
AC 2012-4362: FLEXIBLE AND SUSTAINABLE INTERVENTIONS FOR MATHEMATICS SUPPORT OF FIRST-YEAR STUDENTS

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Abstract

In responding to the need to improve retention in the first year of engineering, many institutions have developed a range of academic support programs, including learning communities, peer mentoring, summer bridge programs, tutorial services and supplemental instructional workshops^{1,2,3,4,5}. Student participation in these programs is intended to engage students more actively in their own learning processes, thus leading to improved learning outcomes, increased student motivation and, ultimately, retention^{6,7}. In this paper, we describe the re-design of a traditional mathematics support program focusing on engineering and computer science students in their first-year of a four-year degree in the LC Smith College of Engineering and Computer Science at Syracuse University. We will present data that assesses student perceptions and performance in both the traditional and re-designed support programs and will make recommendations for future work in this area.

Background

The seminal work of Treisman documented the effectiveness of supplemental workshops in calculus (a key gatekeeper for access to the science, technology, engineering, and mathematics (STEM) disciplines) for underrepresented minorities⁸. Since that time, programs similar to the “Mathematics Workshop Program” have demonstrated higher student outcomes, including persistence to graduation⁹. While a variety of programs have evolved over the past two decades, in Arendale’s review of postsecondary peer cooperative learning programs, they are divided into two groups: (1) those that provide additional support through outside of class activities with little change by the primary instructor and (2) those that reflect a transformed learning environment for all students enrolled in the course⁹. Included in the second category are those workshops using the Peer-Led Team Learning (PLTL) model developed in science education. Keys to the success of the PLTL model are a peer-led workshop that is integral to the course, the close involvement of the faculty in working with the peer leaders, well trained peer leaders, and a challenging and conceptually oriented workshop¹⁰. Because students enter college with varying skill sets, maturity, and academic preparation, support programs, like the PLTLs, need to be designed with increasing flexibility and responsiveness to the diversity found among incoming first-year students.

Syracuse University has a 15⁺-year history of providing institutionalized support programs within the LC Smith College of Engineering and Computer Science. Programs we offer are meant to challenge, inspire, and encourage students to pursue and achieve academic, personal, and professional excellence. One of the signature programs offered is the “Academic Excellence Workshop” (AEW). This program is offered as a one-credit pass/fail course for students in their

first and second years in the College and has met with varying levels of success, as measured by student performance, feedback on student surveys, and faculty perceptions of their effectiveness.

Approximately 100 AEW courses are offered throughout the academic year for mathematics courses (pre-Calculus through Calculus III) and select engineering classes. Students register for AEWs that correspond to the particular mathematics and/or engineering course(s) in which they are enrolled. Because Syracuse University students pay block tuition, there is no financial disincentive to enrolling in the AEWs and enrolling in additional one-credit courses each semester does not increase the time to graduation. In addition, the AEWs are taken as pass/fail, which is not calculated in the GPA so there is no incentive to take the class to potentially boost the overall GPA. The optional workshops are run by a peer (student) facilitator and are structured to promote social interactions while providing additional work in the academic subject area. Students are required to enroll in the workshops by the academic add deadline at the beginning of the semester, attend all workshop meetings, and stay for the entire meeting. Attendance is tracked and students not enrolled in the workshops are not allowed to attend. The workshops meet once a week for a 2 hour block and students complete worksheets that supplement the material being covered in the respective class. The workshops also include a social component where students are actively engaging with one another through ice breakers, team-building activities, and games.

Recently, we completed an analysis of data comparing the mathematics grades of first-year students enrolled in AEWs for pre-Calculus and Calculus versus those not enrolled in any support courses. Surprisingly, students enrolled in the AEWs did no better than those who were not enrolled. In addition to our data analysis, we conducted surveys of all students enrolled in the workshops in December 2010. Overwhelmingly, students commented on being “bored” in their sessions, they believed that the worksheets were “not related to what is happening in class” and many found the ice-breakers and games “useless” and a “waste of time”. It also became clear that the student experience was highly dependent on the perceived strength of the particular peer facilitator. A consequence from these outcomes is that many students who have a negative experience in a single workshop tend to opt out of any future courses.

Peer-Led Study Group Pilot

In Fall 2011, we piloted a re-design of our mathematics workshops to be non-credit peer-led study groups (PLSGs) that use social media (e.g., Facebook) to facilitate interactions among students. The goal of the re-designed PLSGs is to provide a flexible and responsive intervention that will engage students academically as well as provide social support. The PLSGs were re-designed for two sections of pre-Calculus and one section of Calculus I and were run in parallel with the existing for-credit AEWs. The PLSGs were led by facilitators who had previously facilitated in an AEW and the facilitators were under the direct supervision of two mathematics education graduate students who served as learning specialists. The learning specialists

interacted directly with the faculty teaching pre-Calculus and Calculus and provided the peer facilitators with weekly worksheets and information pertaining to the material covered in class that same week.

