Comparison of Course Completion Rates in Intermediate Algebra Based on Term and Modality

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[Abstract] Like other higher education institutions, community colleges have expansively entered the domain of online education. With enrollment growth rates in online courses dramatically outpacing overall enrollment growth, community colleges have clearly responded to the market demand of their students for distance learning. Traditionally, these institutions have served a portion of America's higher education enrollment that has been less prepared for the rigor of college-level coursework than other types of institutions. The researchers set out to determine what differences may exist in course completion rates for community college students in the online teaching modality versus traditional face-to-face instruction. A two-way ANOVA was conducted to analyze 173 sections of Intermediate Algebra for differences between two instructional modalities and across three different term offerings (fall 2014, spring 2015, and summer 2015). Additionally, the interaction effect between instructional modality and term was tested for significance. The researchers determined that there was not a statistically significant difference in course completion rates between the three terms, nor was there a statistically significant interaction effect between teaching modality and term. However, it was determined that there was a statistically significant difference in course completion rates based on instructional modality and further identified that online sections (mean = 0.436, s = 0.118) had a statistically significant lower course completion rate than face-to-face sections (mean = 0.564, s = 0.180).

[Keywords] online education; higher education; mathematics; course completion rate; passing rate; term; modality

Introduction

For the better part of two decades, exponential growth in online education has changed the face of higher education. With technology evolving, computers becoming more affordable and mainstream, and the increasing responsibilities outside of the campus environment, online courses have become a more attractive option for the current generation of college students. Between the fall of 2002 and the fall of 2006, the number of students taking at least one online course grew by a compound annual rate of 21.5% while the total number of students in higher education grew at a much lower annual rate of only 1.5% (Allen & Seaman, 2007). By 2006, "students taking at least one online course [represented] almost 20 percent of total enrollments in higher education" (Allen & Seaman, 2007, p. 5). While some researchers may contribute this high amount of growth to the increase in for-profit online universities, research shows that community colleges had the "highest growth rates" and accounted for "over one-half of all online enrollments" during that time period (Allen & Seaman, 2007, p. 1). Online enrollments continued to increase anywhere from 10% to 21% per year between 2008 and 2010 (Britto & Rush, 2013). While the percentage growth during the next decade is not expected to be as high as the past decade, "enrollments in online courses will likely continue to grow" (Meyer, 2014, p. 576). Influenced by increased demand from students for online courses, the mission of community colleges to provide access for all students has resulted in more and more online courses, and even programs, being offered each year.

Instruction in online courses can be as effective, if not more effective, than face-to-face instruction (Dixson, 2010; Sutton, 2014). However, multiple studies and research articles have found that students are less likely to successfully complete online classes than those students in face-to-face classes, by as much as 10% to 36% (Angelino & Natvig, 2009; Britto & Rush, 2013; Carr, 2000; Dietz-Uhler, Fisher, & Han, 2008; Doherty, 2006; Tirrell & Quick, 2012). While many colleges routinely publish their course completion data as part of their annual review, there is not a significant body of literature that directly compares course completion rates by term and even less research has separated the completion rates for online classes by term. With that in mind, for this study the researchers are interested in any differences in

course completion rates that can be attributed to the class modality, online or face-to-face, the term in which a course is offered, and any interaction between modality and term. The main focus is on two-year colleges and data will be obtained and analyzed from a public, suburban two-year college.

Review of the Literature

Rising public and legislative awareness of the high costs of attending college, coupled with concerns regarding student performance and degree attainment, have evolved into a culture of accountability for America's colleges and universities. Simultaneously, as state and federal funding continues to represent a decreasing percentage of annual operating revenue for most public institutions, the need to attract larger enrollments for tuition revenue has grown (Mortenson, 2012). The demand for consuming higher education via online access is undeniable, as is the response of colleges and universities to cater to that demand as evidenced by the fact that online enrollments continue to represent the fastest growing enrollment category in American higher education (Capra, 2014). Though it has been widely held that no statistically significant difference in completion rates exist between online and traditional courses, much of the literature supporting this viewpoint is aimed at the well-prepared university student (Xu & Jaggars, 2011). The research regarding the efficacy of online (distance learning) courses on student learning and performance at the community college yields conflicting results.

McLaren (2004) conducted a study of students enrolled in online and traditional sections of Business Statistics, all taught by the author who found there to be a statistically significant difference in course completion rates. As part of her study, McLaren (2004) compared the performance of students who completed the course in both formats. Based on the results of a test for independence, chi-square = 2.65 and p = .915, McLaren (2004) concluded that student grade performance is independent from instructional delivery mode.

