Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.4, No.8, 2013

Service-Learning for Introductory and Developmental Math Students

Champike Attanayake*
Department of Mathematics, Miami University, Middletown OH 45042, USA
* E-mail of the corresponding author: anna.smith@ncu.ca

Abstract

University students in an introductory mathematics course attended a local middle school to assist in tutoring activities as a service-learning project. This project enhanced their learning in their university course. The activity was considered a part of the course, and students were assigned a grade in the same way that they would be for any other course component such as homework or another project. It was found that helping younger school children changes students' attitudes about mathematics and increases their motivation to learn mathematics, making the service-learning experience meaningful and valuable to all participants.

Keywords: Service-learning, Critical reflection, Introductory mathematics, College algebra

1. Introduction

Mathematical language is abstract. University mathematics education sometimes tends to be quite distanced from the real world and ignores students' professional interests. Therefore, to a great many students, traditional instruction seems to be much too theoretical. Regrettably, vast numbers of students, especially non-mathematics majors, are unaware of the importance of mathematics in their prospective fields. As a result, several attempts have been made to improve university mathematics education for non-mathematicians. Bringing service-learning experiences into the curricula of some mathematics courses is one such attempt that has produced many positive outcomes (Committee on the Undergraduate Program in Mathematics, 2004).

Service-learning or community engagement can be defined as an activity performed by students to provide a service to the community while enhancing their own learning in the context of a specific course. Students who participate in service-learning projects provide services to the community base on what they are currently learning in the classroom. Robert Sigmon (1994) clarified four different ways to view service-learning. He uses the term *service-learning* to describe a service activity that is completely separate from learning goals. *SERVICE-learning* describes an activity that stresses the use of service and in which learning goals are secondary. For activities in which learning is primary and service is secondary, Sigmon use the term *service-LEARNING*. He describes *SERVICE- LEARNING (SL)* as occurring when service and learning goals are given equal weight so that classroom goals and service outcomes are balanced and complementary for all participants. In particular, Chapman and Ferrari (1999) define SL as "an educational experience that affords students the opportunity to apply experiences gained in helping others to their understanding of material learned in the classroom." Students learn more when they take an active role in their learning. Combining traits of purpose and caring with authentic work gives them a sense of ownership and connection to real-world problems (Huba & Freed, 2000).

Participation in SL fosters not only the development of intellectual skill, but also students' character. Research on service-learning (e.g., Zlotkowski, 2001; Kuh, 2008; Borwnell & Swaner, 2010) also suggests that participants may experience character-related changes, such as a sense of social responsibility, meaningfulness in college life, expectations of a future commitment to community service, and an awareness of social problems.

While numerous studies report the positive effects of community engagement on students, some institutions may find the energy, cost, and resources of large-scale SL experiences to be prohibitive. Moreover, as far as we know, applying service-learning and incorporating critical thinking in a developmental, non-major mathematics course is less common than in upper-level mathematics courses and has not been widely reported in math education literature. The purpose of this paper is to describe our experiences in setting up and implementing a small-scale, low-cost SL program in an introductory, single semester, non-majors mathematics course. The SL experience is to perform teaching and tutoring duties for local middle school children. This project took place in an introductory college algebra course taught by the author that incorporated two key concepts of SL, and was identified and supported by our university as an active part of the larger community. The two key concepts are

meaningful service and critical reflection to enhance students' learning and social responsibility to ensure that pedagogy is based soundly on reciprocity.

According to Victor Donnay (2005), by assisting schoolchildren to learn lower-level mathematics, university students who might be taking a math course to fulfill some type of quantitative requirement will have an opportunity to revisit basic material that they might expect to already know. However, most of the students learn mathematics as a set of skills to be memorized and mimicked. By trying to explain material to schoolchildren, such students will have the chance to engage the material at a deeper level and strengthen their understanding. Such experience can help change students' self-image of themself as poor mathematics learners and help them realize that their abilities are of use and valued by others. Daniel Coyle (2009) explains that, "The effect of first phase of learning seemed to be to get the learner involved, captivated, hooked and to get the learner to need and want more information." The students with a good foundation in a subject tend to become faster and better at acquiring more knowledge and remembering what they learn in their own course.

