Impact of Class Size on Student Success in a Multidisciplinary Honors Program

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Abstract

Research on the impact of class size on student success has primarily been conducted in a K-12 context. In this paper, we look to extend this research to higher education by examining two cohorts of students in the multidisciplinary QUEST Honors Program at the University of Maryland. QUEST students, who have academic backgrounds in engineering, business, and science, take three required, cohort-based courses in addition to two elective courses with other students at the University. In 2013, the QUEST Honors Program switched from cohorts (class sizes) of approximately 65 students to cohorts of approximately 45 students. This paper examines the impact of class size on two proxies of student success, the assessment of individual-level student learning outcomes and final course grades. This longitudinal data was obtained from two cohorts of different sizes in two of the program's required courses. The comparison of learning outcomes assessment data and student grades across various class-size conditions enabled the authors to evaluate the impact of class size on two elements that could indicate student success.

Introduction

The QUEST Honors Program at the University of Maryland unites undergraduate students with backgrounds in engineering, business, and science for a multidisciplinary, hands-on learning experience. The curriculum focuses on quality management, process improvement, and system design through team-based projects. QUEST utilizes a cohort-based model in which students take three required, cohort-based courses in addition to two elective courses with other students at the University.

This paper focuses on two of the program's required courses: the introductory course and the capstone course. In the introductory course, students work with multidisciplinary teams on three projects in which they design atoms-based and bits-based innovations and consult for on-campus clients. In the capstone course, students collaborate on multidisciplinary teams to solve an identified organizational challenge for a sponsoring organization. In the introductory course, students are assigned teams based on an even distribution of their majors. In the capstone course, students are presented with overviews of each of the sponsoring organizations along with the basic scope of each organization's challenge. Students rank projects based on interest and then are placed into teams taking into consideration student rankings, distribution of majors, and any special circumstances for the project. For both courses, students remain in these teams for the entirety of the course.

The original structure of the QUEST program consisted of a one-cohort model in which one cohort of students was admitted each year. In 1992, 30 first-year undergraduate students were admitted as Cohort 1. As the program gained popularity and more qualified students applied, more students were admitted and cohort sizes grew. By 2012, the program admitted 65 first-year undergraduate students into Cohort 20. Recognizing increasing problems with attrition

and that literature generally supports greater student success with smaller class sizes,[1,6,8] QUEST staff and faculty restructured the program to a two-cohort model, admitting 90 students per year into two cohorts of 45 students each. This allowed the program to continue to admit large numbers of quality students while still maintaining the benefits of a small cohort unit. In this new model, classes have a staggered start, with one 45-student cohort taking the introductory course in the fall and the other 45-student cohort taking the introductory course in the spring.

In 2010, the QUEST program developed eight learning outcomes mapped to each of QUEST's three required courses along with assessments used to measure each outcome. For example, Learning Outcome 1 (apply quality management tools, improve processes, and design systems) is first introduced during QUEST students' sophomore year when they work in teams to create a prototype of an innovative consumer product. This learning outcome is further developed through the capstone project as students develop recommendations for their corporate client. Learning outcomes are also used in assessing and improving the program's curriculum and other activities.

This paper focuses on two measures of student success, grades and learning outcomes, in QUEST's introductory and capstone courses. The authors of this paper examined the effects of the one- to two-cohort model switch by comparing QUEST student grades and learning outcomes in the 65-student classes to the 45-student classes. Through this comparison, the authors have determined whether differences exist between student grades and student learning outcomes in the smaller verses larger class sizes.

Background

Research on the impact of class size on student success has primarily been conducted in a K-12 context. The first study on class size was done in 1924. It compared the students in a 100+ class to those in a 40+ class and resulted in inconsequential results.[2] One of the most well-known K-12 studies is Project STAR (Student Teacher Achievement Ratio), led by Charles Achilles in 1995 of Tennessee public schools. Achilles found a clear correlation between smaller class sizes and increased student engagement, development of basic skills, and teachers' morale.[4] In 1997, Angrist and Lavy examined class size results in Israel where Maimonides' Rule states that classes should have no more than 40 students. Other regions in Israel have 25 student caps, which Angrist and Lavy generally found to have greater student success.[1] Furthermore, using data from the National Educational Longitudinal Study (NELS), Goldhaber and Brewer incorporated multiple controls to account for teacher and student ability yet still found a statistically significant effect of class size on standardized test scores.[8] However, in *David and Goliath*, Malcolm Gladwell holds a different opinion, stating that small class size is an example of a "thing we are convinced is such a big advantage [but] might not be such an advantage at all."[3]

