© Journal of Interdisciplinary Studies in Education

ISSN: 2166-2681 Volume 4, Issue 1, 2015

ittc-web.astate.edu/ojs

Evaluating access: Comparing enrollment patterns in traditional versus multidisciplinary, project-based introductory statistics courses

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Abstract

A central challenge of introductory statistics is the development of curricula that not only serves diverse students, but also sparks communication, reasoning and collaboration that clearly crosses traditional disciplinary boundaries. Innovative teaching practices are needed, followed by demonstrated increases in course access based on these innovations. To evaluate the potential impact of a multidisciplinary, project-based course on access to introductory statistics for underrepresented students, this article examines differences in demographic and disciplinary characteristics of students enrolling in a traditional introductory statistics course compared to the multidisciplinary, project-based course. Administrative data were based on individual student enrollment from fall semester 2009 and spring semester 2014. Results indicated that the project-based course provided an increased number of seats and enrollment from a large range of majors. Higher rates of under-represented students chose the project-based alternative over traditional introductory statistics. Though there was evidence that the project-based course also attracted students with lower Math achievement scores, a significant interaction between Math achievement and under-represented student (URM) status demonstrated that URM students selecting the project-based course had lower math achievement scores than URM students selecting the traditional course suggesting that prior math achievement may have influenced URM students in making their choice. Providing students from diverse educational, social and economic backgrounds not only with a seat in a classroom, but also with a welcoming place at the table will afford the best hope for achieving the kind of statistical literacy necessary for meaningful access to research, problem solving and professional development across numerous disciplines.

Key Words: Passion-Driven Statistics; Underrepresented Students; STEM

The days of "silo" science have ended—collaboration and interdisciplinarity is now viewed as essential in order to solve the most important problems faced in the world (von Eckardt 2001; National Academies 2004; NSF 2013; Zorn et al. 2014; ASA 2014). Helping students achieve this kind of inclusive and flexible thinking needs to be supported by curricula that can help them become scientifically and statistically literate (Warwick and Ottewill 2004; Tishkovskaya and Lancaster, 2012; American Statistical Association, 2014). Given that statistics is one of the most salient points of intersection among diverse disciplines, this new need for maximally collaborative research presents both challenges and enormous opportunities for statistics educators. To date, statistics education has generally remained at the poles of discipline-specific instruction (e.g. psychology and economics) or is delivered more abstractly through mathematics departments, often without clear links to the work of any particular discipline (Warwick & Ottewill 2004; Schlotter 2013). Thus, a central challenge of introductory statistics is the development of curricula that not only serve diverse majors, but also spark communication, reasoning and collaboration that clearly crosses the traditional disciplinary boundaries. Previous authors have suggested that this can best be achieved through inquiry-based projects (Bailey, Spence, and Sinn 2013) that allow students to "decompose their topic, identify key components; abstract and formulate different strategies for addressing it; connect the original question to the statistical framework; choose and apply methods; reconcile the limitations of the solution; and communicate findings" (Nolan & Temple Lang, 2009).

Innovations in statistics education aimed at conveying these necessary skills to approach scientific questions have emerged over the past several years (Lovett, Meyer, and Thille 2009; Sosa, Berger, Saw, and Mary 2010; Tintle, VanderStoep, Holmes, Quisenberry, and Swanson 2011; Woodward and McGowan 2012; Garfield, delMas, and Zieffler 2012; Baily, Spence, and Sinn 2013; Lesser et al. 2013; Horton 2015) and have demonstrated positive findings in terms of real world skills and improved attitudes. In a previous publication, we described a multidisciplinary, project-based introductory statistics course that is aimed at developing these skills in students, especially those who might be currently underrepresented in the field, through applied statistical projects that cross both divisional and departmental boundaries (Dierker et al. 2012). Projects in the course were judged to be rewarding or very rewarding by 57.6%of students and 6.8% felt it was the most rewarding project they had ever completed for a course. Less than 2% of students felt that their project was not rewarding. A total of 60.7% rated the project as challenging or very challenging. Only 4.5% of student felt that the project was not challenging. More than 69% of students felt that they were likely or very likely to use the research *skills* that they had learned in the course again and only 6% felt that it was not likely they would be used again. Thus, while the course appears to be succeeding in fostering exposure and appreciation the relevance of statistical inquiry, the potential impact of this type of inquiry-based statistics education on access for underrepresented students, has not been systematically evaluated.