2. Service-Learning Project

We conducted this project in an introductory college algebra course. Basic knowledge of college algebra is essential for the completion of most university degrees. This course at our university is designed as a service course for many different majors, and is a way to fulfill a general quantitative education requirement. Students are placed in early math courses using placement tests, which are required of all incoming first-year students. The placement test is an assessment test and is designed to analyze a student's current abilities in reading, writing, and mathematics. Almost all the students who need this course enroll in it during the first or second semester of their freshman year. Facing the challenges of adjusting to university life, the pain of math anxiety, and differences in their high school math preparation, many of these students drop out or fail college algebra in their first attempt. One of the main observations we made in introductory courses is that in contrast to the students in university-level courses such as pre-calculus and calculus courses, significantly large numbers of students think they are not deserve to be in the introductory college algebra course.

Introductory college algebra is a subject that should be learned as a set of conceptual structures. It is a very logically structured set of ideas. However, most students often do not have complete mastery of the material, and the mastery that they do have is in algorithms. When they get to advanced mathematics or mathematics-related courses, their lack of understanding of the logic and concepts behind basic algebra affects their performances. They see algebra as a meaningless exercise in abstraction and not as a continuation of a set of logical rules. Thus, the motivation to learn and understand algebra (or mathematics) properly is a main issue in this course. Another important issue is math anxiety. In general, causes of math anxiety are insistence on the right answer, the fact that math knowledge is cumulative, and the inability of some students to handle frustration. It is well known that math anxiety and math avoidance hinder academic success, and in a technological society, they also limit career opportunities. Therefore, our primary goals for the service-learning project are to reduce math anxiety and motivate students toward mathematics while they master the basic concepts in algebra.

The community partner for this SL project is a nearby middle school where mathematics scores are marginal relative to national scores. We contacted the schoolteachers through the office of Community Engagement & Services at our university. After outlining the project objective and potential benefits for schoolchildren, the teachers were eager to participate.

We used service learning in this course as an option (although it was a strongly encouraged option). It was the only form of extra credit students could earn all semester. If students agreed to participate in the SL project, then they had to take only two midterm exams instead of three. All the other assignments (homework, quizzes, and final exam) were the same for both groups.

In the SL project, however, students were more involved in the teaching process and evaluating their experiences critically. Participants had to complete two specific activities and two reflections. The activities were twelve hours of teacher assistance and an end-of-semester presentation. Reflection involved keeping a daily journals and writing an end-of-semester reflection paper.

2.1 Activities

On the first day of the class, we described what SL is and why it was important for students to consider taking part. The following week, we had a member of the Community Engagement & Services further explain the benefits and procedures for participation. We also invited a teacher from the middle school to explain about the students and expectations of the school.

When conducting the project activities, students were in groups of three or four. Each group worked with groups of school children to implement and participate in the following three activities:

- assisting the teacher in explaining difficult material and new math concepts;
- working with a small group of weaker students, who may need extra help; and
- working with a small group of advanced students who require extra activities such as math games.

For a few hours each week, participants were taken out of the role of student and became teachers. In the first two visits, they only had to observe classes. During these two weeks, students got a chance to become familiar with their new environment. Then, students spent at least ten hours (one hour per week) tutoring students.

During the last three weeks of the project, students made presentations related to mathematics that could arouse the interest of elementary schoolchildren. We provided them with some helpful links and topics since the students were very creative and there were plenty of ideas available on the World Wide Web. Even though students were a little unhappy about the extra work involved in creating the presentation, it turned out to be one of the most enjoyable and productive assignments we had given in the whole semester.

2.2 Reflection

The critical reflection process is extremely important to this service-learning project. It allows students to make sense of their service-learning experiences and apply what they learned to future experiences.