Unlike the for-credit AEWs, the PLSGs do not meet in required sessions, but rather each facilitator runs a one hour study group session three times a week that is focused on the concepts and problems that are being taught that day in the course. Any student is welcome to attend any PLSG session. Students that want to attend are asked to fill out a sign-up form so that they can be added to the respective PLSG Facebook page, which contains the information on PLSG meetings. In addition, using Facebook and email, the PLSG facilitators offer two hours per week of virtual study groups based on the immediately identified needs of the students. The facilitators also offer two one-hour sessions of in person office hours every week. Since the PLSG is a non-credit course, students are welcome to move in and out of the PLSG based on their needs at any given time. The students attending office hours or study sessions are also welcome to bring friends along. Thus, the PLSGs are structured to be open study sessions available to any student in a course for which a PLSG is offered.

Initial Results

Students' Perspective

Two student surveys were administered during the Fall 2011 semester to determine the students' perspectives on the mathematics workshops. The first survey was a written survey given to students enrolled in Calculus I after completion of the first exam. Students (n=58) were asked about their participation in the PLSGs and AEWs. The results are shown in Table 1 below. Of the students surveyed, 72.4% reported participation in some type of mathematics support group. Of those students, 31% were signed up for a PLSG. For the group not enrolled in either a PLSG or AEW, 3 students indicated that they would be joining the PLSGs.

Table 1: Breakdown of Calculus I student participation in peer-led study groups (PLSGs) and/or existing support workshop (AEW). Total n=58.

Signed up for PLSG	Enrolled in AEW	Count	% of Respondents
No	Yes	24	41.4
Yes	No	10	17.2
Yes	Yes	8	13.8
No	No	16	27.6

In the survey, students were asked the questions “What about the PLSG is helpful to you? Not helpful?” Those students enrolled in the PLSGs were overwhelmingly positive when describing the course and had comments such as “virtual hours make it easy to get help” and “if I am stuck on a particular concept, I just go in and they help me do multiple problems”. Students cited the

ability to go over problems that were brought to the session instead of prepared for the session, like in AEW, as a benefit. Many students responded that the varied hours, including late night and online, to access the PLSGs made it easy to get help. As one student wrote “(PLSG) is helpful because I am able to ask them to go over topics that I didn’t understand even though the class has already past it.” Notably, no students had any comments in response to the “Not helpful?” question.

In the same survey, students were asked to provide answers regarding what was helpful or not helpful for the AEW. For those students enrolled in both PLSGs and AEW, the majority felt that in the for-credit workshop, “the material we cover almost always is outdated”. As one student summarized “I don’t like how (AEW) is behind the class.” Students did report that being able to meet in a small group and go over additional mathematics problems in the AEW was helpful.

At the end of the Fall 2011 semester, a second survey was administered electronically to all students who were eligible for a PLSG during the semester. These included students in pre-Calculus and one section of Calculus I. Of the 133 students surveyed, we received 38 (28.5%) responses. Of the respondents, 10 (26.3%) students had utilized a PLSG during the semester and 19 students (50%) had been enrolled in a AEW. The students were asked the same questions as in the first survey and were also asked to provide “Any other comments regarding PLSGs or AEW that you would like us to know”.

The responses to the second survey were similar to those reported earlier in the semester. Students liked the “ability to go in and get most questions answered at convenient times” aspect of the PLSGs. Some students indicated that they would have liked to have had access to more office hours for the PLSGs and that “it was hard to keep track of the (PLSG) schedule”. Respondents were also very positive about experiences in the AEWs, with the majority of students reporting that “reinforcement of the topics”, “homework help”, and “working with peers” were helpful to them. However, as observed earlier in the semester, students in AEWs found that “sometimes the worksheets weren’t relevant to the material being covered in class and just led to confusion”. Students also reported that the worksheets were “always about physics” as one of the reasons that AEWs were not helpful. In the AEWs, the incorporation of physics-based problems on worksheets is intended to help students see the application of engineering and science in mathematics.

Overall, the comments submitted regarding the PLSGs and AEWs were positive. Two students did note that the AEWs were too long and “takes up too much of my time”. One student commented that “I find (PLSG) more useful because of its open office hours and (AEW) is a one credit course that is required...I would rather go to (PLSG) sessions than have (AEW) on my schedule”. Notably, in response to the question “Would you consider (PLSG) for future semesters?”, 20/28 (71.4%) respondents indicated “yes”.

