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Enrollment and Achievement in Ohio's Virtual Charter Schools

By June Ahn

Thomas B. Fordham Institute
Advancing Educational Excellence

Foreword by

Dara Zeehandelaar and Michael J. Petrilli

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Foreword

By Dara Zeehandelaar and Michael J. Petrilli

A major development in recent years is the explosive growth of online learning. Sometimes it's "partial immersion" (a.k.a. "blended learning"), whereby instruction is provided via a mix of online and face-to-face modalities. Today's students also learn using web-based resources like the Khan Academy or by enrolling in distance-learning "independent study" courses. In addition, a growing number of pupils are taking the plunge into fully online schools: in 2015, there were an estimated 275,000 full-time virtual charter school students across twenty-five states.

To be certain, the Internet has opened a new frontier of possibilities for America's K–12 students. Much less sure, however, is whether these new opportunities are actually improving achievement, especially for the types of students who enroll in virtual schools. We set out to learn more using data from our home state of Ohio. Ohio's fully online charter schools ("e-schools") are a rapidly growing segment of public charter schools that today have an enrollment of more than 35,000—one of the country's largest populations of full-time online students. Ohio e-school enrollment has also grown at a greater rate than enrollment in the state's brick-and-mortar schools, both charter and district, making it a sector well worth paying attention to.

The present study focuses on the demographic characteristics, course-taking patterns, and academic results of pupils attending Ohio's e-schools. How many students are enrolling, and who are they? What types of online courses are students taking? Does it appear that e-schools lead to improved outcomes for kids? To dive into these questions, we partnered with Dr. June Ahn, an associate professor at New York University (NYU)'s Steinhardt School of Culture, Education, and Human Development. His research expertise includes how technology, information, and new media can enhance the way education is delivered—and, ultimately, how they impact the way students learn.

Using student-level data from 2009–10 through 2012–13 obtained from the Ohio Department of Education, Dr. Ahn's analysis finds that e-schools serve a unique student population. On the one hand, e-school students are largely similar in race and ethnicity to brick-and-mortar district schools; they enroll smaller percentages of minority students (and more white students) than brick-and-mortar charters. But compared to students in brick-and-mortar district schools, e-school students are initially lower-achieving (and more likely to have repeated the prior grade), more likely to participate in the federal free and reduced price lunch program, and less likely to participate in gifted education. (Brick-and-mortar charter schools attract lower-performing students still.) Given these characteristics, it's not surprising to observe, as this study does, that students taking online math courses are more likely to enroll in basic and remedial classes and less likely to take advanced ones (such as Advanced Placement) relative to students taking face-to-face math courses.

Dr. Ahn's analysis also confirms that, *controlling for demographics and prior achievement*, e-school students perform worse than students who attend brick-and-mortar district schools; students who attend brick-and-mortar charter schools perform slightly better in some subject areas (and slightly worse in others) than students in district schools. On average, Ohio's e-school students are academically behind at the start of each school year, and they lose even more ground (relative to their peers) during the year spent at the e-school.

These findings are largely congruent with previous research in Ohio, most notably a study of the impact of online charter schools on student achievement from Stanford University's Center for Research on Education Outcomes (CREDO). Its 2015 analysis of virtual charter schools nationwide estimates that the sector's students lose the equivalent of 180 days of learning in math and seventy-two days of learning in reading when compared to similar students attending brick-and-mortar district schools. CREDO also found that the results of Ohio online students generally tracked with these dismal national averages. Using a slightly different analytical approach than CREDO, the results reported here corroborate the disappointing findings on Ohio's online schools.

Importantly, the analysis confirms what some charter advocates in Ohio have long suspected—e-schools weigh down the overall impact of the Buckeye State's charter sector. In fact, by separately analyzing e-schools and brick-and-mortar charters, it finds that brick-and-mortar charters have a positive impact on student achievement for students in grades 4-8 when compared to district schools. In high school, brick-and-mortar charter students perform better in science, no better or worse in math, and only slightly worse in reading and writing, compared to students in district schools. The good news for charter advocates is that Ohio's brick-and-mortar charters may not have an overall negative impact on achievement as previously suggested.

Nevertheless, the consistent, negative findings for full-time e-school students are troubling. One option is to pull the plug—literally and figuratively—but we think that would be a mistake. Surely it's possible, especially as technology and online pedagogy improve, to create e-schools that serve students well. The challenge now is to greatly improve the outcomes for online learners. We therefore offer three recommendations that have the potential to boost student achievement in states, including Ohio, which are wrestling with the rapid development of online schools.

First, policy makers should adopt performance-based funding for e-schools. When students complete courses successfully and demonstrate that they have mastered the expected competencies, e-schools would get paid. Implementing performance-based funding policies would create incentives for e-schools to focus on what matters most—academic progress—while tempering their appetite for enrollment growth and the dollars tied to it. It would also encourage them to recruit students likely to succeed in an online environment—a form of "cream-skimming" that is not only defensible but preferable in this case.

Second, policy makers should explore ways to improve the fit between students and e-schools. A recent Mathematica report on virtual schools found that maintaining student engagement is a major barrier to higher achievement. Ideally, an e-school could increase motivation by allowing students to choose courses based on their own interests and pace them according to their own needs. But based on the demographics we report, it seems that students selecting Ohio's e-schools may be those already lacking engagement in schooling (whether due to difficulties learning in a traditional classroom environment, disillusionment after prior failure, or a lack of support at home).

