COOPERATIVE LEARNING IN A COREQUISITE COURSE

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Abstract
In the fall of 2017, Delta State University implemented new general education mathematics pathways. As part of the new approach to mathematics pathways, Intermediate Algebra was no longer offered at Delta State. Instead, all general education mathematics courses now have corequisite labs. In this presentation, we will discuss the cooperative learning techniques implemented in the fall of 2021 as well as modifications used while social distancing for COVID-19.

The activities discussed in this presentation were specifically chosen to facilitate just-in-time teaching (JiTT). JiTT is an instructional technique that shortens the feedback loop between instructor and student. The activities serve a dual purpose in that they inform the instructor of any pre-existing gaps in student knowledge, and they allow students to process content concurrent with initial instruction. These activities were specifically intended to increase student self-efficacy and improve student engagement.

We will present the instructional framework of the corequisite lecture and lab, particularly regarding the modifications of established cooperative learning groups. We will discuss each of the instructional techniques utilized in the course as well as perceived successes and failures.

Introduction

Delta State University is a regional public university situated in the heart of the Mississippi delta which is located in the southeastern region of the United States. The institutional demographic data provides an accurate picture of the students enrolled in College Algebra. In the fall of 2020, 2,331 students attended DSU. Of these students, 59% are female and 41% are male. The average class size at the institution is 11:1; however, the College Algebra classes typically have a 30-40 student enrollment.

As seen in Table 1, from Fall 2012 to 2018, of the incoming students who provide ACT scores (transfer students are exempt from this requirement), 58% earned less than a 21on the ACT (Institutional Research, 2019). The U.S. Department of Education (2018) has determined earning a 21 or higher on the ACT as an indicator of readiness for college-level mathematics. Therefore, 42%, or significantly less than half, of the students in the College Algebra classes are considered ready to learn the subject matter at hand.

Table 1
Percent of incoming students earning a 21 or higher on the ACT

	Fall 2012	Fall 2013	Fall 2014	Fall 2015	Fall 2016	Fall 2017	Fall 2018
Percent of first-time *freshmen* who have an ACT composite score of 21 or above	41.4%	41.2%	47.6%	46.4%	55.5%	54.6%	53.8%

At Delta State University, students were designated as either traditional or remedial according to their ACT score. A traditional student is a student whose ACT mathematics sub-score was equal to/greater than a 20, whereas a remedial student is defined to be someone who scored below a 20 on the ACT mathematics sub-score.

In the 2017-2018 academic year, Delta State University initiated the co-requisite model in College Algebra. This model required all College Algebra students to enroll in a co-requisite lab section paired with their class, regardless of ACT math subscore. The purpose of implementing the co-requisite model was to increase gateway course completion, where gateway courses are defined to be any course necessary for a student to progress through the student's chosen major. Beginning in the fall of 2022, College Algebra students who do not have an ACT math sub-score of 20 or less will not be required to attend the co-requisite remedial lab section.

Educational Framework

Cooperative learning, over the past few years, has gained distinction as a learning tool with positive results in college classes. Prior to the spring of 2020, Delta State University focused on a single clear understanding of cooperative learning in order to align and integrate the online assessment to produce the positive results touted by previous researchers. "Johnson, Johnson, and Smith (1991) define cooperative learning as 'the instructional use of small groups so that students work together to maximize their own and each other's learning." With this premise, Delta State University implemented modalities for the integration of cooperative learning within a corequisite lab.

The research is predicated with the belief that student "accountability ensures that students learn together, but perform alone" (Jones and Jones, 2008). According to Johnson, Johnson, & Roger (2015) there are three structures for cooperative learning in a university classroom: formal cooperative learning, informal cooperative learning, and cooperative base groups. Delta State University chose to utilize the formal cooperative learning modality in the form of Peer-Assisted Learning (PALS). Peer-Assisted Learning is typified by "students acquiring knowledge and skills through active helping among equal classmates" (Topping & Ehly, 1998). Using PALS promotes interaction through an ongoing dialogue process. This dialogue may be verbal or non-verbal. Students must be

linked with each other in a way so that one cannot succeed unless others do (or vice versa), and other group members' work is mutually beneficial (Johnson, Johnson, & Roger, 2015). PALS is different from peer tutoring in that it is collaborative work produced through cooperation and not through competition.