We cannot only prioritize real inquiry for a select few, but must also expand *access* to these experiences for students from an exceptionally wide range of educational, social and economic backgrounds

(Onwuegbuzie, 1999; Moss-Racusin et al. 2014). Providing students not only with a seat in a classroom, but also with a challenging and safe place at the table will afford the best hope for achieving the kind of statistical literacy necessary for meaningful engagement in research, problem solving and professional development across numerous disciplines (Aliaga et al. 2005; Ben-Zvi & Garfield 2008; Zorn et al. 2014).

Course Descriptions

The **multidisciplinary, project based introductory statistics course** was offered through the Quantitative Analysis Center, a collaborative effort of academic and administrative departments that supports quantitative analysis across the curriculum and provides an institutional framework for collaboration across departments and disciplines in the area of statistics and data analysis. Introduced into the curriculum in the fall of 2009 at a selective liberal arts college, one of the primary goals was to increase access both generally and for students traditionally marginalized within many STEM fields (e.g. women, underrepresented students, educationally disadvantaged students, students pursuing majors that do not require a statistics course, etc.).

Titled Applied Data Analysis, it was described in the university's online course catalogue as a "project-based course, [in which] you will have the opportunity to answer questions that you feel passionately about through independent research based on existing data. Students will have the opportunity to develop skills in generating testable hypotheses, conducting a literature review, preparing data for analysis, conducting descriptive and inferential statistical analyses, and presenting research findings. The course offers unlimited one-on-one support, ample opportunities to work with other students, and training in the skills required to complete a project of your own design. These skills will prepare you to work in many different research labs across the University that collect empirical data. It is also an opportunity to fulfill an important requirement in several different majors."

Utilizing a flipped classroom approach (Bishop and Verleger 2013; Yarbo, Arfstrom, McKnight, and McKnight 2014; Wilson, 2013; Winquist and Carlson 2014) in which class time is hands-on and students view lecture videos outside of class, the course is designed around student research projects of their own choosing and offers individualized hands-on experience. Class periods have minimal lecture time as the majority of each class session is devoted to instructors and peer mentors circulating among students actively working on their analyses and thinking with their data. Students meet three times per week, with the vast majority of this time allotted to hands-on work and one-on-one interaction with an instructor or peer tutor. In the first week, students develop their own research question from a number of large data sets representing different disciplines such as ecology, psychology, economics, planetary science and more. This research question evolves as they continue through the course and apply the new statistical techniques they learn to their research. All of the statistical analyses are done within the context of their research question, and a typical final project follows up on the individually-chosen research question through the use of univariate, bivariate, and multivariate (linear or logistic regression) analyses, univariate and bivariate plots, and through interpretation and integration of the statistical findings with the existing scientific literature. This ongoing work culminates in a research poster session at the end of the semester in which students have the opportunity to describe to peers, instructors, and external experts their process of inquiry, including the different decisions made along the way, their premises, conclusions and any barriers that they faced.

Thinking with data to answer a research question is an important component of the course as is the connection to the applied content, thus implementing two of the ideas in the American Statistical Association's updated guidelines for undergraduate statistics (2014). With the use of software-based analysis of real data, the course closely follows the recommendations outlined in the GAISE college report (Aliaga et al. 2005). In addition, great care is taken to present translations of terminology and vocabulary that are used across different disciplines for similar statistical concepts (e.g., independent and dependent variables vs. predictors and outcomes vs. stimulus and response variables). Statistical topics covered were descriptive statistics and graphing, variation, bivariate and multivariate inferential statistics (Chi square, ANOVA, correlation, linear regression, logistic regression) for categorical and continuous variables along with the concepts of sampling, confidence intervals, hypothesis testing, confounding, and moderation. This is in addition to considerable time on data management (aka, data wrangling) and communicating research findings.

