Estimating the Effects of Online Learning for Secondary School Students: State and district case studies

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Exhibits

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Executive Summary

"Online learning"—instruction that uses the Internet to deliver curricular materials and facilitate student interaction—is a growing phenomenon in K–12 education. Unfortunately, rigorous estimates of the size of elementary and secondary enrollments in online learning are generally hard to come by. One study suggests that more than a million K–12 students in the United States took one or more courses that incorporated online learning during the 2007–08 school year (Picciano and Seaman 2009).[1] Although online learning likely accounts for a relatively small percentage of total U.S. elementary and secondary enrollments (estimates vary between 1 and 2 percent), online learning appears to have a significant presence in the nation's educational system. State-led online learning initiatives, such as state virtual schools, exist in 39 states, accounting for about 450,000 annual course-enrollments in 2009-10 (Watson et al. 2010). In addition to state-supported programs, it is estimated that about 50 percent of all school districts were offering or planning online and blended courses in 2009-10 (Watson et al. 2010). Considering the potential scale and impact of online learning in K–12 education, research-based policy guidance regarding effective online learning practices is strongly needed.

An earlier systematic literature review found only five experimental or quasi-experimental studies of the effectiveness of online learning for K–12 students (U.S. Department of Education 2010). This report is intended to encourage and contribute to the rigorous study of K-12 student outcomes in online learning environments.

This report consists of two independent case studies describing the use of online learning for secondary school students. As a consequence, the findings of this report come from a small sample of sites and are therefore not generalizable. One case study focuses on a statewide implementation of online learning in Florida, with a focus on the Florida Virtual School (FLVS). The other case study concentrates on a large suburban school district in the mid-Atlantic region (referred to as MAVS for "mid-Atlantic virtual school" throughout this report). This study focuses primarily on secondary school students both because these were the only two sites with sufficient enrollments and types of data needed for analysis. This is logical because the majority of enrollments nationally appear to be at the secondary level.

Two courses were selected for each case study: English 1 and Algebra 1 in FLVS andGeometry and English 12 in MAVS. All four courses are considered core academic content required for graduation. These four courses were "fully online courses," a form of online learning in which all instruction and assessment are carried out using online, Internet-based delivery (Picciano and Seaman 2009; U.S. Department of Education 2007). In both cases, students typically took these

1 These estimates should be viewed cautiously because the study's response rate was 5 percent.

courses in places other than school facilities (although some students do take courses inside of school buildings) and outside of traditional time-bound, school class periods.

In 2009–10, FLVS served an estimated 97,183, accounting for some 213,926 enrollments (Watson et al. 2010). Public, private and home-schooled students may enroll in FLVS courses with approval from parents and school representatives. Sixty-seven percent of FLVS students attended public and charter schools, 26 percent were home-schooled and seven percent attended private schools (Florida Virtual School 2009). Whereas students outside the state must pay tuition, all Florida residents can take FLVS courses free of charge, although students are still responsible for the cost of a computer and Internet access, which are necessary to participate in FLVS courses.

In 2008–09, MAVS reported more than 2,000 enrollments per year, representing about 1,700 students. The majority of these students were reported to enroll during the summer. Any student currently enrolled with the district could enroll in an online class for free with permission from his or her school of record. Students outside the district may take an online course, but they pay a fee of $375 per semester course or $750 per year-long course. Students are required to provide their own computers and Internet access. According to MAVS, the students most likely to take advantage of the online program are those seeking honors classes, those seeking credit recovery and students who have disabilities or are homebound.[2]

Key findings from the report include:

- Students enrolled in online courses differed in significant ways from those students enrolled in conventional, place-based versions of the same courses.

- After controlling for prior academic achievement and socio-economic status, students enrolled in online courses had,on average, the same odds of passing a course as their peerswho were enrolled in place-based versions of the same course in three of the four courses studied.

- On average, students enrolled in online courses performed the same as or better on standardized tests designed to measure mastery of course content than students taught in conventional, place-based settings.

Overview of Study Methodologies

This study addresses the following three research questions:

2Students are designated by the district as “homebound” if they are unable to attend school because of illness or disciplinary action. Data regarding numbers and proportions of homebound students were not obtained for either course format.

1) How do the characteristics of students taking online courses in public school programs compare with those of students enrolled in place-based courses?

2) How does the academic achievement of students in online courses compare with that of their peers in place-based instruction?

3) How were credit-bearing high school courses implemented in case study sites?

To address the study's research questions, a post-hoc quasi-experimental design was used to compare student outcomes in four online courses to outcomes for similar students enrolled inthe same four courses provided through place-based instruction. In other words, Algebra 1 students enrolled in an online course were compared to a matched sampleof Algebra 1 students enrolled in the same course through place-based instruction, with four separate analyses – one for each course. The data files contained information on students' demographic characteristics and academic performance as well as school characteristics in which students were enrolled. Data from the Florida's Educational Data Warehouse were used for the FLVS study, including students enrolled in both online and place-based courses. Similar data for students in online and place-based courses were obtained from a different educational data system for the MAVS study.

The FLVS study used student-level quantitative data from 2006–07 and data from site visits to nine districts as well as FLVS headquarters in 2008. The purpose of the site visits was to collect qualitative data to complement the quantitative data. Each site was visited for one to two days, with interviews conducted and observations made, usually by two analysts from the project.

Student achievement data in MAVS were pooled from two school years 2006–07 and 2007–08 to obtain an adequate sample size for the analysis. Interview data for MAVS were collected from a small set of administrators and teachers affiliated with the online program. Online course providers supplied demonstration versions of the four courses for independent review by study analysts.

Multiple outcome measures were used across sites, including course pass rates, grades and standardized tests when available. Results for outcomes are reported for both studies in their original units, such as points on the FCAT exam, to facilitate intuitive understanding of results. Additionally, standardized outcomes (effect sizes) were created to facilitate comparisons across multiple measures and to support future meta-analyses of online learning. An effect size represents the expected change in outcome (like a course grade) in a group participating in an intervention compared with a control group, which in this case was place-based instruction, expressed in standard deviation units. Cohen's d statistic, a standardized measure of effects size, is reported for course grade and Florida Comprehensive Assessment Test (FCAT) outcomes in the FLVS study and for course grades and end-of-course exams in the MAVS study. To compare course pass rates, odds ratios were used. An odds ratio is a measure of effect size that compares the odds of an event (passing a course in this case) for students in the intervention group (e.g.

FLVS and MAVS) with the odds of the same event for students in the control group (place-based instruction).

Readers should keep in mind two important limitations of this study; one is related to the nature of case study work and the other is related to the post-hoc nature of the study. Because the findings in this report are drawn from a small sample of sites, they cannot be generalized to a larger student population.[3] In addition, the analyses documented in this report do not address questions regarding causality. Results are correlational. Regression techniques were used to estimate the associations among online instruction, course and student characteristics and student achievement. Researchers attempted to reduce the bias by comparing achievement just for a sample of students enrolled in online courses and those in place-based instruction that were balanced on observed student characteristics. However, because students select into online or place-bases courses, the students in these samples are likely to differ, in the aggregate, on unobserved characteristics such as motivation or comfort with technology that may also be associated with achievement. As a result, differences in student outcomes may be related to student characteristics or other variables not included in the study introducing a source of error in statistical estimates. Future research will want to address this concern carefully since qualitative data collected suggested that students often enroll in online courses for very specific reasons (e.g. to take a course not otherwise available or to accommodate scheduling conflicts). Additional research is required to more fully understand the impact of online learning relative to place-based learning and how students choosing one format over another may vary systematically in important ways related to achievement.

3 After a systematic search for sites to participate in the study, only two sites were identified (See Appendix A for additional information on site selection and data requirements for inclusion in the study).

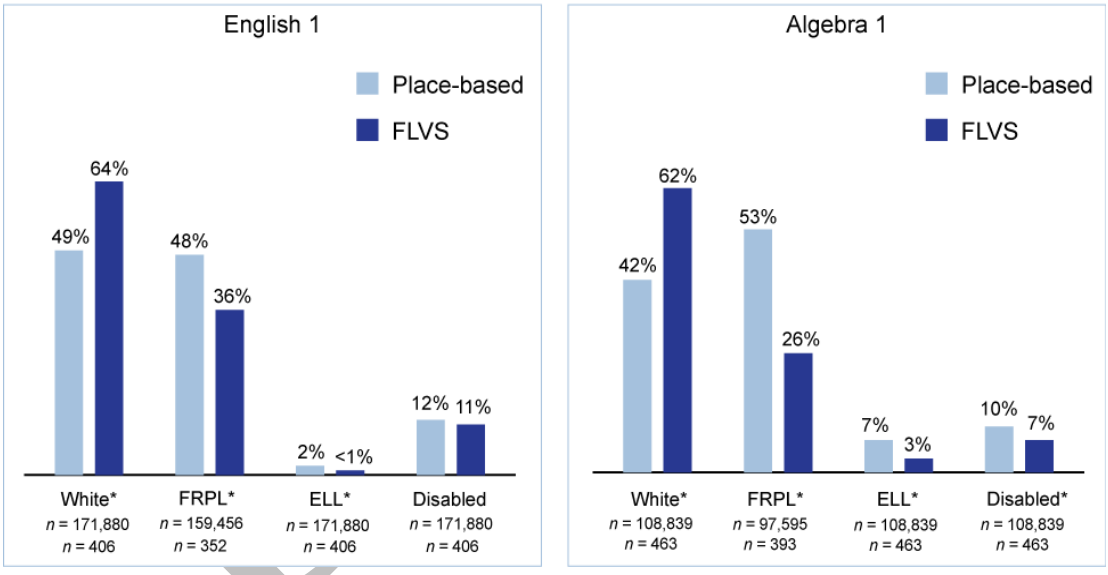
Key Findings

Students who self-selected into online courses differ in significant ways from those in place-based versions of the same courses.

Analysts compared the characteristics of students who self-selected into online courses with their counterparts taking the same courses conventionally. Students in online courses and those in place-based courses differed demographically (Exhibit ES-1). Students in the four online courses studied were less likely to qualify for the federal free- or reduced-price lunch program (FRPL) when compared with their peers in place-based versions of the same courses. Students in three of four online courses studied (English 1 and Algebra 1 in FLVS and English 12 in MAVS) were more likely to be white and less likely to be English-language learners. Similarly, in three of four courses (Algebra 1, English 12 and Geometry) students with disabilities were less likely to enroll in online versions of a course.[4]Many of these differences were statistically significant.[5]

Exhibit ES-1: Student Demographics by Course, Total Sample

Florida



4 Enrollment data indicating special education status for students enrolled in the MAVS district is for 2007 cohort only. Data were not provided for students enrolled in 2008.

5 This study was not able to address the accessibility of online courses to ELL students and students with disabilities, nor does it specifically discuss (in a disaggregated manner) their levels of achievement in such courses. The sample sizes for students with disabilities and ELL students were too small to support subgroup analyses. Therefore, results of this study are not necessarily generalizable to these populations. Findings reported for these subgroups may change significantly when a larger sample is taken.

Exhibit ES-1: Student Demographics by Course, Total Sample[6,7](continued)

District

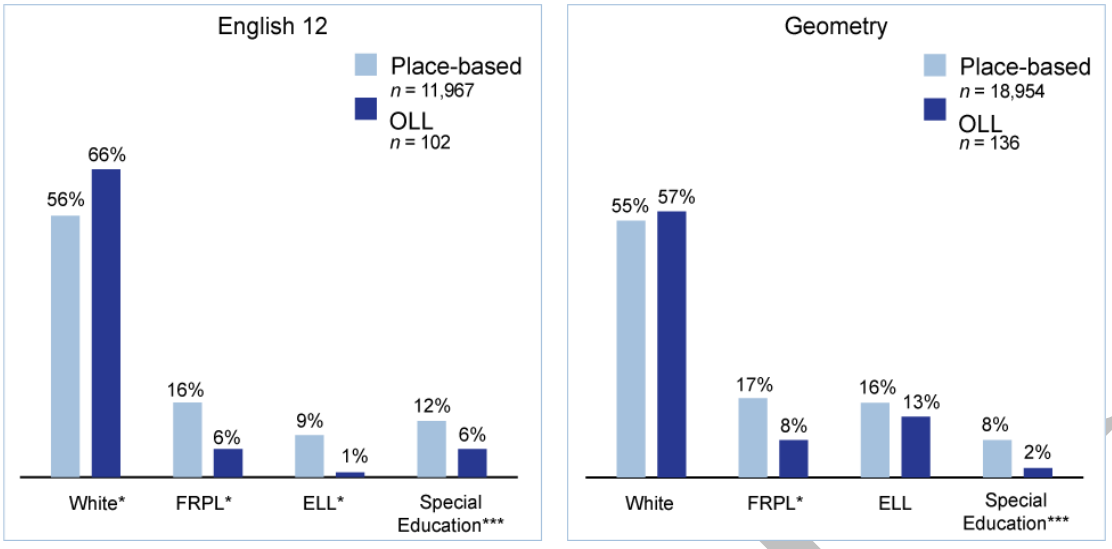


Exhibit reads: Among students enrolled in both semesters of English 1, 49 percent of students in place-based courses were white, compared with 64 percent of FLVS students.

Source: Division of Accountability, Research and Measurement, Florida Department of Education and MAVS District.

*The difference between students enrolled in online courses and those in place-based courses was statistically significant at the 95 percent confidence interval.

**District data regarding students enrolled in special education were only available for SY 2007. Since data was not available for the 2008 cohort, this variable was not included in the analyses of student outcomes reported in the text that follows.

Students also differed from their peers with regard to course taking patterns. On average, students in online courses were more likely to exhibit both accelerated and recovery enrollment patterns. In other words, the grade levels of students in online courses tended to vary more than those for students in place-based courses. In MAVS, students were more likely to use online learning to accelerate learning (e.g., 23 percent of students took English 12 in the 11th grade, compared with just 2 percent of students in place-based courses).[8] Although this finding of

6 This exhibit pulls together data representing similar but not identical populations. FL provided data regarding "disabled" students and the MAVS district reported students enrolled in "special education." While the terms "Disabled" and "Special Education" are similar, they are not interchangeable. As reported by Florida, "disabled" refers to students with a primary exceptionality code indicating any disability, including a mental, emotional, physical, or cognitive disability. "Special Education" represents students receiving special education services or accommodations as reported by the MAVS district.

7 In both FLVS and MAVS studies, students of Hispanic origin are not included in the ethnic categories of "Black" and "White."

8 The MAVS dataset had very few students flagged as having previously failed and they were not typically online students. This suggests different student purposes and uses of online learning across the two sites.

advanced course taking was also true for some FLVS students, students enrolled in English 1 and Algebra 1 at FLVS were more likely to have previously failed the course than their peers in place-based instruction. Students enrolled in FLVS's English 1 course were 13 times more likely than enrollees in place-based versions of the same course to have failed the course previously. FLVS Algebra 1 students were four times more likely to have failed the course in the past. This finding suggests that a sizable percentage of students enrolled with FLVS are enrolled to recover credit required for graduation (40 percent of students in online versions of English 1 and 29 percent of students enrolled in Algebra 1 online). Consistent with this finding, almost all students in place-based versions of these introductory high school courses took them in 9th grade, but most students who took these courses online were already in grades 10 or higher. A full 77 percent of students who enrolled in English 1 online were in grades 10 or above, compared to only 4 percent of place-based students enrolled in English 1. In Algebra 1, 90 percent of the online enrollment were from students in grades 10 or above compared to 15 percent of place-based enrollments.

The juxtaposition of the two case studies included in this report highlights the range of uses for online learning. Students enrolled in online courses in MAVS were less likely to be reported as previously failing the course. MAVS students were more likely to be taking courses in advance of their peers in place-based instruction.

Study respondents in both FLVS and MAVS indicated that other types of students also turn to online options to access courses not available locally. Through FLVS alone, students have access to more than 90 academic and elective courses (Florida Virtual School 2009). In any event, the significant differences in student backgrounds indicate that analyses comparing the performance of online and place-based course enrollees need to account for student characteristics and that there may be other, unmeasured differences among students in one course format compared to the other.

Students enrolled in online courses had the same odds of passing a course as their peers in place-based courses in three of the four courses studied.

Students in FLVS online courses had the same odds of passing English 1 and Algebra 1 as their peers in place-based courses (Exhibit ES-2). Similarly, students had statistically equivalent odds of passing English 12[9] in the MAVS program. However, the odds for passing online Geometry in the MAVS program were 76 percent lower than for place-based Geometry.

9 The odds of students in online courses passing were 32 percent higher than the odds for students in place-based courses, but the difference was not statistically significant.

Exhibit ES-2: Change in Pass Rate Odds by Course

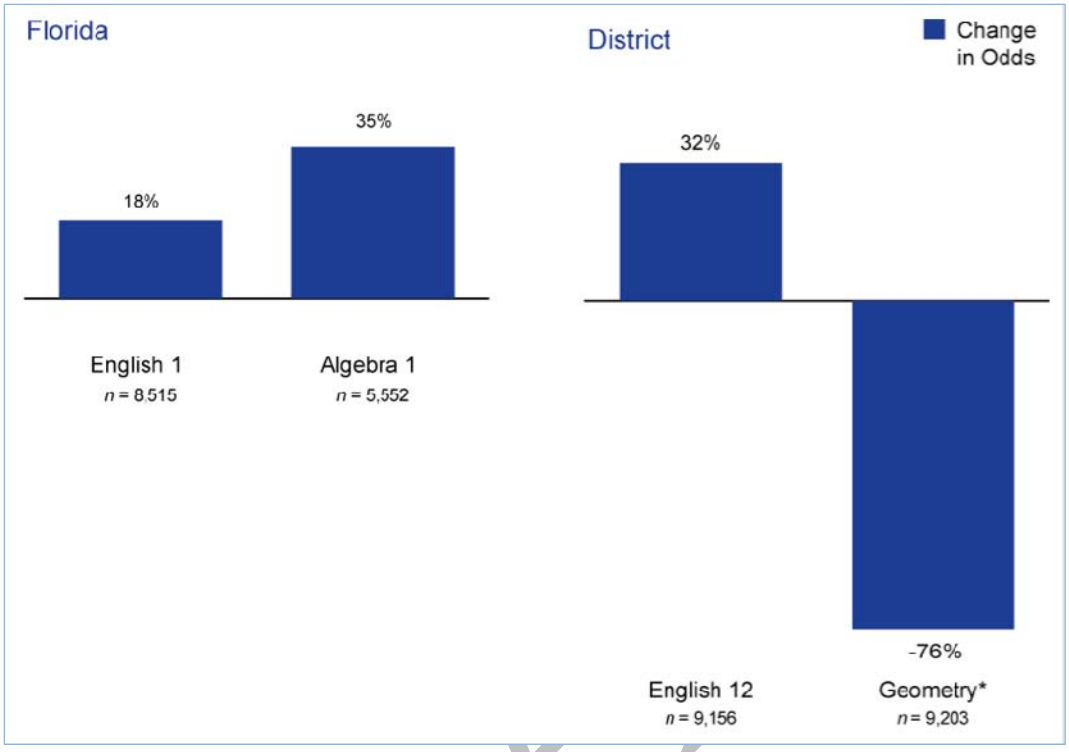


Exhibit reads: FLVS students enrolled in both Semesters 1 and 2 of English 1 had 18 percent greater odds of passing than students in place-based versions of the same course.

Source: Division of Accountability, Research and Measurement, Florida Department of Education and MAVS District.

* The differences between students in place-based and online courses were statistically significant at the 95 percent confidence interval.

Online student performance on standardized tests designed to measure mastery of course content was equal to or higher on average than students taught in conventional settings.

Standardized test scores for students were available for three of the four courses studied. In a matched comparison of 9th- and 10th-grade students in FLVS and place-based courses, students enrolled in a full-year of English 1 or Algebra 1 with FLVS scored higher on standardized tests aligned with course content than did students taking the place-based versions of the same course (and test) in Florida (Exhibit ES-3).

Exhibit ES-3: Standardized Test Scores of FLVS Students Relative to Those of Comparable Students in Place-Based Courses

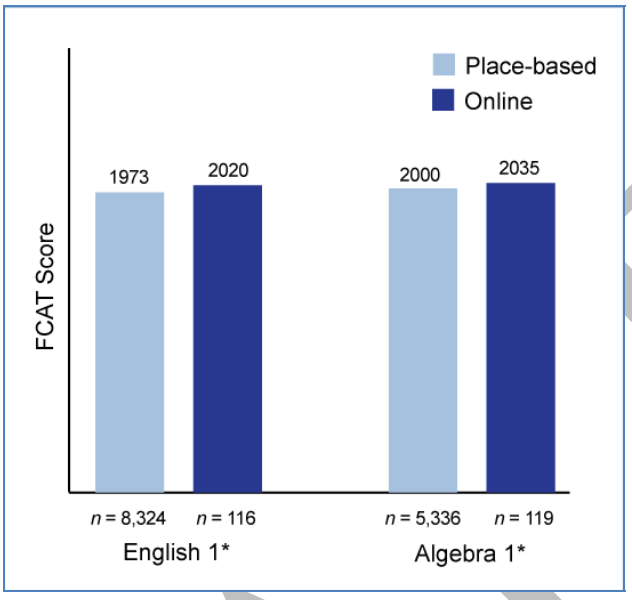


Exhibit reads: Students in FLVS's English 1 course scored almost 47 points higher than students in a place-based English 1 course.Predicted mean FCAT scores are for the average student in the sample.

Source: Division of Accountability, Research and Measurement, Florida Department of Education and MAVS District.

* The differences between students in place-based and online courses were statistically significant at the 95 percent confidence interval.

MAVS had an end-of-course exam in place for Geometry students, but not for English 12 students. The end-of-course exam score for the Geometry course was almost seven points higher for students in online courses than for those in place-based courses, but the difference was not statistically significantat the .05 level (p=0.11).

Students' grades illustrated a pattern of results similar to those for standardized tests when students in online and place-based courses were compared.

The use of course grades as a measure of students' achievement is practicable but not ideal for research like the studies reported here. Course grades have real-world consequences, including high school and college course-taking patterns andcollege admission, as well as some scholarship and financial aid awards. However, individual teachers largely dictate grades and the elements they use to arrive at final grades may vary tremendously. For example, teachers determine which factors (e.g.attendance or class participation) are counted in final grades, as well as the format and timing of quizzes and tests and the types of knowledge and skills graded.

Despite the limitations associated with the use of course grades as an outcome measure, they were included in the analysis as one of three means for comparing student achievement across online and place-based courses. In three of four courses, the grades of a matched sample of students in online courses were as good as or better than those of their peers in place-based instruction (Exhibit ES-4). On average, FLVS students' grades were estimated to be higher than or equal to student grades in place-based courses. In English 1, the online course grade was 0.56 grade points higher than the place-based course grade on a scale of 0 to 4. In Algebra 1, the online course grade was 0.35 grade points higher than the grade in the place-based format. The effect size of FLVS on course grades was larger than the effect sizes for other outcome measures. Students in FLVS's English 1 course had course grades about half of a standard deviation (.47) higher than the course grades of students in place-based courses. The effect size for Algebra 1 was about one-third of a standard deviation (0.30) higher. If grades were the only outcome measure used, analysts would be concerned about the possibility of systematic grading differences between online and place-based courses. However, the general consistency of results across outcome measures lends weight to the overall finding that, on average, students in some online courses learn as much as, or more than their peers in place-based settings. Students enrolled in an online course with MAVS had grades that were not statistically different from those of their place-based peers for English 12 andgrades that were lower thanthose of their peers for Geometry.

Exhibit ES-4: Course Grades of Students in Online Learning Relative to Those of Comparable Students in Place-Based Courses

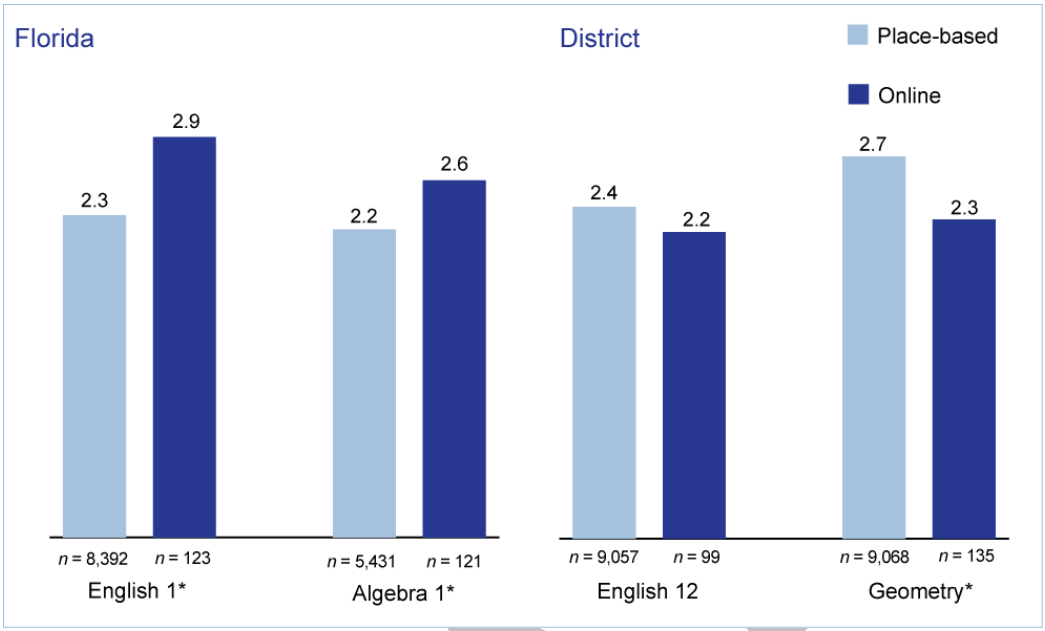


Exhibit reads: Among students who enrolled in both semesters of English 1, FLVS students' predicted mean course grades were about 0.6 grade points higher than place-based students' course grades. Predicted mean course grades in English 1 and Algebra 1 are for the average student in the sample. Predicted mean course grade for English 12 is for students who scored 450 (proficient is 400-499) on the English 11 end-of-course exam in writing and in reading. Predicted mean course grade for Geometry is for students who scored in the proficient range on the Geometry end-of-course exam and are not enrolled in honors Geometry.

Source: Division of Accountability, Research and Measurement, Florida Department of Education and MAVS District.

* The difference between students in place-based and online courses was statistically significant at the 95 percent confidence interval.

Multiple explanations are possible for the mixed outcomes across sites, courses and students. For example, FLVS may have had structures or supports in place that helped students pass courses that were not available in MAVS. Indeed, FLVS teachers and administrators reported that they tracked student performance on a weekly or even daily basis so that they could assist those students who were not on track as early as possible. Differences may be attributable to subject matter as well. Some respondents noted that it was more difficult to teach and learn mathematics online than other subjects (e.g., the unique symbols and equations used in mathematics were more difficult to render on the computer). Respondents also indicated that some students may require additional encouragement and an especially high degree of interactivity with teachers and peers because of "math phobia" and the difficulty that some students have with mathematics generally.

In Florida, the higher achievement of students in online English 1 and Algebra 1 was partially explained by differential attrition after the first semester.

