Benefits to Students of Team-Based Learning in Large Lecture Calculus

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Team-Based Learning (TBL) is a specific form of active learning that utilizes the flipped classroom model. We implemented TBL in Calculus I in both large and small classes and investigated the impact of this form of instruction over two semesters. In the second semester, we observed many positive benefits to students, including exceptionally high class attendance, higher midterm and final exam scores, significantly lower DFW rates, and larger gains on the Calculus Concept Inventory when compared to students enrolled in non-TBL sections.

Keywords: Team-Based Learning, flipped classroom, active learning, calculus, large class

Our ongoing study at Iowa State University addresses the following research question: Is Team-Based Learning Calculus I instruction more effective than non-TBL instruction? In Fall 2015 and Fall 2016, three members of our research group taught Calculus I in large (N~150 students) and small (N~35 students) classes using Larry Michaelsen's TBL approach (Michaelsen, Knight, & Fink, 2004). This teaching strategy is based on a constructivist learning theory and involves students first engaging with introductory material individually and then at a higher level in teams (Hrynchak & Batty, 2012). The students do preparatory work outside of class using reading guides and instructional videos before completing a five-question quiz individually and then again with a team. The majority of class time is spent working on application exercises in teams.

We investigated the impact of this form of instruction over two semesters and noticed steady improvement from the first implementation to the second. In our second implementation, we observed exceptionally high class attendance, including an overall attendance rate of 92% in one of our large classes. In analyzing midterm and final exam scores as well as DFW rates (percentage of students who finish the course with a D letter grade, F letter grade, or withdraw from the course), we compared our TBL students (N~370 students) to non-TBL students enrolled in the course (N~1500 students). The mean score on the departmental midterm exam (out of 100) for the TBL group exceeded that of the non-TBL group by 5.0 points, and the mean score on the departmental final exam (out of 100) for the TBL group exceeded that of the non-TBL group by 7.4 points. The DFW rate for the TBL group (19.1%) was significantly lower than the DFW rate for the non-TBL group (32.0%), with sufficient evidence at an alpha level of 0.01 using a two-sample t-test. We noticed lower DFW rates for TBL female students (24.7%) and TBL ethnic underrepresented students (34.8%) than their non-TBL counterparts (30.1% and 45.5%, respectively). By ethnic underrepresented, we mean African American, Hispanic, Native Hawaiian, Native American, or two or more ethnicities. Finally, the average of gains on the Calculus Concept Inventory (Epstein, 2013) for the TBL group (0.20 +/- 0.02) was larger than that of the non-TBL comparison group of 93 students (0.13 +/- 0.03), and this is statistically significant ($t(357)=2.16$, $p<0.05$).

Our findings have important implications for the way in which calculus is taught. The findings provide further evidence that active learning is an effective way to teach calculus, keeping in line with the study of Characteristics of Successful Programs in College Calculus undertaken by the Mathematical Association of America (Bressoud & Rasmussen, 2015).

References

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