For a college setting, it is generally accepted that lower teacher to student ratios is a positive quality. *U.S. News and World Report* uses class size as two of fifteen inputs in the college rankings formula, though, in actuality, students usually have very little control over choosing small class sizes. In 2010, Cornell University published a study comparing six years of super-sized classes with six years of regular sizes.[8] Super-sized classes were those which had

recently switched from three smaller sections to two larger sections. In total, it considered 88 courses and 1,928 separate course sections and examined student course evaluations, concluding that class size has a negative impact on self-reported amount learned, expected grade, course rating, and instructor rating.[8]

Keil and Partell (1997) found that a student in a class of 5 has a probability of .52 of receiving an A, compared to a student in a class of 290 who has a probability of .22. Additionally, class size lowers student success at a decreasing rate, meaning adding 10 students to a class of 10 has a larger impact than adding 10 students to a class of 200.[6] Furthermore, increased class size negatively impacts student retention. A student with a class size of 20 has a .97 probability of returning to the university, while a student in a class of 240 has only a .80 probability. In contrast to the second-order relation between class size and student success, class size lowers retention at an increasing rate, meaning there is a greater negative effect from adding students to an already large class.[6] However, there are some reported benefits of larger classes including the presence of other student opinions, lower pressure to succeed, instilling a sense of independence, and anonymity of attendance.[2] Students in their third and fourth years of college seem to prefer large classes compared to those in their first year.[2] These few studies make up the majority of research on class size in higher education, showing the lack of available information on the subject.

One possible explanation behind these findings is the type of learning possible in a smaller class. Hornsby and Osman (2014) explain that large classes are mainly problematic when critical thinking and problem solving are the desired learning outcomes.[5] Professors can combat problems with large class sizes by finding teaching strategies that allow for more interactive learning. However, there are clearly constraints with teachers' ability to interact with and accurately assess large quantities of students.[2] This is supported by *The Definitive Article on Class Size*, which states that smaller classes allow for more writing, discussion, and interaction with the professor, leading to increased engagement and better comprehension of material.[4] Looking at the students' perspective, Horning (2007) conducted over 1,600 interviews of undergraduates, finding that "student after student brings up the importance of class size in his or her academic development. Not surprisingly small-group tutorials, small seminars, and one-to-one supervision are, for many, their capstone experience."[4] This clearly relates to the QUEST program, as QUEST focuses on critical thinking and problem solving. Students are encouraged to be creative by finding innovative solutions to real-life problems and to establish relationships with program faculty.

A further consideration in class size determination includes the degree of change required to impact success. It is unclear from the previous studies if there is an optimal class size or what percent increase shows a real change in success. Moreover, there is currently almost no information referring specifically to honors programs. The QUEST program has several qualities that could alter the effect of class size. For example, it is a three-year program. This could intensify the disparity of learning quality between students in different sized cohorts. However, the community aspect and opportunity for extracurricular involvement could increase the student-instructor involvement even in larger classes. QUEST specifically features a lab where students meet and do work in a space directly outside of staff and faculty offices. There are also social and professional events, as well as extracurricular groups to get involved with such as the

QUEST Student Organization, QUEST Recruiting, and QUEST Corporate. These groups encourage relationship building both among students and with faculty, regardless of class size.

Research also shows student interest is a better indicator of success than class size.[2] Honors programs are often selective and students apply with a strong desire to participate. QUEST emphasizes continuous feedback, and students are consulted to suggest class material and activities that would be most interesting and effective. Finally, it has also been shown that class size has a greater effect on disadvantaged students.[7] Honors students are exceptionally intelligent and usually have had a strong education. It is unclear to what degree this factor influences the class size and achievement correlation in the present study.