Delta State University chose to utilize a learning management system as student proof of skill mastery. In the modified cooperative learning technique discussed in this paper, DSU studies the student observational data as well as individual pass/fail ratios as indicators of the success of student learning and skill mastery acquired utilizing the cooperative learning model.

Model

We now introduce the implementation of cooperative learning groups prior to the COVID-19 social distancing requirements as well as how those structures were modified for the fall of 2020 through the spring of 2022.

Prior to the onset of COVID-19 social distancing restrictions, students were placed in formal cooperative learning groups of size four with a heterogeneous structure. Heterogeneous grouping refers to the data-driven process of grouping individuals with varied levels of ability. In this case, we chose a threshold of 20 percentage points based on student test average. For example, if one student had a test average of 80, no other student within the group could have a test average of less than 60. Groups were reassessed at the end of each unit. To ensure effective cooperative interaction, the group assignments included periods of group dependency as well as individual accountability.

With the onset of social distancing protocols, the heterogeneous groups were replaced with student-chosen groups of two. Groups would fluctuate based on student attendance and physical proximity. The instructor may choose to shift the student grouping of two students during an instructional period for extended and/or diversified dialogue through various activities. Students were provided with hand-held white boards so that group work could be facilitated over a distance of 6 feet in the fall of 2020 through the spring of 2021, and later a distance of 3 feet in the fall of 2021 and the spring of 2022. One benefit that should be noted is that this modified form of cooperative learning grouping would also be functional with a much larger class size.

Beginning in the fall of 2020, the cooperative learning structure was integrated into the course lecture as well as the co-requisite lab. The instructor used intervals of ten to fifteen minutes of direct instruction either to introduce a new topic or to reinforce a previous objective. During the 2020-21 academic year, all courses were hybrid. Thus, students were required to watch the asynchronous lecture videos prior to in-person class meetings. Therefore, direct instruction was exclusively reinforcement of content. During the 2021-22 academic year, classes returned to traditional face-to-face meetings with social distancing requirements. In either case, between the intervals of direct instruction, the instructor incorporated one of the four techniques: pairs check, reciprocal teaching, peer edit, and think-pair-share. We will discuss each technique as well as perceived successes and failures. Before discussing the techniques, we note two points here. First, every College

Algebra student at Delta State is required to purchase a lab manual that consists of all notes and examples covered in the course. This manual is updated and reprinted by the university each year. In this way, we can model good note-taking skills as well as facilitate a quick transition between instructional sets. Second, the instructor will monitor groups and intervene when requested with either active questioning or guiding hints.

We first discuss pairs check. This technique requires two teams of two. Each pair of students takes a problem. Within each pair, one of the students works to solve the problem while the other student verbally coaches through the process. Once both pairs have solved the problems, the pairs unite to compare their solutions. If the two teams cannot agree on a solution, the instructor steps in for additional guidance.

We now consider think-pair-share, which is a relatively well-known instructional technique. After a direct instructional set, students are given a problem or topic related to the newly acquired content. They "think" about the prompt individually. Students then discuss the process for solving the problem in pairs, and, if possible, attempt to complete the problem. Pairs are then encouraged to share their work either with the class or with another pair.

The next technique is reciprocal teaching. Students are given a problem, such as in Table 2. The instructor models the solution to the first problem in Table 2 for the whole class. Students are encouraged to take notes on the process as well as marking the solution. Students are then paired, and one student in each pair is asked to reteach the process to their partner using the next example in their lab manual.

Table 2

A sample problem used in reciprocal teaching.

1. Use synthetic division to determine if k is a zero of this polynomial.

$$\frac{2x^5 - 5x^4 + 10x^3 - 4x^2 - 3x}{x - 1}$$

2. Use synthetic division to determine if k is a zero of this polynomial.

$$\frac{x^5 + 6x^4 + 6x^3 - 8x^2 + 2}{x + 4}$$

The fourth and final technique utilized in the College Algebra courses is peer editing. Peer editing is useful for encouraging students to view mathematical approaches to problem solving from another's perspective as well as to assist in guidance for better

organizational skills. Students work independently on a problem before turning to their partner to exchange lab manuals. Pairs review and revise their work together.

