The Impacts of a Service-Learning Experience on Pre-service Mathematics Teachers

Kyong-Hee Lee
Department of Mathematics
University of southern Indiana
8600 University Boulevard
Evansville, IN 47712
kmlee1@usi.edu

Anne Statham
Extended Services Division
University of southern Indiana
8600 University Boulevard
Evansville, IN 47712
aastatham@usi.edu

Abstract

This study examines the benefits that can be achieved by pre-service teachers tutoring mathematics in after school programs. Analysis of student journal entries show enhanced ability to meet National Council of Teachers of Mathematics' (NCTM) process standards and methods of assessment, as well as greater awareness of the need to teach to children's different learning styles and to deal with the child in total life context and a perceived need to move beyond drill and memorizing in the classroom.

Introduction

Previous research suggests that service learning can be a powerful force in preparing pre-service elementary teachers to face future challenges in their careers. Anderson (2000) summarized research which suggests that pre-service teachers who complete a community service activity exhibit higher levels of self-esteem, complexity of thinking, sensitivity to diversity, and commitment to social justice and positive attitudes about community participation. Swick (2001) argued for a "community-centered form of teacher education" that "enables students to enrich their learning through real community service contexts," (p. 261) and that service learning helps to advance this model. He asserted that successful service learning experiences advance the ideas of commitment to community, collaboration and reciprocity, and using diversity to build powerful learning communities. Shastri (2003) considered the more specific impacts on professional preparation. Her pre-service students reported personal, professional, academic, and career benefits from a service learning project in a high-poverty school, although her analysis of these impacts was fairly informal. Boyle-Baise and Sleeter (2000) fully analyzed a plethora of input from their students in two different settings and concluded that community-based experiences, especially those that allow students to interact with families as a whole, start students with little multicultural experience down the path of more effective multicultural education in that they became more knowledgeable of parent's perspectives and aware of community issues. Donahue (1998) found that a curriculum writing project for an international women's center forced four pre-service teachers to confront ethical issues that are rarely directly confronted as students are preparing for the classroom. In this case, the pre-service teachers grappled with the ethical and safety issues around asking students to engage in changing society. All of these are laudable goals, advanced by teacher education systems in our society.

A few researchers have considered the impact of service learning on preparing pre-service teachers to teach mathematics, specifically. Conrad and Tracy (1992) found that sustained community involvement in a course-based project lowered pre-service

teachers' levels of mathematics anxiety. Kirtman (2008) used surveys and reflections from her students' experiences teaching mathematics in an after-school program at a low-performance school to examine the impact on their confidence in teaching mathematics. Her results suggest that this experience did indeed increase her students' level of confidence in their ability to teach mathematics, perhaps in part because they came to see the subject as more fun and less boring than they thought it would be, but also because they thought that through the process of explaining concepts in terms the students could understand, they came to better understand the concepts they were teaching. Another outcome reported in this study was increased understanding of a potential group of students (low income, different ethnic groups). Duke (1999) reported that involving statistics students in preparing data presentations for agencies seeking United Way funding results in the vast majority feeling the experience helped them learn about statistics and how it can be used in the "real world." O'Donnell (2001) reported similar results from a middle school project in which students ran a business of producing and selling crayons to fellow students and their families.

Our study extends these findings by exploring the possibility that a broad array of benefits can be achieved in a variety of settings, including individual tutoring sessions in community centers, not necessarily in a school or classroom setting. We also attempt to delineate the effectiveness of community-based experiences in helping our pre-service teachers understand how to meet the National Council of Teachers of Mathematics' (NCTM) five process standards.

Method

The project was done in a midsized Midwestern town that is surrounded by smaller rural communities. Most of the pre-service teachers in this program are white, middle-class females with little exposure to diverse groups and their learning styles or issues. The project was intended, in part, to give them that exposure, but would also give them direct experience with students and their learning processes. Prior to the first day of class, the instructor made arrangements for the seventeen students in the mathematics education methods course to tutor for one hour once a week for sixteen weeks. The students chose to tutor in one of two afterschool programs that were seeking tutors, one in a Title I elementary school, another in a community center that serves a diverse, predominately low-income population. The pre-service teachers were required to write journal entries at the end of each tutoring session, and then write a one page reflection paper about their overall experience, which we used as data for the analysis.

We read all of the student reflection papers, then used the constant comparison method (Glaser and Strauss, 1967) to develop categories and conduct the analysis. Six categories emerged from this process. Students described their efforts to: 1) Incorporate five process standards of NCTM into their activities; 2) Apply various assessment techniques; 3) Increase awareness of and practice at the teaching and learning style; 4) Obtain greater comfort/skills in working with diverse groups; 5) Enhance personal growth. 6) Make future plans for teaching. We then attempted to connect these categories with the service learning outcomes for the campus. The university service learning program emphasizes two basic elements: Enhancing student learning and providing a valuable service to the community. The first two outcomes in our six emergent categories are associated with enhancing student learning. We address the first

with the student journal entries and the second with comments made by the after school program tutoring coordinators where participants tutored. The last four are somewhat unexpected outcomes that emerged in the process of analysis and categorization of the student journal entries and reflections.