Students wrote a two-page reflection paper after completing their hours. We asked them to think about how their service learning had helped them. This let them think about what they have learned during the semester, both inside and outside of the classroom. We stressed that students should take time to think about what they have done and learned. To ensure this, we talked about the reflection in class several times before giving them the actual due date of the assignment. In the reflection paper, students had to answer two main questions.

- How did the service learning experience change your ideas about importance, relevance and nature of mathematics, ability and interest of mathematics, effective methods to study and learn mathematics, and knowledge and understanding of mathematics?
- How has the service learning experience helped your general communication skills, specific communication skills in mathematics, responsibilities as a citizen of the community, contributions you can make to your community, and clarified your personal objectives and your understanding of yourself?

We almost never commented on students' grammar in this assignment. We encouraged students to write about the content and how things they learned apply to the course they were taking. The process of answering questions about how they witnessed children learn and what mathematical techniques were more effective than others was extremely beneficial, particularly for those with poor study skills.

3. Analysis

Of the 98 students registered in the college algebra course, 42 chose to participate in the SL project and 36 students chose the traditional course assignment. To evaluate the impact of the project, pre- and post-surveys were conducted. When the survey measures were examined for all SL and non-SL students (control group), SL participants showed statistically greater gains compared to non-SL students in terms of competence in mathematics, real-world experience, ability to explain mathematics to others, and study skills. The SL group also responded very positively on community service awareness and project experiences, providing further evidence for the success of the project. The survey results are summarized in Table 1.

In this project, students' comments in journal entries and reflection papers were also very positive. They were able to help others to gain a sense of community and were able to act as role models for the children. Some students also helped with other subjects as well as assisting with math classes. Many students felt that their learning skills had improved. They commented that they had revisited what they had learned in their own math courses and saw them from a different viewpoint. By tutoring and helping schoolchildren, students learned to be patient and persistent in solving problems. Furthermore, students gained much greater respect for teaching and the demand for teaching.

The most positive remarks came from students who said that the SL experience had changed the way in which they perceive mathematics. Some of them believed that they could not do any math and that they had not learned how to study mathematics. This SL experience helps these students both feel better about their mathematical abilities and learn more effective study habits. When students became experts in the eyes of children, the

students' perception of their own capabilities improved. The combined effect of these lessons on our students has made some of them excel in the class and even enjoy mathematics by the end of the semester. Having spent a few hours encouraging schoolchildren, students made extra effort in their own courses.

The final class grades for SL participants were 83.58 compared to 78.92 for the traditional group. Although the SL group showed a slight trend toward higher grades, it can be argued that this was because students who care about serving others would also be concerned about their own grades. These students may simply be more conscientious and thus would get better grades in any environment. However, the sample sizes were small and lack of randomization of the two groups may have introduced a bias in the interpretation of the final grades.

The impact on the middle school children can only be assessed qualitatively. There is no data on how many students have passed their exams or improved their grades as a result of this SL project. The principal and teachers of the middle school indicated that this type of project helped them to rethink how they teach and learn mathematics, and how different and effective these methods were compared to what they used to teach mathematics a few years ago. During the project, the schoolchildren greeted their tutors warmly, and they were very upset upon its completion. They had been made to feel special because of the extra individual attention they received while playing math games and activities with their tutors. Children have shared their learning difficulties and successes with their teacher friends. Yet notably, most students indicated that they have derived more from the SL experience than they have given.

4. Discussion

The present study found that participation in an SL option offered an enhanced learning experience with an element of social responsibility and personal growth. In general, tutors improved their attitudes toward mathematics, re-learned material that might not have been mastered fully the first time, developed new and healthier images of themselves, and developed an appreciation of the teaching process. The experience was perceived as more enjoyable and relevant to the real world, adding an element of student empowerment.