Students enroll in FLVS courses one semester at a time and those who do not complete the first semester are unlikely to enroll in the second. For this reason, the analyses reported above were repeated for Semester 1 students in FLVS and place-based versions of English 1 and Algebra 1.[10]When the comparison was made at the end of the first semester rather than at the end of the year, students in place-based classes completed them more often and had higher course grades than students in online courses. The odds of passing for English 1 students enrolled in Semester 1 of the FLVS course were 80 percent less than those of their peers in place-based courses and in Algebra 1, the odds of passing were 70 percent less than those of their place-based peers. (Exhibit ES-5).

Exhibit ES-5: Semester 1 Students' Odds of Passing FLVS Courses Relative to Comparable Students in Place-Based Courses

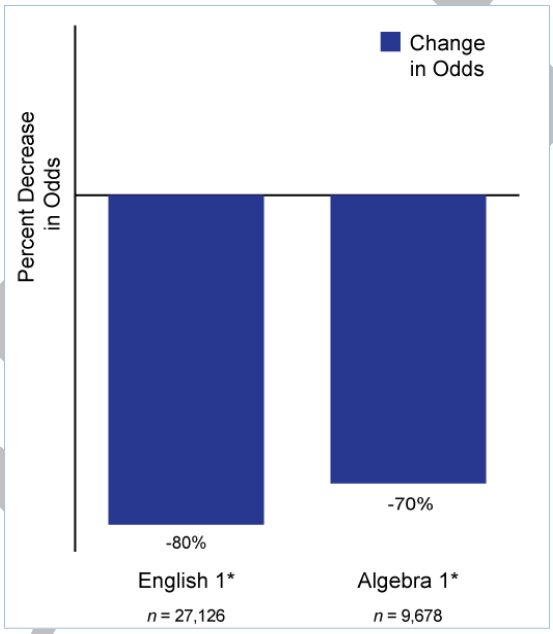


Exhibit reads: FLVS students enrolled in Semester 1 of English 1 had 80 percent lower odds of passing the course than students enrolled in place-based courses in Florida.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

* The difference between students in place-based and online courses was statistically significant at the 95 percent confidence interval.

10 This sample included all students enrolled in Semester 1, including those that went on to enroll in Semester 2.

In contrast, students in FLVS appeared to have an advantage in terms of FCAT scores even when first-semester students were compared (Exhibit ES-6). The FCAT score for Semester 1 English 1 was almost 14 points higher for students in online courses than for those in place-based courses, but the difference fell short of statistical significance. However, the difference for Semester 1 Algebra 1 students was significant, with students in online courses scoring almost 24 points higher, representing an effect size of +0.18. These data seem to suggest that on average, FLVS criteria for passing the first semester of these core courses arelikely to be as rigorous as the criteria “inplace-based courses.

Exhibit ES-6: FCAT Scores of Students in Online Learning Relative to Those of Comparable Students in Place-Based Courses, Semester 1

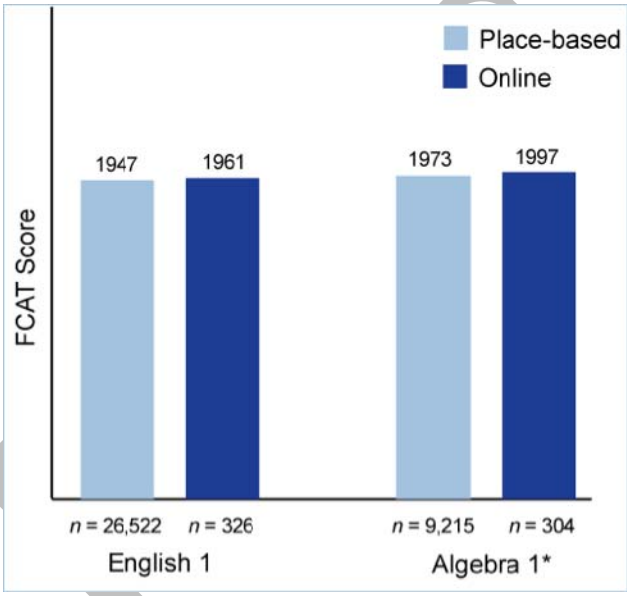


Exhibit reads: Among students enrolled in the first semester of English 1, FLVS students’ FCAT scores were about 14 points higher than the FCAT scores of students in place-based courses, although the difference was not statistically significant. Predicted mean FCAT scores are for the average student in the sample.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

* The difference between students in place-based and online courses was statistically significant at the 95 percent confidence interval.

The major change in Semester 1 versus annual outcomes for online compared to place-based instruction prompted another look at student characteristics. Exhibit ES-7 showsthe demographics of 9th- and 10th- grade students in the final matched samples for each of the courses, who enrolled in Semester 1 courses compared to annual enrollments. Compared to the students who took the first semester of a course online, students who enrolled in the full year of the course are more likely to be white, have somewhat higher prior achievement and are less

likely to qualify for FRPL. In the matched sample for English 1, the mean prior test score for students enrolled in online courses is 55 for Semester 1 students and 60 forstudents who enrolled in the full annual course online and the percent of online student eligible for FRPL drops from 41 percent to 33 percent. The mean prior test score for student who enrolled in Semester 1 of Algebra 1 online is 65, compared to 69 for students enrolled in both semesters online. This finding, in conjunction with the poorer performance of the online students compared to place-based students when considering only Semester 1 outcomes, suggests that students who do not thrive in online courses tend to drop out and not persist into the second semester and that FRPL-eligible students and lower-achieving students drop out of online learning at a higher rate than their higher-achieving peers who do not qualify for the FRPL program

Exhibit ES-7: Demographics for FLVS Students Enrolled in Semester 1 and Annual Courses

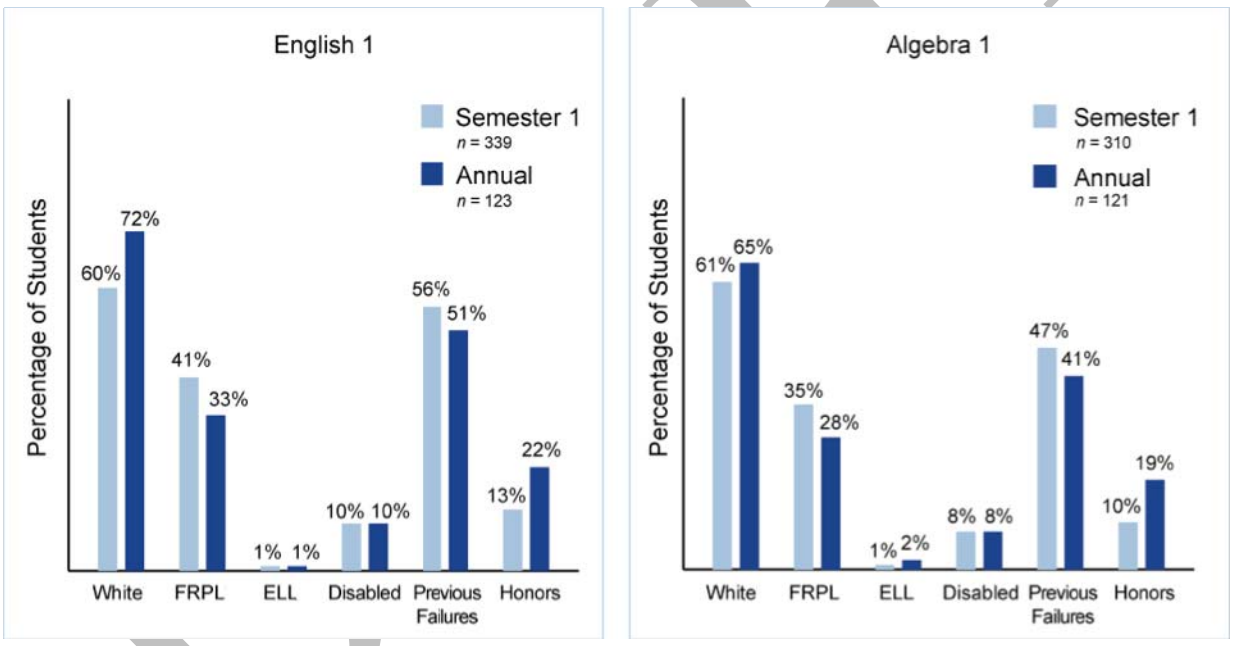


Exhibit reads: Among students enrolled online versions of English 1 with FLVS, 60 percent of students in Semester 1 were white, compared with 72 percent of students who enrolled in the full course.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

Conclusions

Because the research findings documented in this report are based on a small sample of two courses in each of the two sites, they cannot be generalized to a larger set of courses or providers nor can the results be generalized to students not included in the sample. Even with these caveats in mind, the findings suggest that online learning as currently practiced by some mainstream providers is an effective option for some students, but probably not for everyone. This study shows that some students can and do learn online at least on par with their peers in place-based instruction. In Florida, students who completed a core academic course online through FLVS performed better, on average, than students of similar backgrounds who completed the course in regular classrooms in terms of course completion, standardized test scores and final course grades. However, the performance advantage of students in online courses disappeared for most variables when Semester 1 enrollees in online and place-based courses were compared, suggesting that students who persist into the second semester of an online course are more likely to have some important qualities not captured by propensity score matching based on demographics and achievement data. High school teacher respondents suggested that motivation, technical aptitude and the availability of informal academic supports were likely to play roles in student success online.

MAVS data paint a different picture regarding student achievement in online compared to place-based courses, with student outcomes for those enrolled in an online course the same as or worse than their peers in place-based courses. Unfortunately, the available data do not allow for causal inferences regarding differences in student performance between courses within sites or across courses between sites and cannot address questions regarding reasons for differences in outcomes. The variation in findings across two providers, even after controlling for student characteristics such as economic status, gender, race and prior achievement, suggests the need to empirically identify critical implementation features needed to support success in online environments among a broad array of student need, interest and ability.

A deeper and more extended look at instructional components in both place-based and online courses and affordances of each instructional "format" (online or place-based) is required to arrive at informed hypotheses explaining the differences in findings across the MAVS district and the Florida study. Known differences across sites include intensity and duration of teacher professional development, analytic support for continuous improvement systems, scale of operation, course content and funding methods. However, it is not clear whether and how these differences, as plausible as they may seem as explanations, affect student achievement in online and place-based courses.

The study also revealed an opportunity for states and districts to improve the ability of educational data systems to support research and inform decision-making. During the search for potential case studies, it was found that few institutions had data systems that identified whether a course was "online." Similarly, data that would inform questions about "blended learning" (learning that incorporates technology-mediated and place-based instruction) were not identified. If databases include information about curricular format (i.e. fully online, blended, etc), their impact can be more easily studied at relatively low cost.

Lack of data and prior research to inform why learning may be different in one setting over another demonstrate the need for additional research regarding optimal implementations for diverse students. While learning online has demonstrated potential to improve access and improve quality of instruction, the data suggest that secondary students enrolled in online courses differ, on average, from students in place-based courses. The Florida data reported here demonstrated that the students who enrolled in online learning and especially those who persist into the second semester of a core academic course at FLVS, came from more privileged backgrounds than their peers in place-based instruction. Similarly, the MAVS data suggest that both higher prior achievement and higher socioeconomic status are associated with participation in the district's online English 12 and Geometry courses.

Review of demonstration versions of FLVS's English 1 and Algebra 1 course materials indicated that the online courses place heavy demands on students' reading skills. Analysts noted that online course materials were often reliant on text, suggesting that students may need strong communication skills, including writing, to thrive in online learning environments as typically designed. Reading and writing are also required in place-based courses, of course. However, online courses as typically implemented to date seem to rely on text as the dominant form of communication, as opposed to spoken lectures and verbal group discussions that appear more prevalent in place-based courses than online. As a consequence, students who read and write below grade-level may be at a particular disadvantage.

Research and policy are needed regarding the supports necessary for low-achieving students and historically underserved populations, including students with disabilities and English language learners, so that they can fully participate in and benefit from online learning options more fully.Fortunately, practitioners seem to be making progress in finding supports (e.g., on-site facilitators, careful scaffolding of lessons) that may help a wider range of students succeed in online courses. In addition, low-achieving students might benefit from instruction on *how* to learn independently or from curricular materials better designed to cultivate those skills in the context of instruction. These and other modifications appear ready for more empirical study.

As this discussion suggests, the possible reasons fordifferences in student outcomes are many, including administrator and teacher perceptions about who can learn effectively online, course design choices that may better suit particular types of students and basic issues related to

technology access and comfort using technology for academic purposes. Dede, Honan and Peters (2001) have noted that barriers to effectively implementing technologies are not always technical or economic; instead, they may be psychological, organizational, political and cultural. Consideration of these and other potential barriers to online learning will be important to reduce disparity in educational opportunity as online learning expands in elementary and secondary schools.

Introduction to the Report

The term "online learning" represents a wide variety of practices, also called "e-learning," "cyber-learning," "Internet-based learning," and "web-based learning." "Online learning" is used in this report to refer to instruction delivered via the Internet. Unless otherwise specified, "online learning" and "online courses" in this report refer to a course model in which Internet-based materials and communication account for all or most of instruction. In addition, this report uses the term "place-based" to describe K–12 education's usual practice of students meeting face-to-face with teachers and other students in classrooms where a teacher is physically present and delivers all or the majority of instruction to a consistent cohort of students who progress through course content together.[11] Although not addressed here unless explicitly stated, "blended" or "hybrid" instructional approaches that combine online and face-to-face elements in a single course are also emerging as alternatives to online-only learning.

Online learning appears poised to become an important component of the American K–12 educational system. Available evidence suggests that online learning is growing rapidly, although rigorous, recent estimates of online enrollment among elementary and secondary students are not available. A survey of K–12 online providers estimated that 1,030,000 students participated in online learning in the 2008–09 school year, representing an estimated increase of 75 percent in just two years (Picciano and Seaman 2009).[12] The study authors projected that by 2016, six million students, or roughly 9 percent of the estimated national enrollment, could be taking online courses and that nearly half of all high school students would take at least one class online (Picciano and Seaman 2009). Similarly, Watson et al. (2010) found that state virtual schools (one type of online education provider) accounted for about 450,000 annual student enrollments in 2009–10, with many more students enrolled in nonstatevirtual programs. State virtual schools now exist in 39 states; 27 states (and the District of Columbia) offer some other form of full-time statewide online learning option and some states offer both(Watson et al. 2010).

As interest in online learning grows, educational policymakers are seeking sound evidence to judge its impact and guide its implementation. An earlier study found that students who took all or part of a course online performed slightly better on average than those taking the same course through traditional place-based instruction (U.S. Department of Education 2010). The study also found that students enrolled in courses using blended learning performed even better (U.S.

11 Other terms used in the literature to describe this form of education include "face-to-face," "traditional," and "conventional."

12 These estimates should be viewed cautiously because the study's response rate was only 5 percent.

Department of Education 2010).[13] Although findings reported in the meta-analysis are encouraging with regard to the potential for students to learn online as effectively as or better than their peers in place-based courses, caution is required in applying these findings to younger students. Five studies included in the Department's meta-analysis were found to rigorously estimate the impact of online environments on elementary or secondary school students. These studies found outcomes that, although generally positive, were mixed. Three of the K–12 comparisons found significant effects favoring a blended learning condition, one found a significant negative effect for online learning compared to place-based instruction and three reported comparisons that did not attain statistical significance. (Some of the five studies included multiple comparisons.)

To contribute to available evidence of the effectiveness of online learning for K–12 students, this report describes the use of online learning for secondary students in two venues: (1) Florida, with focus on the Florida Virtual School (FLVS), by far the largest state-funded virtual school program in the nation; and (2) a large suburban school district in the mid-Atlantic region, referred to as MAVS for "mid-Atlantic virtual school" throughout this report.These two sites were the only two identified that met inclusion criteria for the study (See Appendix A for additional detail about data requirements and the site selection process).

This report explores the effectiveness of online learning at the secondary level using quantitative data from FLVS and from Florida's Education Data Warehouse (FL EDW) system and from electronic databases maintained by the MAVS district. In both cases, the quantitative data were supplemented with qualitative data collected in interviews, observationsand a review of extant documents. The FLVS study used student-level quantitative data from 2006–07 and qualitative data from site visits to nine districts and FLVS headquarters in 2008 (See Appendix B for additional detail about the methodology and data sources used in the FLVS case study).For the analysis of MAVS student outcomes, researchers aggregated quantitative data from 2006-07 and 2007-08 and collected qualitative data in spring 2008 (See Appendix C for additional detail about the methodology and data sources used for the MAVS case study).

13 The term blended learning has a wide range of definitions. Blended learning is intended to improve the quality of resources available to both teachers and students as well as supplement local teachers' expertise (Graham, Allen and Ure 2003). The U.S. Department of Education's literature review (2010) classified courses as "blended" if between 25 and 80 percent of instruction was delivered online.

Each case study addresses the following three research questions:

1) How do the characteristics of students taking online courses in public school programs compare with those of students enrolled in place-based courses?

2) How does the academic achievement of students in online courses compare with that of their peers in place-based instruction?

3) How were credit-bearing high school courses implemented in case study sites?

Results for outcomes are reported for both studies in their original units. Additionally, effect size data are included to facilitate the inclusion of study results in future meta-analyses. An effect size represents the predicted change in outcome (like a course grade) in a treatment group compared with a control group expressed in standardized units. Cohen's d,a standardized measure of effect size, is reported for course grades and FCAT scores in the Florida study and for course grades and end-of-course exams in the MAVS study. To compare course pass rates, odds ratios were used. An odds ratio is a measure of effect size that compares the odds of an event (passing the course in this case) for students in the intervention group (online instruction) with the odds of the same event for students in the control group (place-based instruction). Every effort was made to conduct parallel analyses, given the differences in the data available from each of the two sites. A more complete comparison of the similarities and differences in approaches across these two case studies is provided in Appendix D.

Because the data sources, methods and limitations of the state and district analyses are specific to the context of the respective sites, this report presents the state and the district studies separately.

Florida Case Study: the Florida Virtual School

Florida was one of two sites identified that could provide adequate data for analysis and had interest in participating in the study (See Appendix A for additional information on research site selection). The Florida case study reported here provides an overview of FLVS policies and practices, a review of the research methods and data used for analysis, examination of the results from analyses comparing student achievement across online and place-based instruction and a discussion of the implications of the data.

Florida Virtual School Overview

Florida, an early leader in online learning for elementary and secondary students, fueled in part by rapid population growth, founded FLVS in 1997—the first state-wide entity to provide online education for secondary students. The Florida Legislature established FLVS as an independent educational entity whose board is appointed directly by the governor. FLVS does not grant diplomas; students earn their diplomas from their school district of record. However, Florida provides FLVS with funds based on the number of student course completions, whereas it funds traditional districts on the basis of enrollment.

Student enrollment in FLVS courses is typically at an individual student's discretion. Students can take multiple online courses. In 2008–09, FLVS served an estimated 64,000 middle and high school students (Young, Birtolo andMcElman 2009) accounting for some 150,000 enrollments (Watson et al. 2009). This suggests that students took, on average, 2.3 courses per year.[14]Public, private and home-schooled students in grades 6–12 may enroll in FLVS courses. Sixty-seven percent of FLVS students attended public and charter schools, 26 percent were home-schooled and 7 percent attended private school (Florida Virtual School 2009). Whereas students outside the state must pay tuition, all Florida residents can take FLVS courses free of charge, although students are still responsible for the cost of a computer and Internet access, which are necessary to participate in FLVS courses.

FLVS makes its courses available in a variety of ways. Typically, a student enrolls directly with FLVS or through his or her district and takes a course 100 percent online. Students may enroll in FLVS courses at any time during the year, but they must also maintain continuous enrollment in their local school or home-school program (Florida Virtual School 2009). When they apply for courses online, they are placed on a waiting list and allowed to select the month when they would like to begin the course (Florida Virtual School 2009). Once enrolled, students can log

14 Data were not available to describe the proportion of students receiving the majority of instruction in one course format or the other.

into their course websites at any time to access lesson materials, hand in homework, complete assessments or post discussion comments.

Districts across Florida are also establishing FLVS franchises, thereby enabling a district to deliver FLVS content to its students using district-hired teachers. In 2008–09, eight of the 67 school districts in Florida were FLVS franchises, increasing to 19 franchise districts in 2009–10. In this model, FLVS staff train teachers and administrators in franchise districts in regard to the FLVS learning management system, its student information system, course content, online instructional strategies and virtual leadership (Florida Virtual School 2010). The franchise district then implements the materials locally, hiring its own teachers and establishing local enrollment policies. Students taking a course through a franchise are more likely to see a teacher face to face, either because the teacher is available for extracurricular activities (e.g., a tutoring session at the local library) or because the teacher also teaches face to face in the district. Three of nine districts in the site visit sample were franchise districts at the time of study.

Instructional Materials

Researchers were given access to demonstration versions of the FLVS English 1 and Algebra 1 courses, which were reviewed to understand and document the affordances of the online interface, the instructional materials available to students and teachers, the opportunities students and teachers have to communicate with one another and the assessments students complete to demonstrate what they know (and do not know) to themselves and their instructors. The features of each course were coded for evidence of research-based practices. Overall, course interfaces appear well-designed and present clear and pertinent information, opportunities for reflection and practice and timely feedback. The Algebra 1 and English 1 courses met relevant national and state standards and provide lessons that allow students to gain a comprehensive understanding of the topics.

Working with parents or guardians and an instructor, students are able to plan and adjust the pace of a course. To cover the full Algebra 1 course, students who follow the traditional course pace budget eight hours a week—two hours a day, four days a week—to complete the course in 32 weeks. English 1 students following the traditional course pace complete the course in 36 weeks. Students may accelerate or slow the pace of the course to meet their scheduling and learning needs. Shifts in pace affect the number of hours students are expected to spend on a course each week as well as target completion dates. For example, English 1 students can complete the course at an accelerated pace in 16 to 18 weeks. Students in both courses are encouraged to move sequentially through the lessons and assessments, even though they can access any part of the course at any time (Florida Virtual School 2009). Assessments are also available at any time. However, once students begin an assessment, they cannot navigate away from the site and then return to it.

Course Structure

Lessons are organized in thematic units called modules. Algebra 1 consists of 10 modules and the concepts and skills contained in each module are connected to a different real-world activity such as travel, communications, sports and leisure, business and the health industry. In addition to core algebra content, Algebra 1 curricular goals include skill-building in areas such as communication, reasoning and problem solving. English 1 includes nine modules, each concentrating on a different literary genre, such as nonfiction, novels, short stories, poetry and drama. Vision is the overall course theme. Each English 1 module contains lessons that help students focus on what they will be doing (Focus On activities), consider things from multiple perspectives (Double Vision) and concentrate on a single idea (Tunnel Vision).

In addition to modules, English 1 students have ongoing assignments such as the Independent Novel Project. Books recommended for all English students include James Baldwin's *Go Tell It on the Mountain*, Ray Bradbury's *Fahrenheit 451* and Sandra Cisneros's *House on Mango Street*. George Orwell's *Animal Farm* and Yann Martel's *Life of Pi* are recommended for honors students or for students who will be reading their book selection online. A webpage includes a one-paragraph summary of each book, the book length and a measure of how difficult the text is to comprehend.

The curriculum specifies that students keep and organize physical records of their assignments and assessments into a travel diary for the Algebra 1 course and a portfolio for the English 1 course. Students review their diaries or portfolios to prepare for assessments and to work toward successfully completing the course. Thus, in addition to ready access to a computer and the Internet, students also need access to printers and related supplies.

Organizational aides are embedded in the curriculum. An introductory checklist at the beginning of each module clearly sets forth expectations, providing a syllabus that includes the expected duration of assignments, how many points the assignment is worth toward the final grade and a place for students to record their scores. Each module also includes learning objectives. In addition, students in English 1 find helpful reminders of ongoing activities that they should be working on (e.g. reviewing Stanford 10 vocabulary lists) or need to complete in the near future (e.g. selecting a novel for an independent reading project). Algebra 1 did not include this kind of review.

Lessons are generally text-based, requiring students to read to learn. The Flesch-Kincaid Grade Level for the Algebra 1 Module 1 is 6.2, suggesting that the text should be easily understandable

by middle and high school students reading at or near grade level.[15] After reading and working through a lesson, students access practice problems that enable them to test their understanding of the new material. Algebra 1 students check their answers by selecting *Check Your Answers* at the bottom of the practice page. After practicing, students access the exercises page and complete problems for points. Algebra 1 students complete hands-on labs by gathering, analyzing and interpreting data from the real world. In one lab, students explore the properties of pendulums and motion by building a simple pendulum, recording measurements in a table, plotting points on a graph and then making inferences based on trends. Some but not all students have access to *Mathtype,* a commercial application that generatesmathematics symbols and equations more easily on the computer. (In focus groups, some students indicated difficulty in generating mathematics equations as a barrier to learning mathematics on the computer.)

Typical Interaction Opportunities

Interactions in FLVS courses occur primarily between individual students and course materials and between individual students and their instructors. Communication between instructors and Algebra 1 and English 1 students occurs both asynchronously through discussion boards and emails and synchronously by way of telephone and instant messenger. FLVS requires that all students receive a welcome call from their instructor on enrollment and that the call must be completed before a student can begin working on assignments (Florida Virtual School 2009). FLVS also requires instructors to interact with their students regularly via phone conversations and voicemails and through tools built into the FLVS courseware such as email and instant messenger. When the need arises, students are encouraged to contact their instructors from 8 a.m. to 8 p.m. Monday through Friday, as well as during weekend hours and instructors are also required to speak with their students and with parents once a month by telephone (Florida Virtual School 2009).

FLVS offers several learning and technical support resources to students. Students can call or email their instructor when they need help. The instructor provides individual students with feedback by answering course-related questions and by reviewing and commenting on student work. For technical issues, students contact the FLVS Support Center for help in registering for courses, retrieving passwords, installing software and in resolving issues related to the grade book, audio/video tools, mathematics-related Java applets and broken links.

FLVS Algebra 1 and English 1 courses collect information about students' prior knowledge and experiences and incorporate it in instruction. From pretests, ongoing conversations with

15 The Flesch-Flesch–Kincaid readability tests indicate the difficulty of comprehending a given passage of contemporary English. The difficulty of the text is scored in terms of grade levels, with most journalistic writing (considered a median adult level) scored at the eleventh-grade level (DuBay 2004).

studentsand review of assignments, instructors are aware of what students know and what they are struggling to understand. Students are encouraged to reflect on their understanding of course content by making sure they are ready to move on to the next activity. However, other than the opening module, which provides general recommendations on how to complete the course successfully, the online courses do not provide regular prompts to remind students to reflect on their thinking or what they have just learned.

Instructors of both courses host synchronous chats frequently throughout the week through the interactive whiteboard and chat room, which allows students to interact with the instructor as they might in a face-to-face environment. In addition to the instructor, online resources such as *Math.com* and *Purdue Online Writing Lab* lessons provide help with specific topics and skills. English 1 lessons, unlike Algebra 1 lessons, link to relevant video and audio clips to reiterate key concepts that can be especially troublesome to students.

Assessment Techniques

Algebra 1 and English 1 are assessment-centered courses. Each day, students are instructed to: (1) read the course email, (2) review work commented on and graded by the instructor, (3) enter grades into their notebook and (4) study before beginning an assessment. Students can submit each assignment twice. The instructor reviews the first submission and, if it is satisfactory, assigns it a grade. Students can make revisions and submit an assignment a second time for a final grade.