Results

A. Service Learning Outcomes

We will first discuss how tutoring in the after school program met the first service learning outcome – Enhancing Student Learning. Students had opportunities to enhance their learning as they attempted to incorporate three of five NCTM process standards into their activities. They also applied assessment techniques learned in class.

1. Enhancing Student Learning

Students enhance their learning by attempting to incorporate five process standards of NCTM into activities.

The course put a strong emphasis on incorporating NCTM's five process standards (Problem Solving, Reasoning and Proof, Communication, Connection, and Representation) in creating classroom activity materials and lesson plans. The participants were encouraged to implement these standards when tutoring the children. As participants engaged in tutoring, they recognized the need for and successfully applied three NCTM standards: Communication, Connection, and Representation.

Communication: Participants worked on communication on two levels. First, they attempted to find various ways to communicate with the children until the children understood the concepts**.** They also helped children to develop their communication skills by encouraging them to explain and/or describe mathematics problems and solutions drawing models.

> There were times when I felt that the objects work[ed], and times that they didn't. If the items I used were not successful, then I tried to find other ways to show [name] how to work his problems. Usually by the end of our session, [name] and I were able to find a solution to help him understand.

> … The student was excellent at multiplying fractions; but when I asked why he ended up with a smaller number even though he was multiplying, he did not understand why this occurred. I spent most of the tutoring time helping him learn concepts; I sometimes had him draw models on paper to demonstrate his homework problems so he could understand why his methods worked.

Connections: Helping the children allowed the participants to attempt to connect mathematics using games with manipulatives that children could associate in their real life.

> She was a first grade student who had an excessive amount of trouble with any sort of math, especially money...we used real life manipulative of real money. We also used a money game and poster ….

> When tutoring students in math we used a game called countdown. All of the students love this game. Each player rolled the dice and then must decide if they want to add, subtract, multiply, or divide. There are blocks labeled 1 through 10. After you roll each time you see what combination you can use to flip over one of your blocks. For example, if a player rolls 4 and 2, they must decide if they want to flip over their 6 (4+2), 2 (4-2), 8 (4x2), or 2 (4/2). The objective is to flip over all of your blocks, and then you win. There is a catch though, if your roll equals 11 you can flip over the block that the other players has flipped over, but if you roll 12 you must flip all of yours back over and start again.

Representation: The participants gained practice representing mathematical concepts using manipulatives, pictures, and mathematical symbols.

> To help [Name] with his mathematics, I tried to find visuals to use so he could see the picture in what the problem was trying to ask. I thought showing him a photograph or using manipulatives would work the best by having him use them to solve his problems.

> We worked on 2 math workbook pages. This was involving data and charting it on a bar graph. It was about different colors of umbrellas counted with "tally" marks. I first went over what \\\\ marks meant. They clearly had either not seen it before or they just didn't understand the system. Once all the different colored umbrellas were counted they had to shade the graph to indicate the quantity. I talked with them about graphs and how graphs can show us a lot of information at a glance of the graph. After the graph was completed they had to answer questions like "What color has the most umbrellas?" or "How many more red than blue umbrellas?" We went through them step by step and evaluated our graph to formulate number sentences or figure out the information at a glance.

Students enhance their learning by applying various assessment techniques.

Students learned various assessment techniques in class – diagnostic, formative, and summative. Since the participants were in an environment that involved one-on-one tutoring, they mainly used diagnostic assessment.

Some participants reported assessing the student' problems with particular operations.

> I noticed that math seemed to be the problem that [name] struggled with the most. He seemed to have difficulty with addition to which those were the worksheets that typically took the longest to complete.

> Within the area of addition, the students had difficulty with the concepts of "carrying the one," so to help….we would use manipulatives to show how the numbers changed in the one's and ten's column as they added.

> The students I would tutor had a very hard time grasping the concept of borrowing.

> When it came to subtraction,… Many of the students wanted to subtract the top number from the bottom number if it were smaller, rather than the correct algorithm of borrowing from the ten's column.

Another participant assessed a student's problems with number facts.

> [Name] was my main student I taught.…She first started adding and subtracting by using her fingers for everything. It amazed me that even small problems such as 6-2, she was using her fingers to count. Though by the end of the semester, I noticed that she was starting to put the numbers in her head and count. That to me was the biggest improvement of the semester.