Ohio recently enacted a provision requiring e-schools to offer an orientation course—a perfect occasion to set high expectations for students as they enter and let them know what would help them thrive in an online learning environment (e.g., a quiet place to do schoolwork, a dedicated amount of time to devote to academics). This is one way to improve the student-school fit. In addition, state lawmakers could explore rules that would exempt e-schools from policies requiring all charters, virtual ones included, to accept every student who applies. This would allow e-schools to operate more like magnet schools that maintain certain admissions procedures and standards for enrollment. There is also a need for rigorous research that investigates which strategies are most effective at sustaining student engagement and lifting achievement in an online environment, especially for students who opt for virtual schools because they are frustrated with (or failing out of) other forms of schooling.

Third, policy makers should support online *course* choice (also called "course access"), so that students interested in web-based learning aren't limited to full-time options. Currently, Ohio students considering digital learning are faced with a daunting decision: either transfer to a full-time e-school or stay in their traditional school and potentially be denied the chance to take any tuition-free credit-bearing virtual courses aligned to Ohio state standards. Instead of forcing an all-or-nothing choice, policy makers should ensure that a menu of course options, including online ones, are available to students. To safeguard quality and public dollars, policy makers must create an oversight body that approves sound online options (and denies shoddy or questionable ones). Financing arrangements may need to change too, perhaps in ways that more directly link funding to the actual course provider.

But done right, not only would course choice open more possibilities for students, it would also ratchet up the competition that online schools face—and perhaps compel them to improve the quality of their own services.

Innovation is usually an iterative process. Many of us remember the earliest personal computers—splendid products for playing *Oregon Trail*, but now artifacts of the past. Fortunately, innovators and engineers kept pushing the envelope for faster, nimbler, and smarter devices; today, we are blessed as customers with easy-to-use laptops, tablets, and more. Though the age of online *learning* has dawned, it's evident that there is much room for improvement as far as online *schooling* goes. Bold changes are greatly needed to spur better opportunities for students. For advocates of online learning—and educational choice—the work has just begun.

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Executive Summary

Online learning is often touted as the future of K–12 public education. It's an efficient way to diversify, and even democratize, educational opportunities and experiences in a connected world. And students are taking advantage: In 2015, an estimated 2.7 million K–12 students took a total of 4.5 million online courses while attending brick-and-mortar schools, and 275,000 students were enrolled full-time in online charter schools (and took another 3.3 million courses).[1]

Despite the popularity and promise of fully online schools, however, we have much to learn about this most immersive form of education technology. These schools have certainly received a fair amount of negative attention concerning their attrition rates, test scores, and capacity to educate the types of students who often attend them: those who are not well-served by the traditional K–12 system. At the same time, online schools could give students the opportunity for an education that is not otherwise available to them. A student in a rural area could learn an uncommon world language, for example, or a high-achieving student living in a low-performing district could access an advanced curriculum. Online schools also offer alternatives to students who may not be succeeding in the conventional system due to behavioral or special needs, and they are growing in popularity among students who are behind in credits and in danger of dropping out, and among parents who choose homeschooling for their children.

However, current evidence suggests that students in fully online schools learn less, and often significantly so, than students in traditional brick-and-mortar schools.[2] This report lends empirical evidence to the discussion by examining two research questions in the state of Ohio (which has one of the largest numbers of full-time online students of any state) regarding its fully online charter schools (or "e-schools"):

1. How many and what kind of students choose e-schools, where do they live, and what courses do they take?

2. How are students performing in Ohio e-schools compared to their peers in brick-and-mortar district schools?

To explore these questions, we partnered with the Ohio Department of Education to access detailed administrative data for all K–12 students in the state. The data encompass approximately 1.7 million students per year for the 2009–2010 to 2012–2013 school years. They include district and school enrollment, course records, demographic information, and test scores on state assessments (but no student names or other personally identifiable information). We utilize this quantitative data to analyze enrollment trends, patterns, and achievement of student populations who choose the online option. Here's what we found:

- » Although e-school enrollment accounts for only 2 percent of Ohio's total public school student population in 2013, the sector experienced larger growth than either brick-and-mortar district schools or charters over the preceding four years.

- » E-school students largely live in and around the state's urban centers, where there are also established brick-and-mortar charter schools. There are a few rural and small-town areas that have relatively high e-school participation rates as well.

- » E-school students are mostly similar in race and ethnicity to students in brick-and-mortar district schools. But compared to students in brick-and-mortar district schools, e-school students are lower-achieving (and more likely to have repeated the prior grade), more likely to participate in the federal free and reduced price lunch program, and less likely to participate in gifted education.

- » Students taking online mathematics courses are more likely to enroll in basic and remedial math courses relative to students taking face-to-face math courses. Almost no students take advanced online courses like AP Statistics, Calculus, or Algebra II, especially compared to their peers in face-to-face settings.

- » Across all grades and subjects, students who attend e-schools perform worse on state tests than otherwise-similar students who attend brick-and-mortar district schools, *even accounting for prior achievement*. In contrast, students in grades 4–8 who attend brick-and-mortar charter schools perform slightly better than students in district schools in both reading and math. (Results are mixed but modest for students in grade 10.)[3]

Online education is reconfiguring the delivery of schooling and the activities that students experience on a daily basis. However, our analyses suggest (in line with other recent reports) that online students are not achieving at the same level as their peers in brick-and-mortar schools. The analyses also support what charter advocates have long suspected—that e-schools actually drag down the achievement of the state's charter sector.

