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Differences in Beliefs Across a Series of Four Mathematics Content Courses

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College students often ask questions such as, "Why do I have to take this class? Is there a point to it?" For Early Childhood Education (ECE) majors these questions may often take on a slightly different form, wondering, "How can I incorporate this information into my classroom?" or "Do I understand this well enough to teach this to my students?" It is especially important for pre-service teachers to feel confident working with the mathematical content that they are learning and for them to believe that they can successfully teach that same information to a group of students. Swackhamer, Koellner, Basile, and Kimbrough (2009) have called for additional research concerning "how content knowledge can support teacher efficacy along with increasing the knowledge of students" (page 75).

The number of mathematics content courses provided to support the development of early childhood education majors understanding of mathematics varies across universities. Some wonder whether it is necessary to have a series of four mathematics content courses or if a fewer number of courses would suffice. This study is intended to determine if there is a significant difference in how pre-service teachers think about teaching mathematics at each stage of a progression of four-course content courses, as well as to determine if there seems to be a ceiling effect when students no longer feel these courses are continuing to improve their content knowledge and subsequent teaching ability.

Cohen and Hill (2001) describe teacher beliefs as, "Teachers' ideas about mathematics teaching and learning" and note that these beliefs may shape their teaching. One aspect of a teacher's beliefs includes her sense of self-efficacy. Researchers have recognized teacher's sense of self-efficacy as an important attribute of effective teaching which is related to positive teacher and student outcomes (Tschannen-Moran, Woolfolk Hoy, & Hoy; 1998). In this study we explore the effects of a series of four mathematics content courses on pre-service teachers' beliefs about teaching mathematics and their own self efficacy beliefs. These classes were designed to improve understanding and self-efficacy in a subject that many students have the most difficulty with. Our study provides a snapshot of students from each of the four content courses in the series by exploring their beliefs about teaching mathematics and their own self-efficacy and beliefs they hold at the end of each course.

Methods

We designed and distributed a Likert scale and short answer survey to ECE students that were finishing one of the four mathematics content courses. The survey began with a series of 27 Likert scale questions; the first 12 were taken from Cohen and Hill's (2001) assessment of teacher beliefs related to reform and traditional practices, and the next 15 were questions of our own composition which asked the students about their personal mathematical ability related to the content taught in the course as well as their self-efficacy and beliefs as future teachers. Two short answer questions asked students to describe one way the course affected their plans for future teaching (tool, teaching style, instructional method, etc.) and one concept that the student understands more deeply than they did when they first entered the class. At the end of the survey, the students were asked to complete a few demographic questions to help us place where these students were in their education and where they wanted to be in their careers. A copy of the survey can be found in the appendix.

The surveys were administered in class during the last two weeks of the semester. Students were asked to answer honestly, and an emphasis was placed on not just telling us what they thought we wanted to hear. Two sections from each of the four courses participated in the survey. There were a total of 23 students from the first course which covered numbers and operations, 17 students from the second course which covers fractions and decimals, 23 students from the third course which covers geometry, and 45 students from the final course which deals with algebraic reasoning.

Results

After a battery of statistical tests including chi square tests, t-tests, and possible factor analysis, Kruskil-Wallis tests revealed a few differences across groups. The ones we found suggest two shifts: (1) a shift towards deeper understand beyond just computation and (2) an improvement in interpreting student work. Using the Kruskal-Wallis test, we found significant differences between classes 1 and 4 on the following items: "If elementary students use calculators, they won't learn the mathematics they need to know" ($p = 0.002481$), "In teaching mathematics, my primary goal is to help students master basic computational skills." ($p = 0.01039$), and "I can revoice students' solution strategies for solving problems" ($p = 0.01008$).

