ASU Online Performance Gap Analysis

Action Lab California Community College Study

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Online education, whether embedded in a fully online program or as a component of “hybrid” courses that blend face-to-face and online components, offer promise as higher education attempts to meet the demands of a growing population and the need for greater access by non-traditional students. But online courses can lack the support structures of traditional, face-to-face courses, requiring students to self-regulate in order to succeed. As a result, the students who stand the most to benefit from increased accessibility and flexibility of online courses – underrepresented minorities, students from low socioeconomic (SES) families, students who work part- or full-time – may be the least likely to succeed in the online education world. Previous research has suggested that this may indeed be so.

In this paper we present three studies that address the efficacy of online education, both in general and for underrepresented student groups: an extension of a large-scale efficacy study on the ASU Online program from 2010 to present, a new study on ASU Online specifically designed to assess performance gaps for underrepresented students, and a focused study examining the move from face-to-face instruction to a hybrid adaptive learning model for ASU’s on-campus college algebra course and its impact on underrepresented students.

The research questions at the core of each study are:
1. How well does online education work?
2. How well does it work for those who have traditionally been underrepresented or disadvantaged in higher education?

Background
As higher education intuitions have grown their online programs over the past decade, debate has escalated on the overall effectiveness and efficacy of online learning as a viable and scalable means for effective pedagogy. Conclusions comparing digital learning to face-to-face learning have varied widely. For instance, in a study of regional community colleges, Xu and Jaggars [2013] report that their “results strongly suggest that online instruction in key introductory college level courses, at least as currently practiced, may not be as effective as face-to-face instruction at 2-year community colleges” (p. 374). Reviewing the existing literature, however, Nguyen [2015] concludes that “there is robust evidence to suggest online learning is generally at least as effective as the traditional format” (p. 309); and a meta-analysis by Siemens, Gašević, & Dawson [2015] similarly concludes that there is “no significant difference” between online and face-to-face delivery. In 2016, the ASU’s Action Lab began a retrospective analysis (2010-2016) of ASU Online to assess the relative efficacy of ASU courses offered in a fully online program in comparison with the same courses when offered in a traditional face-to-face format.

A series of research papers by Xu and Jaggars [e.g., 2011, 2013] from large-scale community college datasets in Virginia (2004-2008) and Washington state (2004-2009) constitute the most widely cited estimates of “online gaps.” As in the present study, Xu and Jaggars separate
persistence (course completion rates) and achievement (passing rates of completers). Their numbers were not flattering for online providers: model estimated course completion gaps for the Virginia sample, for example, ranged from 11 to 17 percentage points, and achievement gaps ranged from 7 to 13 percent [2011, Table 3]. Xu and Jaggars interpret their findings as yielding “robust negative estimates for online learning in terms of both course persistence and course grade, contradicting the notion that there is no significant difference between online and face-to-face student outcomes—at least within the community college setting” [2013, p. 46]. On the other hand, Cavanaugh and Jacquemin [2015] used grade estimation models on a large scale 4-year university sample to find a “negligible difference” between online and face-to-face enrollments of less than 0.07 GPA points, leading them to conclude that “there is little to no difference in grade based student performance between instructional modes” (p. 1). Other comparisons typically employ small sample sizes in narrowly focused disciplinary domains, and many have similarly concluded that there is no significant difference between online and traditional modes of course delivery (cf. Russel’s collection of studies at http://nosignificantdifference.org).

Study 1. Results from the ASU Online Efficacy Study Phase 1

A large-scale study of online education efficacy was conducted on Arizona State University’s ASU Online program, comparing in-course student success in 252 online courses to matched face-to-face courses in ASU’s on-campus program, comprising over 280,000 unique students and 1.3M student-course observations (Action Lab Research Group, 2017; Fikes et al., 2017). Predicted success outcomes (completion rate, passing rate for completers, and B-or-better mastery rate for passers) were derived from logistic regression models run separately on each course. Results shown here are aggregated across all courses.