Our findings reveal some important considerations for Ohio policy makers as they consider the future place of online learning within K–12 education:

1. E-schools serve challenging student populations, by their own design and by the choice of those who attend them. Many of these students may not be well suited or well supported to succeed in online learning environments that require independent learning and self-direction. E-schools must figure out how to do better by this population.

2. If e-schools can't effectively educate the students who choose to enroll, consider utilizing them more strategically—specifically, by targeting students who are poised to benefit most from online delivery.

3. Rethink the "all-or-nothing" nature of enrolling in e-schools. Instead, allow students to combine high-quality fully online and face-to-face classes (without making them jump through hoops to earn credit, or pay tuition).

4. Harness the potential of e-schools to better understand how students learn online.

Though the age of online *learning* has arrived, it's clear that there is much room for online *schooling* to improve—especially in Ohio. There is great potential in the state, and others, to provide high-quality learning opportunities for students via fully online schools (and online courses, and blended learning). For advocates of online learning, and educational choice more generally, recognizing that potential will require a dedication to making continuous improvements to promising practices. It also calls for a willingness to completely overhaul practices that are consistently demonstrated to be ineffective.

Introduction

Today's students are more likely to reach for a smart phone than a textbook. So it's no surprise that online learning is often touted as the future of education. It offers an efficient way to diversify educational opportunities and experiences in a connected world where many equate "unplugged" with "outdated." Computer hardware is now cheaper, Internet access more widely available, digital data easier to collect, and teachers increasingly comfortable with technology.[4] In 2015, 93 percent of U.S. teachers reported using some form of technology to guide instruction, an estimated 275,000 K–12 students were enrolled full-time in virtual charter schools (and took 3.3 million courses), and 2.7 million students took a total of 4.5 million supplemental online courses while still attending brick-and-mortar schools.[5]

Virtual schools are especially positioned to capitalize on the popularity and promise of technology. They can theoretically expand educational options for a large number of students poorly served by traditional schools. At the same time, online schools have received a fair amount of negative attention about attrition rates, poor academic performance, the presence of for-profit operators, and their capacity to educate the types of students who enroll in them. Recent studies of fully online K–12 charter schools have shed some light about the students and families who attend them—as well as their impact on student achievement—but there is still much to learn.[6]

Ohio in particular is one state in which the sector is an especially substantial (and controversial) presence, and it therefore merits its own analysis. With an enrollment in virtual charter schools of over 35,000 (2 percent of the state's total student population in the 2012–13 school year), Ohio has one of the country's largest populations of full-time online students.[7] The sector has also grown tremendously: a 60 percent increase in enrollment over the past four years.[8] This report lends empirical evidence to the debates and concerns surrounding virtual schools by examining two research questions about fully online charter schools ("e-schools") in the state of Ohio:

1. How many and what kind of students choose e-schools, where do they live, and what courses do they take?

2. How are students performing in Ohio e-schools compared to their peers in brick-and-mortar district schools?

Like any fully online or virtual school, Ohio's twenty-four e-schools do not have brick-and-mortar facilities for coursework. Instead, students receive a computer to use at home; all their classes are online courses. E-schools can be chartered (in Ohio, "sponsored") by the state, a district, a state university, or a state-approved nonprofit organization. Of the twenty-four schools, twelve are sponsored by the state; four are district-sponsored, with no residency requirements; and the remaining eight district-sponsored schools limit enrollment to students in that district (or sometimes to students in surrounding districts as well). Because they are charter schools, e-school funding, enrollment, accountability, and regulatory mechanisms are governed by state charter policy. However, some e-schools are designated as dropout prevention schools and thus waived from conventional state accountability regulations.[9]

This report explores critical questions about Ohio's virtual schools and distills some lessons from what we learn about them. Section I provides an overview of online learning, and includes definitions of terms and a description of the history and status of the sector in Ohio. Section II describes the data and methods used to answer our research questions. Section III presents the findings. We conclude with recommendations for policy makers, advocates, and educators moving forward.

Section I:

Overview

Supporters of digital education cite many potential benefits (see *Defining Digital Education* for terminology). For instance, online courses give students access to classes that are not available in their local schools or districts, such that a student in a rural school could take a course in an uncommon world language, or a high-achieving student at a low-performing school could take an Advanced Placement (AP) course. Elementary school students might receive academic support in areas where they're struggling to learn the basics, or enroll in online gifted and talented programs. Online courses and schools also give alternatives to students who may not be succeeding in the traditional system due to behavioral or special needs. Additionally, they are growing in popularity among students who are behind in credits and in danger of dropping out, and among students and parents who opt for homeschooling.

Digital education tools are useful resources for educators as well. Teachers and administrators have access to a wider array of content and can blend online learning with face-to-face interactions, tailoring instruction to student needs and interests. They can use the data collected by online courses to inform decision-making and personalize learning.[10] Finally, online courses and schools have the potential to deliver content at a lower long-term cost than traditional brick-and-mortar schools by having fewer staff and overhead expenses.[11]

Defining Digital Education

There are many different configurations of teachers, students, classrooms, and resources that fall under the umbrella of "digital education." Commonly used terms can refer to different formats (or may not actually be well defined at all). For this report, we use the following vocabulary.