Looking at the first item, "If elementary students use calculators, they won't learn the mathematics they need to know," 77.2% of students who just completed the first class in the series either strongly agreed or agreed, with just 4.6% of students disagreeing. This suggests that after only one class students may still think that math is just about the calculations and how to do computations. However, by the final class in the series 36.1% of students disagreed and 31.8% of students were neutral with that statement. We interpreted this shift to indicate that they put more value on other aspects of mathematics such as sense making and determining what operations were required for problems rather than focusing solely on computations which could be done with a calculator. There were no significant changes in students' responses to this item between any other combination of courses, which suggests that the students perspectives only changed after prolonged exposure through these four of content courses.

These results are also supported by significant differences in the item which states, "In teaching mathematics, my primary goal is to help students master basic computational skills."

90.9% of students that completed the first class agree or strongly agree with this statement, with 54.5% of students strongly agreeing and 35.6% agreeing. The majority (70.4%) of the students who were completing the final course in the series still agreed or strongly agreed that the primary function of teaching mathematics is to teach computation. However, now only 22.7% strongly agreed with the statement and 46.7% agreed. Also noteworthy is an increase in the percent of students who disagreed or strongly disagreed with this statement from 4.3% of students who completed only one course up to 20% of students who had completed all four courses. Together these two items show a shift toward thinking of mathematics in a more reformed way which values more than simple computation, and shows that this shift was only achieved after all four courses were completed.

The item which stated “I can revoice students’ solution strategies for solving problems” also showed significant changes between the first and last class. After completing the first class, 72.7% of ECE students agreed that they felt confident in re-voicing student problem solving. Although this is a large number of students, there is still over one-quarter of the class that does not feel confident in this area. By the end of the four courses, 88.8% of students feel like they can re-voice problem solving confidently with only 9.2% feeling neutral about the idea, and no students disagreeing in any way. This is a fantastic increase because it means that by the end of series, ECE students have improved in their confidence surrounding the interpretation of student work. Such a change is not directly related to any specific branch of mathematics which suggests this shift occurred due to prolonged exposure communicating about mathematics and working with different solution strategies through the series of four courses with gradual improvement along the way accumulating to a significant difference between the first and last groups.

Another instance of gradual improvement can be found in the students’ responses to the open ended question regarding naming one mathematical concept they understood better after taking this course. In the first class, 59% of surveyed students were able to name and describe a concept. By the second class, 63% of students were able to complete the question while 70% of students in the third mathematics content course were able to name a concept that they have a better understanding of after completing the course. Students in the fourth course showed a small decline in their success rate, at 62% which we believe was the result of an interfering factor during completing the survey which may have encouraged students to leave the item blank in order to be finished and dismissed more quickly. From these statistics, we concluded that as the students progressed through the series, they also improved in articulating ideas related to mathematical concepts in general. This is important because in order for students to articulate mathematical concepts, they first must be able to be confident in their understanding on the concepts.

Perhaps as interesting as significant differences are the set of items for which there were no significant differences across groups. All of the classes that were surveyed reported finding these courses improved confidence as a teacher and understanding of mathematics. No one reported that this series of mathematics content courses were unnecessary or took up too much time and effort. Instead, every class surveyed consistently thought that each of these courses were important and effective in improving student understanding and sense of self-efficacy. It is worth noting that this data was gathered during the weeks immediately preceding finals when students are generally under a lot of stress and likely to critique a course in a more negative way, and yet all four courses with different instructors still received positive reviews. This suggests that the four mathematics content courses for ECE students gives students the amount of attention they need for each area of mathematics used in the elementary school setting and that fewer courses may not be as effective in changing beliefs.

Discussion

These findings are consistent with other studies which have found that extended mathematics courses prove to be successful in increasing beliefs and self-efficacy in pre-service teachers (Swars, Hart, Smith, Smith, & Tolar, 2007; Beswick, 2006). One of the interesting ideas about these courses is that they are not strictly standardized. There are main concepts and targeted learning goals that each class must cover, however, there is no uniform method for how they should be taught. Therefore, each instructor may choose to attempt to achieve the learning goals in his or her own way. There are various teaching strategies that students are exposed to and yet they continue to improve. Perhaps it is this diversity which contributes to gradual movement toward significant growth. Each teaching style gives the student another perspective to consider and new strategies to use in their classroom. We view this as a strength of the program and yet another reason a larger number of mathematics content course can benefit students by exposing them to a wide variety of instructional techniques and styles.