Two notable obstacles in organizing the SL project were scheduling and location. Because the project was extracurricular, many students found it difficult to make time available, given the constraints imposed by part-time jobs and other courses. We encouraged students to have set times for the project rather than a flexible weekly schedule. Students could then plan accordingly around their other weekly commitments. Since SL was new to most of the students and teachers, it was very important to have detailed discussions with all the participants about the project goals and objectives before and during the semester. To this end, we made several visits to the middle school, kept in constant contact with schoolteachers, and had weekly conversations with all the students. The culture of volunteering and service seemed to be well ingrained, so making participants aware that they were doing service and learning rather than just service was a challenge.

We strongly believe in the value of SL. There are great benefits to the community and to the participants. This type of project is suitable for students in any introductory level mathematics course, and the skills that they gain can benefit them at any level of mathematics or in any mathematics-related course. Students begin to understand the process involved in thinking mathematically rather than considering skill in mathematics something that is tied to ability. Consequently, they put more time and effort into studying. More importantly, this project resulted in noticeable changes in attitude toward mathematics and a stronger sense of community.

References

Bradford, M. (2005). Motivating students through project based service-learning. *T.H.E. Journal*, **32**, 29-30.

Brownell, J. E., & Swaner, L. E. (2010). *Five high-impact practices: Research on learning outcomes, completion and quality*. Washington, D.C.: Association of American Colleges and Universities.

Chapman, J. G., & Ferrari, J. R. (1999). An introduction to community-based service-learning. *Educating students to make difference: community-based service-learning*. New york: Haworth Press.

Committee on the Undergraduate Program in Mathematics, (2004). *Undergraduate Programs and courses in Mathematical Sciences, CUPM Curriculum Guide.* Mathematical Association of America, Washington, DC.

Coyle, D., (2009). *The talent code: Greatness isn't born. It's grown. Here's how*. NY: Bantam books.

Huba, M. E., & Fred, J. E. (2000). *Learner-centered assessment on college campuses: shifting the focus from teaching to learning.* Allyn and Bacon.

Kuh, G.D. (2008). *High-impact educational practices: What they are, who has access to them, and why they*

matter. Washington, D.C.: Association of American Colleges and Universities.

Sigmon, R. L. (1994). *Serving to Learn, Learning to Serve Linking Service with Learning.* Council for Independent Colleges Report.

Donay, V. J., (2005). Prospective on Education-Orianted Mathematics Projects in a Serivice-Learning Framework. *Mathematics in service to the community*, *MAA Notes*, **66**, 133-146.

Zlotkowski, E. (2001). *Humanistic learning and service-learning at the liberal art college.* Developing and implementing service-learning programs.

Champike Attanayake is Assistant Professor at Miami University at Middletown, where he has been since 2008. He received a B.S. from University of Kelaniya, Sri Lanka in 2000 and an M.S. from Michigan Tech. University USA in 2003. He received his Ph.D. in applied mathematics from Bowling Green State University in 2008. His research interests are numerical analysis, financial mathematics and service learning pedagogy.

Table 1. Responses were rated on a 4-point scale: 1=Strongly Disagree, 2=Disagree, 3=Agree, and 4=Strongly Agree

	Service-learning group N = 42		Control group N = 36	
Measure	Pre	Post	Pre	Post
Criterion	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Math competence	2.18 (0.86)	3.54 (1.01)	2.27 (0.94)	2.79 (0.70)
Interest in math	2.13 (1.14)	2.93 (1.09)	2.24 (1.10)	2.50 (1.07)
Interest in career related to math	1.78 (1.08)	2.04 (1.41)	1.89 (1.29)	1.96 (1.03)
Connecting math to real world	2.64 (0.53)	3.20 (0.60)	2.73 (0.77)	2.93 (0.91)
Ability to explain math	2.39 (0.35)	3.33 (0.67)	2.54 (0.61)	2.02 (0.98)
Changed study habits*	-	3.04 (0.93)	-	2.26 (0.87)
Service to the community**	-	3.44 (0.3)	-	-
Positive experience**	-	3.81 (0.48)	-	-

Note: *Only post-surveys; **Only post-surveys for the service-learning group.