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Making Mathematics Come Alive: The Effect of Implementing Recommended Teaching Strategies in the College Classroom.

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Abstract: *This study examines the experiences of adult students during the implementation of recommended adult education practices in a mathematics methods course. The purpose of the study was to discover what effect utilizing adult education teaching strategies had on graduate students who perceived themselves as uncomfortable or inadequate in mathematics.*

Purpose

Student learning is the goal of education. For this learning to be optimized, teachers need to utilize effective teaching practices. In light of this knowledge, the question “Which practices should we use as educators?” arises. Mainstream adult education literature contains an abundance of material on strategies for teaching adults. In the discussion of recommended teaching practices, there is support for the belief that adult educators should engage in the following practices: 1) offer variety in format and technique; 2) assist learners in their search for meaning; 3) attend to affective and cognitive objectives; 4) help learners make past and future connections to their current learning; and 5) respond to the needs and the purposes of the learners (Draves, 1984; Galbraith, 1990; Knox, 1986; Rogers 1986; and Seaman & Fellenz, 1989).

Throughout the literature on adult education many researchers stress the necessity of creating the right climate for learning (Brown, 1997; Galbraith, 1990; Knowles, 1980; Knox 1986; Rogers 1986; and Seaman and Fellenz, 1989). For instance, Knowles (1980) asserts that the quality and amount of interaction between learners and their environment influence learning. According to Knowles, a ‘climate’ conducive to learning should be one “which causes adults to feel accepted, respected, and supported; in which there exists a spirit of mutuality between teachers and students as joint inquirers; in which there is freedom of expression without fear of punishment or ridicule” (p. 47). He proposes that “it is the critical function of the teacher, therefore to create a rich environment from which students can extract learning and then guide their interactions with it so as to optimize their learning” (p. 56). Brown (1997) reports that adult educators must actively create the classroom cli-

mate conducive to learning and to do this there must be open dialogue between the adult educator and the students. Galbraith proclaimed that adult educators need to establish an educational climate in which “an active, challenging, collaborative, critically reflective, and transformative” atmosphere exists (1990, p. 1). He outlined several principles that adult educators should follow to establish such a climate. The adult educator should do the following: 1) recognize and understand the diversity of adult learners; 2) create a conducive psychological climate for learning; and 3) create a challenging teaching and learning environment that must include “the people involved and how their personal characteristics, that is needs, background experiences, competencies, goals, learning styles, and attitudes” affect the environment (Galbraith, 1990, p. 7).

Literature more specifically related to recommended practices in the mathematics classroom setting has been forthcoming from such researchers as Fiore (1999), Handler (1990), and Tobias (1991). Adult educators must actively seek ways to recognize and alleviate math anxiety and math abuse, especially when it becomes chronic (Fiore, 1999; Handler, 1990). Handler defines math anxiety as “an anxious state induced by fear of failing when attempting to learn or demonstrate one’s learning of mathematics” (1990, p.20). Math abuse is a term used to describe “any negative experience related to an individual’s doing math”(Fiore, 1999, p.403). Both Handler and Fiore describe the environment necessary for conducive learning of mathematics as being one which is nurturing and supportive, where students are encouraged to express themselves and find their own personal power and knowledge. Therefore, math-abused students need a safe place to relearn how to deal with mathematics.

A third component of recommended adult learning practices is the context in which teaching occurs. Brown found that course outcomes are directly affected by the context in which the implementation of recommended adult education teaching strategies occurs (1997). Similarly, Apps proposes that adult educators must “engage their entire personality, how they think, what they know, and how they know it, and how they feel and why they feel that way” in the teaching process (1991, p. 1). Apps further argues that “teaching characteristics such as enthusiasm, caring for others, ability to listen, and knowledge of the subject matter would seem to transcend most teaching situations” (p. 10). He advocates helping adult students relate theory to practice.

Building on this adult education research and their experiences as learners and teachers of mathematics, two adult educators co-designed a course to address those concerns. They planned, implemented, and evaluated a mathematics methods course for graduate early childhood education majors built on the recommended adult education practices presented above. Inherent in its design and implementation were the following cornerstones: 1) Modeling meaningful mathematical instructional techniques; 2) Helping graduate students deal with their math anxiety by gaining a better conceptual understanding of mathematics; 3) Encouraging students’ participation in mathematical discourse by focusing on the process of mathematics; 4) Emphasizing resourcefulness in planning and implementing instruction; and 5) Providing opportunities to develop and implement new techniques.