The **traditional introductory statistics course** was offered through the math department. Titled Elementary Statistics, it was described in the university's online course catalogue as "covering the topics of organizing data, central measures, measures of variation, distributions, sampling, estimation, conditional probability (Bayes' theorem), hypothesis testing, simple regression and correlation, and analysis of variation." As such, it was more focused on the theoretical aspects of statistics than the project-based course.

Both courses were open to all students and there were no prerequisites for enrollment; the project-based course primarily ran in the fall semester, whereas the traditional course ran in fall and spring semesters. When offered, there were multiple sections/instructors of each and different sections/instructors within and across years, which allowed students more choice regarding their enrollment. In both courses, the scheduling has changed during this time period (e.g., 2 longer sessions versus 3 shorter sessions a week). The project-based course could be used as one option to fulfill a major requirement for biology, earth and environmental science, government, neuroscience and behavior, and sociology. Both courses counted toward the major requirements for psychology, but only as alternatives to an introductory statistics course offered directly through the psychology department. Both courses could also be applied to the natural sciences and mathematics general education recommendations. Importantly, neither course was specifically required of any student or represented a single option for fulfilling requirements for any major within the university.

Current Study

To evaluate the potential impact of this multidisciplinary, project-based curriculum on the question of *access* among students underrepresented in STEM, the present paper compares demographic and disciplinary characteristics of students enrolling in the multidisciplinary, project-based introductory statistics course to those enrolling in a traditional introductory statistics course. We first asked how representative students in these courses were of the wider campus community. We next considered how the addition of the project-based course affected the number of students enrolled in introductory statistics courses. We consider this because of concerns about the impact of curricular changes on existing courses. Considering the overall number of seats also addresses the level of interest in an introductory statistics course, within the existing constraints imposed by scheduling and staffing. Finally, we address how student characteristics predict enrollment in the multidisciplinary, project-based course versus the traditional statistics course.

Methods

Participants

Administrative data were examined based on individual student enrollment in both the multidisciplinary, project based (N=450) and traditional introductory statistics (N=344) courses in the five year span from fall semester 2009 to spring semester 2014 (including sections offered during the fall, spring and summer sessions). The traditional introductory statistics course was selected as a comparison group as, like the project-based course, it was open to all students and not focused on only a single major.

The average enrollment per class section in the traditional introductory statistics course was 36.5 (SD = 10.1, range: 18-52) compared to an average of 18.5 (SD = 5.4, range = 4 – 26) in the multidisciplinary, project-based course.

Measures

University-level data was obtained from reports of first-year student enrollment from 2008 to 2012. For the individual classes, administrative data, based on students' application to the university and their chosen major were supplied by the institutional research office. This data included the following variables:

Gender. Students reported their gender as male or female.

Race/Ethnicity. Self-reported race/ethnicity included endorsement of one or more of the following categories, Black White, Hispanic, Asian or other. Those not endorsing any of those categories were considered unknown. Black and/or Hispanic were also collapsed into a secondary variable indicating underrepresented minority students (URM).

Financial aid. University reported financial aid status was recorded as students with demonstrated need, i.e. those receiving grants and/or self-help financial aid vs. those enrolled in the university without financial assistance.

High school type. Students' high school backgrounds were collapsed based on whether they attended a public vs. non-public high school. The non-public category included private schools, religious schools, and home schools.

SAT scores. The SAT is a test of a student's academic achievement skills, used for admission to US colleges. A total of 84% of the multidisciplinary, project-based students and 83% of traditional statistics students provided SAT scores for math, critical reading, and writing.