One participant used his/her diagnostic skills to determine if a child understood the meanings behind computing division problems. By asking the child to find an answer to a division problem through estimation, the participant discovered that even if the child can divide this does not mean that the child truly understood the meaning behind the computation.

> …The boy I tutored earned mostly A's on his report card….When I would ask him to estimate his answers before completing the problem, he was not able to give an estimate. If he incorrectly answered a long division problem by forgetting to put in one of the digits or put a zero at the end, he was not able to judge that his answer could not be correct. (For example, if the problem was 5750/5, he wrote 115, he was not able to look at his answer and tell me why the answer could not be correct.) ….

This led to an insight about teaching concepts.

> I spent most of the tutoring time helping him learn concepts….The most important thing I learned from this experience is the importance of children understanding mathematical concepts and not just learning formulas and rules.

Another participant assessed a child has problems explaining their reasoning.

> Something else I learned right away is if he doesn't know the answer he'll just keep guessing until I tell him he has the right answer. He actually prefers to do stuff in his head or on his fingers and doesn't like to show his work on math problems.

2. Providing a valuable service to the community

Another valuable service learing outcome is that students feel they have made an important contribution to the community. The feedback we received from the coordinators of the after school programs where the participants tutored indicate that they did make a significant contribution.

> ….Tutors sent from your class to our tutoring program made such a difference in the number of students we were able to help this year. We thank you for your time and commitment and want you to know how much we at [Name] appreciated your effort in making this happen.….Thank you again for initiating and carrying through with

> this year's endeavor. We may never know how many beautiful lives may sprout from the seeds planted by your students. [Coordinator of the community center]

> ….The Children needed help with their math and reading skills. One on one attention is very important to our students. Any extra help given our students is greatly appreciated. [Coordinator of the program in the Title I school]

Service-learning experience provided students opportunities to enhance their learning by implementing three of five NCTM's process standards and explore diagnostic assessment technique. Service-learning also provided students with opportunities to contribute a valuable service to the community. Both tutoring coordinators were very pleased about the participants contributing their time and effort to give children one-on-one tutoring.

B. Additional Outcomes

While their learning about the process standards and assessment was the heart of the course, and of most importance in terms of outcomes, other benefits emerged from their reflection journals as we analyzed them. The participants reported four other benefits: 1) increase awareness of and practice at teaching to learning styles; 2) obtain greater comfort/skills in working with diverse groups; 3) enhance ability to promote personal growth; and 4) make future plans for their teaching strategies.

1. Increase Awareness of and Practice at the Teaching and Learning Styles

The tutoring experience helped them see that different children learn mathematical concepts in different ways, and several participants said they had come to value the importance of nurturing individual learning processes in students.

> Each one was different in the way needed to be taught...The students had a thinking style and a way they knew how to learn.

> Each week I had a different student, so I got to work with several different learning styles. I enjoyed working and experiencing all of the different styles.

In seeing that they needed to react flexibly to various teaching situations, participants learned to design activities using numerous manipulatives and real life objects, often trying more than one approach before the student learned the lesson.

> …..I realized pretty quickly that I needed to change my teaching style in order to help the students learn how to do their homework.

> Some students understood the first time I approached the problem, other students had a hard time grasping the new technique and it took me several tries as well as alternating different tactics.

> I used a variety of ways to reach the students in order to help with their understanding.

The importance of helping students find their own learning process and being able to teach to their different styles gained prominence for them as the result of this experience. It also increased their confidence that they could do so.

> I can now use any material I have in front of me to incorporate into a math lesson.

2. Obtain Greater Comfort/Skills in Working with Diverse Groups

The participants tutored children of various age groups, coming to feel comfortable working with children of diverse ages.

> I loved being able to interact with the various ages to learn about them and myself.
>
> I learned a lot about students in grades one through five from tutoring…allowed me to see a wide range of students and their abilities at different grade levels.

3. Enhance Personal Growth

The service-learning experiences helped the participants to see the importance of developing deeper relationships with the students with whom they were working, and this way helping them to grow personally not only academically.

> ... At the beginning…he was a very quiet boy who seemed shy. As we continued working together, I noticed that…he started feeling less nervous and more comfortable. I saw an improvement each and every tutoring session…in the way he acted and opened up his personality.
>
> I got the opportunity to help someone with their school work and make some type of difference. I wanted to be able to come back from tutoring with a positive note, and for the most part, I did
>
> I have learned that tutoring is not always about teaching the material, and that sometimes it is just a chance for students to really understand that someone cares about their well being…I had many weeks where we spent a few minutes talking about issues that arise at home and school before getting started on our work....This whole experience has…helped me to see how students need one on one attention…in order to get learning accomplished.... I know that I have made an impact on these students, and someday they will remember me when they are struggling.
>
> I feel that through this tutoring experience I get to walk away with an opportunity to grow, and it can be helpful to me whenever I become a teacher in the future.