The methods and focus of instruction, which included both student and teacher led activities, were determined from students’ reported data, classroom observations, and student questions to address needs based on the diversity of the learning styles and background experiences of the class participants. These strategies resulted in the utilization of a wide variety of activities including teacher conceptual modeling, labs, demonstrations, discourse, field experiences, group work, reflections, problem solving and skill practices. Teachable moments were embraced and connections were made between students’ real life experiences and the mathematics content as well as methods of instruction. Student assessment techniques encompassed Socratic questioning, student reflection, student demonstration, and paper-and-pencil tests. Within

each class, the adult educators interacted with class members both individually and as a group providing necessary scaffolding and emotional support to create a classroom environment that not only helped to strengthen skills but also attended to students’ math anxieties or fears.

The purpose of this study was to discover what effect utilizing recommended adult education teaching strategies had on adult students who perceived themselves as uncomfortable or inadequate in mathematics. The specific research question guiding the study was: How does active implementation, monitoring, and evaluation of recommended adult education teaching strategies, 1) change graduate students’ level of math anxiety and development of confidence in teaching mathematics, 2) change attitude toward mathematics by the development of a conceptual knowledge base and 3) enhance the students’ ability to “think mathematically.”

Research Design

The purposeful sample consisted of 42 graduate students in three mathematics methods courses. The aggregate of the sample contained 38 females. A qualitative design involving multiple data collection strategies was used. The specific design for this research was the case study method, which involves the exploration of three math methods courses taught during the summer of 1998 by two adult educators who collaboratively planned, implemented, and evaluated the courses. Merriam (1988) advocated the use of documentary data for case studies because “they ground an investigation in the context of the problem being investigated” (p. 109). According to Creswell (1994), typical data for a case study includes documents, observations, interviews, student records, and other such artifacts. A variety of such data was collected throughout the class. Initial data consisted of an autobiography of students’ personal experiences and confidence in learning and using mathematics, a student data sheet, and a pre-test of basic mathematical concepts. Students’ philosophy of teaching mathematics served as a source of data as well. Additionally, the course syllabi, teachers’ lesson plans, formal student evaluations and any other written correspondence from the students served as data sources. Data was collected from students’ reflective papers at the beginning and end of classes. Additional data was also derived from the instructor evaluations.

Creswell's (1994) principles for analyzing case studies were utilized to analyze the data in this case study. First, a detail description of the case and its context was created. Next, classifying the data included using categorical aggregation and establishing patterns of categories by looking at the data and comparing it to the predictions from the literature. Then direct interpretations were used to develop naturalistic generalizations.

Findings and Discussion

The evaluation of implementing recommended adult education teaching strategies to graduate students who perceived themselves as uncomfortable or inadequate in mathematics revealed five major themes. First, the students experienced a removal of fear so that they could engage in meaningful mathematical discourse. Second, the students gained the ability to competently do mathematics. Third, the students acquired a deeper understanding of mathematical processes. Fourth, students developed the ability to foster learning in both themselves and their students. Fifth, through the development of competence in these four areas, students gained a higher confidence level in both doing and teaching mathematics. Finally, the students acknowledged that the techniques modeled by the two adult educators had a positive impact on their learning.

Many students noted their fear of mathematics in the beginning questionnaire and their mathematics autobiographies. The adult educators witnessed many incidents of fear which arose throughout the course as students struggled with concept development which impacted their learning. As these fears were confronted by the implementation of recommended adult educational strategies, students began to overcome their math anxieties. At the end of the course students shared many anecdotes and reflected upon their feelings regarding mathematics. For instance, students repeatedly reported that they did not realize that math could be fun. Another example can be seen by the teacher, who was teaching Language Arts in fifth grade because she was afraid of math, that person now plans to integrate math into her Language Arts class. Similarly, a student who was very fearful of math proclaimed, "Through this course I have discovered I would love to teach math." One student captured the essence of the students' repeated feedback which pertains to this theme by stating:

This course has greatly improved my opinion of mathematics. I have grown as a math student as well a math teacher and no longer cringe at the thought of teaching mathematics. Before, I did not even want to think about teaching mathematics. My personal experience in math had been negative. I had never thought of myself as being good in math and would not choose to take a math class for fun. But now I have very specific ideas about mathematics instruction and the teaching of mathematics.

It was evident that utilizing the adult education strategies allowed students to let go of their fear of mathematics.

As students' fear of mathematics was reduced, their ability to perform mathematical processes increased. The data revealed that 59.9% of the participants discovered that they perceived a gain in their mathematical ability. Two student remarks capture the essence of this occurrence. One exclaimed, "I have developed skills that I didn't have before. I had no skills. I know that it's ok to use a deck of cards or a puppy to teach math. Do what works!" While the other student expressed the following feeling, "I feel that I have knowledge and valuable resources that will provide my students with instruction for knowledge and understanding."