Students complete various kinds of assessments, including pretests, quizzes, evaluations, tests and exams. The Algebra 1 semester exam accounts for 20 percent of a student's course grade and students must pass the exam to earn course credit. Each Algebra 1 module includes a pretest, lessons, practice sets, exercises, quizzes, tests, labs, optional honors activities and an end-of-module exam. If students know little to nothing about the module content, they can skip the optional pretest and move directly to the lessons. If students choose to complete the pretest, they are asked to do so without outside assistance or tools such as a calculator. The pretest results are used to determine what students already know about the concepts taught in the module. After students submit the pretest, they are instructed to follow the sequence of lessons in the module until contacted by their instructor, who grades the pretest and determines which assignments, if any, the student can skip.

All Algebra 1 assessments are timed (1.5 to 2.5 hours) and once students begin the assessment, they cannot stop the clock or return to the page if it is closed. English 1 assessments are not timed. Theytend to have fewer questions and include multiple-choice, true-false, fill-in-the-blank, or essay questions. After an assessment is submitted, some items are autograded, with students shown immediately which items they answered correctly and which they did not.

Students are not told the correct answer for the questions they missed. The instructor scores the other items.

Summary of the Florida Study Research Methods and Data Sources

Data Sources

The state study drew on a variety of sources, including:

- Student demographic and achievement data obtained from the Florida State Department of Education for 2006–07
- Student enrollment data for 2006-07 from the FL EDW (for place-based students) and from FLVS (for students who took the courses online)
- Qualitative data from interviews, focus groups and observations in nine districts and at two FLVS sites in Florida in 2008.
- Other quantitative and qualitative data from FLVS, including independent review of demonstration versions of course materials

English 1 and Algebra 1 were selected in Florida because of their large enrollments and their importance in school progression and graduation.

Researchers used the qualitative data collected during the site visits in 2008–09 to describe implementation characteristics of online learning not available in quantitative data sets, including student motivations for enrolling in online courses and perceptions of their experience. Efforts were also made to note variations of online learning models in use in Florida and to seek emerging practices that practitioners have identified as effective. A purposeful sample of 10 districts was selected on the basis of quantitative analysis of district-level student achievement in order to identify districts with typical or above average student outcomes.[16] District selection also took geographic location, district size and other characteristics into account to ensure variety. Appendix B provides additional details about the selection process.

Whenever possible, two researchers conducted onsite interviews with teachers and administrators, led student focus groups and observed place-based courses. In total, they asked approximately 75 administrators, 12 teachers and 40 students about online instructional design; communication and instructional support for online learning; online instructor recruitment,

16 Districts with lower than average student outcomes in online courses were omitted due to concern that districts with below-average achievement may have problems not specific to online learning (e.g. leadership transitions, poorer school climate) that would limit value of information collected. Unforeseen obstacles precluded the participation of a tenth district.

characteristics and training; technical support for online learning; quality assurance; facilitators and barriers to online learning; costs and benefits of online learning; financing models for online learning; student demographic information; and student perspectives and experiences with online learning.

Quantitative Methods

A post hoc quasi-experimental design was used to compare student outcomes in online Algebra 1 and English 1 courses with student outcomes in place-based courses. Analysts first compared the composition of students enrolled in online and place-based versions of the two courses using a chi-squared test of independence for proportions and a t-test of difference in means for continuous variables. After determining that there were statistical and substantive differences between online and place-based students enrolled in both courses, analysts used student propensity scores as well as student grade level and district to match students in online courses with similar students in place-based courses.[17] Propensity scores were calculated by grade level using the student characteristicand prior achievement indicators listed in Exhibit B-1. To reduce variation in student enrollment patterns and outcomes related to differences in course content, all comparisons were for students taking the same course, whether online or in a conventional classroom setting. Comparing students taking the same courses reduces variation in student achievement associated with course content (Dickson 2005).

To compare outcomes for the matched set of students, analysts used a two-level hierarchical model, with students nested in districts. Researchers compared mean predicted outcomes for the matched samples of students enrolled in the two courses. They analyzed three outcomes: (1) whether or not a student passed the course, (2) student grades in the course as assigned by teachers and (3) SY 2006-07 student-level scores on the Florida Comprehensive Assessment Test (FCAT), a standardized test specifically designed to align with the curriculum in Florida. Because the FCAT scores were available only for 9^{th-} and 10^{th-}graders, the analyses were conducted using a restricted sample of students enrolled in place-based and online versions of the courses from these grade levels only. The predicted mean effect of taking the course online was similar to those estimated using the full sample of students for the course passing and course grade outcomes. Appendix B provides additional details about the matching procedures and achievement models.

17 Analysts used caliper matching with replacement to match each online student with all students from the same grade level and district who enrolled in the placed-based versions of the same course and whose propensity score (in logits) was within .20 caliper of the online student (in standard deviations of the online student's propensity score).

Two student populations were analyzed: (1) students enrolled in both semesters of English 1 or Algebra 1 during 2006–07 and (2) students enrolled in the first semester of English 1 or Algebra 1 during 2006–07. Although the first of these populations is a subset of the second, the two populations differed from each other in significant ways, as discussed below. This report focuses on student enrolled in both semesters, also referred to as annual enrollments.

Multiple outcomes were used in order to try to balance the strengths and limitations of individual outcomes. For example, course grades are in many ways problematic as an outcome because teachers may vary in grading stringency and the components they use to grade students (e.g., tests, quizzes, homework, classroom participation). Nevertheless, course grades were included as one outcome because of the influence they have on future course-taking patterns, graduation rates and college-going rates. FCAT scores were also included as an outcome measure because students in both online and place-based versions of a course took the same FCAT, which measured their attainment of grade-level standards in spring 2007 (toward the end of their course work). Standardized outcomes (effect sizes) were calculated to allow easy comparison across multiple measures. Reporting data for effect sizes also facilitates inclusion of study results in future meta-analyses regarding online learning.

Trained analysts conducted qualitative analyses of the site visit interviews using interview transcripts, interview notes, site summaries prepared by the research team and additional materials respondents provided.

Limitations of the Research Approach

Researchers systematically identified the best data available for the analyses. However, the post hoc nature of the quasi-experimental design presented in this report has inherent limitations associated with models that do not account for "selection bias," caused by student self selection into either the online or place-based instructional format.[18] To control for errors associated with selection bias, researchers used quantitative data to "match" students across course formats in regard to data associated with student academic status. Those data included students' demographic and previous academic achievement data obtained from the Florida State Department of Education. By identifying statistically similar students across groups, researchers controlled for variation associated with those characteristics. However, research suggests that students who enroll in online courses differ from their peers in place-based courses in ways that district and state educational databases do not capture (Kozma and Zucker 2003). Online students are more likely than other students to be home-schooled, homebound, or athletes who

18 Selection bias occurs when students self-select into online learning, as is often the case. This situation presents the possibility that students who choose one format over another differ systematically in ways that are not captured in the available data, thereby biasing the estimates derived from the models.

travel often. Other unobserved student characteristics (e.g., technological aptitude, maturity, motivation) may also influence both the decision to take a course online and success in an online environment. An experimental study that uses random assignment would provide a more definitive test of the impacts of online learning.

The data are further limited by the absence of a grade point average (GPA) as a measure of prior achievement; a high proportion of missing cases for some of the variables from FL EDW, particularly for free or reduced-price lunch (FRPL) eligibility for grade 8 and tests scores; and loose coupling between quantitative and qualitative data. Using course grades as an outcome also entails limitations as described below along with descriptions of attempts to minimize their effects when possible:

- The FL EDW provided only one measure of prior achievement, Stanford 10 test scores and was not able to provide students' high school GPAs from the prior year. Because FL EDW does not maintain a point-in-time GPA, the GPAs received were largely from the end of the 2006–07 and could not be used as a measure of prior achievement. As a result, analysts had to rely on Stanford 10 test scores as the sole measure of prior achievement.
- One of the challenges of building the dataset for analysis was the high proportion of missing cases for some variables, particularly test scores. Data on whether a student received FRPL in eighth grade were also missing for many students, further reducing the analytic sample.However, with few exceptions, online students included in the analytic sample (used for matching) did not differon demographic and prior achievement indicators from those excluded from the analytic sample.[19] There were more differences between students enrolled in place-based courseswho were included and excluded from the analytic sample due to missing data. However, the fact that students enrolled in place-based courses were matched with online students and then weighted in the final analysis weakens the impact of the attrition pattern for the students in place-based courses. Please see Appendix B for detailed attrition information.
- Inferences relating qualitative and quantitative data should be viewed tentatively because the qualitative data were collected two years after the quantitative data. Respondents suggested that many changes had occurred on sites during the two-year interval. Changes included revisions to course materials at FLVS as well as changes in implementation in various districts such as scale of program, identify of teachers in both course formats and supports provided to students.

19 To be categorized as different, the difference must be greater than 10 percentage points for dichotomous variables or translates to an effect size of greater than 0.2 for continuous variables in addition to being statistically significant at the 0.05 significance level.

Student Demographic Analysis

Analysts compared the demographic and achievement records of students taking FLVS courses in English 1 and Algebra 1 in 2006–07 with those of FL EDW records for students enrolled in place-based courses in each of these two subjects across the state. For both courses, the students in online courses differed in terms of eligibility for FRPL, ethnicity and English learner status (Exhibit 1).[20]This finding suggests that students who were minorities, economically challenged or learning English as a second language were less likely in a given school year to be enrolled in FLVS English 1 or Algebra 1 courses than their peers who were white,[21] economically advantaged and native English speakers (English 1 courses specifically for speakers of other languages have separate course codes and were not included in the analysis).For Algebra 1 only, students with disabilities were less likely to enroll in the online version of the course. All of these differences were statistically significant.[22]

20 Rates of online enrollment among males (51 percent) and females (49 percent) were not statistically different from each other or from rates of enrollment in place-based courses.

21 In the FLVS study, the ethnic categories "White" and "Black" exclude students of Hispanic origin.

22 The Study is not meant to address the accessibility of online courses to ELL students and students with disabilities, nor does it specifically discuss (in a disaggregated manner) their levels of achievement in such courses. The sample size for students with disabilities, ELL students and students of other disadvantaged subgroups was too small to support subgroup analyses. Findings reported for these subgroups may change significantly when a larger sample is taken.

Exhibit 1: Demographics for Students Enrolled in Annual Course

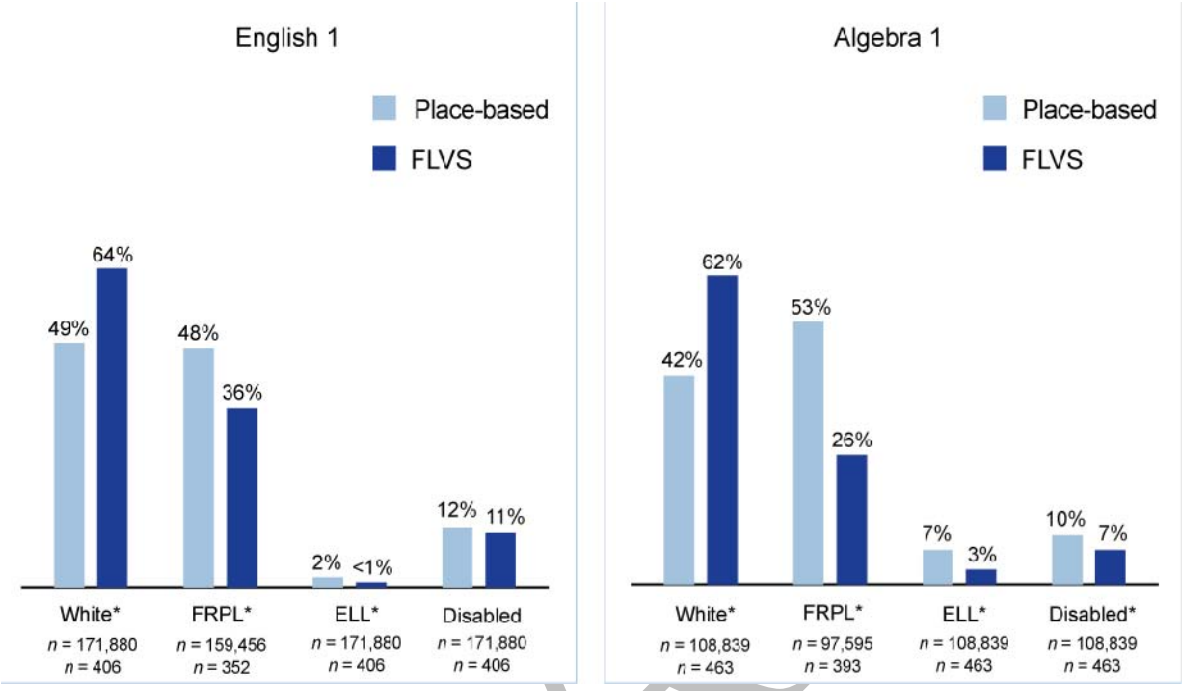


Exhibit reads: Among students enrolled in both semesters of English 1, 49 percent of students enrolled in place-based versions were white, compared with 64 percent of FLVS students.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

* The difference between students in place-based and FLVS courses was statistically significant at the 95 percent confidence interval.

Poorer students may be less likely to participate in FLVS because of lack of convenient computer and Internet access. Students typically engage with FLVS courses outside of formal school settings, although site visitors saw other models of FLVS-use in case study districts (see the *Implementation of Online Learning in Florida* section below). FLVS seeks to improve access among students without Internet-connected computers at home by reducing technology access barriers through the Foundation for Florida Virtual School (Exhibit 2).

Exhibit 2: An Effort to Improve Equitable Access to the Internet

Established in 2000, the Foundation for Florida Virtual School (the Foundation) is FLVS' philanthropic arm. In fall 2008, after the Foundation's website announced a newly expanded laptop loan program, numerous requests were received from FLVS families who wanted to take advantage of the laptop loans—several thousand requests were received for the few hundred laptops available. Unable to accommodate all the requests, the Foundation removed the announcement from its website. The Foundation also faced other difficulties with its laptop loan program. For example, many students did not voluntarily return the laptops at the end of the course. Moreover, with only one full-time employee, the Foundation did not have the resources to actively manage the program.

As a result, the Foundation modified "Laptops for Learners" by eliminating direct loans to students. Instead, the Foundation now concentrates on providing laptops to community centers, which in turn make them available to students. The Foundation had provided several hundred laptops to public libraries in three counties and planned to expand the program to libraries and community centers in 13 more counties in 2010. The equipment remains the property of the Foundation, but no termination date is specified for the extent of the loan. The libraries provide the laptops to anyone who requests them on a 1-hour basis, with the condition that the equipment is not to leave the premises. Laptop users must provide a library card but are not required to show proof of enrollment in FLVS. The Foundation hoped that FLVS students would take advantage of the community centers for a wide range of resources, including the provision of free wireless access. The Foundation was concerned, however, that some at-risk FLVS students could not take advantage of the laptops because they either did not possess a library card or had unpaid library fees that prevented their card from being active.

The Foundation's website indicated it provided the following support in 2009: 300 FLVS students received laptops on loan; 30 community organizations, public libraries and e-learning centers were supplied with laptops, headsets and printers.

Sources: Email correspondence and phone interview with Raven McElman, Foundation Executive Director, April 2010. FLVS Foundation website: flvsfoundation.com.

Students enrolled in FLVS English 1 and Algebra 1 also differed from their counterparts in place-based courses in that they were more likely to have previously failed the course (Exhibit 3). For students enrolled in English 1, online students were 13 times more likely than enrollees in place-based versions of the same course to have failed the course previously. For Algebra 1, online students were four times more likely to have failed the course in the past.

Exhibit 3: Percentage of Students Who Previously Failed English 1 and Algebra 1

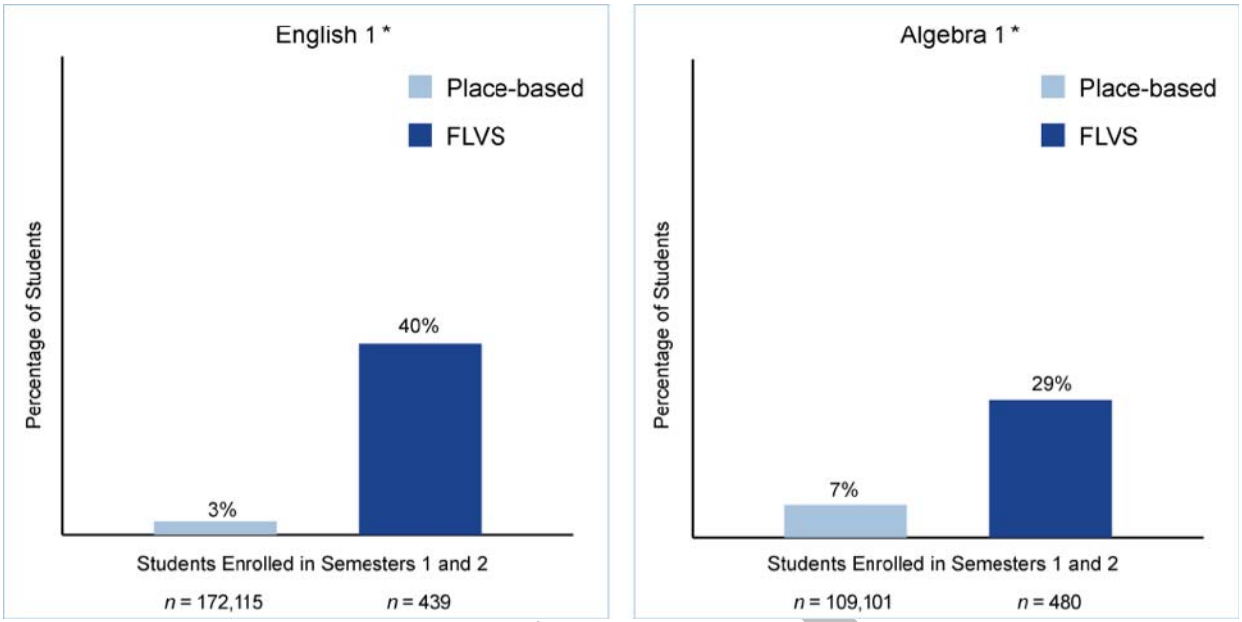


Exhibit reads: Among students enrolled in both Semester 1 and 2 of English 1, 3 percent of students enrolled in place-based versions of the course had previously failed the course, compared with 40 percent of FLVS students.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

* The difference between students in place-based courses and students in FLVS courses was statistically significant at the 95 percent confidence interval.

As the greater frequency of previous failures among FLVS students suggests, students enrolled in English 1 and Algebra 1 with FLVS were more likely than classroom enrollees to be in grades other than grade 9 (Exhibit 4). In addition to students in higher grades who may have failed Algebra 1 earlier, the FLVS Algebra 1 enrollment included more eighth graders than did place-based Algebra 1 classes.

Exhibit 4: Grade-Level Distributions of FLVS Students and Students in Place-Based Courses

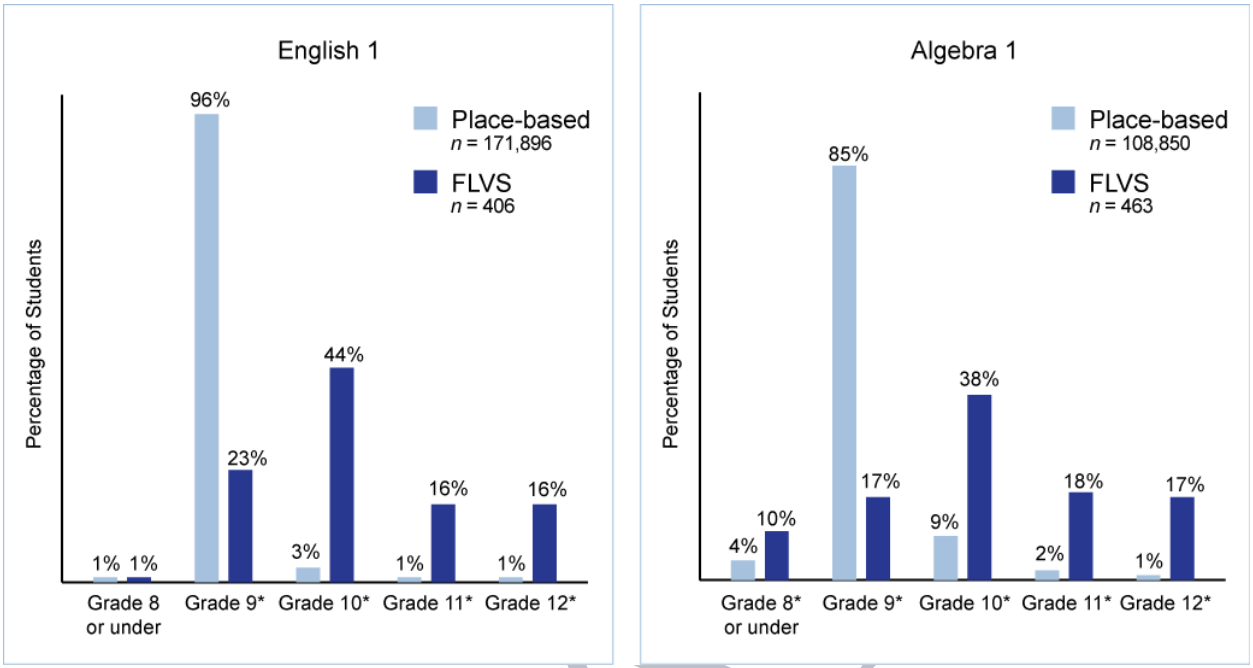


Exhibit reads: Among students enrolled in both Semester 1 and 2 of English 1, 96 percent of students in place-based versions of the course were 9th graders, compared with 23 percent of FLVS students.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

* The difference between students in place-based courses and students in FLVS courses was statistically significant at the 95 percent confidence interval.

These data suggest that although credit recovery is a major purpose for taking English 1 and Algebra 1 online, students also use the Algebra 1 online option to accelerate their mathematics programs. Students in focus groups in case study districts also indicated that access to courses not available locally as a motivating factor in enrolling in an online class.[23]

The significant differences in student characteristics such as previous failures and grade level need to be accounted for in analyses comparing the performance of online and place-based course enrollees.

Mean prior Stanford 10 scores across students in FLVS and place-based courses were similar for English 1 and different for Algebra 1. English 1 students had an average Stanford 10 score of

23 Through FLVS alone, students have access to more than 90 courses spanning core academic subjects and electives (Florida Virtual School 2009).

59.8 compared with an average score of 59.1 for students in place-based courses. Algebra 1 students had a larger point differential—an average Stanford 10 score of 68.3 for FLVS students versus 61.6 for students in place-based courses. This difference is statistically significant at the 99confidence interval.

Student Achievement Analysis

For the present study, analysts controlled for the significant existing differences between the two groups using propensity score matching to select a sample of students enrolled in place-based courses who were comparable to FLVS studentson observed student characteristics (Appendix B describes the matching process and methodology in greater detail). As discussed in the data limitations section, selection bias may still introduce error to estimates given that the full-range of potentially relevant context data andstudent characteristics (e.g., student access to adequate technology, student technological aptitude and motivation) were unavailable for inclusion in the statistical models.Three outcome measures were used to compare student achievement in FLVS courses with students in place-based instruction: odds of passing the course, course grade and a standardized FCAT achievement score.

In a matched comparison of 9th- and 10th-grade students in FLVS and place-based courses, the odds of passing the course were equivalent for FLVS students compared to students in placed-based courses(18 percent greater for English 1; 35 percent greater for Algebra 1) (Exhibit 5).

Exhibit 5: Change in Odds of FLVS Students Passing a Course Relative to Those of Comparable Students in Place-Based Courses, Annual Enrollments

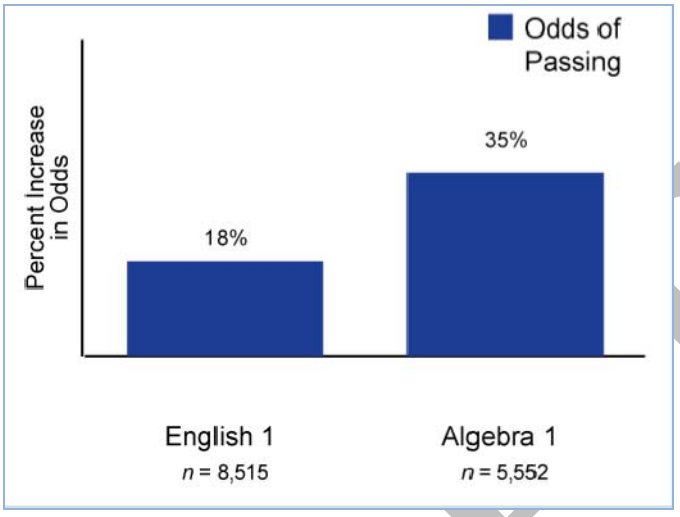


Exhibit reads: FLVS students enrolled in both Semesters 1 and 2 of English 1 had 18 percent greater odds of passing than did students in place-based courses.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

* The difference between place-based and FLVS students was statistically significant at the 95 percent confidence interval.

FLVS 9th- and 10th-grade students were more likely to receive better grades than students in the place-based version of the course (Exhibit 6). The analysis considered non-completers to be failures, with a grade of zero on the traditional 4-point grading scale. The predicted mean end-of-course grade for FLVS students in English 1 was 0.56 grade points higher than that of place-based students. The predicted mean course grade for FLVS students in Algebra 1 was 0.35 grade points higher thanthat of place-based students. This represents an effect size of about .47 in favor of online learning for English 1 and an effect size of 0.30 for Algebra 1.

Exhibit 6: Course Grades of Students in FLVS Semesters 1 and 2 Relative to Those of Comparable Students in Place-Based Courses

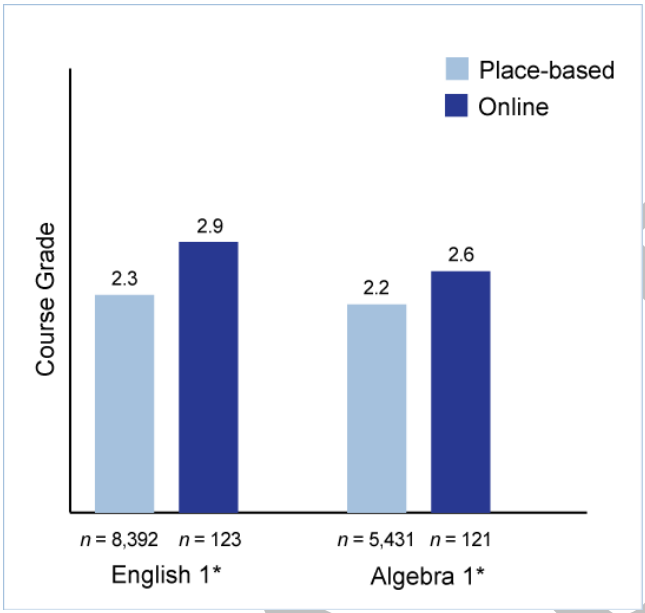


Exhibit reads: Among students enrolled in both semesters of English 1, FLVS students' course grades were about 0.6 points higher on average than grades for students in place-based courses. Predicted mean course grades are for the average student in the sample.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

*The difference between place-based and FLVS students was statistically significant at the 95 percent confidence interval.