4. Make Future Plans for Teaching

As students examined the children's homework assignments and assessed their conceptual understanding, the participants began to think more critically about teaching methods that are used in current elementary schools.

> I learned that the majority of his math homework was a worksheet with over twenty problems. The purpose of this homework was to drill the students… As a teacher, I

> need to allow children to work with numbers and models to gain understanding. I want to avoid teaching students "quick" methods and rules for solving problems. I also do not think homework that involves drill of over twenty problems is beneficial to students.

Participants also had an opportunity to apply what they learned in class and found out what worked well and what didn't. This discovery will help the students in their future teaching.

> I was able to bring in things I learned from this class and incorporate them into the students' lessons.
> It was great to have this opportunity because I tried things out on the students that we discussed in class. I was able to…see what worked and what did not work…

Further, the tutoring provided them an opportunity to think about applying new ideas in their future teaching.

> I learned some new, cool activities that I can use in my student teaching experience and my future classroom.

> Through the concepts I have learned within this course and having one-on-one time with the students in the classroom, I see a huge benefit in working with children from a young age on developing the number connectivity. It may take longer, initially, to develop, but it is a process that will help them with future explorations with different kinds of math and will actually bring more meaning for them and their understanding. I believe children could learn to love math when they are presented with opportunities to explore and discover their own process.

Overall, participants felt they had benefitted in their understanding of the importance of teaching to the learning styles of the students they will encounter and promoting personal as well as academic growth. They appreciated that they had the opportunity to work with children of different ages and make some definite plans for interactive classrooms in the future.

CONCLUSION

The participants' reflections and feedback from after school programs where the participants tutored indicates that the participants fulfilled both of the service learning outcomes - enhancing student learning and providing a valuable service to the community. Students had opportunities to enhance their learning as they incorporated three of five NCTM's process standards (Communication, Connection, and Representation) into their activities with children. They also applied diagnostic assessment technique while they were tutoring children. The comments from after school programs coordinators showed that the children were able to receive one-on-one tutoring and the participants made such a difference in the children's lives – and in the programs where they tutored. In addition, the participants began to realize that they need to be able to teach to children's different learning styles and feel confident working with children of diverse learning styles and ages. Furthermore, the service-learning experience helped the

participants understand teaching as involving much more than intellectual learning, but that it also encompasses seeing the child in his or her entire life context, to understand how to fully engage them in the learning process. They had come to see this dealing with "the whole child" as an important component of their teaching, and to appreciate the personal growth they had facilitated in the children they had tutored. The participants also began to realize that majority of current classroom teaching methods in elementary schools rely heavily on the drill and practice approach. Participants began to think about new activities and ideas to use in their future teaching that is more understanding mathematical concepts rather than drill and practice.

This study demonstrates that pre-service teachers can benefit substantially from even a relatively short amount of time, not necessarily in a classroom or school situation. In fact, Boyle-Baise and Sleeter (2000) found that experiences in community settings that involve families have a more profound impact on students' loss of stereotypes about different communities they may encounter. Unreported results from our analysis suggest that the students in this study who worked in the community setting actually gained more insights into the NCTM process standards and diagnostic assessment strategies that were studied in the class.

REFERENCES

Anderson, Jeffrey. 2000. *Service-learning and teacher education.* Washington, DC: ERIC Digest. (ERIC Document Reproduction Service No. ED421481)

Boyle-Baise, Marilynne and Christine Sleeter. 2000. *Community-based service learning for multicultural education,"* Educational Foundations. 2:33-50.

Conrad, Karen and Dyanne Tracy. 1992. *Lowering teachers' mathematics anxiety through an experience-based mathematics methods course.* Rochester: Oakland Univeristy. (ERIC Document Reproduction Service N. ED 355099)

Donahue, David. 1998. *Service-learning for pre-service teachers: Ethical dilemmas for practice,* Teaching and Teacher Education 15:685-695.

Duke, Johnny. 1999. *Service learning: Taking mathematics into the real world,* Mathematics Teacher. 92:794-6+

Glaser, Bernard and Anslem Strauss. 1967 The Discovery of Grounded Theory.

Kirtman, Lisa. 2008 *teachers and mathematics: The impact of service-leanring on teacher preparation,"* School Science and Mathematics 108:94-102.

O'Donnell. 2001. *A personal Journey: Integrating mathematics and service learning,* Mathematics Teaching in the Middle School. 6:440-446.

Shastri. Anuradhass. 2003. *Pre-service Teachers' Responses to a Service-Learning Experience.*(ERIC Document Reproduction Service No. ED478764)

Swick, Kevin. 2001. *Service-learning in teacher education: Building learning communities,* The Clearing House. 74:261-264