Major. Students from the following majors enrolled in the project-based and/or traditional statistics course: math and science (i.e., biology, chemistry, computer science, earth and environmental sciences, environmental studies, math, molecular biology and biochemistry, neuroscience and behavior, and physics); social science (i.e., African American studies, American studies, anthropology, archaeology, interdisciplinary social science, economics, feminist, gender and sexuality studies, government, psychology, science in society, and sociology) and arts/humanities (i.e., visual and performing arts, English, history, philosophy, religion, and foreign languages and cultures).

Class status. Class year (freshman, sophomore, junior, senior, designating 1st through 4th year students) was dichotomized into lower vs upper classmen. Freshmen and sophomores represented students enrolled in a statistics course prior to declaring a major while students in their junior and senior year had declared and were completing one or more majors.

Analyses

To evaluate the present sample in terms of is representativeness of the larger university community, binomial tests were used for each demographic variable. Sample proportions of students were compared to the range and average proportion of all enrolled students at the university. Bivariate analyses, stratified by class status (freshmen and sophomores vs. juniors and seniors), were then conducted for each student characteristic predicting course enrollment (project-based vs. traditional). Chi-square Tests of Independence and ANOVA were used for categorically and continuously measured characteristics, respectively. For significant bivariate associations, logistic regression analyses were conducted to evaluate the presence of possible confounding effects of individual student characteristics on the association of interest. For significant associations, their interactions were also tested.

Results

Statistics students' representativeness of the wider campus community

First, binomial tests were conducted to determine how representative the sample of introductory statistics students was of the larger university community. We found that students enrolling in the project-based and traditional statistics courses were more likely to be women (statistics: 62%, CI: 59% - 66%; university rate: 52%, range: 49% - 57%; z = 5.92, p < .001) but statistically similar in terms of rates of under-represented students (statistics: 20%, CI: 19% - 22%; school: 19%, range: 18% - 24%), public school attendance (statistics: 56%, CI: 52% - 60%; school: 53%, range: 49% - 57%), and financial aid (statistics: 48%, CI: 45% - 52%; school: 47%, range: 45% - 51%).

Changes in available seats

To estimate the number of introductory statistics seats added to the curriculum and accessible to all students, seat counts were averaged over the academic years before and after the introduction of the project-based course. In academic years 2006-2007, 2007-2008, and 2008-2009, before the introduction of the project-based course, the traditional statistics course enrolled on average 83 students per year. The introduction of the project-based statistics course added a total of 450 seats over 5 years. During the five years following the introduction of the project-based statistics course, the traditional course averaged 68.8 (range: 50 to 83) seats per year, an average reduction of 9.5 seats each year compared to its earlier enrollment patterns. Subtracting

9.5 seats from enrollment in each of the 5 academic years that the project based course was offered, suggests that the traditional statistics course served 47.5 fewer students during this five-year time period than would have been expected, based solely on its enrollment patterns prior to the introduction of the project-based course. In total, however, this yields an estimated addition of 403 seats (450 project-based seats minus 47.5 fewer seats in the traditional statistics course).

Student characteristics by course

A comparison of demographic and disciplinary student characteristics in the multidisciplinary, project-based course vs. the traditional introductory statistics course is presented in Table 1. A significant association between course and class status showed that juniors and seniors were more likely to enroll in either of the two statistics courses (59.8%) compared to freshmen and sophomores (40.2%), χ^2 (1, N = 794) = 4.36, p = .04. Biology and psychology majors, both of whom could receive major credit from either of the two courses showed opposite preferences. While psychology majors were more likely to choose the project-based course, biology majors were more likely to choose the traditional statistics course. When considering majors for whom only the project-based course was one option for fulfilling a major requirement, both government and sociology majors were more likely to enroll in the project-based course, though neuroscience and behavior majors were equally likely to enroll in both courses. Molecular biology and Biochemistry majors who could receive major credit for the traditional statistics course, were more likely to enroll in traditional statistics than in the project-based course. When considering students from disciplines for which neither course could be applied to their major requirements, math majors were marginally more likely to enroll in the project-based course compared to the traditional statistics course (p=.06) while Chemistry majors were significantly more likely to enroll in the traditional statistics course. All reported differences by major persisted in logistic regression analyses after controlling for selection of multiple majors. When examining demographic characteristics, both courses were similarly successful in enrolling White, Asian and Hispanic students, students from public high schools, and those receiving financial aid.