ONLINE COURSES

Terms like "virtual," "digital," "distance," or "online" education (or learning) generally refer to any educational activities that take place over the Internet. By definition, virtual education writ large does not involve face-to-face interaction with a teacher. It can be a formal, credit-bearing course or simply supplemental instructional materials. Learning activities can be synchronous (i.e., real-time interaction) or asynchronous (i.e., not occurring at the same time). In K–12 settings, the term "online courses" has a more specific meaning: formal classes for which a student receives official credit on his or her transcript. These typically require a credentialed teacher of record who guides and interacts with students. Students and their teachers of record are geographically distributed, meaning that they are not in the same room; instead, they use a web-based system to deliver content and facilitate communication among students and between students and instructors. Students access the system from the location of their choice, usually at home.[12] This report uses "online courses" to describe formal classes (a) with a credentialed teacher of record who is not in the same room as the student and (b) for which a student receives official credit on his or her transcript.

ONLINE SCHOOLS

Students take online courses in a variety of ways. They can be enrolled in a "brick-and-mortar" district or charter school (in Ohio, a "community school") and take one or more fully online courses as a form of independent study.[13] They can also enroll full-time in virtual or online schools—in Ohio, all public virtual schools are charter schools (called "e-schools"), but in other states online schools can be operated by a state or school district. The exact structure of online public schools varies from state to state because much of it is determined by state law.

In Ohio, e-school students access the entire curriculum for all their courses via the Internet. Instead of face-to-face interaction with a teacher, e-school students receive content via recorded videos or other media, or use course materials that are either downloaded or mailed to their homes. (While brick-and-mortar students are allowed to take online "independent study" courses, e-school students can't take any face-to-face courses. All e-school students are full-time.) Problem sets, homework assignments, and course exams are also generally conducted using online platforms. Older students tend to use more digital resources, while younger ones more often rely on physical materials.

Each e-school course is taught by a licensed Ohio teacher. Students may connect with the teacher (or other students in the course) in real time, using videoconference, email, or chat to work on problems together. Interactions can also be asynchronous, where (for example) teachers provide feedback on student work over email, or students connect with one another using online discussion forums. In addition, parents may be asked to work through a curriculum and associated activities with students at home. There is no assigned location for any of these learning activities—students receive a computer and Internet access at home, and they can work from home, a library, or any other site. (The exception is when students take state-mandated tests. Ohio law requires that e-schools provide a testing location within fifty miles of the home of each enrolled student.) Upon graduation, e-school students receive the same high school diploma as all other public school students.[14]

Research shows mixed results relative to whether various forms of online learning improve student achievement.[15] The current evidence suggests that online charter school students perform worse on achievement measures, and often significantly so, than similar students in traditional brick-and-mortar district schools.[16] While students who are not succeeding in the traditional K–12 system now have online alternatives, it is an open question whether these student populations are suited for a fully online environment that requires independent learning and self-motivation.[17] Two recent studies of online credit recovery courses support the notion that students requiring remediation may not be the best fit for virtual coursework. Although the studies examine students taking individual online courses while still enrolled in their home schools (rather than in fully online schools), one found that students learn less taking the same class online as opposed to face-to-face; the other found that students were more likely to succeed in online courses if they had in-person supports at their home school.[18]

Further, the K–12 online education sector has seen much debate over how much it costs to educate a student virtually, how to track student "attendance" and the "length of the school day" offered by schools, how to ensure that online schools are providing a high-quality education, and how they should fit into the state's accountability system.[19] Ohio is a representative example: Its e-schools, some of which are operated by for-profit entities, frequently face criticism for poor student outcomes while growing their enrollment and revenue numbers.[20]

Recent History of Ohio E-schools

State law first recognized fully virtual charter schools as different from brick-and-mortar charters in 2003, and (like all charters) at the time they had significant operational autonomy. Subsequent legislation outlined requirements related to e-schools' instructional expenditures, operational standards, attendance tracking, and the number of students per credentialed teacher. It also codified consequences for lack of compliance with state laws. The state placed a moratorium on authorizing new e-schools in 2005, which it then lifted in 2011. Now up to five new e-schools can open each year; three opened in 2013. Also in 2013, the state implemented an annual cap on the enrollment growth of existing online schools—15 percent for schools with 3,000 students or greater, and 25 percent for schools with fewer.

Most recently, in late 2015 the Ohio General Assembly passed a comprehensive charter school reform package (House Bill 2) that included several provisions directly impacting e-schools. The legislation includes sections that better guarantee e-school compliance with the International Association for K–12 Online Learning (iNACOL) operating standards,[21] ensure that e-schools are keeping accurate records of students' daily participation in online courses, mandate a student orientation prior to enrollment, and require greater communication between e-schools and parents about students' academic progress.[22] In March 2016, news broke that two of the state's smaller e-schools would be required to pay back a portion of their state funding due to discrepancies between Ohio's new attendance-tracking policies and e-schools' practices.[23] One month later, the legislature began hearings on a bill that would add further administrative regulations for the state's online schools. As of publication, both e-schools and their opponents are turning to lobbying and the courts as new laws are being discussed, and existing ones implemented.[24]

Clearly, the current debate around e-schools in Ohio is unresolved. Supporters maintain that virtual schools empower families to meet the individual needs of each child, no matter where they live, but detractors question the effectiveness and costs of fully online education and call for even more regulation and transparency of the sector. This study uses comprehensive student data and rigorous analysis to lend empirical evidence to the conversation.