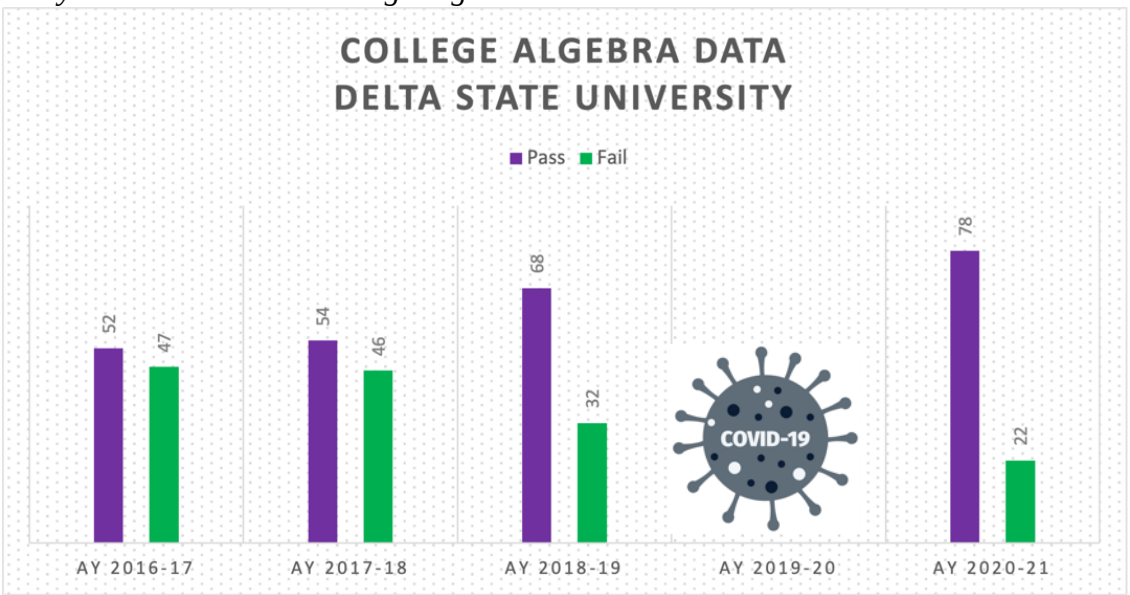
Throughout the instructional period, the instructor monitors the groups for emerging needs in content remediation or necessary reteaching. During this process, the instructor utilizes Just-in-Time Teaching (JiTT) methodologies. Students are encouraged to view the activities as a valuable tools that allow them to adjust their thinking prior to a summative assessment (National Research Council, 2000). Thus, students are regularly reminded by the instructor to view the group work as a time to review and prepare for future unit assessments.

Results

Since the implementation of cooperative learning techniques in College Algebra at Delta State University, student pass rates, where an A, B, or C final letter grade is defined as a passing grade, have risen from 52% to 68% (See Table 2). With the modified form of cooperative learning beginning in the fall of 2020, the pass rate increased to 78%. The researchers are of the belief the increasing trend in the pass rate may be attributable to ongoing improvements in the instructor's cooperative learning pedagogy and/or to the fact that students who entered into the university without an ACT score in the 2020-21 academic year were placed into remedial general education courses by default.

Table 2

Yearly Pass/Fail Data in College Algebra



Throughout each semester of full implementation cooperative learning, both before and after the onset of COVID-19 policies, the instructor observed an appreciable shift in student anxiety and self-efficacy. This shift occurred through the culture/climate shift within the student population. Student dialogue within the groups as well as with the instructor increased.

As the course progressed from unit to unit, students appeared to be more confident in their ability to interact with each other as well as in their ability to succeed in the course overall. Students were more likely to openly share work and discuss problems within class time, allowing for the instructor to have a clearer understanding of student content knowledge. Additionally, the instructor experienced less direct intervention with the groups as the students seemed to become more comfortable with the cooperative learning structure.

Conclusion

Data from the fall of 2017 through the fall of 2018 are indicative of the success of the implementation of the cooperative learning and online assessments initiative. Note that the data for the 2019 – 20 school year was omitted due to the onset of COVID-19. The shift from primarily lab-based cooperative learning to the use of cooperative learning groups as the predominant instructional procedure in both lab and lecture periods has shown gains in pass rates. Preliminary results from the 2021 – 22 academic year, while still being assessed, are also encouraging and will be included in the next research study to be written in the near future.

Given the observations over the last several years, the authors are currently implementing a qualitative study of any potential correlation between cooperative learning groups as outlined in this paper and both math anxiety and student self-efficacy. Additionally, the authors plan to next investigate content retention and student success in subsequent math and science courses.

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