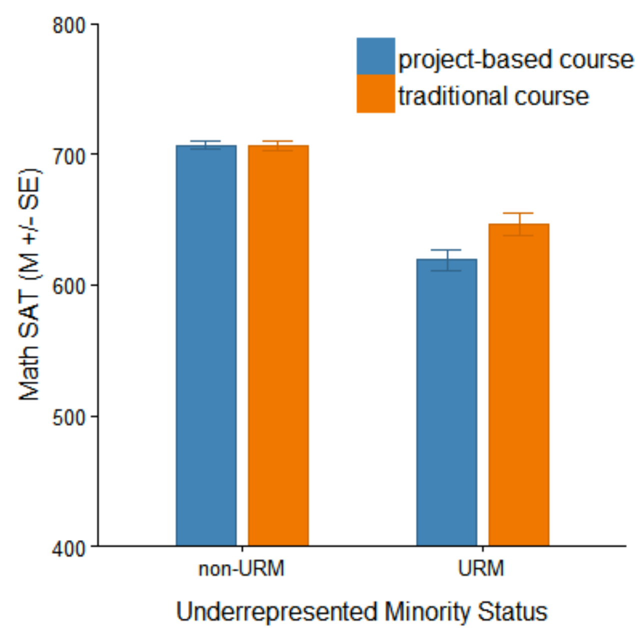

Figure 1. Mean math SAT scores among students enrolled in the multidisciplinary, project-based course vs. the traditional introductory statistics course by under-represented student (URM) status.

Average SAT scores in critical reading and writing were also statistically similar among students in both courses. The project-based course however, attracted marginally higher rates of Black students (12.7%) compared to the traditional statistics course (8.7%), χ^2 (1) = 2.72, p = .10. When this analysis was stratified by class status, the p-value reached statistical significance and paired comparisons showed that the project-based course attracted significantly higher rates of Black freshmen and sophomores than the traditional course, but not higher rates of Black juniors and seniors (Table 1). Further, the project-based course enrolled students with lower average SAT scores in math ($M = 685.9$, $SD = 69$) compared to the traditional introductory statistics course ($M = 696.3$, $SD = 59.0$), $F(1,663) = 4.17$, $p = .04$. When analyses were conducted based on under-represented (URM) student status (i.e. Black and/or Hispanic), again, URM students were found to be significantly more likely to enroll in the project-based course (24.0%) compared to the traditional statistics course (15.7%), O.R. 1.70, CI: 1.38 – 2.45, $p = .004$, and this finding remained significant after individually controlling for class status, gender, financial aid, public school attendance, and writing and critical reading SAT scores in logistic regression analyses. When controlling for class status, a significant URM x math SAT interaction (p = .04), illustrated in Figure 1, showed that the difference in math SAT scores for those enrolled in the project-based vs. traditional course were only found *within* the URM group. That is, the project-based course attracted URM students with significantly lower math SAT scores than the traditional course, but no differences were found in math SAT scores among non-URM students. Though both courses show similarly high rates of female enrollment (>60%), when examining this finding by lower vs. upper classmen, juniors and seniors enrolled in the project-based course were significantly less likely to be female than lower classmen in both the project-based and traditional introductory statistics course (Table 1). This finding, however, was confounded by SAT scores and did not remain significant in the logistic regression model.