Method

In order to evaluate the relationship between class size and student success, data on student grades and student performance on learning outcomes was gathered for students enrolled in two QUEST courses under two different class size scenarios. There were 340 observations for student grades (128 observations for large classes and 112 observations for small classes). There were 1,276 observations for learning outcome performance (453 observations for large classes and 823 observations for small classes). In this paper "small class size" refers to classes of approximately 45 students. "Large class size" refers to classes of approximately 65 students.

Upon gathering this data, a series of tests were run to (1) evaluate if class size was related to student grades and (2) evaluate if class size was related to learning outcome performance. To evaluate the relation of class size and student grades a bivariate regression model was run where grade was predicted by class size (a dummy variable was used which took a value of 1 if the student was in a big class). To evaluate the relation of class size and learning outcome performance, a chi-squared test of independence was run where learning outcome score (an ordinal variable falling from 0-4) was predicted by class size (big or small). All analyses were run in the R environment.[9]

Table 1 provides information about gender and GPA of students in the large and small classes. As evidenced in this table, GPAs are very similar for both small- and large-sized groups. While not fully controlling for different academic performance between the differently sized classes, this helps isolate class size as an independent predictor of performance in this analysis. There is a larger difference in the division of gender between the small and large sized classes. While this could contribute to student performance, it should be noted that a larger presence of females is typically believed to enhance team performance.[10] If results show that performance is stronger for the small class size condition (classes with a higher percentage of male students), this could mean that the influence of small classes may be even stronger than demonstrated in the present analysis.

Table 1: GPA and gender for differently sized classes

	Average GPA	Percent Male
Large Class Size	3.60	0.49
Small Class Size	3.61	0.60

Results

Median and mean learning outcome scores were determined for small and large classes. Students enrolled in large classes scored a median of 3 and mean of 3.20 across all learning outcomes. Students enrolled in small classes scored a median of 3 and mean of 3.18 across all learning outcomes. The results, though statistically significant ($\chi^2 = 24.97, p < 0.005$), did not demonstrate a practical difference between learning outcome performance based on class size. Though large classes scored slightly higher on learning outcomes, this difference may be a function of the large sample used in the analysis rather than meaningful differences in performance based on class size. The higher percentage of female students in the large classes could lead to higher performance on the learning outcomes evaluated in this study. As noted by Woolley et al. (2010), the proportion of females on a team tends to positively impact team performance.[10] This could be considered in future work on this topic.

Median and mean grades were determined for the larger and smaller classes based on a scale with 4.3 correlating to an A+. Larger classes earned a median of 4.0 and a mean of 4.00 while smaller classes scored a median of 4 and mean of 4.02. The results of this analysis showed no difference in grade based on class size (F=0.439, p = 0.508).

Conclusions and Limitations

Although prior research has shown benefits of smaller classes over larger classes, this study has not reached the same conclusions. Decreasing class size by 20 students did not impact QUEST student success in any meaningful way. Thus, we might suggest that other honors programs consider expanding to admit greater numbers of quality students without having to worry about the negative impacts on student success. It is possible that the nature of the QUEST program, which involves significant teamwork, real life application, and teacher/student interaction, has a stronger effect on student success than the class size, supporting background research that small class size is only a means to ensure learning through critical thinking. This suggests that an educator with a large class size could add specific activities and programs to facilitate the same high level learning as a smaller class.

Our study had several limitations, which could lend themselves to further research. First, the professor for the introductory course switched between the 2013 and 2014 school years. Thus, grading systems may be inconsistent. The QUEST program attempted to quell this issue by having the incoming professor co-teach the introductory course with the current professor during his last semester. Thus, the incoming professor was able to observe and learn the way in which the course had been taught and graded in prior semesters. Another limitation is that the program did not keep formal records of student attrition rates prior to the two-cohort model. Thus, this study was unable to look at retention in the larger verses smaller classes as a measure of student success. This would be an interesting area for future research. Furthermore, some of the previous studies on class size included self-reported answers from students. It could be beneficial to compare perceived learning and experiences from students in different sized cohorts in the QUEST program.

Despite the lack of practical significance of this study's results, the findings here contribute to a growing body of literature relating to the measurement of student success in higher education. Research should continue in this area to enable more formal guidelines to be developed regarding best practices in undergraduate teaching in engineering education and more broadly.

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