Figure 1 provides a summary of performance gaps for online (ASUO) and on-campus (F2F) delivery modalities. A performance gap is defined as the difference in predicted success between two student groups (e.g., over and under-represented ethnicities).

Results show that, controlling for student characteristics, the online gaps (comparing on-campus and online) are closed for completion and mastery and small for passing (less than 2 ppts), and online performance gaps are the same size or smaller than the associated on-campus performance gaps. With the Exception of part-time students, performance gaps are small overall for completion and passing; with student characteristics entered as covariates, performance gaps for at-risk students are somewhat larger for mastery, but at-risk students fare no worse – and in some cases substantially better – in online than in on-campus environments.

We also conducted a restricted analysis for the approximately 21,000 California students (11,000 on-campus and 10,000 ASU Online, comprising over 168,000 total student-course observations). California students showed performance gaps of less than 1 ppt (completion and passing) and just under 2 ppts (mastery). Our first-pass analysis here suggests that California students are well represented in our data set, and perform similarly to students from other regions. The overall results should therefor provide valid information for inferences about online and performance gaps in California students.
Figure 1. Overall online gap (F2F vs. ASUO) and performance gaps for socioeconomic status (Pell eligible vs. Pell ineligible at the time of the course), ethnicity (white and Asian vs. underrepresented), full- vs. part-time students, continuing- vs. first-generation college students, and Californian vs. non-Californian students. Performance gaps are shown separately for each delivery modality, with F2F in red and online in green. With the exception of part-time, performance gaps are small for completion and passing, mostly less than 1 percentage point. Underrepresented ethnicities, lower SES (Pell eligible) students, and part-time students show somewhat large performance gaps in mastery. Notably, performance gaps are the same size or smaller for ASUO relative to F2F.
(Figure 1., cont.)
Performance Gap Analysis: ASU Online and On-Campus Programs

In Study 1, we draw on existing data from an earlier efficacy project using binary outcome measures modeled separately in each course. A follow-up aggregate study examined whether there were any meaningful differences in average course grades and completion rates between ASU Online and face-to-face students, after taking into account relevant student (e.g., prior GPA), course (e.g., course difficulty), and temporal (e.g., term the course was taken in) variables. The study also investigated whether there were any differences in performance between modalities and salient student characteristics (e.g., ethnicity, academic load, Pell Status). The initial sample included more than 1 million undergraduate student-course observations across 358 undergraduate ASU courses. To account for the observational (non-experimental) nature of the data, the sample was further refined down by matching students, ensuring that the two populations of students (those on campus and those in ASU Online) were similar on all measured variables.

For continuous course grade, the matched sample included over 190,000 student-course observations (over 71,000 online), representing over 72,000 unique students across the 358 courses. The parameters were estimated using a linear regression model, and a summary of estimates derived from this model presented in Figure 2 (left panel). The overall average course grade for the sample was 3.02 (slightly higher than a B average).

For the completion rates, the sample comprised over 211,000 student-course observations (over 80,000 online), representing over 77,000 unique students across the 358 courses. The parameters were estimated using a logistic regression model, and a summary of the completion rate estimates is presented in Figure 2 (right panel). The overall average completion rate for the sample was 96%.

Results for course grade show very small (< 0.1 ppts) gaps for low SES (Pell eligible status), and small gaps small (< 0.2 ppts) for underrepresented ethnicity and part-time students. Moreover, gaps are nearly identical in size for online and on-campus students. The overall online gap (F2F vs. ASUO) is nonsignificant and closed at less than 0.001 grade points difference.

Results for course completion are similar, and corroborate the completion results and conclusions from Study 1: gaps are small (generally less than 1 ppt), and are the same or (in the case of SES) closed in ASUO relative to F2F. The one important exception to small gap size is in the case of part-time students, who on average show a 22ppt lower completion rate; however, this gap is significantly reduced to 16 ppts for ASUO students.