Section II:

Data and Methods

This study examines the following two questions:

1. How many and what kind of students choose e-schools, where do they live, and what courses do they take?

2. How are students performing in Ohio e-schools compared to their peers in brick-and-mortar district schools?

To explore these questions, we partnered with the Ohio Department of Education for access to detailed administrative data for all K–12 students in the state. These data encompass approximately 1.7 million students per year for the 2009–10 through 2012–13 school years. They include district and school enrollment, course records, demographic information, and test scores on state assessments (but no student names or other personally identifiable information). We utilize these data to analyze enrollment trends, demographics, and achievement of students who choose the online option, and to make comparisons with their brick-and-mortar peers.

We aim to contribute empirical evidence informing two critical debates surrounding e-schools. First, e-school providers and supporters often state that these schools serve unique, challenging student populations with a history of lower academic achievement. Thus, our first question explores the enrollment patterns of Ohio e-schools and the characteristics of the students who enroll in them, as well as how they compare to brick-and-mortar charter and district schools.

Second, we examine how students perform in e-schools compared to similar peers in other school types. To this end, we use traditional panel data econometrics to compare the achievement of otherwise-similar students who attend brick-and-mortar district schools with that of students attending either e-schools or brick-and-mortar charters. We evaluate the achievement of tenth-grade students in the 2011–12 and 2012–13 school years, and we analyze achievement for students in grades 4–8 in the 2010–11, 2011–12, and 2012–13 school years.

The outcome measures are students' point-in-time "current" state math and reading scores: Ohio Achievement Assessment (OAA) math and reading scores for students in grades 4–8 and Ohio Graduation Tests (OGT) scores in math, reading, science, social studies, and writing scores for students in grade 10 (Table 1). We control for student characteristics (including race and ethnicity, free and reduced price lunch (FRPL) participation, special education status, Limited English Proficiency status, participation in gifted education, and whether the student repeated the prior grade), prior-year school type, and prior achievement (previous-year OAA scores for students in grades 4–8 and eighth-grade OAA scores for tenth graders).[25] The achievement analysis does not include students in ninth, eleventh, and twelfth grade because only tenth graders take the OGT. We also restrict comparisons to students who attended the same school in the prior year. This within-school comparison limits our analysis to students who shared common school experiences, at least in the year prior. In short, our methods are similar to those commonly used to estimate teacher and school value-added measures and have been shown to estimate unbiased effects of school types/sectors on student achievement.[26]

TABLE 1. FULL DATA AND SUBSETS USED FOR ANALYSES

	2009–10	*2010–11*	*2011–12*	*2012–13*
Elementary and Middle School				
Included in full data set?	Yes	Yes	Yes	Yes
Included as an outcome of achievement analysis?	No	Yes (grades 4–8 only)	Yes (grades 4–8 only)	Yes (grades 4–8 only)
Outcome of achievement analysis ("current" test scores)		2010–11 OAA	2011–12 OAA	2012–13 OAA
"Prior" test scores used as control variable in achievement analysis		2009–10 OAA	2010–11 OAA	2010–11 OAA
High School				
Included in full data set?	Yes	Yes	Yes	Yes
Included as an outcome of achievement analysis?	No	No	Yes (grade 10 only)	Yes (grade 10 only)
Outcome of achievement analysis ("current" test scores)			2011–12 OGT	2012–13 OGT
"Prior" test scores used as control variable in achievement analysis			2009–10 OAA	2010–11 OAA

Note that our question pertaining to student achievement is similar to that in a recently released CREDO (2015) report on the effect of virtual charter schools on student achievement across a number of states.[27] However, we use different analytical strategies. The CREDO study first uses a “virtual twin” matching procedure. This approach pairs students who attend online schools to a virtual twin in feeder traditional district schools with exact demographic characteristics and similar prior achievement (but who have never and will never attend an e-school). They then use the matched data set to estimate a similar statistical model to the one used in this report, which compares the achievement of e-school students in a given year to all students in brick-and-mortar charters and district schools that same year, regardless of the school type they attend in subsequent years. Our analysis does not first make a matched data set before estimating the statistical model because we want to simultaneously compare student achievement across the three separate sectors. Our analysis also differs in that we do not restrict our comparison to e-school students and those who attend district schools and will never attend an e-school.

Finally, CREDO uses growth (year-to-year change in academic performance relative to peers) as an outcome measure, whereas we use single-year achievement relative to peers.[28] Their choice reflects the multi-state nature of their study. If two states receive the same single-year “score” of academic performance based on state tests, their students still might not be achieving at the same level due to differences in the content and scoring of the assessments. However, if two states have the same change in growth, students in both states show the same level of improvement relative to peers in their home states. Since our analyses apply only to Ohio, using single-year achievement as an outcome measure provides the same value for the variable of interest (the impact of attending a certain type of school). Our report finds qualitatively similar results to the CREDO report, and we get nearly identical results if we use the same comparison group as the CREDO study. This suggests to us that our methodology, while different from the CREDO report, is also a robust way to examine student achievement differences between students in e-schools and their otherwise-similar peers in traditional school districts.