FLVS receives its funding on the basis of the number of students completing each course segment rather than on the number enrolled—an arrangement that could be construed to give FLVS an incentive to be lenient about passing students who take an online course. The higher predicted mean grades and tests scores of online students could be explained by more lenient grading or passing criteria of FLVS teachers;however, FLVS students also had higher mean predicted FCAT scores than comparable students in the place-based version of the course (Exhibit 7), suggesting that students with similar prior achievement levels learn more in the online environment that their place-based peers. The effect size for English 1 was 0.16 and the effect size for Algebra 1 was 0.28. This suggests that the FLVS grading system is at least as rigorous as those found in place-based instruction.

Exhibit 7: FCAT Scores of FLVS Students Relative to Those of Comparable Students in Place-Based Courses

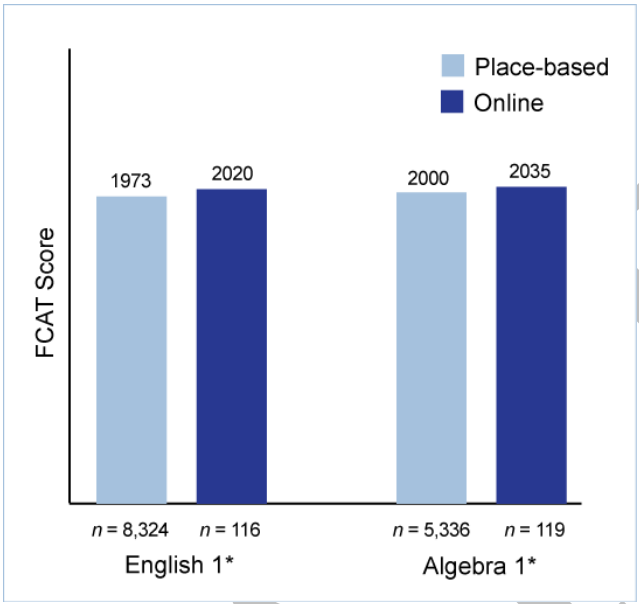


Exhibit reads: Among students who enrolled in the Semesters 1 and 2 of English 1, FLVS students' predicted mean FCAT scores were about 47 points higher on average than the FCAT scores of students in place-based courses. Predicted mean FCAT scores are for the average student in the sample.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

*The difference between place-based and FLVS students was statistically significant at the 95 percent confidence interval.

Students enroll in FLVS courses one semester at a time and those who do not complete the first semester are unlikely to enroll in the second semester. For this reason, the analyses reported above were repeated for Semester 1 students in FLVS and place-based versions of English 1 and Algebra 1. When the comparison was made at the end of Semester 1 rather than at the end of the year, the advantage for course completion and course grades changed to favor students in place-based versions of the courses. English 1 students enrolled in Semester 1 of the course with FLVS had an 80 percent decrease in the odds of passing compared with their peers in place-based courses (Exhibit 8). Similarly, online Semester 1 Algebra 1 students had a 70 percent decrease in the odds of passing compared with students in place-based Algebra 1 courses.

Exhibit 8: Odds of FLVS Semester 1 Students Passing a Course Relative to MatchedStudents in Place-Based Course

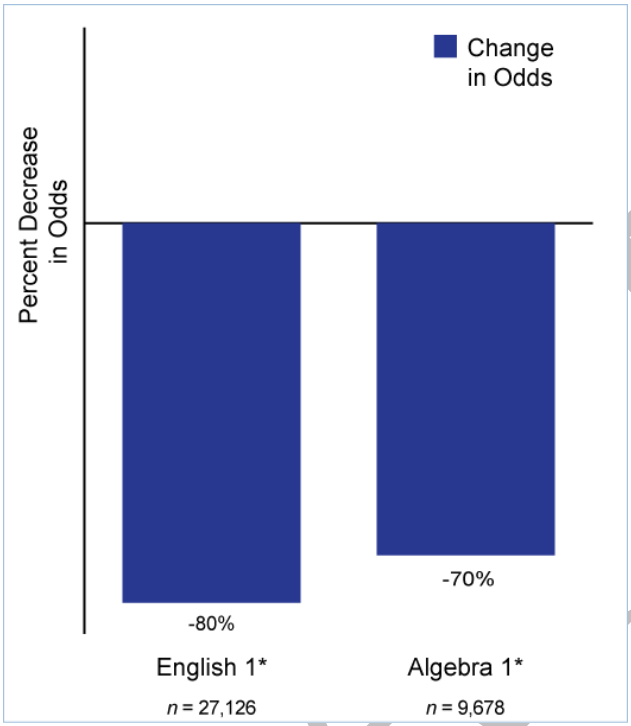


Exhibit reads: FLVS students enrolled in Semester 1 of English 1 had 80 percent lower odds of passing the course on average than students enrolled in place-based courses.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

*The difference between FLVS students and students in place-based courses was statistically significant at the 95 percent confidence interval.

In contrast, students in online versions of English 1 appeared to have better end-of-year FCAT scores, even when the samples of online and place-based students enrolled in the first-semester were compared (Exhibit 9). The difference for Semester 1 students in English 1 fell short of statistical significance, with students in online versions scoring 14 points higher on average. However, the difference for Semester 1 Algebra 1 students was significant with students in online versions scoring 24 points higher on average, representing an effect size of +0.18.

Exhibit 9: FCAT Scores of FLVS Semester 1 Students Relative to Those of Comparable Students in Place-Based Courses

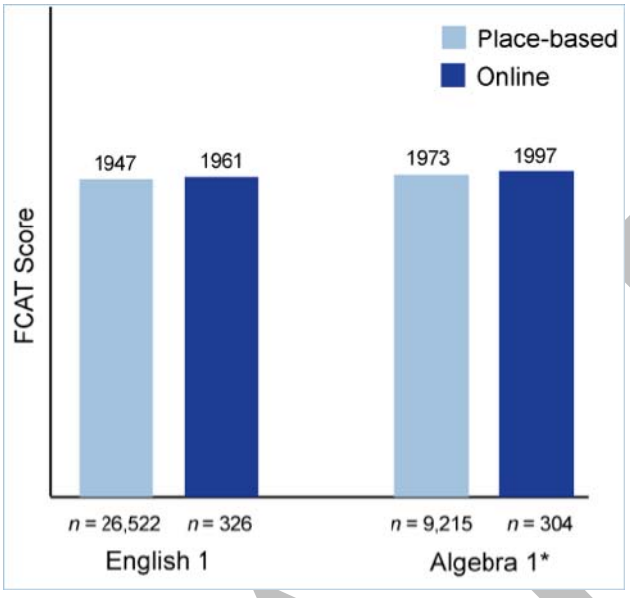


Exhibit reads: Among students enrolled in Semester 1 of English 1, FLVS students' FCAT scores were about 14 points higher on average than FCAT scores of students in place-based courses. Predicted mean FCAT scores are for the average student in the sample.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

*The difference between students in FLVS students and students in place-based courses was statistically significant at the 95 percent confidence interval.

The major change in Semester 1 versus annual outcomes for online compared to place-based instruction prompted another look at student characteristics. Exhibit 10 shows the demographics of 9th- and 10th- grade students in the final matched samples for each of the courses, who enrolled in Semester 1 courses compared to annual enrollments. Compared to the students who took the first semester of a course online, students who enrolled in the full year of the course are more likely to be white, have somewhat higher prior achievement and are less likely to qualify for FRPL. In the matched sample for English 1, the mean prior test score for students enrolled in online courses is 55 for Semester 1 students and 60 forstudents who enrolled in the full annual course online and the percent of online student eligible for FRPL drops from 41 percent to 33 percent. The mean prior test score for student who enrolled in Semester 1 of Algebra 1 online is 65, compared to 69 for students enrolled in both semesters online. This finding, in conjunction with the poorer performance of the online students compared to place-based students when considering only Semester 1 outcomes, suggests that students who do not thrive in online courses tend to drop out and not persist into the second semester and that FRPL-eligible students and lower-achieving students drop out of online learning at a higher rate than their higher-achieving peers who do not qualify for the FRPL program.

Exhibit 10: Demographics for FLVS Students Enrolled in Semester 1 and Annual Courses

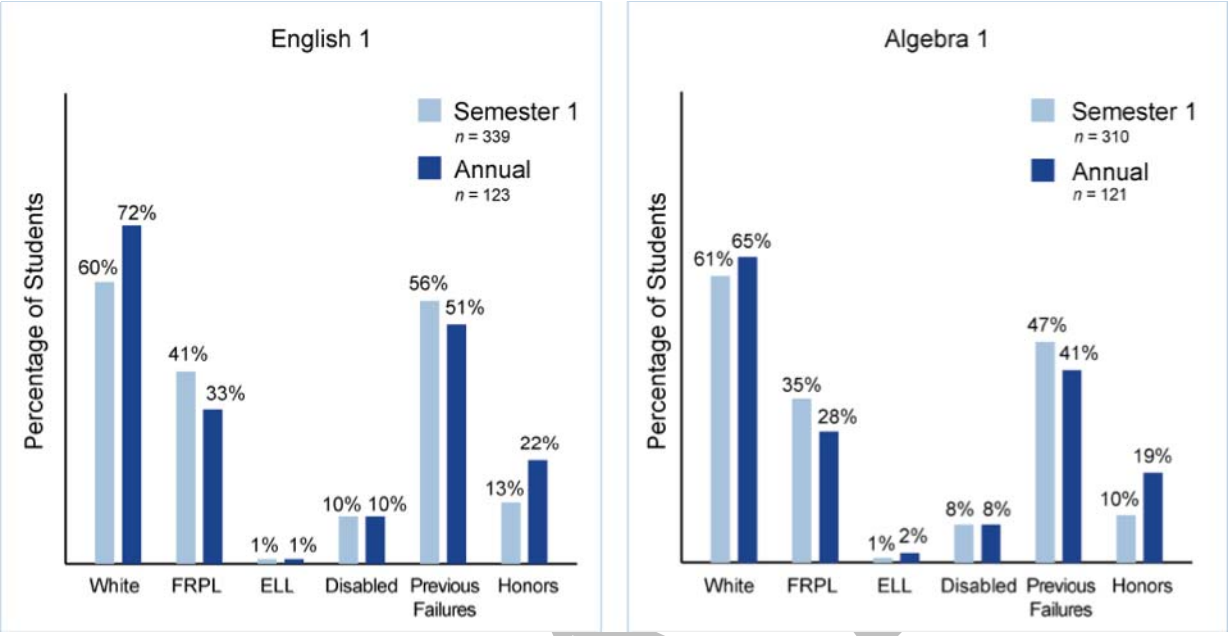


Exhibit reads: Among students enrolled online versions of English 1 with FLVS, 60 percent of students in Semester 1 were white, compared with 72 percent of students who enrolled in the full course.

Source: Division of Accountability, Research and Measurement, Florida Department of Education.

The implication of this difference between the demographics of Semester 1 and annual enrollees is that non-white FRPL-eligible students were more likely to choose to leave the online environment after Semester 1 or to fail to pass Semester 1. Unfortunately, data are lacking on whether students taking only Semester 1 returned to conventional classrooms for Semester 2 or failed to earn a full credit. FLVS interviews indicated that some students entered Semester 1 online without intending to take Semester 2. Nor do the data identify differences in motivation or circumstances of the students who took only Semester 1 online compared with students who take took both semesters.

More research is needed to examine why students do not persist in online learning (e.g., as a result of lack of access, temperament, skill deficiencies, or other factors). Theanalysis of student demographic information as well as the site visit data described in the following section suggest that students often took an online course because they needed an alternative; for example, they had failed a place-based version of the course and needed to make up the class while keeping pace with their grade-level cohort, or they were hospital- or home-bound, or they had other scheduling challenges like work or family responsibilities.

Implementation of Online Learning in Florida

Despite the dominance of FLVS in Florida and in other K-12 online learning systems across the United States, site visitors found a wide diversity of online learning providers in Florida districts (Exhibit 11). These providers, although less rigorously studied than FLVS, also constitute a part of the online learning environment among Florida's K–12 student population.

District administrators indicated several reasons for selecting one provider over another, or for selecting multiple providers at the same time to meet a diverse range of students needs. Teachers, students and administrators directly involved in FLVS indicated that the FLVS courses are rigorous. Some districts, in fact, are concerned that low-performing students struggle in FLVS because it is too challenging.

Administrators affiliated with online programs in case study districts wanted answers to the following questions about serving struggling students with online resources: What is the alternative for these students if the online option fails? How can online learning be made more welcoming to these students? At least three of the 9 districts included in the FLVS site visit sample combine online courses with face-to-face interaction: students gather in a classroom or computer lab setting and may work on the same or different courses. A proctor, although often not highly qualified for the particular online course or courses, serves as a learning mentor by making sure that students stay on task, answering their questions and ensuring that the technology is available and running smoothly.

Schools using this hybrid model have chosen to do so at the suggestion of vendors or have decided that students benefit from structured access to course materials. Respondents consistently suggested that this model provided students with the additional support they needed. For example, one school visited did not have a qualified teacher available to teach algebra and thus enrolled eighth grade students in a proctored FLVS Algebra class. A mathematics teacher with elementary credentials that did not include algebra served as proctor, grouping students working on similar lessons together so that they could readily help each other and also monitoring students to make sure they focused on their Algebra assignments. This teacher suggested that students should move from one group to another each week. FLVS has also started encouraging that adaptation be made to its original model to combine online courses with some sort of structured face-to-face interaction (see http://www.flvs.net/educators/Pages/e-LearningCenterTraining.aspx for more information).

Students can engage with FLVS materials in many ways: they can enroll directly with FLVS or in franchise districts and they may have the option of taking the course primarily from home or with other students in a scheduled class equipped with Internet at school. As noted, other online providers also operate in Florida and additional data should be collected to address the differential effectiveness of online learning providers and practices.

Exhibit 11: Overview of Alternative Online Providers

Researchers identified seven providers in the 10 districts included in the FLVS site visit sample, in addition to FLVS. Each is described briefly below to indicate the range of products in use.

Apex Learning offers more than 60 online courses, mostly for high school Advanced Placement credit. Apex Learning has a staff of certified teachers to provide instruction and guidance and it provides digital content and assessments that classroom teachers can use as a supplement to in-classroom instruction or as remediation materials.

Source: www.apexlearning.com

Compass Learning, an online learning tool targeted at districts and teachers, offers specialized curriculum and assessment tools that teachers can use to augment classroom instruction or by students without a teacher. Compass Learning, which describes its learning materials as highly interactive, does not provide for interaction with an online teacher.

Source: www.compasslearning.com

*EdOptions*is an automated learning system that provides teachers with tools for instant assessments, grading and feedback. It is promoted as a tool to relieve teachers of the burden of preparing classroom activities, homework assignments, tests and grading, thus freeing their time for more one-on-one interaction with students. EdOptions offers two automated products, Novel and Stars Suite, which provide a wide range of online curriculum materials.

Source: www.edoptions.com

NovaNET, which is owned by the Pearson Corporation, began as an assessment tool to help teachers provide individualized tests that could be quickly graded and tracked using an online gradebook. It provides teachers with a broad range of tools for assessment, tracking and reporting on student progress. NovaNET's products also include online courseware.

Source: www.novanet.com

OdysseyWare targets the credit recovery population. Its Prescriptive Credit Recovery (CRx) option addresses students' credit recovery requirements, helping them test out of instruction on skills they have already mastered. OdysseyWare provides an online curriculum but does not employ online teachers.

Source: www.odysseyware.com

Plato Learning, the oldest online provider among the group, provides teachers with web-based assessment tools for tracking student progress. It also offers online curriculum materials, many of which are interactive, that teachers can use to augment their classroom instruction. Plato Learning focuses on services for credit recovery and at-risk students.

Source: www.studyweb.com

Moodle is an open-source tool that facilitates rapid content-rich communication between teachers and students and among students. Moodle provides a platform for virtual classrooms in which teachers and students can interact with course content and with one another.

Source: www.moodle.org

Implications of Data

The enrollment data collected raise concerns about equity of access and opportunity in online learning. Minority and economically disadvantaged students are less likely to enroll in online learning than their white and more affluent peers. Students enrolling in the FLVS English 1 or Algebra 1 courses are consistently:

- Less likely to qualify for FRPL
- More likely to be white
- Less likely to be English language learners.

Differences in FRPL qualifications are more pronounced in mathematics than in English; online students enrolled in a full year of Algebra 1 were half as likely as place-based Algebra enrollees to qualify for FRPL.

Students who completed English 1 or Algebra 1, both core academic courses, online achieved better grades and achievement scores than students of similar backgrounds who completed the course in place-based classrooms. But the performance advantage of online students disappeared for most variables when Semester 1 enrollees in online courses were compared with their peers in the first semester of a place-based course, suggesting that students who persist to Semester 2 of an online course are more likely to have important characteristics not captured by propensity score matching that is based on demographics and prior achievement data. Teachers who work with high school students suggest that motivation, technical aptitude and social supports may come into play in this regard.

The data reported here also demonstrate that students who enroll in online learning and especially those who persist and take Semester 2 of a core academic course, come from more privileged backgrounds than do Florida's general student population, despite FLVS efforts to serve all students equally. This raises concerns about seeming disparities in opportunity across students. There are many reasons for such differences, including availability of computers and the Internet for personal use, administrator and teacher perceptions about who can learn effectively online, course design choices that may best suit particular types of students, or issues related to comfort with using technology for academic purposes. Dede et al. (2001) have noted that barriers to effectively implementing new technologies in schools are not always technical or economic, but often psychological, organizational, political and cultural. These and other potential barriers to online learning should be addressed to reduce disparity in educational opportunity.

Practitioners have identified supports to help a wider range of students succeed in online courses, including onsite facilitators and careful scaffolding of lessons. Low-achieving students might benefit from direct instruction on *how* to learn independently or from curricular materials that are

better designed to cultivate these skills in the context of instruction. A review of demonstration versions of FLVS's English 1 and Algebra 1 course materials suggests that the online courses place heavy demands on students' reading skills. Course materials could include scaffolds that prompt and support students in monitoring and evaluating their thinking and understanding. Research and policy development are needed regarding the supports necessary for low-achieving students and historically underserved populations, including students with disabilities and English language learners,so that they can fully participate in and benefit from online learning options.

The Mid-Atlantic School District Case Study

The MAVS district analysis used enrollment data from 2006–07 and 2007–08 for Geometry and English 12, which were selected because they were the core academic courses with the highest online enrollment in MAVS over the two years examined.

District Online Program Overview

The district's online program began in 1998 with a course in creative writing. The district soon expanded the program to include core courses such as Algebra and Geometry. During its early years, the online program relied on outside providers such as FLVS and Class.com for much of its course content. As the program expanded, district teachers began to contribute more and more of the content. At the time of the study (2008–09), the district generated the entire online curriculum and had sold some of its courses to commercial online content providers.

The district's online program employs about 35 teachers during the regular academic year and about 45 during the summer. Most of these teachers also teach in conventional classrooms throughout the district, although the online program has four full-time resource teachers. The online teachers must meet the same certification requirements as other teachers in the district and they are also required to complete a five-week preparatory course, in which they learn how to conduct asynchronous and synchronous communication activities and how to use the course software. The online program encourages teachers to view themselves as facilitators of students' self-paced learning; frequent feedback is an important part of this function.

By 2008–09, the district's online program had more than 2,000 enrollments per year, representing about 1,700 students. The majority of these students enroll during the summer. The district offers about 50 online courses, covering a broad range of core and elective content. Students choose to enroll in an online course. Any student currently enrolled within the district may enroll in an online class for free with permission from his or her school of record. Students outside the district may take an online course, but they pay a fee of $375 per semester course or $750 per year-long course. Students are required to provide their own computers and Internet access. According to the district, the students most likely to take advantage of the program are those seeking honors classes, those seeking credit recovery and students who have disabilities or are homebound.[24] In a video provided by the district, students were asked about their experiences in the online learning program. They said they liked the online classes because of the self-pacing,

24 Data regarding numbers and proportions of homebound students were not obtained for either course format. Enrollment data provided for the two courses analyzed by this study did not indicate large proportions of students who received special education or accommodations, but we do not have data for courses not included in this study.

the rolling enrollment and the ability to work from home with a flexible schedule. When asked why they chose to enroll in an online course, students indicated many reasons, including:

- Scheduling conflicts with other classes
- The need for remedial work or credit recovery
- The desire to graduate early
- Transfer from out of state
- Extended absences due to illness
- The need to work during regular school hours.

Some middle school students said that the online campus allowed them to take high school level courses, such as Algebra 2, ahead of schedule.

The district's courses are fully online and self-paced. Students may enroll in an online course at any time, but they must fulfill course requirements according to the same semester schedule as students in place-based courses. Although students enrolled in online courses are not required to have face-to-face instructional time with their online teacher or classmates, they do participate in a face-to-face orientation and interim face-to-face conferences with teachers. In addition, they must participate in certain scheduled synchronous online activities. The district asserts that programmed times for synchronous communication provide important opportunities for students to interact with the teacher and with other students.

For the most part, students work from home according to their own schedules. Teachers monitor their weekly progress and are available throughout the day and in the evenings for real-time help either by email or telephone.

The district's website describes online courses as using a standard textbook as the centerpiece of the curriculum to maintain comparability with the same course as taught in a conventional setting. But online courses supplement the textbook with a variety of multimedia and communication technologies to augment learning. Email is the primary form of communication among online teachers and students, but video, instant messaging, phone calls and chat rooms and discussion boards are also used. Students receive notifications, progress updates and online learning materials through a common, commercially available learning management system. Teachers are required to provide parents and students with an update on the students' progress every five to 10 days. In many of the district's online courses, students are expected to take advantage of the immense resources available on the Web for expanded learning experiences.

Students use a unique username and password to gain access to the learning management system, which in turn gives them access to the courses they have enrolled in. Because classes share many technical similarities, once a student learns how to navigate one class, subsequent classes look

and feel familiar. On entering the courses, students have ready access to (1) course-related announcements, email and a discussion board; (2) course materials, documents, assignments and assessments; (3) the instructor's contact information; (4) their grades; and (5) video archives of interactive class meetings. Among the student tools are a blog tool, course calendar, grades and personal information manager, course podcasts, a learning management system user manual and a Wiki tool. Students can edit personal information such as their email addresses and postal addresses, but cannot change their first or last names. The calendar includes details of lessons and topics that students should complete by a given date, assessment dates and district holidays. Through a tasks tool, students can organize, prioritize and track assignments and projects.

Instructional Materials

Researchers reviewed the district's online Geometry and English 12 courses to understand and document the salient characteristics of the online interface, the instructional materials available to students and teachers, the opportunities they have to communicate with one another and the assessments students complete to demonstrate what they know (and do not know) to themselves and their instructors. Researchers were given unrestricted access to all parts the Geometry and English 12 courses and the features of each course were coded for evidence of research-based practices. Overall, course interfaces were structurally identical, varying only in the content they contained and presented. They appeared well designed and presented clear and pertinent information; offered opportunities for reflection and practice; and relied on timely feedback from the technology, peers and the instructor. The courses met relevant national and state standards and provided lessons that students need to gain a comprehensive understanding of Geometry and English 12.

Students are required to access their online class regularly in order to make steady progress through course materials. In the Geometry course policies, the instructor makes clear that she expects students to log in to the course every day, Monday through Friday. Failure of English 12 students to make weekly progress for 15 consecutive days results in their administrative removal from the course.

Course Structure

The English 12 course consists of five study units: (1) justice and dignity, (2) generations, (3) courage and struggle, (4) technology and the individual and (5) writing a well-documented major research paper. The unit on technology and the individual contains seven lessons; each lesson includes sections on readings, writing process, vocabulary and language study. Small variations exist among the units, but the general structure is common across units. For example, the unit on courage and struggle includes five lessons with the four sections listed above and the unit on

generations includes seven lessons with the four sections, plus discussion board requirements for each lesson.

Central to each English 12 unit is a novel that reflects the theme of the unit. Students can acquire the book or access it online as a webpage or audio book. Chapters of each novel are grouped to focus students' reading. The students are quizzed on the material and for each chapter of each novel, they keep a reading log and complete a journal assignment. These assignments include summaries, responses and reactions; comments on characters; speculations and predictions; and an analysis of critical quotes. Almost all English 12 lessons are text-based, requiring students to read to learn. The English 12 Unit on "Technology and the Individual" scores an 8.4 on the Flesch-Kincaid Grade Level,[25]suggesting that high school students reading at or near grade level should be able to easily read all materials. This measure of readability, however, accounts for word and sentence length and does not evaluate the maturity or complexity of the content.[26]

Resources provided in the online Geometry course include text, images, self-check questions and problems and links to videos, interactive simulations and audio books. Students also have access to a navigation bar that indicates where they are currently in the course. At the beginning of each unit, students see an overview and a bulleted list of the learning objectives. Students also see details about their required participation in virtual chats and discussion boards. To learn, students primarily read and decode images and diagrams. Then they test their understanding of the new concepts by completing self-check activities. At the end of each topic, students solve and then check practice problems in their textbooks. They are required to show their work, not just the final answers.

Geometry course materials are organized into 16 units with titles such as "Logic and Reasoning," "Properties of a Triangle," and "Surface Area, Volume and 3-D Visualization." Regular Geometry students complete units 1–12; honors students also complete units 13–16. In the Geometry course, units are organized into two to four lessons and lessons are made up of one to four topics. Each topic includes one to five image- and text-rich slides, which use contrasting colors and shading to alert students to important features of static and dynamic diagrams, images and graphs, with bold, italicized and underlined text to highlight important keywords and concepts. Examples of resources provided in the course include:

- Math Open Reference's Flash-based video demonstrating how to create a perpendicular line from an external point (http://www.mathopenref.com/constperpextpoint.html).

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25 The Flesch-Kincaid readability tests measure comprehension of a passage of contemporary English. The difficulty of the text is scored in terms of grade levels; for example, most journalistic writing (considered to be of medium difficulty for) scores at the eleventh-grade level (DuBay 2004).

26 The first chapter of *Brave New World*, which students read in this unit, has a Flesch-Kincaid Grade Level of 7.6. Although it has a lower grade level, that chapter comprises more sophisticated ideas and themes. The Flesch-Kincaid measure, therefore, is best understood as a general indicator of readability.

- Java-based simulation that allows them to explore and test two rules about angles and parallel lines (http://www.rfbarrow.btinternet.co.uk/htmks3/Angle2.htm).
- GeoGebra (a free, interactive Geometry browser plug-in that supports graphical and algebraic inputs) and asks students to calculate the slope of a line.

Researchers did not observe banner ads or inappropriate materials on pages that students access outside the course learning management system.

Geometry lessons are text, symbol and image-based, requiring students to read and decipher to learn. The Flesch-Kincaid Grade Level for the Geometry Unit on triangles is 6.7, suggesting that the text should be easily readable by middle and high school students reading at or near grade level.

Typical Interaction Opportunities

Interaction in MAVS courses occurs primarily between individual students and course materials and individual students and their instructors through technology, either synchronously by telephone, instant messaging, or Web conference, or asynchronously by email or discussion board. The course website highly encourages students to contact their instructors through email, telephone and chat. The class as a whole, however, interacts through an online discussion board and multimedia-infused Web conferences. Outside of the whole class activities, researchers found no evidence that students worked collaboratively on tasks or assignments.

