their high school courses, invited them into the world of mathematics. Rather, they felt like strangers in a strange land.

It is no wonder then that these students were inclined to view mathematics as something which "you have or you don't." This was another theme that we noted. Math tended not to be seen as a learned experience but rather as a genetic endowment. This view of mathematics as an inherited aptitude seemed to coincide with the students' perception of mathematics as rigidly rule-bound. The algorithmic nature of mathematics was not seen as accessible to interpretation but only to memorization. Paralleling their perception of mathematics as an endowed aptitude was their belief that mathematics was not conducive to collaborative learning with peers. They felt that the "one right answer" nature of mathematics made cooperative learning feel like cheating. They reported a sense of isolation in their mathematics classes which seemed to emanate from the absence of multiple perspectives.

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MATHEMATICS AS A HUMAN ENDEAVOR

The themes which emerged from our conversations with students suggest that these students do not view mathematics as a human endeavor. It is not seen as a peopled undertaking to which their particular persons can gain access and to which they can contribute. In the words of the MAA, their experiences with collegiate mathematics have not enabled them "to grapple with the development of their own mathematical knowledge."

In an invited address on mathematical knowledgeability given at the American Educational Research Association, Carl Bereiter (1997) argued that:

> Mathematics education ought to be making students feel at home in an environment of mathematical ideas. They ought to feel at home because they have approached those ideas from different directions, used them for different purposes, raised and investigated questions about them, discovered that they can reconstruct them from parts or even perhaps create new ones. (p. 7)

His exhortation that mathematics courses need to help students learn their way around and feel at home in an environment of mathematical ideas requires attention to what Bereiter calls "the hidden substrate of what we normally recognize as mathematical knowledge." This substrate, he maintains, "is hidden because it is psychological, a property of individual minds." (p. 6) If we are to create collegiate courses which help students to make sense of mathematical ideas, then we must attend not only to knowledge of mathematics but also to knowledge of how we learn mathematics.

> At least one of the barriers to reform is a limiting psychology that does not allow educators to conceive of mathematical ideas as real things. Until they are able to do so, they will continue to turn out students who do not have an inkling that the world of mathematical ideas exists, let alone that it is a world they could enjoy working and learning in. That is why I think it behooves mathematics educators to delve deeper into theories of mind and cognition. (Bereiter, p. 8)

MATHEMATICS AS A FEMININE ENDEAVOR

About the same time that we were having discussions with the undergraduate education majors about their mathematical experiences, one of our graduate students was conducting a study in which she surveyed over 150 gifted high school students to examine the effects of gender on career and college choices. Participants consisted of rising high school juniors and seniors selected to attend a three week Governor's School program. To gain admission into the program these students were required to meet stringent academic standards.

Only 19% of the girls surveyed identified mathematics as a favorite subject. Twice as many girls cited English and History as favorite subjects. The survey consisted of questions related to motivating factors for choice of colleges and careers. Because of the open-ended nature of the questions the graduate student was able to ascertain attitudes toward school subjects and college majors. In her conclusions she noted that:

"Across the survey, students responded that males are better in mathematics and females are better in English. When questioned about a sibling's best subject, brothers were seen as more proficient in math while sisters were more talented in English."

When juxtaposed with the results of our conversation with the education majors, the survey results are provocative. While they reveal nothing new, they do elicit some surprise at the persistence of the old. Bereiter's challenge to mathematics educators "to delve deeper into theories of mind and cognition" in order to unveil the psychological substrate of mathematical knowledge may need to encompass the differences between the masculine and feminine psyches. It is generally agreed that a masculine bias surrounds mathematical ideas, but perhaps the bias actually invades the ideas. Mathematics is, after all, a human construction, and, as such, carries the characteristics of its makers. Most of the makers have been men. As more women mathematicians become makers of mathematical ideas, there may naturally evolve a mathematics that is more appealing to women.

This short essay does not purport to provide answers but simply attempts to make visible some of the complexities involved in rethinking the collegiate curriculum in mathematics. Attention to these complexities may help us circumvent the fate of much educational reform where solutions have oftentimes introduced difficulties more challenging than the original problems. Educational problems are particularly perplexing because of the incestuous nature of our profession. Persons who have been successful students in educational settings tend to reenter those settings as teachers and are inclined to perpetuate the conditions which made them successful. It may be the lack of inclination of women to pursue mathematics and the difficulty with which they do so that constitutes our best option for understanding what needs to change in collegiate mathematics.

REFERENCES

Bereiter, Carl (1997). Mathematical Knowledgeability. Invited address, SIG/Research in Mathematics Education, *American Educational Research Association*.

Mathematical Association of America (1991). A call for change*: Recommendations for the mathematical preparation of teachers of mathematics*, Washington, D. C.

National Research Council (1991*). Moving beyond myths: Revitalizing undergraduate mathematics*, Washington, D. C.

National Science Board (1996). *Science and engineering indicators*, Washington, D. C.

GEOMETRY IN NATURE

I had never noticed all the geometry;
angles and shapes in nature for all to see.
The obtuseness of a mountain peak;
the angle of a ballerina's leap.
A rainbow is an arc of colors in the sky;
repeating flowers in a collinear line, oh my.
A hummingbird in mid-air, flying free;
the vertex of its beak pointing at me.
The world is filled with geometry;
Open your eyes, really look and see.

Rachel Finkelstein

TRIANGLE

A
triangle
is the sturdiest
shape of all. they
use it to brace a ceiling
and use it to hold up a wall.
It will not bend. It is very stable.
In fact it is holding up this table. A
triangle is every builder's friend and now
my poem is at an end.

Ian Ross