A critical feature of our data set bears mention. Ohio’s data system allows districts to designate a variety of online learning delivery methods when inputting course records, such as "face-to-face," "online," "distance education," and "blended." However, stakeholders informed us that districts rarely use these designations and that the variables are unreliable for interpretation. This was substantiated by anecdotal accounts and interview data from superintendents and other district personnel. We were told that, besides the most commonly used and easily understood categories of “face-to-face” and “online,” the course designations were not typically used at all. Further, there was ambiguity as to how a student at a brick-and-mortar school who took a fully online course would be recorded.

Because reporting practices did not adequately or accurately capture the range of online learning that occurs across the state, we could not explore the demographic and other characteristics of students who are enrolled in brick-and-mortar schools but take online courses as "independent study"; neither can we include the full range of online learning options in the achievement analysis.[29] The achievement analysis is therefore limited to e-schools (rather than exploring the impact of various other forms of online learning). This also affected our description of course-taking patterns.

Section III:

Results

1 How many and what kind of students choose e-schools, where do they live, and what courses do they take?

E-school Enrollment by the Numbers

Table 2 presents enrollment trends by school type: e-schools (fully online charter schools), brick-and-mortar charter schools, and brick-and-mortar district schools. E-school enrollment rose from approximately 22,000 students in 2009–10 to over 35,000 students in 2012–13, an increase of 60 percent in a four-year period. In comparison, enrollment in brick-and-mortar charter schools grew by approximately 4,000 students (a 7 percent increase), and enrollment in district schools decreased by approximately 71,000 students (a 5 percent drop) during this period. **Although e-school enrollment accounts for only 2 percent of Ohio's total public school student population in 2013, the sector experienced the largest growth from four years previous.**

TABLE 2. ENROLLMENT IN PUBLIC SCHOOLS

	2009–10	*2010–11*	*2011–12*	*2012–13*
Brick-and-Mortar District Schools	1,569,149	1,545,644	1,541,638	1,498,078
Brick-and-Mortar Charter Schools	59,049	61,545	69,174	63,168
E-schools	22,173	25,910	31,850	35,512

Table 3 breaks down e-school enrollment trends by grade level over time. A common assumption is that older students (i.e., high school) are the main consumers for online learning. This is partly true in Ohio. For example, in 2012–13, 58 percent of all e-school students were in grades 9–12. However, a substantial portion of e-school enrollment that year was comprised of elementary and middle school-aged children (approximately 20 percent each). High school students accounted for the greatest increase in e-school enrollment in the four-year period (enrollment grew by 70 percent), but elementary and middle schools also saw consistent growth (increases of 40 and 57 percent).[30]

TABLE 3. E-SCHOOL ENROLLMENT BY GRADE LEVEL

	2009–10	*2010–11*	*2011–12*	*2012–13*
Elementary School (K–5)	5,437	6,151	6,894	7,633
Middle School (6–8)	4,581	5,193	6,389	7,213
High School (9–12)	12,155	14,566	18,567	20,666

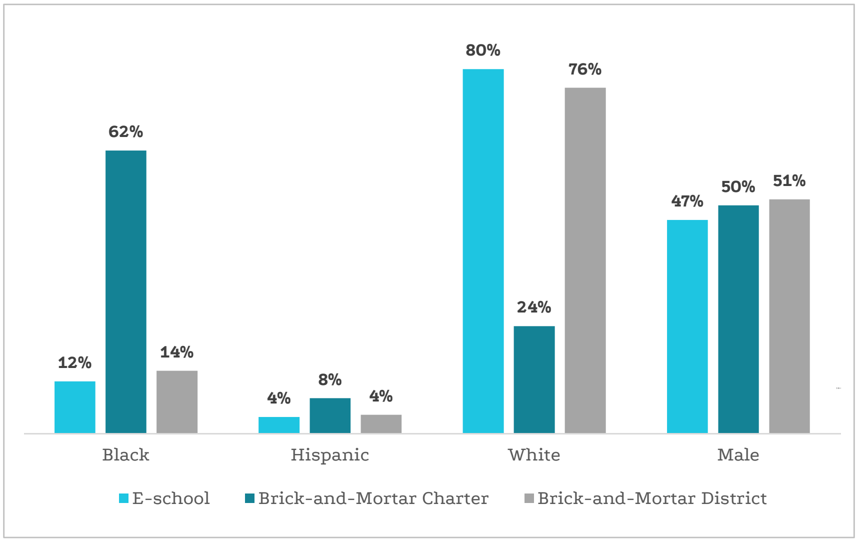
Student Demographics and Achievement

Next, we are interested in whether students who choose the e-school option are different than their peers in brick-and-mortar schools. We find that e-school students are largely similar in race and ethnicity to students in brick-and-mortar district schools; e-schools enroll smaller percentages of minority students (and more white students) compared to brick-and-mortar charters. But **compared to students in brick-and-mortar district schools, e-school students are lower-achieving (and more likely to have repeated the prior grade), more likely to participate in the federal free and reduced price lunch program, and less likely to participate in gifted education.**

The racial and ethnic demographics of e-school students are approximately similar to their district school peers, but unlike that of other charter students (Figure 1). Eighty percent of e-school students and 76 percent of district school students are white, respectively, while only 24 percent of brick-and-mortar charter school students are white. Similarly, e-schools and district schools enroll approximately the same percentage of black students (12 percent and 14 percent, respectively) and Hispanic students (both 4 percent), while brick-and-mortar charters are 62 percent black and 8 percent Hispanic.