Each unit includes a designated discussion board that is accessible only to students and teachers enrolled in that course. Participants can input rich text, images and tables into the post and attach files such as spreadsheets, videos and audio. After students have uploaded a post, they can modify or erase it. For each unit, students are required to go to the discussion board and post at least one question or complete one collaborative assignment related to the unit. As part of their participation in the discussion, students are required to reply to at least one post from a classmate. Synchronous, technology-mediated sessions are also required regularly. These include communication with peers and the instructor via "chat" tools, quizzing and polling tools and a webcam tool. The instructor can upload PowerPoint slides to the interactive whiteboard.

Parents of students enrolled in the district's online learning program can create their own accounts for the system. After registering and having the account validated at their child's school, the parents can access all the child's active courses, as well as other district-wide career and college planning tools.

Assessment Techniques

Students enrolled in online courses must take the same assessment tests as other students in the district. For courses in which the state standardized test is required, online students take it at the same time and place as all other students in the district. For many core high school classes, they must also complete end-of-course exams, which are identical in both the online and place-based versions of the course. Some unit-level assessments are completed at home and under parental or guardian supervision. Webcams can be used to verify identity and to proctor exams and students are required to show ID at the beginning of the session. Students must be present on campus in a proctored setting for the midterm and final exams. If the midterm does not correspond with a student's previous performance, every unit test after that is proctored in order to ensure a student participates in assessments appropriately. Administrators reported that they had experienced few instances of students cheating.

Geometry and English 12 exhibit an assessment-centered design. All activities either prepare students for graded assignments or are themselves graded. Approximately one-third of topics in the Geometry course are self-check activities. Questions are presented with either a limited number of answer choices or a field for inputting short answers. After making their selections, students select a button labeled "Check Answers." Correct answers are marked with a green check; incorrect answers are marked with a red X. Students have the option of seeing the correct answers and receiving feedback, but first they must answer all the questions. At their discretion, students can reset the page and thereby clear their choices and any feedback they may have received.

Once students begin a Geometry quiz or test online, they may not stop and return to the assignment later. If the student navigates away from the assessment page, anything that has not been submitted is lost. Students use paper and a pen or pencil to record their work and answers to each assessment; these records are stored in the students' notebooks.

Students may use a graphing calculator during assessments, but they may not consult notes or other resources or other people to help them while they are completing their assessment. A student who has completed the textbook graded assignment after each lesson receives a password for the quiz; after the last lesson of the unit, the student receives the password for the unit test.

Each of the major readings in the English 12 course includes multiple assessments that test, among other things, understanding of vocabulary words and reading comprehension. Some assessments can be completed only once; others can be submitted twice before a final grade is assigned to the work. Some assessments can be saved and resumed later; others must be completed in a single sitting.

Vocabulary-based assessments contain 20 matching questions. Students are given a sentence from the related text and asked to match the numbered and underlined word with the best

definition from a list of possible definitions. Assessments of reading comprehension include 10–20 multiple choice and matching questions that test students' understanding of key events, main characters and themes.

Summary of the Mid-Atlantic SchoolDistrict Study Research Methods and Data Sources

Data Sources[27]

The MAVS district provided enrollment files that included information about thedemographic characteristics and academic performance of students enrolled in English 12 and Geometryin 2006–07 and in 2007–08. The dataset indicated whether a student took the class in an online or place-based format, making it possible to compare the two populations of students.

In addition to the quantitative dataset provided by the district, qualitative data were collected regarding district policies and practices. Project staff interviewed two program administrators, reviewed two videos provided by the district and independently analyzed the format and content of the online course demonstrations the district provided. These data were supplemented with information, including policy and program documents, from the district's website.

Quantitative Methods

A post hoc quasi-experimental design was used to compare student outcomes in online Geometry and English 12 courses with student outcomes in place-based courses. Analysts first compared the composition of students enrolled in online and place-based versions of the two courses using a chi-squared test of independence for proportions and a t-test of difference in means for continuous variables. After determining that there were statistical and substantive differences between online and place-based students enrolled in each course, analysts used student propensity scores as well as student grade level to match students in online courses with similar students in place-based courses.[28]Propensity scores were calculated by grade level using student demographic and prior achievement indicators (for a full list, see the student characteristics listed in appendix Exhibit C-1).

27 See Appendix C for additional information about the data sources, methods and matching process for the MAVS district case study.

28 Researchers used caliper matching with replacement to match each online student with all students from the same grade level and the same previous failure status who enrolled in the placed-based versions of the same course and whose propensity score (in logits) was within .20 caliper of the online student (in standard deviations of the online student's propensity score).

Analysts used the matched samples compare achievement outcomes for students enrolled in online and place-based versions of Geometry and English 12. They conducted logistic regressionsto predict the log-odds of course passing and used linear regression to predict course grades. End-of-course exam scores for Geometry students were also analyzed using linear regression.[29]

Limitations of the Research Approach

Although researchers systematically identified the best data available for their analyses, the post hoc nature of the quasi-experimental design presented in this report has inherent limitations associated with models that do not account for "selection bias," which may be caused by students' self-selection into either the online or the place-based instructional format.[30] To control for errors associated with selection bias, researchers used quantitative data to "match" students across course formats in regard to data associated with student academic status. Those data included students' socio-demographic status and measures of previous academic achievement, which were obtained from district educational databases. By identifying statistically similar students across groups, researchers controlled for variation associated with those characteristics. However, research suggests that students who enroll in online courses differ from their peers in place-based courses in ways that district and state educational databases do not capture (Kozma and Zucker 2003). For example, online students are more likely than other students to be home-schooled, homebound, or athletes who travel often. If any of these unobserved characteristics are also associated student achievement, estimates of the impact of the online format will be biased.

Other student characteristics (e.g., technological aptitude, maturity, motivation) may also influence success in an online environment. An experimental study that uses random assignment would provide a more definitive test of the impacts of online learning. Recent empirical studies comparing the results of randomized controlled trials and designs using propensity score matching have found that when prior achievement is used as a matching criterion and the two groups do not diverge too greatly on the matching variables, propensity score matching can substantially eliminate bias in estimating causal effects in quasi-experiments (Bifulco, Cobb and Bell 2009; Cook, Shadish and Wong 2008; Cook and Steiner 2010; Cook, Steiner and Pohl 2009).

Because the number of online enrollments in both the Geometry and English 12 courses were lower than desired for analytic purposes, it was necessary to pool data from both 2006–07 and

29 No end-of-course of exam for English was available.

30 Selection bias occurs when students self-select into online learning, as is often the case. This situation presents the possibility that students who choose one format over another differ systematically in ways that are not captured in the available data, thereby creating a source of error for estimates derived from the model.

2007–08 to achieve the necessary analytic power. Because students' special education status was only available for 2006-07, this was only included in propensity score models for this year and there is no way to know if online and place-based students were similar in the aggregate in terms of special education rates in the 2007-08 sample. In addition, it was not possible to find placed-based matches for the small number of online students who had previously failed the course. Including students with previous failures in the final analysis would have shed light on patterns of online learning for credit-recovery students.

Due to missing values on demographics and achievement indicators, 11 percent and 25 percent of the online students were excluded from the Geometry and English 12 analytic sample respectively. The exclusion rate is lower for students in place-based courses (around 7 percent for both outcomes). With few exceptions, online and place-based students included in the analytic sample (used for matching) did not significantly differ from those excluded from the analytic sample on demographic indicators[31]. Please see Appendix C for detailed attrition information.

Other limitations related to estimates of students' academic achievement and constrained outcome measures. Prior GPAs, an important measure of prior achievement, were not available. For English, prior achievement was measured using the students' previous year end-of-course exam scores for reading and writing. For the Geometry enrollees, end-of-course Algebra 1 exam scores were used to select students of similar mathematical aptitude across groups. However, the end-of-course exam scores were not scaled to be equivalent from 2005 to later years. Finally, the subjective nature of course grades limits their use as an outcome.

Student Demographic Analysis

Using basic descriptive statistics and tests of significance, the analysts compared the characteristics of district students in online courses with those of their counterparts taking the same courses conventionally. The analysis suggests that the two sets of students differed demographically (Exhibit 12). Students in online versions of the English 12 and Geometry courses were less likely to qualify for FRPL than their peers in place-based versions of the course. In the online English 12 courses, online students were more likely to be white[32] and to speak English as a first language. Based on the data available for 2006-07, students participating in special education were less likely to enroll in online learning compared to place-based peers.[33]

31 To be categorized as different, the difference must be greater than 10 percentage points for dichotomous variables or translates to an effect size of greater than 0.2 for continuous variables in addition to being statistically significant at the 0.05 significance level.

32 In the MAVS study, the ethnic categories "White" and "Black" exclude students of Hispanic origin.

33 This study is not meant to address the accessibility of online courses for ELL students and students with disabilities, nor does it specifically discuss (in a disaggregated manner) their levels of achievement in such courses.

Exhibit 12: Demographics of Students Enrolled in English 12 and Geometry

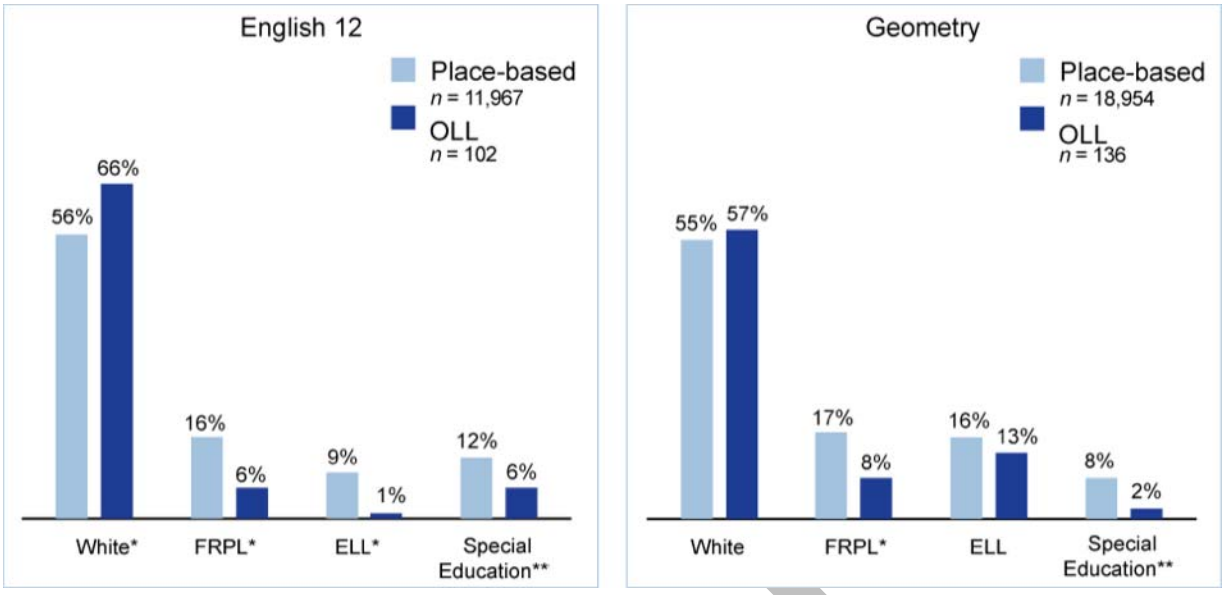

Exhibit reads: Among students who enrolled in English 12, 56 percent of students in place-based versions of the course were white, compared with 66 percent of students in online courses.

Source: District data

* The difference between students in place-based courses and students in online courses was statistically significant at the 95 percent confidence interval.

**Special education data were only available for the 2007 cohort. Data for students enrolled in 2008 were not available.

These demographic differences were similar to but less pronounced than those found between online and place-based cohorts in the Florida study.

In addition to differences in demographic characteristics, students in online courses tended to take Geometry and English 12 earlier than students in place-based courses did (Exhibit 13). For example, only 2 percent of Geometry students in place-based courses were in the eighth grade, compared with 20 percent of Geometry students in online courses. Likewise, whereas 23 percent of students took online versions of English 12 while they are still in the eleventh grade, only 2 percent of students in place-based versions of the course accelerated their coursework in that way. In general, online students also tended to have higher prior achievement than students in place-based courses, as measured by end-of-course exams in Algebra 1 and English 11.

Exhibit 13: Grade-Level Distributions of Students Enrolled in English 12 and Geometry

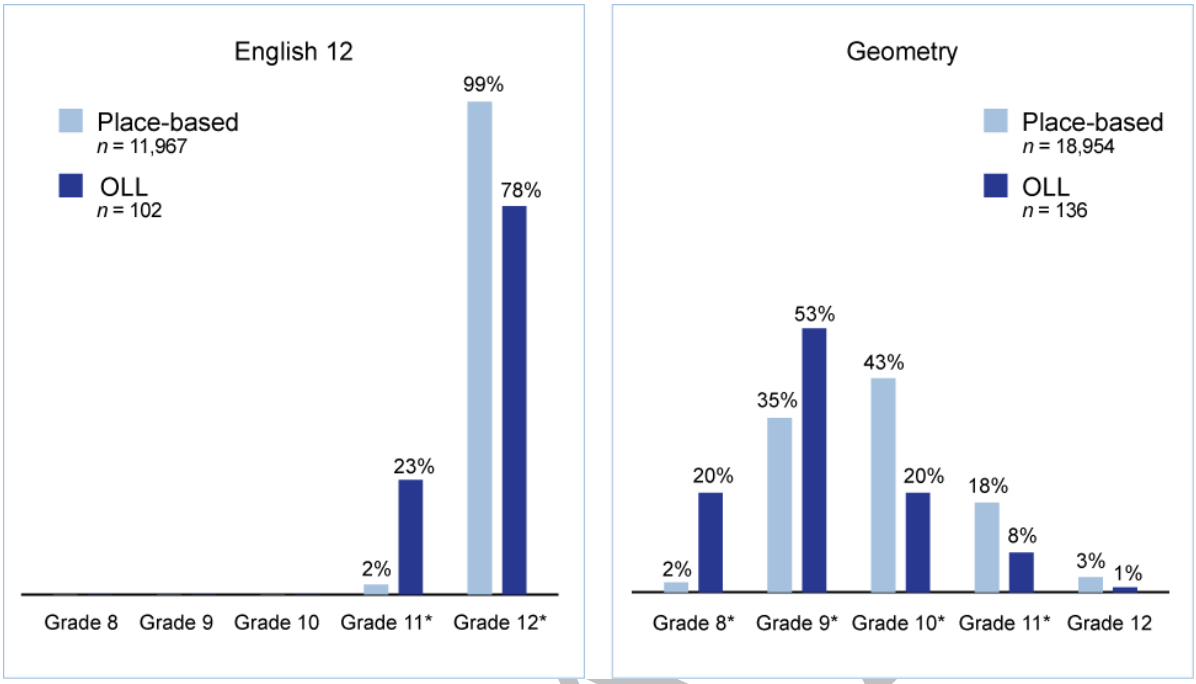

Exhibit reads: Among students enrolled in English 12, 2 percent of students in place-based versions of the course were eleventh graders, compared with 23 percent of students in online versions of the course.

Note: Totals may not sum to 100 percent because of rounding.

* The difference between students in place-based versions of the course and students in online versions was statistically significant at the 95 percent confidence interval.

Source: District data.

Student Achievement Analysis

Using the matching process detailed in the methodology section, researchers used statistical regression techniques to estimate student achievement outcomes in online Geometry and English 12 courses compared with place-based versions of the same courses. Analysts created a sample of students in place-based courses that was demographically and academically similar to the students in the online courses.

Two outcomes were used to measure student achievement:

- Odds of passing the course
- Final course grade.

In addition, the analysts used a standardized end-of-course exam as a measure of student achievement in Geometry. No similar test scores were available for the English 12 course.

The predicted odds of passing the course were lower for the online than for the classroom-based version of Geometry. There was no statistically significant difference in the odds of passing English 12 (Exhibit 14). The odds of students passing the online version of Geometry were 76 percent lower than the odds for students in place-based versions of the course ($p<.01$). For English 12, the odds of students in online versions of the course passing were 32 percent higher than the odds for students in place-based versions of the course, but the difference was not statistically significant ($p=.67$).

Exhibit 14: Change in Odds of Online Students Passing a Course Relative to Students in Place-Based Courses

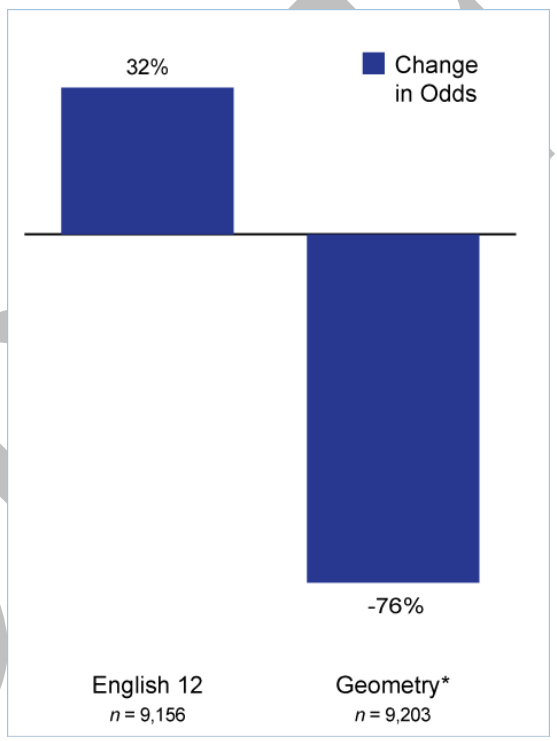

Exhibit reads: The 32 percent increase in online students' odds of passing English 12 was not statistically significant.

* The difference between students in place-based and online versions of the course was statistically significant at the 95 percent confidence interval.

Source: District data.

A similar pattern emerged when course grades were used as an outcome measure. Compared with students in place-based courses, online students had predicted grades that were lower for

Geometry and not statistically different for English 12 (Exhibit 14). In Geometry, the predicted mean online course grade was 0.45 grade points lower than the place-based course grade on a scale of 0 to 4, representing an effect size of 0.17 ($p<.01$), amounting to a little more than the difference between a B and a B minus. In English 12, the predicted mean online course grade was lower than the predicted grade in the place-based format, but the difference fell short of statistical significance at the 95 percent confidence level ($p=.06$).

Exhibit 15: Course Grades of Students in Online Learning Relative to Those of Comparable Students in Place-Based Courses

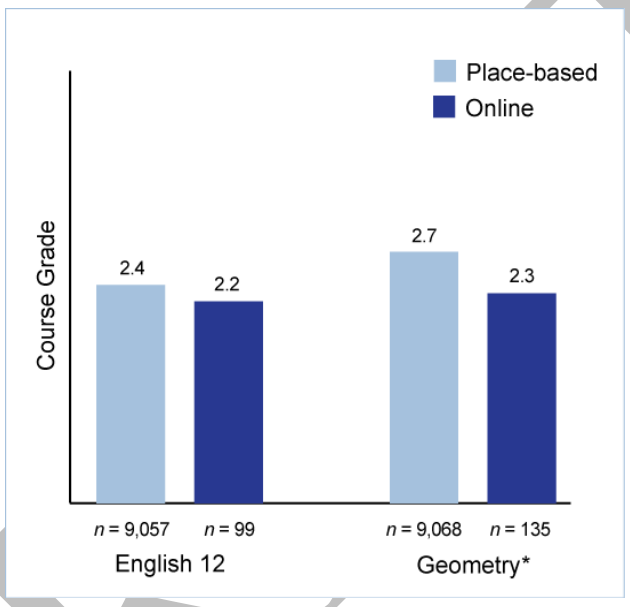

Exhibit reads: Among students enrolled in English 12, grades of students in online versions of the course were 0.2 grade points lower than grades of students in place-based versions of the course, although the difference was not statistically different. Predicted mean course grade in English 12 are for students who scored 450 (proficient is 400-499) on the English 11 end-of-course exam in writing and in reading. Predicted mean course grade in Geometry is for students who scored proficient on the Geometry end-of-course exam and are not enrolled in honors Geometry.

* The difference between students in place-based versions and students in online versions was statistically significant at the 95 percent confidence interval.

Source: District data.

In addition to course passing and course grade, the researchers used an end-of-course exam for Geometry to estimate student achievement in place-based and online formats. The predicted end-of-course exam score was almost 7 points higher for students in online versions of the course than for students in place-based versions, but the difference was not statistically significant ($p=0.11$).

Implications of the Data

Online learning in K–12 in the United States was initially implemented for high-achieving students. The rationale was that academically advanced students had the skills and abilities needed to persevere without intensive face-to-face schedules and the supports afforded in classroom-based teaching. The data presented in this report suggest that not only higher achievement but also higher socioeconomic status are associated with use of the district's online English 12 and Geometry courses. The grade-level distribution across course formats indicated that many students used the online courses to accelerate their coursework (i.e., they were more likely on average to take either course earlier than peers in place-based versions of the course).

After controlling statistically for these advantages, students in online courses fared worse than their peers in place-based courses on most of the available outcome measures. Unfortunately, the available data do not allow for causal inferences regarding why students were less likely to pass and less likely to get a higher grade in the online versions of the courses. A deeper analysis of instructional components in both place-based and online courses would be required to arrive at initial hypotheses about the differences in findings. Known differences across sites include intensity and duration of teacher professional development, analytic support for continuous improvement systems, scale of operation and funding methods. However, it is not clear whether and how these differences, as plausible as their influence may seem, affect student achievement in online and place-based courses.

References

Bifulco, R., C. Cobb and C. Bell. 2009. "Can Interdistrict Choice Boost Student Achievement? The Case of Connecticut's Interdistrict Magnet School Program." *Educational Evaluation and Policy Analysis* 31: 323-345.

Cochran, W. 1983.*Planning and Analysis of Observational Studies*, edited by Lincoln E. Moses and Frederick Mosteller. Wiley Series on Statistics and Probability.

Cohen, J. 1992. "A Power Primer." *Psychological Bulletin* 112:155-159.

Cook, T. D., W. Shadish and V. C. Wong. 2008. "Three Conditions Under Which Experiments and Observational Studies Produce Comparable Causal Estimates: New Findings from Within-Study Comparisons." *Journal of Policy Analysis and Management* 27: 724-750.

Cook, T. D. and P. M. Steiner. 2010. "Case Matching and the Reduction of Selection Bias in Quasi-Experiments: The Relative Importance of Pretest Measures of Outcome, of Unreliability of Measurement and of Mode of Analysis." *Psychological Methods* 15: 56-68.

Cook, T. D., P. M. Steiner and S. Pohl. 2009. "How Bias Reduction is Affected by Covariate Choice, Unreliability and Mode of Data Analysis: Results from Two Types of Within-Study Comparisons." *Multivariate Behavior Research* 44: 828-847.

Dede, C., J. Honan and L. Peters, eds. 2001. *Scaling Up Success: Lessons Learned from Technology-Based Educational Improvement*. The entity from which ERIC acquires the content, including journal, organization and conference names, or by means of online submission from the author. What is the phrase starting with "The entity" supposed to mean? Indianapolis, IN: Jossey-Bass.

Dickson, P. (2005, October). Toward a deeper understanding of student performance in virtual high school courses: Using quantitative analyses and data visualization to inform decision making. Paper presented at the North American Council for Online Learning, Denver, CO.

Dubay, W. 2004.*The Principles of Readability.* Costa Mesa, CA: Impact Information. Downloaded from: http://www.eric.ed.gov/ERICDocs/data/ericdocs2sql/content_storage_01/0000019b/80/1b/bf/46.pdf

Florida Department of Education, *2006–07 Florida School Indicators Report*, available online at http://www.fldoe.org/eias/eiaspubs/fsir.asp as of 1/2/ 2010.

Florida Tax Watch Center for Educational Performance and Accountability. August 2007. *Final Report: A Comprehensive Assessment of Florida Virtual School.* Tallahassee, FL: author.

Florida Virtual School. 2009. *Stakeholder's Surveys 2008-2009*. Tallahassee, FL: Optimal Performance, Inc. Downloaded from: http://www.flvs.net/areas/aboutus/Documents/Annualpercent20Evaluations/Exec09_v62009.pdf

Florida Virtual School. 2010. *FLVS Franchise Overview*. Downloaded from: http://www.flvs.net/areas/elearning/Documents/Franchisepercent20Overviewpercent20010709.pdf

Graham, C. R., S. Allen and D. Ure. 2005. "Benefits and Challenges Of Blended Learning Environments." In *Encyclopedia of Information Science and Technology*, ed. M. Khosrow-Pour. (Hershey, PA: Idea Group, 2005), 253–259.

Picciano, A. and J. Seaman. 2009. *K-12 Online Learning: A 2008 Followup of the Survey of U.S. School District Administrators*. Needham, MA: Sloan Consortium. Downloaded from: http://www.sloanconsortium.org/publications/survey/pdf/k-12_online_learning_2008.pdf

Reardon, S., A. Atteberry, N. Arshan and M. Kurlaender. 2009. *Effects of the California High School Exit Exam on Student Persistence, Achievement and Graduation.*Full paper available at irepp.stanford.edu.

Trotter, A. 2001. "Testing Firms See Future Market in Online Assessment." *Education Week* 20.

U.S. Department of Education, Office of Planning, Evaluation and Policy Development. 2010. *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies (Revised).* Washington, D.C.: Author.

Watson, J., B. A. Murin, L. Vashaw, B. Gemin and C. Rapp. 2010. *Keeping Pace with K-12 Online Learning: An Annual Review of Policy and Practice*. Downloaded from: http://www.kpk12.com/wp-content/uploads/KeepingPaceK12_2010.pdf on 1/2/11.

Watson J., B. Gemin, J. Ryan and M. Wicks. 2009. *Keeping Pace with K-12 Online Learning: A Review of State-level Policy and Practice, 2009*. Downloaded from: http://www.kpk12.com/wp-content/uploads/KeepingPace09-fullreport.pdf on 1/2/11.

Young, J., P. Birtolo and R. McElman. 2009. "Virtual Success: Transforming Education Through Online Learning." *Learning & Leading with Technology*36: 12–17.

Zandberg, I. and L. Lewis. 2008. *Technology-Based Distance Education Courses for Public Elementary and Secondary School Students: 2002–03 and 2004–05 (NCES 2008–008).* Washington, D.C.: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Available at http://nces.ed.gov/pubs2008/2008008.pdf

Appendix A: Site Selection and Data Requirements

SRI conducted a systematic search for secondary data (as opposed to conducting original data collectiong specifically for the project) for use in comparing (1) the characteristics of online and place-based course students and (2) achievement in online and place-based K–12 courses, controlling for student characteristics including prior achievement. Analysts began by conducting a power analysis to determine the minimum number of enrollments needed per course and by identifying both required and preferred data elements to complete the analysis. Analysts solicited nominations for promising sites and providers and also used extant data to identify states that were likely to be able to provide the required data elements and had high online enrollments. Analysts conducted follow-up interviews with representatives of state virtual schools and/or the state education agency to determine whether they had the required data elements and sufficient online enrollments for the analysis. This appendix summarizes the data search, with focus on the lessons learned and implications for future data collection and search efforts.

