Promoting Success in College Algebra by Using Worked Examples in Weekly Active Group Work Sessions

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At a research university near the east coast, researchers have restructured a College Algebra course by formatting the course into two large lectures a week, an active recitation size laboratory class once a week, and an extra day devoted to active group work called Supplemental Practice (SP). SP was added as an extra day of class where the SP leader has students to work in groups on a worksheet of examples and problems, based off of worked example research, that were covered in the previous week's class material. Two sections of the course was randomly chosen to be the experimental group and the other section was the control group. The experimental group was given the SP worksheets and the control group a question and answer session. The experimental group significantly outperformed the control on a variety of components in the course, especially when SP attendance was factored into the analysis.

Keywords: College Algebra, Cognitive Science, Worked Examples, Large Lecture Supplemental Sessions

INTRODUCTION

A Commitment to America's Future: Responding to the Crisis in Mathematics and Science Education states that ``nationally 22% of all college freshman fail to meet the performance levels required for entry level mathematics courses and must begin their college experience in remedial courses" (p. 6). The enrollment in college algebra has grown recently to the point that nationally there are estimated 650,000 to 750,000 students per year (Haver, 2007) and has surpassed the enrollment in Calculus recently. Although there are almost three fourths of 1 million students enrolling in college algebra, it is estimated conservatively that 45% of these students fail to receive a grade of A, B, or C and can reach percentages in the sixties at some colleges. To address this non-success of students at a large research university in the eastern part of the United States, faculty members teaching Applied College Algebra have implemented a new structure in the course that emphasizes active learning through a day called Supplemental Practice.

BACKGROUND AND BRIEF LITERATURE REVIEW

Supplemental Practice Structure

The idea of Supplemental Practice, denoted SP, was implemented during the fall 2004 and was modeled after Supplemental Instruction (Arendale, 1994; SI Staff, 1997). The normal structure of the Applied Algebra Class that consisted of three lectures a week morphed into a structure of two lectures a week in a large lecture room, and an active laboratory class once a week in computer classrooms where students meet in smaller groups. The lab class was held on Tuesdays while the lecture class was held on Mondays and Fridays. The SP days on Wednesdays were originally added to the weeks' schedule to help lower-achieving students. This was done by requiring students that scored lower than an 80 on a placement exam or scored lower than a 70 on any regular exam, to attend

the SP sessions. Starting in the fall 2006 semester, the SP sessions have since morphed into active problem session days modeled after the cognitive science "worked-out example" research. The worked-out example research ask students to study a worked out example for a particular topic, ask questions about anything in the example that they do not understand, and finally work a similar example without reference to the worked out example nor other outside sources (Cooper and Sweller, 1985; Ward and Sweller, 1990; Zhu and Simon, 1987; Carroll, 1994, Tarmizi and Sweller, 1988). Most all of "worked-out example" research has been in a laboratory setting rather than in classroom settings. In this research, the researcher randomly designated one of the course sections as the control group and the other two sections as the experimental group. In the experimental group, the students were given a worksheet at the beginning of the SP day and ask to work in groups to complete the worksheet. Three to four class assistants circulated around the room to answer any student questions about the worksheet. In the control group, a graduate student organized a question and answer session during the extra day instead of giving a worksheet to the students. Students were able to get any question answered, but the graduate student only answered student questions and did not generate questions themselves. For the most part, the graduate student spent all of the class time answering student generated questions. The research questions that will be addressed in the research are the following:

1. Do students in the experimental group earn a significantly different course grade/exam scores/quiz scores/etc… than students in the control group?
2. What are students overall perceptions and experiences of the SP sessions?

Past research on worked-out examples in mathematics has been conducted in a laboratory setting. This research is conducted in a large lecture classroom setting and concentrates on determining if worked-out examples helps promotes success in the course. In addition, past worked-out example research in mathematics has not dealt with college mathematics courses, classes in a large lecture setting, or implementing an extra day of class to focus on working with students to master material. The research could be valuable to other researchers that are working to promote student success in large lecture classes.

METHODOLOGY

The setting for the research was a college algebra course with an annual enrollment of around 1000 students. This course is one of three different types of college algebra courses at the university. One type of college algebra is called a 3-day algebra course that comprises of two lectures a week in a large lecture setting and one day a week in the lab where students actively work in smaller group math labs. The second type is the college algebra 4-day course in which this study took place in. The 4-day college algebra course is the same as the 3-day except the 4^{th} day is spent in SP. The final type is a 5-day college algebra course that is comprised of 5 lectures a week in a class size of approximately 40 students. Each type of college requires specific placement exams scores. The 3-day algebra course requires the highest placement score and the 5-day algebra course requiring the lowest placement score.

One of the three sections of College Algebra was randomly selected as the control group and the other two sections served as the experimental group. Quantitative data

(course scores, supplemental days attended, class attendance, total points,…) was collected for each student in both the control and experimental groups and analyzed at the end of the semester. There were similar demographics in both the control and experimental groups.

RESULTS

The researcher compared the data for the control and experimental groups to determine whether there was any significance in total course points, exam scores, quiz scores, and lab scores. Students in the experimental group significantly outperformed students in the control group on total points on exams and quizzes, final exam, exam 3, and quizzes ($p < 0.05$) using a t-test. Using previous data on SP sessions, the researcher has established in previous semesters that students who voluntarily attend eight or more SP sessions are more successful on passing the class than students who attend seven or less days of SP sessions. When the researcher includes only the students that have attended eight or more SP sessions in the experimental group and compares these students to the control group, students in the experimental group significantly outperform ($p < 0.01$) students in the control group on everything (total course points, each exam, final, laboratories, and quizzes) except on the first exam using a t-test. The researcher believes that the reason the first exam is not being significant is because students are just being introduced to the active SP sessions and worked-example worksheets and there are only two active SP sessions before the first exam.

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