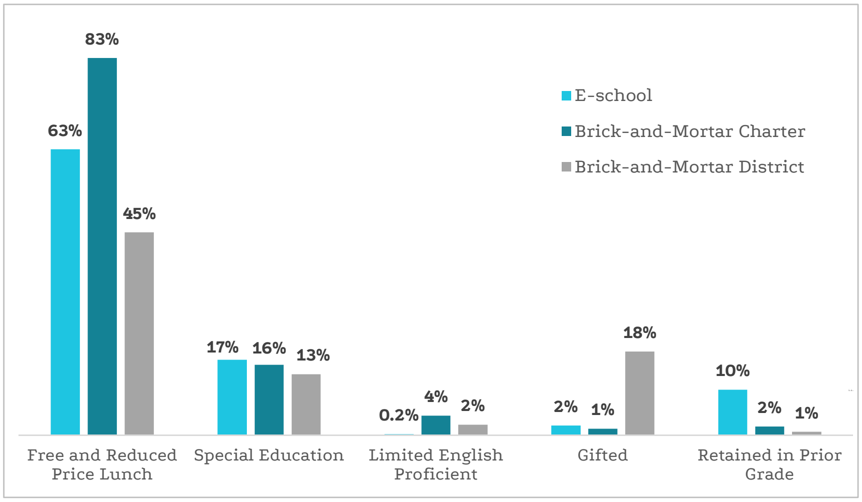
The gender distribution is not generally different across school types, although there is a greater percentage of female students in e-schools at the high school level compared to either type of brick-and-mortar school. (For a full summary of statistics for all years and by grade level, see *Appendix: Additional Results*, Tables A.1–6).

FIGURE 1. STUDENT DEMOGRAPHICS BY SCHOOL TYPE (2012-13)



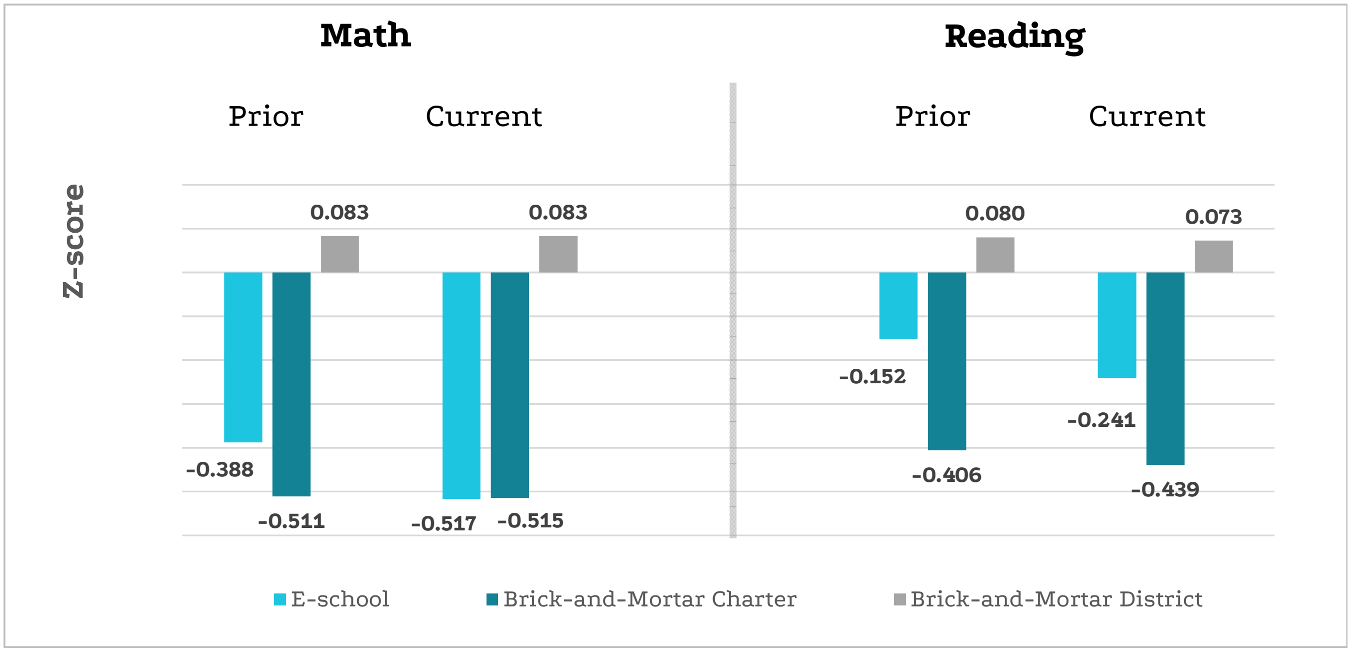
E-school students are noticeably different from students in brick-and-mortar schools other than in race, ethnicity, and gender (Figure 2). Compared to district schools, a greater share of e-school students participate in the federal free and reduced price lunch program (63 versus 45 percent) and are designated as special education (17 versus 13 percent).[31] Only 2 percent of e-school students are identified as gifted, compared to 18 percent in district schools. Finally, 10 percent of e-school students repeated the prior grade, compared to 1 percent in district schools. E-schools are different from brick-and-mortar charter schools in some of these characteristics as well: A smaller share of e-school students participate in the federal lunch program than do brick-and-mortar charter students (63 versus 83 percent), and a smaller share are identified as Limited English Proficient (0.2 versus 4 percent).