These results suggest that, when matching on student characteristics, a properly supported online program performs comparably overall, and does not exacerbate disadvantages to underrepresented students, in online relative to on-campus programs.
Figure 2. Results of Study 2 showing overall performance (blue star), online gap (F2F vs. ASU Online), and a number of performance gaps overall and disaggregated for F2F and ASUO. F2F is shown in red, ASU Online in green; gap estimates are followed by an asterisk (*) to indicate statistical significance at p<.01. LEFT PANEL: estimated grade (in grade points) showing no online gap (F2F = ASUO), small performance gaps overall (less than 0.2 ppts), and nearly identical gaps for online and on-campus. RIGHT PANEL: a similar analysis for course completion using the same sample and methods as for estimated grade. Although gaps are substantial and significant for part-time students, those gaps are smaller for online than for on-campus. Other gaps are small in size and comparable for on-campus and online.
Study 3. Effects of Adaptive Tutoring Technology on College Algebra Performance: Evidence from a Natural Experiment

College mathematics is the gateway to most academic majors and career paths. Undergraduate students enter college with a wide range of mathematics ability and most of them are required to pass a fundamental course in college algebra. The following results address the question of how effective hybrid instruction is compared to face-to-face instruction for different student populations, in particular for underrepresented minorities, first-generation college students, and Pell grant eligible students.

Before Fall 2016, ASU students with low math-placement scores were placed into a remedial math course before taking college algebra. Starting in Fall 2016, all students directly enrolled in a new hybrid version of college algebra which incorporated an adaptive tutoring system called ALEKS. Students use the online system to receive tailored support based on an entrance test that determines each student's incoming math ability. This ASU policy change provides a natural experiment to estimate causal effects of hybrid relative to face-to-face instruction.

Student Population

This research involves data on 7,792 ASU undergraduate students who took Introduction to College Algebra between 2014-2017. Over a third of the students (38%) enrolled the hybrid version of the course starting in Fall 2016. Students had an average age of 19, 20% are first-generation college students, 41% have underrepresented minority (URM) status, and 41% applied for and were determined eligible for Pell grant support during their time at ASU.

Results

Figures 3 and 4 compare average course outcomes between face-to-face and hybrid instruction for different student subpopulations. Figure 3 shows the rate of passing the course and Figure 4 shows the rate of mastery, which is defined as receiving a 'B' or higher grade in the course. Each figure panel shows a distinct student breakdown to evaluate how hybrid instruction affected the outcomes of different subpopulations, in particular URM students (left panel), Pell-grant eligible students (center panel), and first-generation college students (right panel).

Relative to face-to-face instruction, hybrid instruction significantly increased the passing rate by 11% for White and Asian students, 9% for URM students, 10% for continuing-generation college students, 12% for first-generation students, 11% for not Pell eligible students, and 7% for Pell eligible students. These effects are relatively small given that the passing rate is already above 70%. We therefore also examined mastery.

Hybrid instruction significantly increased the mastery rate by 56% for White and Asian students, 57% for URM students, 57% for continuing-generation college students, 60% for first-generation students, 55% for not Pell eligible students, and 54% for Pell eligible students.

Summary

This analysis provides three key insights:

1. The move to hybrid instruction substantially increased student performance in college algebra.
2. Historically underserved populations benefitted from hybrid instruction as much as other students.
3. Historically underserved populations performed better with hybrid instruction than other students with face-to-face instruction.

**Figure 3.** Passing rate in college algebra with face-to-face instruction (grey) and hybrid instruction (blue) for different student subpopulations: underrepresented minority compared to White and Asian students (left); Pell grant eligible compared to never Pell eligible students (center), and first-generation compared to continuing-generation college students (right). Error bars represent 95% confidence intervals. Hybrid instruction increased passing rates for all student subpopulations.

**Figure 4.** Mastery rate (percentage of students receiving a ‘B’ or higher grade) in college algebra with face-to-face instruction (grey) and hybrid instruction (blue) for different student subpopulations: underrepresented minority compared to White and Asian students (left); Pell grant eligible compared to never Pell eligible students (center), and first-generation compared to continuing-generation college students (right). Error bars represent 95% confidence intervals. Hybrid instruction increased mastery rates for all student subpopulations.
References


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