Similarly, in a study comparing completion rates and student performance measures between online and face-to-face courses at a small public university, Atchley, Wingenbach, and Akers (2013) showed that there was a statistically significant difference in retention rates, course grades, and course completion rates for students based on course modality. "Additional analysis indicated that students enrolled in online courses had a lower course completion rate (93.3%) than students enrolled in traditional courses (95.6%)" (Atchley et al., 2013, p. 113).

In an analysis of roughly 24,000 students from 23 community colleges in Virginia, Xu and Jaggars (2011) set out to determine if there were any effects on students taking their first college-level math or English course in an online format. Utilizing logistic regression and controlling for student self-selection via propensity matching strategies, the authors' findings "show robust estimates of a negative impact of online learning on course retention and course performance in both math and English" (Xu & Jaggars, 2011, p. 362). In their concluding remarks, Xu and Jaggars (2011) noted that despite a commonly held belief that online education evolves rapidly, their study encompassed a four year period from 2004 to 2008 over which the results for online students did not improve statistically, indicating that "evolving technologies were either not adopted or did not have a strong impact on online success rates" (p. 375).

On the other side of the spectrum, Bassett and Frost (2010) showed that both passing rates and student learning were improved through a redesigned developmental math sequence that incorporated online modules at Jackson State Community College. While most sections included in the pilot initiative were taught in a face-to-face format, all students regardless of delivery method utilized an online homework tool for completing the modules. Students were supported by their instructor and tutors via the 'SMART Math Centers' which housed computers for student use. Bassett and Frost (2010) were able to show that "[t]he spring 2008 traditional class passing rate was 41%, comparable to JSCC's historical 42% passing rate" (p. 872). While the authors failed to complete significance testing, they did report passing rates for the students enrolled in the redesigned pilot by semester as follows: spring 2008 (54%), fall 2008 (57%), spring 2009 (59%), and fall 2009 (60%). No passing rate data was provided for the traditional sections offered during the pilot terms beyond the spring 2008 semester.

Waschull (2001) evaluated data from two separate studies of students enrolled in an introductory psychology course at Athens Technical College. In the first study, students self-enrolled into either a

traditional course or an online course. In the second study, students were randomly assigned to either a traditional course or an online course. Based on the results of the first study, Waschull (2001) concluded that "online students scored non-significantly lower on course tests and the final exam. Online students were more likely to fail the course" (p. 143). While the study showed no statistically significant differences in attrition rates, "the pattern of non-significant mean differences translated into a higher rate of course failure. This pattern is consistent with Ridley's (1998) finding that students have somewhat lower GPAs in online versus classroom courses" (Waschull, 2001, p. 145).

Research Implications

As performance-based funding models continue to develop across the country, public colleges and universities increasingly find a portion of annual operating income tied to student performance measures such as retention, program completion, and even passing rates of individual courses. In this environment of elevated scrutiny and heightened financial stakes, it is imperative that college and university administrators understand the performance outcomes associated with different instructional modalities.

Additionally, student passing rates have an increasingly vital impact on persistence and graduation rates due to implications related to financial aid eligibility, academic probation, third-attempt rules, and legislation limiting total attempted credit hours toward degree completion. These factors tend to be more impactful on community college students who are more likely to qualify for federal financial assistance and less likely to be academically prepared for the rigor of higher education.

Purpose Statement

The purpose of this study is to determine if there are significant differences in course completion rates based on term/semester and modality. A purposeful sample of 173 sections of Intermediate Algebra (MAT 1033) from the most recently completed academic year (2014-2015) was selected from the college at which the researchers are employed. Intermediate Algebra is an entry-level course, which does not count for general education credit, for students lacking a strong algebraic background. Most community college students enroll in Intermediate Algebra as their first college-level mathematics course. The course covers topics such as the real-number system and its properties, factoring of polynomials, systems of linear equations, rational expressions, radical expressions, and equation solving. This course was selected for the following reasons: it is the largest enrollment mathematics course and one of the largest enrollments of all courses offered at the college; the course offers the largest number of online sections within the mathematics department and is one of the largest online courses by enrollment at the college; the course is considered a gateway course and course performance is measured at the state level; and the course has a past history within the department of lower course completion rates in online sections as compared to face-to-face courses.