Power Analysis

SRI conducted a power analysis to estimate the sample size needed to achieve 80 percent power given an alpha level of .05 and both a continuous and a binary outcome. For both outcome types, the conservative assumption was that there would be 10 times as many students in the dataset in place-based courses as in online courses. Analysts determined that a minimum of 100 students per online course were required to detect an effect size of .20 or a difference in pass rates between platforms of 12 percent and that between 400 and 500 online enrollments were needed per course to detect an effect size of .10 or a difference in the odds of passing of five percent.

Data Elements

SRI identified the data elements required for the analysis, as well as those that were preferred because they would provide nuance or context for interpreting the study results but were not critical for carrying out the study design. Exhibit A-1 lists these elements; required elements are marked with an asterisk. The data elements fall into seven categories: (1) course characteristics, (2) teacher qualities, (3) course enrollment information, (4) student achievement, (5) student characteristics, (6) school context and (7) online practice characteristics.

Exhibit A-1: Identified Data Elements

Course Characteristics
Format (Online, place-based, blended)*
Subject (with enough detail to determine comparable courses)*
Credits*
Designation (honors, AP, remedial, college credit)*
Class Size (instructor: student ratio)
Instructional time (time on task)

Teacher Qualities
Instructor unique identifier
Instructor certification
Instructor training in online course delivery

Course Enrollment Information
Dates of enrollment (online: start and end; place-based: year and term)*
Course completion/withdrawal/failure*
Course grade*

Student Achievement
Grades in previous courses or Standardized test scores*
Previous course failure*
Other assessments (must be same for online and place-based students; validity and reliability evidence must be available)

Student Characteristics
Gender*
Grade level*
Age*
Race/Ethnicity
Free/reduced lunch
English language learner/English as a Second Language/ bilingual*
Special Ed/Individualized Education Program*
Absenteeism
Parental Income
Parental Education
Single-parent household

School Context
School type (public, private, homeschool, public charter or unique NCES identifier)*
Percentagestudent receiving free or reduced lunch
Percentage of students English language learners
School code (unique identifier)*
School size

On-line Practice Characteristics
Feedback (frequency of contact)
Type of computer-mediated communication (synchronous v. asynchronous with peers, instructor)
Learning experience type (expository, active, interactive)

Other Outcomes
AP scores / SAT II or ACT scores (date, subject and score)
College enrollment
Enrollment in subsequent higher-level courses
*Required

Data Search Process

SRI used a two-step process for identifying viable data sources, first identifying promising sites through nominations and analysis of extant data and then conducting follow-up interviews to verify the data available. Analysts sought nominations from members of the Technical Working Group (identified in the acknowledgements section of this report) for states or other entities most likely to have the necessary data. Analysts also consulted the Data Quality Campaign state survey on longitudinal data to identify states that were likely to be able to provide the required data elements for place-based course students and determined which of these states also had high online enrollments from publications that included state virtual school enrollment numbers. Analysts then conducted follow-up interviews with representatives of virtual schools in states and/or the state education agency to verify if they had the required data elements and sufficient online enrollments for the analysis.

Data Availability

In all, SRI contacted 10 states about the availability of data for the secondary data analysis: Alabama, Arkansas, California, Florida, Georgia, Michigan, New Mexico, South Carolina, Tennessee and Virginia. Representatives from Alabama, Georgia and South Carolina expressed reluctance to participate in the study, regardless of the availability of data. Arkansas, New Mexico and Tennessee were initially promising, but enrollments in individual online courses in those states were too low for the analysis. Student-level longitudinal data were not available in California, Michigan or Virginia. Experts with knowledge of online learning and educational data systems were contacted to request nominations for possible non-state entities that may have sufficient data to support analyses. In the end, SRI obtained data from Florida and one large suburban district, enabling parallel analysis of two sites. District data was identified through a separate search process that relied on expert nominations.

Appendix B: Expanded Data Sources, Methodsand Resultsin the Florida Case Study

This appendix describes the data sources, dataset construction and analytic methods used for Florida as well as full results of the achievement models.

Data Sources

To compare characteristics and achievement of students in online and place-based courses, we constructed a database using student-level data from two sources: Florida Virtual School (FLVS) and the Florida Education Data Warehouse (FL EDW), Florida's longitudinal data system. SRI obtained data from FLVS and FL EDW for all public school students enrolled in the focal English and math courses in 2006–07. Analysts obtained online course enrollment information for students enrolled English 1 or Algebra 1 through the FLVS. Those data included a unique district-assigned student identifier in addition to course characteristics and student grade. Analysts submitted these records to FL EDW to be augmented with student demographic data (e.g., a student's 2006–07 grade level and his or her physical school and district code) and achievement data (e.g., the Stanford Achievement Test Version 10—Stanford 10—scores), which were not available from FLVS. FL EDW was able to match 79 percent of the FLVS records submitted and also provided comparable course enrollment, student achievement and demographic data on all students enrolled in place-based versions of the two courses in Florida public high schools in 2006–07.

Dataset Construction

Analysts took the following steps to ensure the consistency of course enrollment data from FLVS and FL EDW:

Course enrollments: For place-based enrollments, FL EDW counts enrollments during a survey week, typically a little more than one month after school begins.[34] FLVS students are considered enrolled after they successfully complete the online course request process and have not withdrawn within the first 28 days. Analysts coded FLVS course outcomes as failures if a student withdrew ("withdrawn failing") from the course after that time or completed the course with a failing grade ("complete failing"). This approach to counting enrollments was comparable to that for establishing place-based enrollments in the FL EDW.

34Personal communication on 12/11/2008 from Tammy Duncan, Customer Relations Manager, Florida PK-20 Education Data Warehouse.

Course grades: Analysts converted course grades to a scale of 0 (failing) to 4. FLVS assigns numeric grades ranging from 60 to 100. Students with a course outcome of withdrawn failing or complete failing were assigned a course grade of 0 and course grades of 90 to 100 were assigned a 4, 80 to 89 were assigned a 3, 70 to 79 were assigned a 2 and 60 to 69 were assigned a 1. Course grades from place-based courses from FL EDW were converted from A to 4, B to 3, C to 2, D to 1 and F to 0. Analysts eliminated from consideration the fewer than 2 percent of place-based records that had nonstandard course grade outcomes of I, N, NG, P, S, or U.

Semester 1 records: FLVS enrollments and course outcomes are reported on a semester basis, whereas records in FL EDW can be coded annual, semester, quarter, summer, or a variety of other term codes. To create a file of Semester 1 records only, place-based course records with a Semester 1 term code were retained, as were records with Quarter 1 term codes worth 0.5 credits (no summer records were retained). For FLVS records, the analysts retained all Semester 1 records.

Annual records: Analysts created an annual analysis file that included only students who took the full year of a course either online or place-based. For place-based records, only students with annual, semester, quarter, or summer term codes were retained. Analysts created annual records for enrollments from semester or quarter calendar systems by averaging the final grade for each student across the two terms. For online students, analysts used the same process of averaging across the two terms to create an annual course grade for each enrollment. Because students can attempt a given semester of an online course multiple times in 1 year, only a student's first attempt was retained before taking the average of the two semesters. Analysts coded the outcome of course passing as a failure for annual enrollment if either term resulted in a failure.

The final step was to eliminate online enrollments that appeared to be duplicative recorded in FL EDW as place-based enrollments. Analysts did this by combining the online and place-based records and identifying all the place-based enrollments that had an identical place-based enrollment record (same student ID and course outcome). Analysts retained only the online record on the assumption that the enrollment was submitted by a district to FL EDW but was not coded as having been taken online.

After creating the Semester 1 and annual enrollment files, analysts appended student demographic and tests score data from FL EDW. Analysts created a flag if a student attempted and failed a course online or place-based before 2006–07.

See Exhibit B-1 for detailed definitions of student demographic and achievement indicators.

Exhibit B-1: Student Demographic and Achievement Indicators

Student level	
Grade level	Student grade level in 2006–07 from FL EDW. For students who had more than one grade level on record for the school year, the higher grade level was retained to best match their grade level at the time they took the FCAT, which is administered in March.
Old for grade level	Calculated from birth month and year and grade-level data provided by FL EDW. Defined as a student who is 15 or older as of June before the 9th-grade year or a student who is 18 in June before the twelfth-grade year.
Young for grade level	Calculated from birth month and year and grade-level data provided by FL EDW. The student is not yet 14 as of September of 9th-grade year or not yet 17 at beginning of the twelfth-grade year.
Previous failure	Flag to indicate whether the student failed all or part of course in a school year before 2006–07.
Free or reduced-price lunch (FRPL)	Student FRPL-qualified in grade 8.
English language learner	Flag for limited English proficiency students.[35]
Gifted	Flag for students with a primary exceptionality code indicating gifted status.
Disabled	Flag for students with a primary exceptionality code indicating any disability, including a mental, emotional, physical, or cognitive disability.
Gender	Flag for gender, male or female.
Race	Categories include Asian; African American, not of Hispanic origin; Hispanic; white, not of Hispanic origin; or Other (other includes "decline to identify").
Test scores	Florida public school students are tested in reading and mathematics every year from grade 3 through 10. Stanford 10 standardized scores (normal curve equivalent—NCE) in reading (for English 1) and in mathematics (for Algebra 1) as a measure of prior achievement in this analysis. For students in grades 9 though 11 in 2006–07, the scores are from spring 2006. Because students are not tested in grade 11, 2004-2005 scores for twelfth graders were used.
Same grade	Flag to indicate whether the grade level of the spring 2006 test was the same as a student's 2006–07 grade level.
Student outcomes	
Passed course	Provided by FL EDW for place-based course students and by the FLVS for online students. For online students and place-based course students whose grades were reported on a semester basis, the student was counted as failing the course if he/she failed either semester.
Course grade	A = 4, B = 3,C = 2, D = 1, F = 0. FLVS awards numeric grades from 60 to 100. These were recoded on a 4-point scale with 90–100 = 4, 80–89 = 3, 70–79 = 2, 60–69 = 1 and F = 0.
Test scores	Stanford 10 NCE scores from spring 2007, for 9th- and 10th-grade students only. FCAT Developmental Scale Score in reading for English 1 or mathematics for Algebra 1.
Note: SRI hoped to use students' grade point average as a control for prior achievement, but this data item was not available from FL EDW.	

Restricted samples: To examine student achievement as measured by test scores, restricted annual and Semester 1 samples were created that included only students from grades 9 and 10

35 English 1 courses specifically for speakers of other languages have separate course codes and were not included in the analysis.

with valid Stanford 10 scores from spring 2007. Analysts attempted to exclude students who did not have at least some exposure to the course before the March 2007 administration of the Stanford 10. For the annual file, analysts excluded place-based enrollments from the summer terms; for online enrollments, students who completed Semester 1 or 2 on June 15, 2007, or laterwere excluded. The Semester 1 file included only place-based course students enrolled in Semester 1 or quarter 1, which occur in the fall. For online enrollments, analysts excluded students who completed Semester 1 on March 15, 2007, or later. Analysts did not have completion dates for FLVS student who withdrew failing; those student were retained in the restricted files and the timing and length of their course exposure is not known.

The initial data received from FL EDW did not contain reading scores for any students in place-based courses or scores for many of the 9th- or 10th-grade students. Updated test score files received from FL EDW still had a high proportion of cases with missing test scores.[36] Test score data were slightly more likely to be missing for students in online courses, with 23 percent of 9th grade students in online courses missing test scores compared with 14 percent of students taking place-based courses. Otherwise, about 15 percent of data were missing for enrollments for other grades for both online and place-based courses. The greater amount of missing data for 9th grade students suggests that students resembling place-based course enrollees (given that English 1 and Algebra 1 are typically taken in the 9th grade) were disproportionately missing from the analysis. This means that the final achievement comparisons were made for a matched sample of students with a higher proportion of students in the 10th grade than the actual distribution of students taking these freshman-level courses online. Exhibits B-2 and B-3 compare characteristics of students who were included in the analytic sample and those who were not on for the annual English and Algebra analyses respectively.

36 An FL EDW staff member attributed the high proportion of missing cases to the mobility of the student population (personal communication 2009).

Exhibit B-2: Comparison of Student Characteristics for Students Included and Excluded from Annual English Analysis Due to Missing Data

		Online				Place-Based			
		Excluded	Included	Difference	*p*Value	Excluded	Included	Difference	*p* Value
Failed course in prior year	Mean	0.4118	0.5435	-0.1317	0.0291	0.057	0.0201	0.0369	<.0001
	N	136	138			31050	130102		
Old for grade level	Mean	0.2132	0.1522	0.0611	0.1921	0.2425	0.1578	0.0847	<.0001
	N	136	138			31039	130102		
Young for grade level	Mean	0.0809	0.029	0.0519	0.0604	0.0396	0.0228	0.0168	<.0001
	N	136	138			31040	130102		
Honors	Mean	0.1838	0.2319	-0.0481	0.3289	0.2602	0.361	-0.1009	<.0001
	N	136	138			31050	130102		
Gifted	Mean	0.0368	0.0797	-0.0429	0.1297	0.0227	0.0645	-0.0418	<.0001
	N	136	138			31050	130102		
Disabled	Mean	0.1103	0.1159	-0.0056	0.8832	0.1289	0.1088	0.02	<.0001
	N	136	138			31050	130102		
ELL	Mean	0	0.0072	-0.0072	0.3191	0.0361	0.0151	0.021	<.0001
	N	136	138			31050	130102		
Free or Reduced Price Lunch	Mean	0.3818	0.3188	0.063	0.3025	0.5479	0.4635	0.0844	<.0001
	N	110	138			19461	130102		
Black	Mean	0.1397	0.1304	0.0093	0.8231	0.2574	0.2364	0.021	<.0001
	N	136	138			31050	130102		
Hispanic	Mean	0.0882	0.1014	-0.0132	0.7103	0.2077	0.2274	-0.0197	<.0001
	N	136	138			31050	130102		
Asian	Mean	0.0221	0.0072	0.0148	0.3105	0.0225	0.0208	0.0018	0.0574
	N	136	138			31050	130102		
White	Mean	0.6765	0.7319	-0.0554	0.3167	0.4794	0.4872	-0.0079	0.0129
	N	136	138			31050	130102		
Male	Mean	0.4706	0.5725	-0.1019	0.0921	0.5268	0.4987	0.028	<.0001
	N	136	138			31050	130102		
	SD	0.501	0.4965			0.4993	0.5		
Same grade level*	Mean	0.1512	0.1087	0.0425	0.3522	0.0782	0.0113	0.0669	<.0001
	N	86	138			8283	130102		
Previous Stanford 10 Reading	Mean	60.5337	59.7891	0.7446	0.7873	52.9497	59.5907	-6.641	<.0001
	N	86	138			8283	130102		
	SD	21.115	19.3879			17.3324	16.417		

Exhibit B-3: Comparison of Student Characteristics for Students Included and Excluded from Annual English Analysis Due to Missing Data

		Online				Place-Based			
		Excluded	Included	Difference	*p* Value	Excluded	Included	Difference	*p*Value
Failed course in prior year	Mean	0.3548	0.391	-0.0361	0.5513	0.096	0.0603	0.0357	<.0001
	N	124	133			21878	72121		
Old for grade level	Mean	0.1774	0.0602	0.1173	0.0039	0.2584	0.1704	0.088	<.0001
	N	124	133			21871	72121		
Young for grade level	Mean	0.0887	0.0752	0.0135	0.6939	0.0546	0.0273	0.0273	<.0001
	N	124	133			21871	72121		
Honors	Mean	0.2581	0.2331	0.025	0.6433	0.1253	0.1815	-0.0563	<.0001
	N	124	133			21878	72121		
Gifted	Mean	0.0726	0.0977	-0.0252	0.4732	0.0135	0.0332	-0.0196	<.0001
	N	124	133			21878	72121		
Disabled	Mean	0.0726	0.0752	-0.0026	0.9367	0.0933	0.1059	-0.0126	<.0001
	N	124	133			21878	72121		
ELL	Mean	0.0323	0.0226	0.0097	0.6367	0.1734	0.0427	0.1308	<.0001
	N	124	133			21878	72121		
Free or Reduced Price Lunch	Mean	0.26	0.2707	-0.0107	0.8559	0.5862	0.5221	0.0641	<.0001
	N	100	133			12161	72121		
Black	Mean	0.121	0.1203	0.0007	0.987	0.2567	0.2533	0.0033	0.3202
	N	124	133			21878	72121		
Hispanic	Mean	0.1613	0.1654	-0.0041	0.9292	0.3126	0.2851	0.0275	<.0001
	N	124	133			21878	72121		
Asian	Mean	0.0323	0.0526	-0.0204	0.4183	0.0244	0.0166	0.0078	<.0001
	N	124	133			21878	72121		
White	Mean	0.6452	0.6466	-0.0015	0.9806	0.3766	0.4191	-0.0425	<.0001
	N	124	133			21878	72121		
Male	Mean	0.4758	0.5188	-0.043	0.4929	0.523	0.5059	0.0171	<.0001
	N	124	133			21878	72121		
Previous Stanford 10 Reading	Mean	67.7432	70.1346	-2.3914	0.2507	55.996	61.6843	-5.6883	<.0001
	N	95	133			5208	72121		
	StdDev	14.5247	16.0898			17.1302	16.6074		
Same grade level*	Mean	0.1053	0.0301	0.0752	0.0333	0.1267	0.0234	0.1033	<.0001
	N	95	133			5208	72121		
	StdDev	0.3085	0.1714			0.3327	0.1513		

Methodology

Analysts compared student achievement for online and place-based course students in English 1 and Algebra 1 separately and conducted separate analyses comparing students enrolled in these courses for a full year and Semester 1 only. Analysts examined three measures of student achievement for parallel samples of students in grades 9 and 10: (1) course passing, (2) course grades and (3) Florida Comprehensive Assessment Test (FCAT) scores from spring 2007. Because online and place-based course students varied considerably in regard to the student and school characteristics detailed in Exhibit B-1 and because those differences varied by course, a matched sample of place-based course students was created for each set of online enrollments. The matching process and achievement analysis are detailed below.

Comparison of FLVS and Place-based Student Characteristics

Students enrolled in English 1 and Algebra 1 in 2006–07 were profiled (Exhibit B-4 and B-5). For both courses, the percentage of placed-based students in the 9th grade exceeds 85 percent; fewer than 25 percent students who took the course online were in 9th grade (23 percent for English 1 and 18 percent for Algebra 1). Instead, students who took these courses online were more likely to do so later in high school (in 10th grade or later).

Exhibit B-4: Comparison of Student Characteristics by Platform, English 1 and Algebra 1 Annual Enrollments Pre-Match

Full Year Sample		English 1			Algebra 1		
		Place-Based	Online	*p*	Place-Based	Online	*p*
Grade	***N***	**171896**	**406**		**108850**	**463**	
	Grade 8 and under	<.01	<.01	0.08	0.04	0.10	<.01
	Grade 9	0.96	0.23	<.01	0.85	0.17	<.01
	Grade 10	0.03	0.44	<.01	0.09	0.38	<.01
	Grade 11	0.01	0.16	<.01	0.02	0.18	<.01
	Grade 12	<.01	0.16	<.01	0.01	0.17	<.01
FRPL (grade 8)	***N***	**159456**	**352**		**97595**	**393**	
	FRPL	0.48	0.36	<.01	0.53	0.26	<.01
	non-FRPL	0.52	0.64	<.01	0.47	0.74	<.01
Race	***N***	**171880**	**406**		**108839**	**463**	
	African American	0.24	0.17	<.01	0.25	0.13	<.01
	Hispanic	0.22	0.13	<.01	0.29	0.16	<.01
	Asian	0.02	0.02	0.89	0.02	0.06	<.01
	White	0.49	0.64	<.01	0.42	0.62	<.01
	Other race	0.03	0.04	NA	0.02	0.03	NA
Sex	***N***	**171880**	**406**		**108839**	**463**	
	Male	0.51	0.51	0.95	0.51	0.50	0.75
	Female	0.49	0.49	0.95	0.49	0.50	0.75
Student Achieve-ment	***N***	**172115**	**439**		**109101**	**480**	
	Previous fail	0.03	0.40	<.01	0.07	0.29	<.01
	Honors	0.33	0.19	<.01	0.19	0.26	<.01
	N	**147299**	**335**		**87837**	**415**	
	Mean Stanford 10	59.05	59.80	.47	61.64	68.25	<.01
	Same grade level	.02	.09	<.01	.03	.03	.52
Other Back-ground	***N***	**171880**	**406**		**108839**	**463**	
	Old for grade	0.18	0.17	0.56	0.18	0.08	<.01
	Young for grade	0.03	0.05	0.01	0.03	0.08	<.01
	Gifted	0.06	0.06	0.94	0.04	0.09	<.01
	Disabled	0.12	0.11	0.79	0.10	0.07	0.01
	English language learner	0.02	<.01	<.01	0.07	0.03	<.01

Note: For categorical variables (grade and race), reported values represent the percentage for each category within the total population. For dichotomous variables (FRPL, sex and other background variables), reported values represent proportions. For Stanford 10, which is the only continuous variable, reported values represent the mean test score for students in online and place-based courses, respectively. “Same grade level” indicates that the student took the grade level of the Stanford 10 test (grade 9, 10, 11, or 12) which corresponded to that student’s grade level in 2006–07.

Exhibit B-5: Comparison of Student Characteristics by Platform, English 1 and Algebra 1, Semester 1 Enrollments Pre-Match

Full Year Sample		English 1			Algebra 1		
		Place-Based	Online	*P*	Place-Based	Online	*p*
Grade	***N***	**125114**	**1234**		**74536**	**1129**	
	Grade 8 or under	<.01	<.01	<.01	0.01	0.06	<.01
	Grade 9	0.93	0.23	<.01	0.84	0.19	<.01
	Grade 10	0.05	0.40	<.01	0.11	0.41	<.01
	Grade 11	0.01	0.17	<.01	0.03	0.17	<.01
	Grade 10	0.01	0.18	<.01	0.01	0.16	<.01
FRPL (grade 8)	***N***	**114649**	**1059**		**65820**	**959**	
	Free or reduced-price lunch (8th grade)	0.46	0.43	0.02	0.48	0.36	<.01
Race	***N***	**125114**	**1234**		**74536**	**1129**	
	African American	0.24	0.18	<.01	0.24	0.18	<.01
	Hispanic/Latino	0.16	0.16	0.91	0.19	0.17	0.10
	Asian	0.02	0.02	0.30	0.02	0.04	<.01
	White	0.56	0.61	<.01	0.52	0.58	<.01
Sex	***N***	**125114**	**1234**		**74536**	**1129**	
	Male	0.51	0.53	0.14	0.52	0.49	0.09
Student Achieve-ment	***N***	**125146**	**12919**		**74559**	**1162**	
	Failed course in prior year2	0.05	0.46	<.01	0.08	0.38	<.01
	Enrolled in honors	0.32	0.11	<.01	0.17	0.15	0.07
	N	**103591**	**994**		**59241**	**945**	
	Mean SAT 10 score, normal curve equivalent	58.81	55.19	<.01	62.99	62.66	0.57
	(Standard Deviation)	16.82	19.89		16.29	17.47	
	Same grade level*	0.02	0.12	<.01	0.03	0.08	<.01
Other Back-ground	***N***	**125095**	**1234**		**74524**	**1129**	
	Old for grade	0.21	0.27	<.01	0.21	0.17	<.01
	Young for grade	0.02	0.04	0.01	0.03	0.05	<.01
	N	**125114**	**1234**		**74536**	**1129**	
	Gifted	0.04	0.04	0.69	0.03	0.07	<.01
	Disabled	0.12	0.12	0.63	0.10	0.07	0.00
	English language learner	0.02	0.01	<.01	0.06	0.02	<.01

Note: Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent proportions.

*Spring 2006 Stanford 10 test grade level is same as student's 2006-07 grade level

Matched Sampling

To compare student achievement in online and place-based courses, analysts used propensity score matching to construct a comparison group of students in place-based courses that was comparable to each cohort of students in online courses on all the student and course characteristics listed in Exhibit B-1. Two student populations were analyzed: (1) 9th- and 10th-grade students enrolled in both semesters of English 1 or Algebra 1 during 2006–07 and (2) 9th- and 10th- grade students enrolled in the first semester of English 1 or Algebra 1 during 2006–07. The matching process was conducted for each sample of English 1 and Algebra 1 students separately, so that four samples were constructed. Analysts calculated propensity scores for students by grade level, modeling the log-odds of a student in a given grade taking a particular course online as opposed to place-based. Analysts performed the matching by grade level in each course because the grade level at which students took each online and place-based course differed substantiallyfor both Semester 1 and annual enrollments, even after restricting our analysis to 9th- and 10th-grade students (Exhibit B-6 and B-7). Analysts also matched exactly on the districts where the students' physical schools were located; place-based enrollments for students from districts that had no online enrollments for a given sample were excluded from the dataset before the propensity scores were calculated.

Exhibit B-6: Comparison of Student Characteristics by Platform, English 1 and Algebra 1 Annual Enrollments Restricted Sample: Pre-Match

		English 1			Algebra 1		
		Place-Based	Online	p	Place-Based	Online	p
Grade	***N***	**152562**	**172**		**89617**	**153**	
	Grade 9	0.98	0.26	<.01	0.91	0.29	<.01
	Grade 10	0.02	0.74	<.01	0.09	0.71	<.01
FRPL (grade 8)	***N***	**147636**	**154**		**85551**	**138**	
	Free or reduced-price lunch (8th grade)	0.47	0.33	0.00	0.52	0.28	<.01
Race	***N***	**152562**	**172**		**89617**	**153**	
	African American	0.24	0.13	<.01	0.25	0.11	<.01
	Hispanic/Latino	0.22	0.09	<.01	0.27	0.16	<.01
	Asian	0.02	0.01	0.28	0.02	0.05	0.05
	White	0.50	0.73	<.01	0.43	0.66	<.01
Sex	***N***	**152562**	**172**		**89617**	**153**	
	Male	0.50	0.58	0.04	0.51	0.52	0.71
Student Achieve-ment	***N***	**152562**	**172**		**89617**	**153**	
	Failed course in prior year	0.02	0.53	<.01	0.06	0.38	<.01
	Honors	0.35	0.23	0.0004	0.18	0.23	0.10
	N	**137587**	**145**		**79101**	**142**	
	Mean SAT 10 score, normal curve equivalent	59.55	59.94	0.81	61.93	70.13	<.01
	(Standard Deviation)	(16.44)	(19.27)		(16.56)	(15.99)	
	Same grade level	0.01	0.10	0.00	0.02	0.04	0.45
Other Back-ground	***N***	**152562**	**172**		**89617**	**153**	
	Old for grade	0.17	0.16	0.93	0.18	0.08	<.01
	Young for grade	0.02	0.03	0.45	0.03	0.07	0.05
	Gifted	0.06	0.06	0.86	0.03	0.09	0.01
	Disabled	0.11	0.12	0.66	0.10	0.08	0.49
	English language learner	0.02	0.01	0.0611	0.05	0.03	0.03

Note: Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent proportions.