Peer Facilitators' Perspective

The PLSG peer facilitators chosen for this pilot were students who had at least one semester of AEW experience. Their training was identical to that given to the AEW facilitators. Two of the PLSG facilitators were juniors and two were seniors. The learning specialists met with the peer facilitators once a week to go over the next week's worksheets, to provide support and guidance, and to make changes to provide the maximum flexibility in PLSGs for the students. This weekly meeting also served to help the peer facilitators re-familiarize themselves with the material. The learning specialists also modeled with the peer facilitators how to support the students in productively struggling with problems, rather than leading them to the solutions.

At the end of the semester, we solicited feedback from the peer facilitators regarding their experiences in leading the PLSGs. All of them thought that the PLSGs were a good idea and that they were a valuable resource for students. The facilitators noted that the Calculus I PLSGs were better attended than the pre-Calculus sessions. Even though both mathematics courses were taken by first year students, the facilitators attributed the lack of response in the PLSGs to the belief that most students did not take advantage of a PLSG because it wasn't required of them and they didn't know any better. As one facilitator summarized "They did not come to (PLSG) because it was not a mandatory course that they were receiving a grade in". Another mentioned "I just don't think that first-year students understand the value of this program being so easily accessible to them". For those students that did attend a PLSG, the facilitators reported that they primarily wanted to work on test review, homework problems, and WebAssign problems.

In terms of suggestions for improvements for the PLSGs, the peer facilitators thought that providing some "incentive" for participation in a PLSG might make it more valuable to students. Most of the suggested incentives centered around some type of class grade credit or even making it mandatory like the AEWs. Other suggestions were that the PLSGs be more widely advertised and that the structure of the office hours and group sessions be changed. The peer facilitators could not cite any clear reasons why the pre-Calculus PLSGs were less attended than the Calculus I PLSGs although advertising and awareness of the sessions were mentioned as possible reasons. It is interesting to note that the Calculus I instructor seemed more proactive in encouraging her students to attend a PLSG than did the pre-Calculus instructor and could account for at least part of our observation.

Summary

Overall, our initial results are surprising, promising, and provide us with some directions for future work. One of the most surprising results of our pilot was the overall low participation in the pre-Calculus PLSGs but satisfactory participation in the Calculus I PLSGs. We anticipated that students would take advantage of the flexible nature of the PLSGs and move in and out of different sessions based on their needs throughout the semester. However, the students who participated in the PLSGs were largely those who came at the beginning of the semester and

continued to attend for the entire semester. The Calculus I students were engaged from the beginning and continued to utilize the PLSGs throughout the semester while the pre-Calculus PLSGs never seemed to gain momentum and saw only sporadic attendance. Another surprise was that the Facebook pages and the virtual office hours did not see a lot of use by the students. We expected that students would want to communicate in real-time with their peer facilitator and would utilize social media for that purpose.

One of the most promising of our results is the overwhelming feedback from both the students and the peer facilitators regarding the timeliness of the PLSG worksheets. The learning specialists worked closely with the pre-Calculus and Calculus I professors to coordinate the worksheets and help prepare the facilitators in the material. Another promising result is that the PLSGs were able to be responsive to the needs of the students. Even though worksheets were available in the PLSGs, they often were only used as supplementary work after the students worked on actual homework problems. In addition, the PLSGs met multiple times per week in different formats, which allowed the peer facilitators to be available to the students at times when they needed it most. In contrast, the AEWs meet only once per week and students are required to complete the worksheets. This often leaves little to no time, or desire, to work on homework problems.

Future Work

The data we have collected in the PLSG pilot will be used to refine our design of flexible and responsive solutions that will provide mathematics support to first-year students in engineering and computer science. We are planning to run a second pilot of our PLSGs during Spring 2012 and will focus on the following:

1. Engage additional mathematics faculty in awareness and promotion of PLSGs. We anticipate this will increase student participation.
2. Engage new peer facilitators in the PLSGs. Two of our previous peer facilitators are not returning next semester so we will be training and using two new peer leaders. We also have two new learning specialists. This will give us the opportunity to look at the sustainability and transferability of our previously developed worksheets and the overall PLSG design.
3. Expand the PLSGs to include Calculus II. Many of our PLSG participants will be progressing to Calculus II next semester and we want to take advantage of their awareness of the PLSGs by offering them for the next semester of their mathematics sequence. We will develop the Calculus II PLSGs in conjunction with running the Calculus I PLSGs using worksheets developed in the first phase of the pilot.
4. Offer more weekend and night sessions for PLSGs. Many of the most utilized PLSG sessions were those offered on the weekends and on nights before exams. We will also

aim to increase our social media usage, especially to advertise the different PLSG group sessions and office hours.

5. Track students who participate in PLSGs so that we can link their performance with attendance in the PLSGs. Peer facilitators will ask students to sign in to the sessions/office hours so that we can perform a quantitative analysis of students enrolled in AEWs, students enrolled in PLSGs, students enrolled in AEWs and PLSGs, and students not enrolled in any support. This will enable us to assess effectiveness of our re-designed mathematics support courses.

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