Discussion

Funded by the National Science Foundation and first introduced into the curriculum at a selective liberal arts college in the fall of 2009, a multidisciplinary, project-based course (Dierker et al. 2012) was developed to increase access to introductory statistics both generally and for students traditionally marginalized within many STEM fields (e.g. women, underrepresented students, educationally disadvantaged students, students pursuing majors that do not require a statistics course, etc.). Data drawn from individual student enrollments in both the multidisciplinary, project-based course and a traditional statistics course were used to evaluate changes in opportunities for enrollment in introductory statistics and differences in demographic and disciplinary characteristics between students selecting a project-based over traditional curriculum. Results indicated a) success in providing an increased number of seats in introductory statistics; b) a range of majors attracted to both the project-based and traditional courses and c) higher rates of underrepresented students choosing the project-based alternative over traditional introductory statistics.

Overall, juniors and seniors were significantly more likely than freshmen and sophomores to enroll in both the project-based and traditional statistics courses and both courses also attracted higher rates of female students compared to their representation in the larger university community. The higher representation of upperclassmen could be largely driven by the fact that most juniors and seniors had declared a major that included requirements fulfilled by one of the introductory statistics courses. Anecdotally, we have also found that seniors enrolled in statistics often described a desire to "gain new skills for the job market." In our most recent offering of the project-based course, over 40% of students were first semester seniors. Given that participation by upperclassmen in introductory statistics courses has little chance of influencing students selection of major, and by extension, little chance of reversing the 'leaky pipeline' in which students turn away from plans to major in STEM fields (Blickenstaff 2005), more needs to be done to encourage enrollment of students in statistics courses as early as possible in their academic careers (Seymour, Hunter, Laursen, and Deantoni 2004; ASA, 2014). Both courses also attracted higher rates of female students compared to their representation in the larger university community. The fact that high rates of women choose to enroll in one of the introductory statistics courses is consistent with emerging trends in the statistics profession (Groshen and Shierholz 2015).

When considering the range of majors for whom one or both of the statistics courses did or did not fulfill a required credit for that major, there was evidence that social science students gravitated more toward the project-based course and natural science students more toward the traditional course. That is, psychology, sociology and government majors were significantly more likely to enroll in the project-based course while biology, chemistry and molecular biology/biochemistry students were more likely to enroll in the traditional statistics course. It is important to note that either course could count towards a requirement for psychology and biology, which indicates that something more than course requirements is driving student's selection. When considering neuroscience and behavior, these majors were equally likely to enroll in both of the introductory statistics courses, though the project-based course provided credit toward fulfilling that major while the traditional statistics course did not. Counter to what might be expected based on these enrollment patterns, however, math majors were found to be marginally more likely to enroll in the project-based course than in the traditional course.

Despite science majors in our sample being less likely to be URM students (16.8%) than social science majors (23.5%), the significantly elevated rates of URM students in our project-based course could not be accounted for by patterns of course enrollment by major. Instead, URM students were more likely to enroll in the project-based course than the traditional statistics course regardless of class status and after controlling for a myriad of demographic factors. Furthermore, the interaction between math SAT and URM in predicting course enrollment demonstrated that among URM students, those selecting the project-based course had significantly lower math SAT scores than those selecting the traditional statistics course. Thus, lower math achievement could not explain the higher rate of URM students in the project-based course, but rather, suggested that math achievement may have influenced URM students in making their choice.

It should be noted that because of the selective nature of the university in which this multidisciplinary, project-based course was developed, SAT scores of both URM and non-URM students are quite high, with both mean and median scores well above 600. In other words, scores for the URM students in this study were not low, but instead, for those in the project-based course, just relatively lower than those of URM students selecting the traditional statistics course. Notably, previous research has shown that African American and Hispanic college students with high grade point averages and SAT scores above 600 typically do not pursue STEM college majors for reasons including poor teaching in STEM courses, lack of encouragement from teachers or parents, and self-perception of their own inability to be successful in STEM majors (George, Neale, Van Horne, and Malcolm 2001). While we are not yet able to evaluate the potential impact of the project-based course in terms of future academic decisions-making, the present findings suggest that a course in which students "have the opportunity to answer questions that [they] feel passionately about through independent research based on existing data", may represent a more attractive option for engaging students in the process of statistical inquiry.