*Spring 2006 Stanford 10 test grade level is same as student's 2006-07 grade level

Exhibit B-7: Comparison of Student Characteristics by Platform, English 1 and Algebra 1 Semester 1 Enrollments Restricted Sample: Pre-Match

		English 1			Algebra 1		
		Place-Based	Online	p	Place-Based	Online	P
Grade	***N***	**103920**	**459**		**58722**	**402**	
	Grade 9	0.96	0.26	<.01	0.90	0.27	<.01
	Grade 10	0.04	0.74	<.01	0.10	0.73	<.01
FRPL	***N***	**100417**	**410**		**56026**	**360**	
	Free or reduced-price lunch (8th grade)	0.44	0.40	0.10	0.46	0.34	<.01
RACE	***N***	**103920**	**459**		**58722**	**402**	
	African American	0.23	0.17	<.01	0.23	0.15	<.01
	Hispanic/Latino	0.15	0.15	0.90	0.18	0.18	0.96
	Asian	0.02	0.01	0.06	0.02	0.03	0.15
	White	0.57	0.62	0.02	0.54	0.61	<.01
	Old for grade	0.18	0.26	0.00	0.18	0.17	0.58
	Young for grade	0.02	0.02	0.91	0.03	0.05	0.01
Sex	***N***	**103920**	**459**		**58722**	**402**	
	Male	0.50	0.58	0.00	0.51	0.51	0.99
Student Achievement	***N***	**103920**	**459**		**58722**	**402**	
	Failed course in prior year	0.03	0.56	<.01	0.06	0.46	<.01
	Honors	0.34	0.14	<.01	0.18	0.14	0.03
	N	**92904**	**379**		**51558**	**346**	
	Mean SAT 10 score, normal curve equivalent	59.73	55.69	<.01	63.77	65.80	0.02
	(Standard Deviation)	16.45	20.25		15.66	15.38	
	Same grade level*	0.01	0.14	<.01	0.02	0.08	<.01
Other Back-ground	***N***	**103920**	**459**		**58722**	**402**	
	Disabled	0.12	0.10	0.31	0.10	0.09	0.58
	English language learner	0.02	0.01	<.01	0.04	0.02	0.00

Note: Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent proportions.

*Spring 2006 Stanford 10 test grade level is same as student's 2006-07 grade level

The model for calculating the propensity score is shown below.

$$p = \text{Prob}(Y = 1|\beta)$$

$$Log\left(\frac{p}{(1-p)}\right) = \beta_0 + \beta_1(x_1) + \beta_2(x_2) + \cdots + \beta_n(x_n) + \varepsilon$$

Where

Y = 1 for students in online courses

Y = 0 for students in place-based courses

β_n=student-level covariates listed in Exhibit B-1

Analysts included all the available student-level characteristics listed in Exhibit B-1 except grade level as covariates in modeling the propensity scores by grade level: English language learner status, gender, race, FRPL eligibility in eighth grade, prior failure, enrolled in honors, prior Stanford 10 normal curve equivalent score and flag for the same test grade level. For Semester 1 records from the all-grade-level sample only, propensity scores were calculated by a two-level hierarchical model with students clustered by district, with the following random intercept term added to the equation[37]:

$$\beta_{0j} = \gamma_{00} + \mu_{0j} \text{ for district j}$$

Analysts used caliper matching with replacement to match each online student with all students from the same grade level and district who enrolled in the placed-based versions of the same course and whose propensity score (in logits) was within .20 caliper of the online student (in standard deviations of the online students' propensity scores). To ensure equal representation in the comparison group of the characteristics of each online student, each of the matches for a given online student were weighted by the inverse of the number of matches for that student in the comparison group. These weights were used in all analyses comparing the achievement of online and place-based course students.

Evidence for the effectiveness of the matching procedure in achieving a sample of online and place-based students that are similar, in the aggregate,on observed student characteristics is provided in Exhibit B-8. After matching, there were no differences between online and place-based students on any of the variables available that were significant at the .05 level.The analysis of students enrolled during the first semester illustrates a similar pattern of results (Exhibit B-9). In both the Algebra 1 and English 1 samples, FLVS and place-based students are similar in terms of prior achievement, race/ethnicity and FRPL eligibility. Although not statistically significant, a

37 For all other samples, calculating propensity scores using a hierarchical model was not needed to achieve a balanced sample of online and place-based course students; indeed, for the for full-year records, the number of districts represented in each grade level was not adequate to allow for the estimation of parameters using a hierarchical model.

few differences between place-based and online students remain even in the matched samples. The percent of online students who previously failed the course is higher for online student in both samples and in the matched sample for English 1, 15 percent of place-based students have a primary disability code, compared to 10 percent of online students.

Exhibit B-8: Comparison of Student Characteristics by Platform, English 1 and Algebra 1 Full-Year RecordsAfter Matching[38]

		English 1			Algebra 1		
		Place-Based	Online	*p*	Place-Based	Online	*p*
N		**8392**	**123**		**5431**	**121**	
Grade	Grade 9	0.25	0.25	1	0.29	0.29	1
	Grade 10	0.75	0.75	1	0.71	0.71	1
FRPL (grade 8)	Free or reduced price lunch (8th grade)	0.32	0.33	0.92	0.31	0.28	0.57
Race	African American	0.13	0.13	0.96	0.11	0.12	0.75
	Hispanic/Latino	0.09	0.11	0.33	0.15	0.16	0.74
	Asian	0.02	0.01	0.19	0.04	0.05	0.79
	White	0.73	0.72	0.66	0.68	0.65	0.50
Sex	Male	0.53	0.56	0.44	0.54	0.54	0.97
Student Achieve-ment	Failed course in prior year	0.56	0.51	0.28	0.34	0.41	0.07
	Honors	0.21	0.22	0.77	0.21	0.19	0.64
	Mean SAT 10 score, normal curve equivalent	58.91	59.88	0.59	69.26	69.30	0.98
	(Standard Deviation)	(19.53)	(19.07)		(15.09)	(15.70)	
	Same grade level	0.09	0.09	0.85	0.03	0.02	0.97
Other Back-ground	Old for grade	0.16	0.14	0.59	0.06	0.04	0.37
	Young for grade	0.03	0.03	0.98	0.08	0.06	0.46
	Gifted	0.07	0.09	0.41	0.11	0.11	0.98
	Disabled	0.15	0.10	0.08	0.07	0.08	0.49
	English language learner	0.01	0.01	0.90	0.02	0.02	0.53

Note: Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent proportions.

*Spring 2006 Stanford 10 test grade level is same as student's 2006-07 grade level

38. 9th- and 10th-grade school year records with spring Stanford 10 scores.

Exhibit B-9: Comparison of Student Characteristics by Platform, English 1 and Algebra 1 Semester 1 Records After Matching[39]

Full Year Sample		English 1			Algebra 1		
		Place-Based	Online	*P*	Place-Based	Online	*P*
N		**26787**	**339**		**9368**	**310**	
Grade	Grade 9	0.24	0.24	1	0.26	0.26	1
	Grade 10	0.76	0.76	1	0.74	0.74	1
FRPL (grade 8)	Free or reduced-price lunch (8th grade)	0.46	0.41	0.12	0.39	0.35	0.14
Race	African American	0.17	0.19	0.50	0.13	0.15	0.20
	Hispanic/Latino	0.18	0.16	0.45	0.23	0.20	0.23
	Asian	0.01	0.01	0.84	0.03	0.03	0.94
	White	0.60	0.60	0.92	0.61	0.61	0.97
Sex	Male	0.58	0.58	0.92	0.52	0.50	0.52
Student Achieve-ment	Failed course in prior year	0.57	0.56	0.62	0.42	0.47	0.08
	Honors	0.13	0.13	0.96	0.13	0.10	0.18
	Mean SAT 10 score, normal curve equivalent	53.89	54.78	0.41	64.01	64.78	0.37
	(Standard Deviation)	18.61	20.16		14.86	14.74	
	Same grade level*	0.14	0.13	0.76	0.09	0.08	0.77
Other Back-ground	Old for grade	0.24	0.23	0.53	0.17	0.17	0.99
	Young for grade	0.02	0.01	0.30	0.05	0.04	0.17
	Gifted	0.05	0.05	0.56	0.06	0.05	0.56
	Disabled	0.10	0.10	0.95	0.08	0.08	0.71
	English language learner	0.00	0.01	0.34	0.01	0.01	0.84

Note: Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent proportions.

*Spring 2006 Stanford 10 test grade level is same as student's 2006-07 grade level

39 Florida public school students and all FLVS cases matched to the Florida EDW.

Achievement Analysis

After constructing the matched comparison groups, analysts compared mean achievement in each sample for online and place-basedcourse students. For 9th- and 10th-grade students, the three outcomes considered were course grade, course passing andperformance on the FCAT test in spring 2007. Analysts also looked at course passing and course grades only for students from all grade levels. The results were similar and are not reported here. Because student achievement varied by district, a hierarchical model was used with students *(i)* clustered by district *(j)* and a random intercept β_{0j}. Before determining the final achievement models, analysts also checked for variation in the contrast between achievement in online and place-based courses by district, adding a random term to the coefficient β_{1j} on the dummy variable for course platform. This model allowed the contrast between achievement outcomes for online and place-basedcourse students to vary by district. Because a random online coefficient was evident in only four of the 20 models, a random intercept, but not a random slope,was included in all the final achievement models.

For the final achievement models, prior test scores were included as a measure of prior achievement in all the models comparing mean achievement for online and place-based course students, as well as a flag for whether the student's grade level was the same as the grade level of the prior test score, a proxy for grade retention. Analysts also included a flag for whether the student enrolled in an honors version of the course and whether the student had previously failed the course in either platform. Finally, an interaction term was included between the course platform and the prior-year Stanford 10 score to check for evidence that online courses were more or less effective for higher achieving students and one between platform and previous failures to see whether online courses varied in their effectiveness for credit recovery.

The final achievement model used was the random intercept model shown below.

Level 1:

$$[Y_{ij} = \beta_{0j} + \beta_{1j}(ONLINE)_{ij} + \beta_{2j}[(Prior\ Achievement)_{ij} + \beta_{8j}[(Online * Prior\ Achievement)]$$

Level 2: $\beta_{0j} = \gamma_{00} + \mu_{0j}$

Where, *Y* is the outcome of interest (course grade or 2007 test score), *ONLINE* is a dummy variable coded 1 for online courses and 0 for place-based courses and Prior Achievement is the student's Stanford 10 normal curve equivalent score in mathematics (for Algebra 1) or reading (for English 1) from spring 2006. The model also includes a dummy variable that indicates whether the grade level of this prior test score was the same as the student's 2006-07 grade level, a proxy for grade retention. All covariates in these models were grand-mean centered.

For course passing, the covariates in the model are the same but the model estimates the log of the odds of successfully completing the course:

$$p_{ij} = \text{Prob}(Y = 1|\beta)$$

Level 1:

$$\left[Log\left(\frac{p_{ij}}{(1-p_{ij})}\right) = \beta_{0j} + \beta_{1j}(ONLINE]_{ij}\right) + \cdots + \beta_{2j}[(Online * Previous\ Failure]_{ij}) + r_{ij}$$

Level 2: $\beta_{0j} = \gamma_{00} + \mu_{0j}$

The coefficient of interest for the comparison was that of the variable indicating online course enrollment, with the null hypothesis that mean achievement in online and place-based courses was the same—in other words, that the coefficient on β_{1j}, the dummy variable indicating that the course was taken online, is 0.

Before determining the final achievement models,analysts also checked for variation in the contrast between achievement in online and place-based courses by district, adding a random term to the coefficient β_{1j}. That model allowed the contrast between achievement outcomes for online and place-basedcourse students to vary by district and the coefficient β_{1j} was an estimate of the average effect across districts. In these models, the *ONLINE* variable was centered around the district mean and the proportion of online students by district (mean of the *ONLINE* variable by district) was entered as a covariate.

Level 1: $[Y_{ij} = \beta_{0j} + \beta_{1j}(ONLINE]_{ij} - ONLINE_j) + r_{ij}$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}(mn_{online})_j + \mu_{0j}$

$\beta_{1j} = \gamma_{10} + \mu_{1j}$

For the binary course passing outcome, the functional form was the same, but the model estimated the log of the odds of successfully completing the course:

$$p_{ij} = \text{Prob}(Y = 1|\beta)$$

Level 1: $\left[Log\left(\frac{p_{ij}}{(1-p_{ij})}\right) = \beta_{0j} + \beta_{1j}(ONLINE]_{ij} - ONLINE_j\right) + r_{ij}$

Level 2: $\beta_{0j} = \gamma_{00} + \gamma_{01}(mn_{online})_j + \mu_{0j}$

$\beta_{1j} = \gamma_{10} + \mu_{1j}$

The analysis of the four samples of Semesters 1 and 2 enrollments found no evidence of a random coefficient. The four samples of Semester 1 enrollments contained more student enrollments nested in a larger number of districts and possibly as a result of these increased numbers the platform effect varied by district for some achievement outcomes. For each sample and outcome, analysts determined whether evidence existed for variation in the online effect by district (Exhibit B-10). Because a random online coefficient was evident in only four of the 20 models, a random intercept was modeled only in all the final achievement models. Exhibits B-10 and B-11 show models investigating the relationship between taking online courses and student achievement for annual and Semester 1 enrollments respectively.

Exhibit B-10: Evidence of Variation in Online Effect by District

		Course Passing	Course Grade	Test Scores
Semester 1 and 2 samples				
English 1	Grades 9 and 19	No	No	No
	All grades	No	No	
Algebra 1	Grades 9 and 19	No	No	No
	All grades	No	No	
Semester 1 samples				
English 1	Grades 9 and 19	Yes	No	No
	All grades	Yes	Yes	
Algebra 1	Grades 9 and 19	Yes	Yes	No
	All grades	No	No	

Exhibit B-11: Models Investigating the Relationship between Taking Online Courses and Student Achievement. Annual Enrollments

Predicted English 1 Course Passing				
Restricted Sample, n=8,515 32 Districts				
Fixed Effects	**Beta**	**SE**	**p**	**OR**
Intercept	2.36	0.33	<.0001	
Online	0.17	0.42	0.69	1.18
Stanford 10 NCE	0.01	0.00	<.0001	
Same grade level	-1.49	0.12	<.0001	
Online*Stanford 10	0.00	0.02	0.96	
Honors course	-0.09	0.10	0.38	
Previously failed	-0.35	0.08	<.0001	
Online*Previous failure	2.41	0.87	0.01	
Random Effects	**Variance component**	**SE**		
Intercept	3.18	0.96		
Predicted English 1 Course Grade				
Restricted Sample, n=8,515				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	2.30	0.10	<.0001	
Online	0.56	0.12	<.0001	
Stanford 10 NCE	0.01	0.00	<.0001	
Same grade level	-0.57	0.04	<.0001	
Online*Stanford 10	0.00	0.00	0.37	
Honors course	0.14	0.03	<.0001	
Previously failed	-0.31	0.03	<.0001	
Online*Previous failure	0.23	0.18	0.21	
Random Effects	**Variance component**	**SE**		
Intercept	0.33	0.09		
Residual	0.95	0.01		
Student-level Variance Explained (proportion)	0.09			

Exhibit B-11: Models Investigating the Relationship between Taking Online Courses and Student Achievement. Annual Enrollments*(continued)*

Predicted FCAT Reading Score				
Restricted Sample, n=8,440				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	1973.16	14.2	<.0001	
Online	46.99	23.60	0.05	
Stanford 10 NCE	10.19	0.13	<.0001	
Same grade level	6.91	8.92	0.44	
Online*Stanford 10	-2.97	0.95	0.00	
Honors course	63.93	6.48	<.0001	
Previously failed	8.77	5.48	0.11	
Online*Previous failure	13.35	36.80	0.72	
Random Effects	**Variance component**	**SE**		
Intercept	5923.24	1602.43		
Residual	36540.81	563.85		
Student-level Variance Explained (proportion)	0.46			

Predicted Algebra 1 Course Passing				
Restrictive sample, n=5,552 28 Districts				
Fixed Effects	**Beta**	**SE**	**p**	**OR**
Intercept	1.83	0.25	<.0001	
Online	0.30	0.33	0.37	1.35
Stanford 10 NCE	0.03	0.00	<.0001	
Same grade level	-1.00	0.19	<.0001	
Online*Stanford 10	-0.01	0.02	0.56	
Honors course	-0.34	0.13	0.01	
Previously failed	-0.87	0.09	<.0001	
Online*Previous failure	0.00	0.57	1.00	
Random Effects	**Variance component**	**SE**		
Intercept	1.57	0.52		

Predicted Algebra 1 Course Grade				
Restrictive sample, n=5,552				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	2.20	0.07	<.0001	
Online	0.35	0.10	0.00	
Stanford 10 NCE	0.02	0.00	<.0001	
Same grade level	-0.44	0.09	<.0001	
Online*Stanford 10	-0.01	0.01	0.15	
Honors course	-0.07	0.04	0.11	
Previously failed	-0.50	0.03	<.0001	
Online*Previous failure	-0.16	0.19	0.41	
Random Effects	**Variance component**	**SE**		
Intercept	0.14	0.04		
Residual	1.00	0.02		
Student-level Variance Explained (proportion)	0.13			

Exhibit B-11: Models Investigating the Relationship between Taking Online Courses and Student Achievement*(continued)*

Predicted FCAT Math Score				
Restrictive sample, n=5,455				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	1999.55	5.97	<.0001	
Online	35.48	8.22	<.0001	
Stanford 10 NCE	5.67	0.10	<.0001	
Same grade level	-47.97	8.43	<.0001	
Online*Stanford 10	-0.25	0.52	0.62	
Honors course	25.60	3.76	<.0001	
Previously failed	5.20	2.90	0.07	
Online*Previous failure	-15.33	16.40	0.35	
Random Effects	**Variance component**	**SE**		
Intercept	927.18	280.82		
Residual	7011.07	134.71		
Student-level Variance Explained (proportion)	0.46			

Exhibit B-12: Models Investigating the Relationship between Taking Online Courses and Student Achievement. Semester 1 Enrollments

Predicted English 1 Course Passing				
Restricted Sample, n=27126 Districts=41				
Fixed Effects	**Beta**	**SE**	**p**	**OR**
Intercept	2.66	0.24	<.0001	
Online	-1.63	0.19	<.0001	0.20
Stanford 10 NCE	0.02	0.00	<.0001	
Same grade level	-0.84	0.05	<.0001	
Online*Stanford 10	-0.01	0.01	0.36	
Honors course	0.52	0.08	<.0001	
Previously failed	-0.21	0.04	<.0001	
Online*Previous failure	0.78	0.26	0.00	
Random Effects	**Variance component**	**SE**		
Intercept	2.20	0.59		

Exhibit B-12: Models Investigating the Relationship between Taking Online Courses and Student Achievement. Semester 1 Enrollments*(continued)*

Predicted English 1 Course Grade				
Restricted Sample, n=27126				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	2.32	0.08	<.0001	
Online	-0.22	0.09	0.01	
Stanford 10 NCE	0.01	0.00	<.0001	
Same grade level	-0.30	0.02	<.0001	
Online*Stanford 10	0.00	0.00	0.36	
Honors course	0.31	0.02	<.0001	
Previously failed	-0.18	0.02	<.0001	
Online*Previous failure	0.25	0.12	0.05	
Random Effects	**Variance component**	**SE**		
Intercept	0.25	0.06		
Residual	1.24	0.01		
Student-level Variance Explained (proportion)	0.08			
Predicted Stanford 10 Reading Score				
Restricted Sample, n=27126				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	57.60	0.92	<.0001	
Online	1.40	1.03	0.17	
Stanford 10 NCE	0.63	0.00	<.0001	
Same grade level	3.47	0.25	<.0001	
Online*Stanford 10	-0.03	0.04	0.45	
Honors course	7.49	0.28	<.0001	
Previously failed	-1.16	0.19	<.0001	
Online*Previous failure	-1.14	1.48	0.44	
Random Effects	**Variance component**	**SE**		
Intercept	33.35	7.82		
Residual	175.74	1.51		
Student-level Variance Explained (proportion)	0.45			

Exhibit B-12: Models Investigating the Relationship between Taking Online Courses and Student Achievement. Semester 1 Enrollments*(continued)*

Predicted FCAT Reading Score				
Restricted Sample, n=26848				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	1947.01	18	<.0001	
Online	13.60	15.60	0.38	
Stanford 10 NCE	9.40	0.07	<.0001	
Same grade level	-8.30	3.90	0.03	
Online*Stanford 10	-1.33	0.55	0.02	
Honors course	104.62	4.12	<.0001	
Previously failed	16.89	2.90	<.0001	
Online*Previous failure	-1.72	22.40	0.94	
Random Effects	**Variance component**	**SE**		
Intercept	13086.55	3014.77		
Residual	38901.71	336.07		
Student-level Variance Explained (proportion)	0.45			

Predicted Algebra 1 Course Passing				
Restricted Sample, n= 9678 Districts 36				
Fixed Effects	**Beta**	**SE**	**p**	**OR**
Intercept	2.08	0.18	<.0001	
Online	-1.21	0.16	<.0001	0.30
Stanford 10 NCE	0.04	0.00	<.0001	
Same grade level	-0.37	0.10	0.00	
Online*Stanford 10	0.00	0.01	0.75	
Honors course	0.00	0.13	0.99	
Previously failed	-0.31	0.07	<.0001	
Online*Previous failure	0.50	0.29	0.09	
Random Effects	**Variance component**	**SE**		
Intercept	1.06	0.31		

Predicted Algebra 1 Course Grade				
Restricted Sample, n=9678				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	2.02	0.08	<.0001	
Online	-0.17	0.07	0.02	
Stanford 10 NCE	0.03	0.00	<.0001	
Same grade level	-0.25	0.04	<.0001	
Online*Stanford 10	0.00	0.00	0.62	
Honors course	-0.02	0.04	0.67	
Previously failed	-0.29	0.03	<.0001	
Online*Previous failure	0.11	0.13	0.40	
Random Effects	**Variance component**	**SE**		
Intercept	0.23	0.06		
Residual	1.18	0.02		
Student-level Variance Explained (proportion)	0.12			

Exhibit B-12: Models Investigating the Relationship between Taking Online Courses and Student Achievement. Semester 1 Enrollments *(continued)*

Predicted Stanford 10 Math Score				
Restricted Sample, n=9678				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	60.56	0.58	<.0001	
Online	1.97	0.82	0.02	
Stanford 10 NCE	0.74	0.01	<.0001	
Same grade level	3.41	0.48	<.0001	
Online*Stanford 10	0.06	0.05	0.26	
Honors course	3.12	0.45	<.0001	
Previously failed	-1.94	0.30	<.0001	
Online*Previous failure	-1.50	1.51	0.32	
Random Effects	**Variance component**	**SE**		
Intercept	10.53	3.16		
Residual	150.69	2.17		
Student-level Variance Explained (proportion)	0.41			

Predicted FCAT Math Score				
Restricted Sample, n=9519				
Fixed Effects	**Beta**	**SE**	**p**	
Intercept	1973.09	5.26	<.0001	
Online	24.03	6.37	0.00	
Stanford 10 NCE	5.57	0.08	<.0001	
Same grade level	-43.59	4.23	<.0001	
Online*Stanford 10	0.83	0.40	0.04	
Honors course	29.36	3.54	<.0001	
Previously failed	25.17	2.37	<.0001	
Online*Previous failure	-24.62	11.80	0.04	
Random Effects	**Variance component**	**SE**		
Intercept	898.10	259.82		
Residual	9054.23	131.59		
Student-level Variance Explained (proportion)	0.40			

Case Study Sample Selection

This section describes the identification and nomination of 10 districts for the FLVS case study (Exhibits B-12 and B-13; see also Appendix A).

Student data from 2006–07 were obtained from FLVS and the Florida Department of Education. Before analyzing the data through regression techniques, analysts identified districts with high enrollment. High-enrollment districts were defined as those with at least 20 students enrolled in online courses and at least 10 students enrolled in a given course segment. Analysts focused on these districts to ensure an adequate level of online learning to merit site visits. Thirty-five sites had at least 20 students enrolled in an online courses and at least 10 students enrolled in any single online course in 2006–07. Analysts also calculated the number of different courses in which students were enrolled.

Within the pool of high-enrollment districts, student pass rates and student achievement were statistically analyzed, controlling for a variety of student and school characteristics. Using statistical analyses, researchers identified sites with above-average achievement as well as average achievement, as measured by final course grades. Student retention rates in individual mathematics and English courses were also computed.

District-level student achievement was analyzed using linear regression with a set of covariates representing student- and school-level characteristics. Covariates in the model included student grade level, a flag for limited English proficiency status, FRPL status in grade 8, prior-year FCAT scores in reading (for English courses) or in mathematics (for mathematics courses) and a dummy variable that indicated whether the student had previously attempted and failed the course. The model also included median school Stanford 10 scores in mathematics and reading for grade 9 in 2006–07. The model was estimated without a constant term and with a dummy variable representing each district so that the estimated mean for each district could be compared with the overall mean.[40] An F-test was used to compare the mean estimated final grade for each district, with the mean across all districts estimated to identify those sites with achievement that was statistically different from average. Models for mathematics and English courses were estimated separately. Six districts had above-average achievement in English significant at the .05 level and seven had above-average achievement in mathematics at the .05 significance level. Districts with above-average achievement or pass rates in both mathematics and English were given priority.

40 An identical set of covariates but estimated with an intercept and one district dummy variable dropped was also estimated to examine the model fit. The coefficients in these models explained 0.19 percent of the variance in mathematics grades and 0.18 percent of the variance in English grades.

Similarly, district pass rates were analyzed using logistic regression with the same set of covariates described above. After estimating the regression model, a Wald test was used to compare the estimated odds of passing the course for each district with the estimated odds across all districts to identify those sites with pass rates that were statistically different from the average pass rate. Considering only those districts that had coefficients that were significant at the .05 level, five districts had above-average odds of passing in English and six had above-average passing odds in mathematics.

From this analysis, five implementation sites with *exemplary* achievement, including pass rates (Exhibit B-12) and five sites with *typical* achievement (Exhibit B-13) were identified using coefficients from the district dummy variables and results of the significance tests.[41] Districts were selected to ensure that sites were not homogenous (e.g., that they were all large districts) and that there was some diversity in the characteristics of students who took online courses in the district. Three of the exemplary districts turned out to be franchise districts that leased materials and obtained training from FLVS but implemented FLVS locally, with locally hired teachers and local administration.

41 Districts with below average student outcomes in online courses were excluded due to concern that districts with below-average achievement may have problems not specific to online learning (e.g. leadership transitions, poorer school climate) that would limit value of information collected.