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References

Beswick, K. (2006). Changes in preservice teachers' attitudes and beliefs: the net impact of two mathematics education units and intervening experiences. School Science and Mathematics, 106(1), 36-47.

Cohen, D. & Hill, H. (2001). Learning policy: When state education reform works. New Haven, CT: Yale University Press.

Swackhamer, L.E., Koellner, K., Basile, C., & Kimbrough, D. (2009). Increasing the self-efficacy of inservice teachers through content knowledge. Teacher Education Quarterly, Spring, 63-78.

Swars, S., Hart, L. C., Smith, S. Z., Smith, M. E., & Tolar, T. (2007). A longitudinal study of elementary pre-service teachers' mathematics beliefs and content knowledge. School Science and Mathematics, 107(8), 325-335.

Tschannen-Moran, M., Woolfok-Hoy, A., & Hoy, W. K. (1998). Teacher efficacy: Its meaning and measure. Review of Educational Research, 68(2), 202-248.

Appendix

Survey Items:

Please think about teaching and learning of mathematics in general when answering the following questions. (Responses given on Likert scale) (1-12 taken from Cohen and Hill, 2001)

1. Students learn mathematics best in classes with heterogeneous groups of students.
2. Students need to master basic computational facts and skills before they can effectively engage in mathematical problem solving.
3. Students learn best when they study mathematics in the context of everyday situations.
4. Teachers should make students figure things out for themselves rather than tell them how to solve a mathematics problem.
5. Students learn mathematics by discussing different approaches to a task, even when some of them are wrong.
6. It is not a good idea to have students work together in solving mathematical problems.
7. If elementary students use calculators, they won't learn the mathematics they need to know.
8. Teachers should make sure that students are never confused at the end of a mathematics period.
9. Students talented in mathematics need a special curriculum.
10. Students should write about how to solve mathematical problems.
11. Teaching a mathematical concept should begin with a concrete example or model.
12. In teaching mathematics, my primary goal is to help students master basic computational skills.

Please think about your experiences in your most recent content course when answering the following questions. (Responses given on Likert scale)

13. I am confident in my ability to do mathematics.
14. The way I was taught in this course changed how I plan to teach in my own classroom.
15. I can teach the content covered in this course.
16. My mathematical confidence improved throughout the course.
17. I can explain this content to a student.
18. The class did not improve my comprehension of mathematics.
19. I can revoice students' strategies for solving problems.
20. The instructional methods used in this course were effective.
21. This class clarified mathematical misconceptions.
22. I understand the basic concepts of this class better than I did at the beginning of the semester.
23. I can explain the content learned in this course to a student.
24. This course did not impact how I plan to teach this content.
25. The class improved my understanding of math.
26. I am going to use instructional strategies similar to the ones used in the mathematics education content courses.
27. I feel confident in my understanding of the material covered in this course.

Open-Ended Questions

1. If possible, please provide a specific example of how you feel this course has affected your plans for future teaching (a tool, teaching style, instructional method, etc.). If this course has not affected your plans, please write "none. "

   Topic: ____

   How I would have taught it:
   How I plan to teach it after completing this course:
2. Please describe one specific concept you understand more deeply after completing this course. What do you understand about the concept now that you did not completely understand before? If you do not understand any topic more deeply after completing the course, write "none."

   Concept:______________________________________

Demographic Information

Gender (circle one): Male Female Prefer not to respond

Age (circle one): 18-21 22-25 26-30 31-35 36-40 40-45 46-50 50+

Grade level (circle one): Freshman Sophomore Junior Senior

Enrollment (circle one): Full-Time Part-Time

Math Educations courses taken (circle all that apply) :
MATH XX1 MATH XX2 MATH XX3 MATH XXX4

Have you transferred credits from another institution in place of taking MATH XX1?
Yes No

Grade(s) intended to teach after graduation: ____