It is also important to note that the project-based course is aimed at taking advantage of students' natural curiosity and providing a common language for approaching questions across numerous disciplines. The curriculum specifically uses a variety of large data sets to allow students to build their research question on prior interests and knowledge. In addition, the selection and presentation of inferential tests is geared towards the type of analyses appropriate for data in different disciplines. Students are thinking with data as they learn the statistical content necessary to do so. Though we believe that this inclusive and comparative approach (e.g., varied datasets, statistics relevant to multiple disciplines) allows students to widely communicate across disciplines on a variety of computational issues, we also recognize that there is more to be done to enhance access to truly interdisciplinary research and thinking beyond attracting students from diverse majors. We hope to achieve this in future iterations of the course through reliance on more interdisciplinary data sets (e.g. outcomes and predictor variables measured from cells to society) and through group projects drawing on the range of disciplinary backgrounds of our students. In addition, we are engaged in ongoing data collection that will allow us to next address how individual differences may relate to performance, behaviors, and attitudes in these two classes.

Project-based learning, of course, presents its own challenges and customarily, courses offering opportunities for independent statistical inquiry have required a smaller group format (e.g. 20 or fewer students) compared to courses that rely on more traditional pedagogies. As noted in the methods, during development of our project-based course (fall 2009 to fall 2013), the average class sections were smaller (18.5 students (SD = 5.4, range = 4 – 26) than that of the traditional course (36.5 students (SD = 10.1, range: 18-52). Our most recent offering of the project-based course, however, (i.e. fall 2014) increased most sections sizes to 30 students with great success, and plans for fall of 2015 include moving out of the computer lab into collaborative space that will allow students the mobility of laptops, the flexibility of different table and seat configurations and space for sections of 50 to 60 students. With the appropriate supporting infrastructure (e.g. helpful materials for outside of class that enhance engagement in active class sessions and a network of peer mentors), we hope to demonstrate that this project-based approach can be delivered by expending no more resources than traditional lecture courses while continuing to achieve greater representation of underrepresented students.

Identifying appropriate comparison groups in this type of research can be challenging given that many educational settings have created structured requirements that give students little choice or flexibility that might uncover preferences for particular curriculum. Though only quasiexperimental, a strength of the present study is that it was conducted at a university with an open curriculum (i.e. no requirements other than completing 8 semesters and completing a major) in which a new statistics course could be introduced that provided an alternative for fulfilling major requirements across diverse disciplines. Another potential limitation to consider includes additional factors that may influence student enrollment. Given the 5-year period during which the data was collected, along with variation in instructors and scheduling options, we believe many of these confounding factors have largely been mitigated.

This research is of value in that it successfully demonstrates one way (e.g., a project-based course) in which access to statistics can be increased, which is a relevant goal for statistics educators (ASA 2014). We believe that this multidisciplinary, project-based model can benefit other schools and are currently disseminating it within high school, community college, private college, and state university settings, which will allow consideration of the generalizability of the results presented here. We are happy to share our course materials with others and encourage instructors to consider using a multidisciplinary, project-based approach in their own classrooms: (http://passiondrivenstatistics.com/)
Statistics and the newer, related field of data science are critical drivers for innovation in all sectors and the focus of tremendous workforce development. As such, they have the potential to set a new bar for inclusion and begin to meaningfully empower individuals from groups currently underrepresented in some of the most fast growing fields (Berman and Bourne, 2015)

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Acknowledgements

This research was supported by grant 0942246 and 1323084 from the National Science Foundation, Transforming

Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES) and the Lauren B. Dachs Grant in Support of Interdisciplinary Research in the Social Impacts of Science. We appreciate the generous efforts of our colleagues and advisors who contributed to the development and implementation of this course.