The data revealed that as mathematical ability improved, so did mathematical understanding. Moreover, 57.1 % indicated that not only were they more competent in their mathematical abilities, but they had a better understanding of the "hows" and "whys" of mathematics. Students made comments like, "For once in my life I can understand math. There are ways to help me see the concepts that I never got as a child," and "I have a better grasp of why certain mathematical algorithms work." As seen by these statements, and the student comment, "I can now understand why things in math are the way they are...When I was in school it was never explained," the utilization of recommended adult education teaching strategies had a positive impact on the development of students' mathematical understanding.

Using recommended adult education teaching strategies that provided students with opportunities to explore mathematical concepts and examine their own learning, the students were afforded a means for reflection and a method for modifying their learning approach. Throughout this process, they were able to apply this ability to foster learning in

others. Comments such as “I have a better understanding of how to teach higher level concepts using manipulates/concrete approach,” and “ I am able to apply the use of manipulatives in my classroom,” illustrate the students’ ability to apply mathematical theory in their teaching strategies. Drawing upon their experiences in the mathematics class, students articulated the fact that they had more ideas and strategies to help a child grasp a concept and motivate that child to learn.” The reflection feedback from the students was rich in documentation of evidence to support how the use of the adult educational teaching strategies helped them to achieve the desire and ability to foster learning.

Increased confidence in students’ abilities in mastering both the content and methodology presented in the course was enumerated by both the dialog that occurred among the adult educators and their students and in student documents. Data from student documents indicated that 64.2% of them felt that they were more confident in their mathematical abilities by the end of the course. Both adult educators heard comments from students regarding the “new-found” desire to teach math and the confidence to do so effectively. For instance, one female voiced the following sentiments; “This course has directly affected my confidence. I now have the confidence in myself to know that I could teach math in an interesting way.” Similarly, students repeatedly expressed remarks such as, “I’m very comfortable with math now because I have more confidence in myself.” Confidence changes in some of the students were very powerful as characterized in the following declaration given by a student who was frightened of math at the beginning of the course, “I actually have some confidence in mathematics.”

The effect of the adult educators’ modeling of recommended methods of instruction on students’ learning was the final practice examined. Current adult education literature supports the premise that if adult educators follow recommended teaching strategies, the adult learners will be successful in the classroom. Both adult educators established supportive classrooms, which responded to the needs of the learners and assisted learners in their search for meaning as the framework in which meaningful mathematics were discussed and modeled. Data from this study demonstrates that the students realized that the adult education practices

modeled by the two teacher educators had a positive influence on their learning. “You are a terrific teacher of teachers. Thank you for all of your careful planning this semester. It was very apparent that you always did your best to give us what you felt we were telling you we needed.” Other data emphasizes the helpfulness of the adult education strategies by reporting, “The instructor went to great lengths and put forth a great amount of effort to show numerous ways of modeling and methods of instruction. These examples were most helpful.” More specifically, the two adult educators’ philosophy in teaching mathematics affected students’ attitudes. The data indicated 57.1% of the students reported that the attitudes of the adult educators were extremely important in helping them be successful in their learning. Furthermore, the data indicated that 59.5% of the adult students perceived that the adult educators’ methods of instruction positively influenced their learning. One student aptly summarized support of the effectiveness of the environment by stating, “The instructor’s philosophy changed my whole view of the teaching of mathematics.”

In summation, the data revealed several themes that emerged when adult educators employed recommended adult education teaching strategies in college classes that consist of students who perceive themselves as uncomfortable or inadequate with the course content. The students experienced the types of teaching strategies, which they should use as teachers. Accordingly, their own confidence in mathematics increased as they gained more understanding of mathematical concepts, ability to learn and do mathematics. As these students developed their repertoire of appropriate instructional strategies to use in their own classrooms, they also realized the importance of providing an atmosphere where students can take risks safely.

Implications

This study accounts for the experiences of a group of graduate students in a mathematics methods course. The visibility of their experiences raises strong affirmation regarding the validity of using the recommended adult education teaching strategies in the mathematics classroom. Major conclusions from these findings are that the recommended adult education teaching techniques can and do enhance students’ development of self-confidence and understanding of mathematical concepts, especially

those that have math anxiety or been math-abused. The findings support the importance of allowing students who have had difficulty learning mathematics the opportunity to experience mathematics in a “riskable” classroom. This research has implications for how to help adults become numerate. Although this study specifically examines mathematics content knowledge, these findings have implications for providing instruction to adults who have previously been unsuccessful in learning other content. Attention to students’ perceptions of their inadequacies and creating a classroom environment which have multifaceted instructional pieces encourages conceptual understanding of the content and the ability to apply the subject matter.

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