Methodology

A quantitative research design, defined by Creswell (2014) as "an approach for testing objective theories by examining the relationship between variables" (p. 4), was determined to be the appropriate design for this research based on the purpose of testing for differences between term and modality. The grade distributions for each section were obtained from the institution's office of institutional research. For each section of the course, the course completion rate was then calculated as the proportion of enrolled students who earned a grade of 'C' or higher. The justification for using a 'C' as the minimum completion grade, as opposed to a 'D' grade which is included in the passing rate at some colleges and universities, was due to the fact that students must have a 'C' or higher in order to meet the prerequisite for the four general-education mathematics courses that require successful completion of Intermediate Algebra. This definition of course completion is also consistent with state reporting guidelines. Course completion rate, a continuous and ratio-level of measurement with values between 0 and 1, was used as the dependent variable.

Each section of the Intermediate Algebra course was grouped by two independent variables: term and modality. There are three groups within the term variable based on the semester that the section of the

course was offered: Fall 2014, Spring 2015, and Summer 2015. There are two groups within the modality variable: online and face-to-face. Online sections of the course were 100% online, with no scheduled meetings on campus, utilizing both a learning management system and adaptive learning software designed for mastery of mathematics objectives. All tests were required to be proctored either on campus, at another physical location, or through an online proctoring service. Face-to-face sections of the course were offered in two different formats: a traditional lecture format that utilized an online homework delivery system and a computer-based instructional method utilizing the same adaptive learning software used in the online sections. While it is possible that some students took the course more than once in different terms and possibly different modalities, the variables are focused on individual class sections, not individual students, and thus each section can be considered independent of all other sections. It should also be noted that students were able to self-enroll into whatever section was open and available at the time of their registration. The possibility does exist that some students enrolled in a specific modality not by choice but due to being the only available section, however the number of students in this situation should have been minimal enough to not unduly influence the course completion rates by section.

In order to determine if there were any statistically significant differences between course completion rates by section, a two-way ANOVA was run using SPSS. Based on the independent variables of term and modality, there were three null hypotheses tested:

1. There is no statistically significant difference in course completion rate based on term.
2. There is no statistically significant difference in course completion rate based on modality.
3. There is not a statistically significant interaction effect between term and modality.

Limitations

The focus of this study was only on one particular course, Intermediate Algebra, offered at one institution for only one academic year. Thus the sample sizes within some of the levels of term and modality were quite small. There are also three other variables that were not controlled for in this study: instructor, format, and session length. All but one of the instructors who taught the course in the online modality also taught at least one face-to-face section in the same term. However, no more than four sections were taught by individual instructors within any given mode, thus the decision was made to not include instructor as an independent variable.

As indicated previously, there were two formats used in the face-to-face sections: a traditional lecture format that utilized an online homework delivery system and a computer-based, adaptive-learning approach. It was decided that the analysis would not control for format or include format as a grouping variable due to the fact that the online sections only used the adaptive software.

The third variable, session length, refers to courses that were offered for the full term (15 weeks) as opposed to those offered in shorter sessions (12-week and 8-week sessions in Fall and Spring, 6-week sessions in Summer). This variable was excluded due to the fact that the numbers of sections offered in the shorter sessions were five or less per term and thus would have produced questionable results due to small sample sizes.

Results and Analysis

There were 173 sections of Intermediate Algebra offered at the subject institution in the 2014-2015 academic year. The breakdown by term was 88 sections in Fall 2014, 66 sections in Spring 2015, and 19 sections in Summer 2015. For the modality, there were 20 sections offered in the online format and 153 sections offered face-to-face. The descriptive statistics for each of the groupings are shown in Table 1.

Table 1
Course Completion Rates for Sections of Intermediate Algebra

	Online			Face-to-Face			Total		
Term	n	Mean	SD	n	Mean	SD	n	Mean	SD
Fall 2014	8	0.385	0.064	80	0.574	0.173	88	0.557	0.174
Spring 2015	8	0.468	0.161	58	0.512	0.181	66	0.506	0.178
Summer 2015	4	0.475	0.081	15	0.708	0.132	19	0.659	0.155
Total	20	0.436	0.118	153	0.564	0.180	173	0.549	0.179

Note. SD = standard deviation

It is important to note that this analysis was conducted on a per-section basis, thus the mean course completion rates are by section and are not necessarily representative of the course completion rate per student due to unequal enrollments per section. For example, the overall course completion rate for all 4,571 students who took Intermediate Algebra in the 2014-2015 academic year was 0.54890 whereas the mean course completion rate per section was 0.54894. The differences are likely to be more pronounced in the individual groupings of term and modality due to smaller sample sizes. However, for the purposes of this study, the course completion rate represents the performance that the instructor of a particular section can expect for that section as a whole group.