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Table 1. Demographic and disciplinary student characteristics in the multidisciplinary, project-based course vs. the traditional introductory statistics course

	Multidisciplinary, Project-Based Course *N* = 450		Traditional Statistics Course *N* = 344		Difference
Demographics	Fresh/Sophomore n=166	Junior/Senior n=284	Fresh/Sophomore n=153	Junior/Senior n=191	
Female	116 (69.9%)[a]	158 (55.6%)[b]	105 (68.6%)[a]	117 (61.3%)[a,b]	$\chi^2(3) = 12.1$, $p = .007$
Public High School	89 (53.6%)	157 (55.3%)	85 (55.6%)	114 (59.7%)	n.s.
Financial Aid	76 (45.8%)	143 (50.4%)	71 (46.4%)	94 (49.2%)	n.s.
Racial Categories[1]					
White	90 (54.2%)	156 (54.9%)	93 (60.8%)	121 (63.4%)	n.s.
Black	28 (16.9%)[a]	29 (10.2%)[b]	13 (8.5%)[b]	17 (8.9%)[b]	$\chi^2(3) = 7.9$, $p = .049$
Hispanic	17 (10.2%)	36 (12.7%)	12 (7.8%)	15 (7.9%)	n.s.
Asian	25 (15.1%)	62 (21.8%)	31 (20.3%)	35 (18.3%)	n.s.
Other	20 (12.0%)	25 (8.8%)	16 (10.5%)	23 (12.0%)	n.s.
Underrepresented(URM)[2]	43 (25.9%)[a]	65 (22.9%)[a]	23 (15.0%)[b]	31 (16.2%)[b]	$\chi^2(3) = 8.9$, $p = .03$
SAT	n=131	n=248	n=121	n=165	
Math	676.3(77.18)[a]	690.9 (63.85)[a,b]	701.6 (58.55)[b]	692.4 (59.15)[a,b]	$F(3, 661) = 3.32$, $p = .02$
Critical Reading	669.5 (73.89)	688.0 (71.83)	681.6 (73.18)	690.9 (74.16)	n.s.
Writing	685.5 (73.61)	698.1 (72.49)	691.7 (67.7)	691.4 (66.57)	n.s.
Major[3]		n=156		n=129	
Biology		31 (10.9%)		43 (22.5%)	OR = 0.42 CI: 0.25 –

			0.70, $p <$ .001
Chemistry	3 (1.1%)	14 (7.3%)	OR = 0.14 CI: 0.03 – 0.42, $p =$ .002
Government	52 (18.3%)	16 (8.4%)	OR = 2.45 CI: 1.38 – 4.57, $p =$ .003
Math	12 (4.2%)	2 (1.0%)	OR = 4.17 CI: 1.12 – 26.99, $p =$ .06
Molecular Biology & Biochemistry	10 (3.5%)	22 (11.5%)	OR = 0.28 CI: 0.12 – 0.59, $p =$ .001
Neuroscience & Behavior	51 (18.0%)	26 (13.6%)	n.s.
Psychology	91 (32.0%)	23 (12.0%)	OR = 3.45 CI: 2.12 – 5.80, $p <$ .001
Sociology	33 (11.6%)	10 (5.2%)	OR = 2.38 CI: 1.68 – 5.20, $p =$ .02
English	11 (3.9%)	9 (4.7%)	n.s.
Science in Society	19 (6.7%)	7 (3.7%)	n.s.
College of social studies	26 (9.2%)	9 (4.7%)	n.s.

[1] Racial categories are non-mutually exclusive.

[2] Underrepresented minority students (URM) are those indicating Black and/or Hispanic ethnicity. Pairwise comparisons between older traditional students and younger project-based students as well as between older traditional students and older project-based students approached significance at .067 and .09 respectively.

[3] Majors that enrolled 10 or more students in the project-based and/or traditional statistics courses are included in the table.