Exhibit B-13: Nominated Exemplary Districts

District Name	District Characteristics			Online Course Students					English				Math			
									Final Grade		Odds of Passing		Final Grade		Odds of Passing	
									n = 2,934		*n* = 4,368		*n* = 2,154		*n* = 3,263	
	District High School Enrollments	Median National percent Rank Score NRT Reading Grade 9	Median National percent Rank Score NRT Mathe-matics Grade 9	Number of Unique Students Enrolled in Online Learning Program	FRPL (percent)	English Lan-guage Learner (percent)	African American (percent)	Latino (percent)	District Mean(percent ± overall mean)	*p* value	District Mean(percent ± overall mean)	*p* value	District Mean (percent±overall mean)	*p* value	District Mean(percent ± overall mean)	*p*value
A*	75,037	74	78	128	27.3	10	33	29.7	2.63	.06	73	.24	1.58	.31	59	.27
B*	105,695	57	66	593	53.0	2	20	58.9	0.95	.21	6	.29	2.21	<.01	8	.62
C	12,117	70	69	121	32.2	N/A	29	3.3	4.37	<.01	6	.31	0.40	.81	23	.56
D	11,165	68	72	310	19.4	>1	8	5.8	0.73	.34	-20	.28	2.69	.02	37	.21
E*	8,084	82	82	175	14.9	1	5	2.9	1.53	.18	1	.93	3.32	<.01	39	.26

Exhibit Reads: Students in exemplary districts displayed, on average, relatively higher grades and/or odds of passing selected English and mathematics online courses than the average across districts, after adjusting for student demographics and prior achievement. *p* Values for at least one of these comparisons were significant in four of the five selected districts.

*FLVS Franchise districts

Exhibit B-14: Nominated Typical Districts

District Name	District Characteristics			Online Course Students					English				Mathematics			
									Final Grade		Odds of Passing		Final Grade		Odds of Passin	
									n=2,934		*n*=4,368		*n*=2,154		*n*=3,263	
	District High School Enrollments	Median National percent Rank Score NRT Reading Grade 9	Median National percent Rank Score NRT Mathe-matics Grade 9	Number of Unique Students Enrolled in Online Learning Program	FRPL (percent)	English Language Learner (percent)	AfricanAmerican (percent)	Latino (percent)	District Mean (± overall mean)	*p*value	District Mean(percent± overall mean)	*p* value	District Mean(± overall mean)	*p* value	District Mean(percent± overall mean)	*p*
I	21,593	67	72	324	27.8	2.8	6.8	18.5	0.15	.85	-6	.80	-0.84	.43	28	
J	5,804	81	81	46	17.4	N/A	2.2	6.5	-0.51	.82	-20	.23	0.20	.94	82	
K	18,307	71	73	340	29.7	0.6	3.8	7.4	0.70	.37	-20	.28	0.81	.48	-32	
L	12,058	75	79	123	22.8	N/A	6.5	5.7	1.24	.30	-18	.39	1.59	.36	-34	
O	19,864	71	74	362	25.7	N/A	9.4	12.7	0.09	.90	8	.29	-2.59	.05	-7	

Exhibit Reads: Students in typical districts displayed, on average, the same grades and/or odds of passing selected English and mathematics online courses as the overall mean across districts, adjusting for student demographics and prior achievement. *p* Values for one of these comparisons was significant in at the 90 percent level for the five selected districts.

Appendix C: Expanded Data Sources, Methods and Results in the Mid-Atlantic School District Case Study

Database Construction

The MAVS district provided a single file for each year containing enrollment information (including course number and course grades), demographic data and test scores for all students enrolled in Geometry or English 12 in the district, regardless of platform (Exhibit C-1). Online courses in the district are open to all students, but the files did not contain records for students enrolled in self-contained place-based special education or English for Speakers of Other Languages courses. Before conducting the analysis, researchers discarded all online and place-based enrollments that resulted in withdrawals or incompletes (71 cases from a total of 10,578 for Geometry and 25 cases from a total of 6,567 for English in 2007; 60 cases from a total of 10,353 for Geometry and 25 cases from a total of 6,458 records for English in 2008). There is no honors version of English 12; advanced students take Advanced Placement English courses, for which no data were received. Because of the relatively small number of online enrollments in each year, analysts pooled data for each course across two years, as well as across school year and summer enrollments.

End-of-course exam scores for English 11 and Algebra 1 were used as measures of prior achievement for the analysis of achievement in the English 12 and Geometry courses, respectively. No end-of-course exam was available for English 12, but end-of-course Geometry exam scores were examined as an outcome. The standardized end-of-course exam scores were scaled to be equivalent across years from 2006 on. The only test scores used before that were 2005 Algebra 1 tests scores as prior achievement. Analysts handled records with 2005 scores somewhat differently from other records, as described below in the Sampling and Analytic Methodology section.

For students who took Geometry courses in both the school term and the summer term in a given year—and who, therefore, had two records in the data for that year—analysts kept the record for the course for which each student took the end-of-course test immediately after the course (June for the school term and August for the summer term). For students who took English 12 courses in both the school term and the summer term in a given year, analysts kept both records. The vast majority of students with duplicate records took the same course the second time after failing it

initially. For these students, analysts assigned a previous failure flag to the record of the second course enrollment.[42]

Some students were not included in the subsequent analyses due to missing values on variables used in the analysis. Exhibits C-2 and C-3 compare students who were included in the analytic sample and those who were not on student characteristics for geometry and English 12 analyses respectively.

Exhibit C-1: Course Enrollment, Student Demographic and Achievement Variables

Course enrollment	
Academic year	Enrollment in 2006–07 or 2007–08
School year	Flag indicating school year (as opposed to summer) enrollment
Online	Flag indicating online enrollment
Honors	Flag indicating honors enrollment (Geometry only)
Student characteristics	
Previous failure	Flag indicating that the student previously failed the course
Grade level	Student grade level at the time of course enrollment
Special education	Flag for students receiving special education services or accommodations
Gender	Flag for gender
Race	Categories include Asian, African American, Hispanic, White, or Other (Other includes Pacific Islander/Native Hawaiian, American Indian/Alaskan Native and multiracial)
Free or reduced price lunch (FRPL)	Student receives free or reduced-price meals
English language learner	Flag for students with limited English proficiency
Old for grade level	Calculated from age (in years, as of August 1 of school year for general education student and September 30 for special education students) and grade level provided by the district. Old if the student was older than 15 in grade 9, 16 in grade 10, etc.
Young for grade level	Calculated from age (in years) and grade level provided by the district. Young if the student was younger than 14 in grade 9, 15 in grade 10, etc.
End-of-course exam (prior course)	State standardized Algebra 1 or English 11 assessment
Student outcomes	
Passed course	Completed course with passing grade (D- or above)
Course mark	A=4, A-=3.5, B=3, B-=2.5, C=2, C-=1.5, D=1, D-=.5, F=0
End-of-course exam	State standardized Geometry assessment

42 The MAVS district provided a previous failure indicator in which students who failed the course in past years were flagged but not students who failed the course in the year the data were collected.

Exhibit C-2: Comparison of Student Characteristics for Students Included and Excluded from Geometry Analysis Due to Missing Data

		Online Students				Place-Based Students			
		Excluded	Included	Difference	P Value	Excluded	Included	Difference	*P* Value
Honors	Mean	0.125	0.0221	0.1029	0.2508	0.1253	0.2172	-0.0919	<.0001
	N	16	136			1508	19089		
Special Education	Mean	0.0625	0.0074	0.0551	0.3943	0.0477	0.0408	0.0069	0.2219
	N	16	136			1508	19089		
Female	Mean	0.6875	0.4853	0.2022	0.1276	0.4695	0.4991	-0.0296	0.0267
	N	16	136			1508	19089		
Black	Mean	0.0625	0.0515	0.011	0.853	0.1631	0.0985	0.0646	<.0001
	N	16	136			1508	19089		
Hispanic	Mean	0	0.0441	-0.0441	0.0138	0.1877	0.122	0.0657	<.0001
	N	16	136			1508	19089		
Asia	Mean	0.1875	0.2426	-0.0551	0.6263	0.1691	0.189	-0.0199	0.0486
	N	16	136			1508	19089		.
Other ethnicity	Mean	0	0.0882	-0.0882	0.0004	0.0603	0.0452	0.0152	0.0163
	N	16	136			1508	19089		
Free or Reduced Price Lunch	Mean	0.0625	0.0735	-0.011	0.8731	0.2487	0.1722	0.0765	<.0001
	N	16	136			1508	19089		
ELL	Mean	0.0625	0.125	-0.0625	0.4675	0.1903	0.1611	0.0292	0.0052
	N	16	136			1508	19089		
Old for grade level	Mean	0.125	0.0074	0.1176	0.1897	0.0398	0.0171	0.0227	<.0001
	N	16	136			1508	19089		
Young for grade level	Mean	0.1875	0.1912	-0.0037	0.972	0.1326	0.1371	-0.0045	0.6268
	N	16	136			1508	19089		

Exhibit C-3: Comparison of Student Characteristics for Students Included and Excluded from English Analysis Due to Missing Data

		Online Students				Place-Based Students			
		Excluded	Included	Difference	P Value	Excluded	Included	Difference	*P* Value
Honors	Mean	0	0	0	.	0	0	0	.
	N	37	111		.	849	11978		.
Special Education	Mean	0.0541	0.027	0.027	0.5102	0.0353	0.0625	-0.0272	<.0001
	N	37	111			849	11978		
Female	Mean	0.5405	0.5045	0.036	0.7064	0.4935	0.434	0.0595	0.0007
	N	37	111			849	11978		
Black	Mean	0.1622	0.027	0.1351	0.039	0.1802	0.1166	0.0636	<.0001
	N	37	111			849	11978		
Hispani	Mean	0.0811	0.0631	0.018	0.7076	0.1861	0.1221	0.064	<.0001
	N	37	111			849	11978		
Asian	Mean	0.3243	0.2162	0.1081	0.1868	0.2073	0.164	0.0433	0.0026
	N	37	111			849	11978		
Other ethnicity	Mean	0.027	0.0541	-0.027	0.4365	0.0342	0.0367	-0.0026	0.6992
	N	37	111			849	11978		
Free or Reduced Price Lunch	Mean	0.2162	0.0541	0.1622	0.0293	0.2756	0.1577	0.1179	<.0001
	N	37	111			849	11978		
ELL	Mean	0.1892	0.009	0.1802	0.0095	0.2509	0.0898	0.1611	<.0001
	N	37	111			849	11978		
Old for grade level	Mean	0.0541	0	0.0541	0.1601	0.066	0.0068	0.0591	<.0001
	N	37	111			849	11978		
Young for grade level	Mean	0.2973	0.1712	0.1261	0.0997	0.1602	0.1418	0.0183	0.1583
	N	37	111			849	11978		

Methodology for Comparing Characteristics of Online and Place-Based Enrollments

Analysts compared the characteristics of students taking online and place-based versions of each course. Pearson's chi-square tests of independence were used to compare the percentage of students in online and place-based courses with a particular characteristic. If the proportion of students is the same in online and place-based courses, the student characteristic can be considered to be independent of course format. End-of-course exam scores were the only continuous variable. For this measure of prior student achievement, analysts compared the mean score of students in online and place-based courses using a t-test of difference in means. In both cases, the null hypothesis is that the mean or proportion is the same for students in online and place-based courses.

Sampling and Analytic Methodology for Achievement Analysis

Analysts compared student achievement for online and place-based students in Geometry and English 12 separately. They examined three measures of student achievement: (1) course passing, (2) course grades and (3) end-of-course Geometry exam scores. Because students in online and place-based courses varied considerably on the student and school characteristics detailed in Exhibit C-1 and these differences varied by course, analysts created a matched sample of place-based students for the online enrollments in each course.

To compare student achievement in online and place-based courses, analysts constructed a comparison group of students in place-based courses who were comparable to the cohort of online students on all the student, course and school characteristics listed in Exhibit C-1 using propensity score matching. The process was conducted for Geometry and English 12 and for 2007 and 2008 separately. Because the standardized end-of-course exam scores before 2006 cannot be assumed to be equivalent to those from 2006 on, for the analysis of 2007 Geometry, analysts posited the model separately for students with prior Algebra 1 end-of-course test scores from 2005 and those with prior Algebra 1 test scores after 2005.[43] For each analysis, researchers first posited a propensity score model estimating each student's propensity of taking online Geometry or English 12 based on his or her prior achievement and demographic background. Analysts performed the matching by grade level and previous failure status for 2007 and 2008 separately for each subject.[44]

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43 The only test scores before those for 2006 were the 2005 Algebra 1 test scores as prior achievement.

44 For the Geometry analysis, students with 2005 Algebra 1 as prior achievement were matched separately from those having later Algebra 1 test scores.

The model for calculating the propensity score is as follows:

$$Pr(Y=1|B)=p$$

$$\text{Log } (1/1-p) = b_0+b_1(x1)+b_2(x2)+\ldots+b_n(Xn)+e$$

Where

Y=1 for students in online courses

Y=0 for students in place-based courses

Analysts included all the student enrollment and student characteristic covariates listed in Exhibit C-1 in propensity score modeling. They used caliper matching with replacement[45] to match each online student with all students from the same grade level and the same previous failure status who enrolled in the placed-based versions of the same course and whose propensity score (in logits) was within .20 caliper of the online student (in standard deviations of the online student's propensity score).[46] To ensure equal representation of the characteristics of each online student in the comparison group, analysts weighted each of the matches for a given online student by the inverse of the number of matches for that student in the comparison group. These weights were used in all analyses comparing the student achievement in online and place-based courses.

The result of this process was that, in the aggregate, the students in this comparison group had similar characteristics and test scores to those of students who took the same class online. Profiles for the online and matched samples for Geometry and English 12 are shown in Exhibits C-4 and C-5, respectively. There were no statistically significant differences between online students and their place-based comparison students in any of the variables tested, except school year. Compared with the matched sample of place-based students, much smaller percentages of online students took the courses during the school year. The small number of online students with previous failures could not be matched, so achievement comparisons do not include any students who previously failed the course. For the sake of including more comparison students, analysts did not match specifically on school year.

After constructing the matched comparison group, analysts compared mean achievement in each course for online and place-based students for each subject, combining the 2007 and 2008 cohorts. The three outcomes analyzed were course grade, course passing andGeometry end-of-course exam results. The analysis included prior test scores as covariates (Algebra 1 for Geometry and reading and writing for English 12) in the models comparing mean achievement for online and place-based students.

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45 See Reardon et al. (2009) for an example of the matching approach.

46 Matching within 0.2 standard deviations of a normally distributed covariate (propensity score, in this case) has been suggested to remove 98 percent of the bias in the distribution of the covariate (Cochran 1983).

Exhibit C-4: Comparison of Student Characteristics by Platform for Geometry

		Geometry 2007			Geometry 2008		
		Place-Based	Online	*p*	Place-Based	Online	*p*
Number (n)		**9594**	**65**		**9360**	**71**	
Grade	School year	0.92	0.14	<.0001	0.94	0.08	<.0001
	Grade 8	0.02	0.22	<.01	0.01	0.17	<.01
	Grade 9	0.36	0.55	<.01	0.34	0.51	<.01
	Grade 10	0.43	0.15	<.0001	0.42	0.24	<.01
	Grade 11	0.17	0.08	0.01	0.18	0.07	<.01
	Grade 12	0.03	0.00	<.0001	0.03	0.01	0.16
FRPL	FRPL	0.15	0.05	<.01	0.19	0.10	0.01
Race	African American	0.10	0.08	0.59	0.10	0.03	<.01
	Hispanic	0.11	0.05	0.01	0.13	0.04	<.01
	Asian	0.19	0.25	0.25	0.19	0.24	0.27
	Other Ethnicity	0.04	0.11	0.10	0.05	0.07	0.46
Sex	Female	0.50	0.43	0.26	0.50	0.54	0.52
Student Achieve-ment	Previous failure	0.01	0.00	<.0001	0.01	0.00	<.0001
	Honors	0.22	0.03	<.0001	0.21	0.01	<.0001
	Prior Algebra 1 score	485.5	493.5	0.23	481.4	504.4	<.01
		(52.2)	(44.6)		(50.3)	(48.8)	
	Prior Algebra 1 score 2005	474.2	454.0	0.36			
		(44.4)	(52.9)				
Other Back-ground	Old for grade level	0.01	0.00	<.0001	0.02	0.01	0.75
	Young for grade level	0.14	0.20	0.15	0.14	0.18	0.25
	Special education	0.08	0.02	<.0001	NA*	NA*	
	English language learner	0.15	0.17	0.70	0.17	0.08	0.01

Note. Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent the percentages.

*Special education status not available for 2007-08

Exhibit C-5: Comparison of Student Characteristics by Platform for English 12

		English 2007			English 2008		
		Place-Based	Online	*p*	Place-Based	Online	*p*
Number (n)		**5994**	**54**		**5973**	**48**	
Grade	School year	0.98	0.56	<.0001	0.99	0.73	0.00
	Grade 10	0.00	0.00	0.32	0.00	0.00	0.16g
	Grade 11	0.02	0.26	0.00	0.01	0.19	0.00
	Grade 12	0.98	0.74	0.00	0.99	0.81	0.00
FRPL	FRPL	0.15	0.11	0.45	0.17	0.00	<.0001
Race	African American	0.12	0.04	0.00	0.11	0.02	<.0001
	Hispanic	0.12	0.09	0.59	0.13	0.00	<.0001
	Asian	0.16	0.22	0.21	0.17	0.19	0.73
	Other Ethnicity	0.03	0.02	0.39	0.04	0.10	0.15
Sex	Female	0.44	0.56	0.08	0.43	0.44	0.92
Student Achieve-ment	Previous fail	0.00	0.00	0.08	0.00	0.00	0.00
	Prior reading score	503.2	531.8	0.00	498.0	521.1	0.0
		(54.0)	(58.2)		(54.5)	(50.4)	
	Prior writing score	475.1	501.7	0.01	483.6	510.5	<.0001
		(50.9)	(71.3)		(46.3)	(48.2)	
Other Back-ground	Old for grade level	0.01	0.00	<.0001	0.01	0.00	<.0001
	Young for grade level	0.15	0.20	0.29	0.13	0.17	0.48
	Special education	0.12	0.06	0.03	NA*	NA*	.
	English language learner	0.09	0.00	<.0001	0.09	0.02	0.00

Note. Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent the percentages.

*Special education status not available for 2007-08

The linear regression model for comparing achievement (course grade and, for Geometry, end-of-course exam scores) follows:

$$Y=b_0+b_1(\text{ONLINE})+b_2(\text{Prior Achievement})+ b_3 (\text{Honors})+e$$

Where, Y is the outcome of interest (course grade or end-of-course exam score), ONLINE is a dummy variable coded 1 for online courses and 0 for place-based courses. For Geometry, prior achievement is proficiency levels (proficient and advanced versus not passing) in prior Algebra 1 achievement. Analysts used proficiency level instead of test scores because 2005 Algebra 1 test scores were not comparable with scores from later years. Analysts also included being in an honors class as a predictor for the Geometry analysis. For English, prior achievement is prior end-of-course reading and writing exam scores.

For logistic regression, the functional form is the same, but the model estimates the log of the odds of successfully completing the course:

$$P(Y=1|B)=P$$
$$\text{Log } (1/1\text{-}P)=b_0+b_1(\text{ONLINE})+b_2(\text{Prior Achievement})+ b_3 (\text{Honors})+e$$

The coefficient of interest for the comparison is that of the variable indicating online course enrollment, with the null hypothesis that mean achievement in online and place-based courses is the same; in other words, that the coefficient on b_1 (the dummy variable indicating that the course was taken online) is 0. The null hypothesis is that there is no difference across course formats.

Exhibits C-5 and C-6 show compare students across platforms by course, after the matching process. Exhibit C-7 shows models investigating the relationship between taking online courses and student achievement.

Exhibit C-6: Comparison of Student Characteristics by Platform for Geometry, After Matching

		Geometry 2007			Geometry 2008		
		Place-Based	Online	*p*	Place-Based	Online	*p*
Number (n)		**4135**	**64**		**4933**	**71**	
School year	School year	0.69	0.14	<.0001	0.77	0.08	<.0001
FRPL	FRPL	0.03	0.05	0.52	0.09	0.10	0.86
Race	African American	0.05	0.08	0.36	0.03	0.03	0.94
	Hispanic	0.04	0.05	0.84	0.04	0.04	0.89
	Asian	0.29	0.25	0.47	0.32	0.24	0.14
	Other ethnicity	0.08	0.09	0.71	0.05	0.07	0.51
Sex	Female	0.53	0.44	0.15	0.52	0.54	0.82
Student Achieve-ment	Honors	0.02	0.03	0.60	0.01	0.01	0.96
	Prior Algebra 1 score	501.7	492.6	0.13	504.6	504.4	0.96
		(46.7)	(44.4)		(49.2)	(48.8)	
	Prior Algebra 1 score 2005	454.0	454.0	1.00			
		(31.1)	(52.9)				
Other Back-ground	Old for grade level	0.00	0.00		0.01	0.01	0.70
	Young for grade level	0.15	0.19	0.39	0.16	0.18	0.59
	Special education	0.02	0.02	0.82	NA*	NA*	.
	English language learner	0.13	0.17	0.32	0.10	0.08	0.58

Note. Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent the percentages.

*Special education status not available for 2007-08

Exhibit C-7: Comparison of Student Characteristics by Platform for English 12, After Matching

		English 2007			English 2008		
		Place-Based	Online	*p*	Place-Based	Online	*p*
Number (n)		**5113**	**53**		**3944**	**46**	
Academic year	Academic year	0.83	0.57	0.00	0.93	0.76	0.01
FRPL	FRPL	0.16	0.09	0.09	0.00	0.00	.
Race	African American	0.04	0.02	0.39	0.01	0.02	0.70
	Hispanic	0.10	0.09	0.81	0.00	0.00	.
	Asian	0.27	0.23	0.44	0.19	0.20	0.94
	Other ethnicity	0.02	0.02	0.83	0.09	0.07	0.57
Sex	Female	0.55	0.57	0.82	0.41	0.43	0.77
Student Achieve-ment	Prior reading score	528.7	533.1	0.59	515.5	521.7	0.44
		(47.8)	(57.9)		(53.3)	(51.4)	
	Prior writing score	503.4	502.2	0.91	508.54	508.13	0.95
		(73.3)	(71.9)		(47.8)	(47.8)	
Other Back-ground	Old for grade level	0.00	0.00	.	0.00	0.00	.
	Young for grade level	0.25	0.21	0.52	0.16	0.17	0.87
	Special education	0.06	0.06	0.81	NA*	NA*	.
	English language learner	0.00	0.00	.	0.05	0.02	0.17

Note. Means and standard deviations are presented for continuous variables. Values reported for dichotomous variables represent the percentages.

*Special education status not available for 2007-08

Exhibit C-8: Models Investigating the Relationship between Taking Online Courses and Student Achievement

Predicted Geometry Course Passing (n=9203)			
Variable	Coefficient	Standard Error	Pr > |t|
Intercept	1.32	0.44	0.00
Online	-1.41	0.39	0.00
Prior_proficient	2.36	0.45	<.0001
Prior_advanced	5.75	0.67	<.0001
Honors	0.75	2.25	0.74
Predicted Geometry Course Grade (n=9203)			
Variable	Coefficient	Standard Error	Pr > |t|
Intercept	1.32	0.14	<.0001
Online	-0.45	0.07	<.0001
Prior_proficient	1.40	0.14	<.0001
Prior_advanced	2.27	0.14	<.0001
Honors	-0.11	0.07	0.10
R squared=.24			
Predicted Geometry End of Course Test Scores (n=9203)			
Variable	Coefficient	Standard Error	Pr > |t|
Intercept	408.31	8.69	<.0001
Online	6.61	4.16	0.11
Prior_proficient	66.80	8.72	<.0001
Prior_advanced	121.94	8.72	<.0001
Honors	16.16	3.98	<.0001
R squared=.26			
Predicted English Course Passing (n=9156)			
Variable	Coefficient	Standard Error	Pr > |t|
Intercept	-13.90	0.79	<.0001
Online	0.28	0.65	0.67
SOLSS reading	0.04	0.00	<.0001
SOLSS writing	0.00	0.00	0.00
Predicted English Course Grade (n=9156)			
Variable	Coefficient	Standard Error	Pr > |t|
Intercept	-1.15	0.11	<.0001
Online	-0.18	0.10	0.06
SOLSS reading	0.01	0.00	<.0001
SOLSS writing	0.00	0.00	<.0001
R squared=.13			

Appendix D: Comparison of Student Achievement Methodology Across the Two Sites

As much as possible, parallel analytic approaches were used to compare student achievement between online and place based students for each site; however, the courses analyzed, the local context and the specific variables available from the two sites differed, resulting in differences in the specifics of the two analyses. Exhibit D-1 summarizes the analyses. For both, the study began by comparing the demographic and prior achievement of students enrolled in online and place-based versions of each course. Afterdetermining that the population of students who took courses online was significantly different from the population of students enrolled in place-based versions of the same coursesat each site, the study selected a sample of students enrolled in place-based courses that was similar to the students enrolled in online courses in terms of prior student achievement and background characteristics using propensity score matching. The propensity score was modeled separately for students in each grade level and (for the MAVS) school year. As much as possible, students were matched on school year and previous failure in the District and on grade level and district in Florida. In both sites, caliper matching with replacement was used to match each online student with all students from the same grade level and, in Florida, from the same school district who enrolled in the place-based versions of the same course and whose propensity score (in logits) was within .20 caliper of the online student (in standard deviations of the online students' propensity scores). For the final achievement models, a hierarchical model was used in Florida, where students were nested by district and linear and logistic regression was used in the MAVS where students all came from the same district.

Exhibit D-1: Comparison of Methods for the FLVS and MAVS Studies

	MAVS		Florida	
Courses	Geometry	English 12	Algebra I	English I
Population				
Years	2007-08; 2008-09	2007-08; 2008-09	2006-07	2006-07
Summer enrollments	Yes	Yes	No	No
Grade levels	9-12	11 and 12	9 and 10	9 and 10
Outcomes	-Course passing -Course grade -End-of-Course exam	-Course passing -Course grade	-Course passing -Course grade -FCAT mathematics score, spring 2007	-Course passing -Course grade -FCAT reading score, spring 2007
Covariates in propensity score models				
Prior achievement	Algebra 1 end-of-course exam	English 11 end-of-course exam	-Stanford 10 Math -Flag indicating if test grade level was same as student's current grade level	-Stanford 10 Reading -Flag indicating if test grade level was same as student's current grade level
Demographics (same across all models)	-Gender -Race (asian, black [not of Hispanic origin], Hispanic, white [not of Hispanic origin], other) -English language learner -Under or over age for grade	Same as Geometry	Gender -Race (asian, black [not of Hispanic origin], Hispanic, white [not of Hispanic origin], other) -English language learner -Under or over age for grade	Same as Algebra I
Demographics (differences between District/Florida)	-Free or reduced price lunch -Special education -School year (not summer session) enrollment	Same as Geometry	-Free or reduced price lunch (8th grade) -Disabled -Gifted -Previously failed course -Honors course	Same as Algebra I
Exact matching variables	-Year -Grade level -Failed course in prior school year*	Same as Geometry	-District -Grade level	Same as Algebra 1
Covariates in achievement models	-Scored proficient or advanced on Algebra 1 exam -Honors	-English 11 reading score -English 11 Writing score	-Stanford 10 Math -Flag indicating if test grade level was same as student's current grade level -Honors -Failed course in prior school year Interaction terms: -prior achievement*online -previous failure*online	-Stanford 10 Reading -Flag indicating if test grade level was same as student's current grade level -Honors -Failed course in prior school year Interaction terms: -prior achievement*online -previous failure*online

*There were very few students with previous failure in the sample and we matched exactly on the variable. However, no students with previous failure could be matched due to missing covariates on the very few online students with previous failure.