Before testing for the differences between course completion rates, it first had to be determined if the error variances were equal across the groups. Based on the results of Levene's test for equality of error variances, $F(5,167) = 2.005$ and $p = .080$, there was not a statistically significant difference between the error variances, thus no adjustments to the two-way ANOVA were required. The results of the subsequent ANOVA are shown in Appendix A.

The term in which the class section was offered was the first grouping variable tested. Based on the results of the analysis, $F(2,167) = 2.141$ and $p = .121$, the researchers concluded that there was not a statistically significant difference in course completion rate between the three terms in the study: Fall 2014 (mean = 0.557, $s = 0.174$), Spring 2015 (mean = 0.506, $s = 0.178$), and Summer (mean = 0.659, $s = 0.155$). A post-hoc analysis was not necessary since there was not a significant difference between the three terms. Approximately 2.5% of the variation in course completion rate was accounted for by term.

Modality was the second grouping variable that was tested. Based on the results of the analysis, $F(1,167) = 12.982$ and $p = .000$, the researchers concluded that there was a statistically significant difference in course completion rate between the two modalities. Online sections (mean = 0.436, $s = 0.118$) had a statistically significant lower course completion rate than face-to-face sections (mean = 0.564, $s = 0.180$). Approximately 7.2% of the variation in course completion rate was accounted for by modality.

In the final step in the analysis, the interaction between term and modality was tested. With $F(2,167) = 1.961$ and $p = .144$, the researchers concluded that there was not a statistically significant interaction effect between term and modality. Because there was not a significant interaction effect, it was not necessary to construct any interaction plots. Approximately 2.3% of the variation in course completion rate was accounted for by the interaction between term and modality. Overall, the analysis accounted for only 14.6% of the variation in course completion rate.

Conclusion

As the rate of enrollment in online courses continues to outpace the overall enrollment rates at community colleges, the question of efficacy becomes increasingly important. As this study and others (Angelino & Natvig, 2009; Atchley et al., 2013; Britto & Rush, 2013; Carr, 2000; Dietz-Uhler et al., 2008; Doherty, 2006; McLaren, 2004; Tirrell & Quick, 2012; Xu & Jaggars, 2011) have shown, course completion rates for online sections of classes may not be on par with completion rates of traditional, face-to-face instruction. With the development of performance funding models placing high-stakes on student performance,

community college administrators should strive to be informed about where their enrollments are situated and work to provide their students with the best possible chance for success. Future research in this area should address any effects of accelerated course work (shortened semesters) as well as the impact of hybrid course formats on course completion rates. Additionally, research focused on the impact of integrated academic support on completion rates for online courses could help to identify best practices for closing any completion rate gap between online courses and their traditional counterparts.

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Appendix A – SPSS Output

Between-Subjects Factors

		Value Label	N
Term	1	F14	88
	2	Sp15	66
	3	Su15	19
Mode	1	DL	20
	2	F2F	153

Descriptive Statistics

Dependent Variable: PassRate

Term	Mode	Mean	Std. Deviation	N
F14	DL	.3851713	.06354331	8
	F2F	.5744432	.17245822	80
	Total	.5572367	.17414510	88
Sp15	DL	.4677075	.16094517	8
	F2F	.5114679	.18052695	58
	Total	.5061636	.17769530	66
Su15	DL	.4753000	.08089022	4
	F2F	.7081027	.13201320	15
	Total	.6590916	.15541399	19
Total	DL	.4362115	.11789957	20
	F2F	.5636741	.18012183	153
	Total	.5489386	.17854295	173

Levene's Test of Equality of Error Variances[a]

Dependent Variable: PassRate

F	df1	df2	Sig.
2.005	5	167	.080

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Term + Mode + Term * Mode

Tests of Between-Subjects Effects

Dependent Variable: PassRate

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.803[a]	5	.161	5.727	.000	.146
Intercept	16.345	1	16.345	583.185	.000	.777
Term	.120	2	.060	2.141	.121	.025
Mode	.364	1	.364	12.982	.000	.072
Term * Mode	.110	2	.055	1.961	.144	.023
Error	4.680	167	.028			
Total	57.614	173				
Corrected Total	5.483	172				

a. R Squared = .146 (Adjusted R Squared = .121)