FIGURE 2. STUDENT CHARACTERISTICS BY SCHOOL TYPE (2012-13)



Finally, the achievement of e-school students is generally at the lower end of the distribution (Figures 3 and 4), which is not surprising given that the population of students they serve.[31] On measures of academic performance, e-school students are most similar to other charter students and unlike students in brick-and-mortar district schools. In fact, although some assert that e-schools enroll students with state test scores markedly lower than *all* other students, it is actually brick-and-mortar charter students who have the lowest scores—a consequence of state policies that limit the location of brick-and-mortar charters to communities with low-performing district schools.[32, 33]

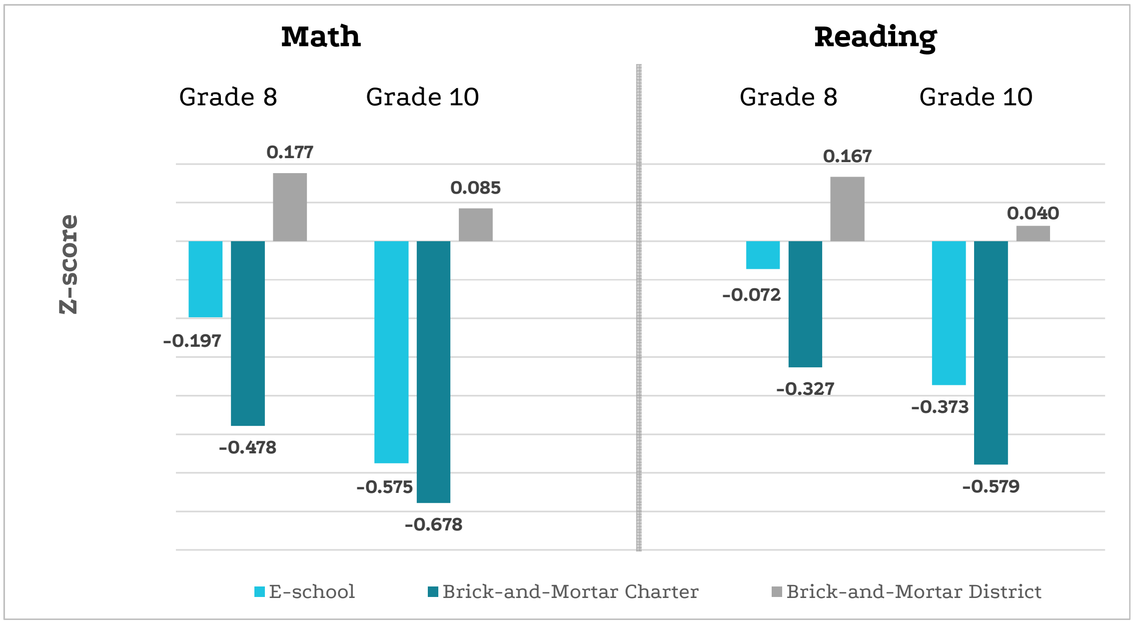
FIGURE 3. AVERAGE CURRENT AND PRIOR ACHIEVEMENT FOR STUDENTS IN GRADES 4-8



Note: The figure combines three cohorts of students: those in grades 4-8 in the 2010-11, 2011-12, and 2012-13 school years. "Current" achievement is students' scores on that year's math and reading Ohio Achievement Assessment (OAA), and "prior" achievement is the scores of those same students one year previous. See Table 1 for more.

How to read this figure: Test scores are "normalized" to Z-scores with a mean of zero and a standard deviation of one. A Z-score of zero means that, on average, that group of students scored at the overall state average. A positive Z-score indicates performance above the state average, and a negative score is performance below average. Z-scores are also equivalent to percentiles; a Z-score of zero is equivalent to achievement in the fiftieth percentile; a Z-score of 0.1 is the fifty-fourth percentile (and of –0.1 is the forty-sixth).

FIGURE 4. AVERAGE CURRENT AND PRIOR ACHIEVEMENT FOR STUDENTS IN GRADE 10



Note: The figure combines two cohorts of students: those in tenth grade in the 2011-12 and 2012-13 school years. "Grade 10" achievement is students' scores on that year's math and reading Ohio Graduation Tests (OGT), and "Grade 8" achievement is the scores of those same students on the OAA test taken two years previous. See Table 1 for more.

How to read this figure: Test scores are "normalized" to Z-scores with a mean of zero and a standard deviation of one. A Z-score of zero means that, on average, that group of students scored at the overall state average. A positive Z-score indicates performance above the state average, and a negative score is performance below average. Z-scores are also equivalent to percentiles; a Z-score of zero is equivalent to achievement in the fiftieth percentile; a Z-score of 0.1 is the fifty-fourth percentile (and of –0.1 is the forty-sixth).

E-school Enrollment by Geography

E-school students live largely in and around the state's urban centers, where there are also established brick-and-mortar charter schools. Figures 5 and 6 show the percentages of students living in a given school district who are enrolled in e-schools (blue shading), as well as the locations of brick-and-mortar charter schools (yellow dots). Figure 5 illustrates the share of e-school enrollment for 2009-10 and Figure 6 for 2012-13. The darker shading indicates that a greater percentage of students are enrolled in e-schools. Note that enrollment share is relatively small, since across the state, e-schools enroll approximately 2 percent of all public school students.

FIGURE 5. ENROLLMENT IN E-SCHOOLS BY SHARE OF A DISTRICT'S STUDENTS (2009-10)

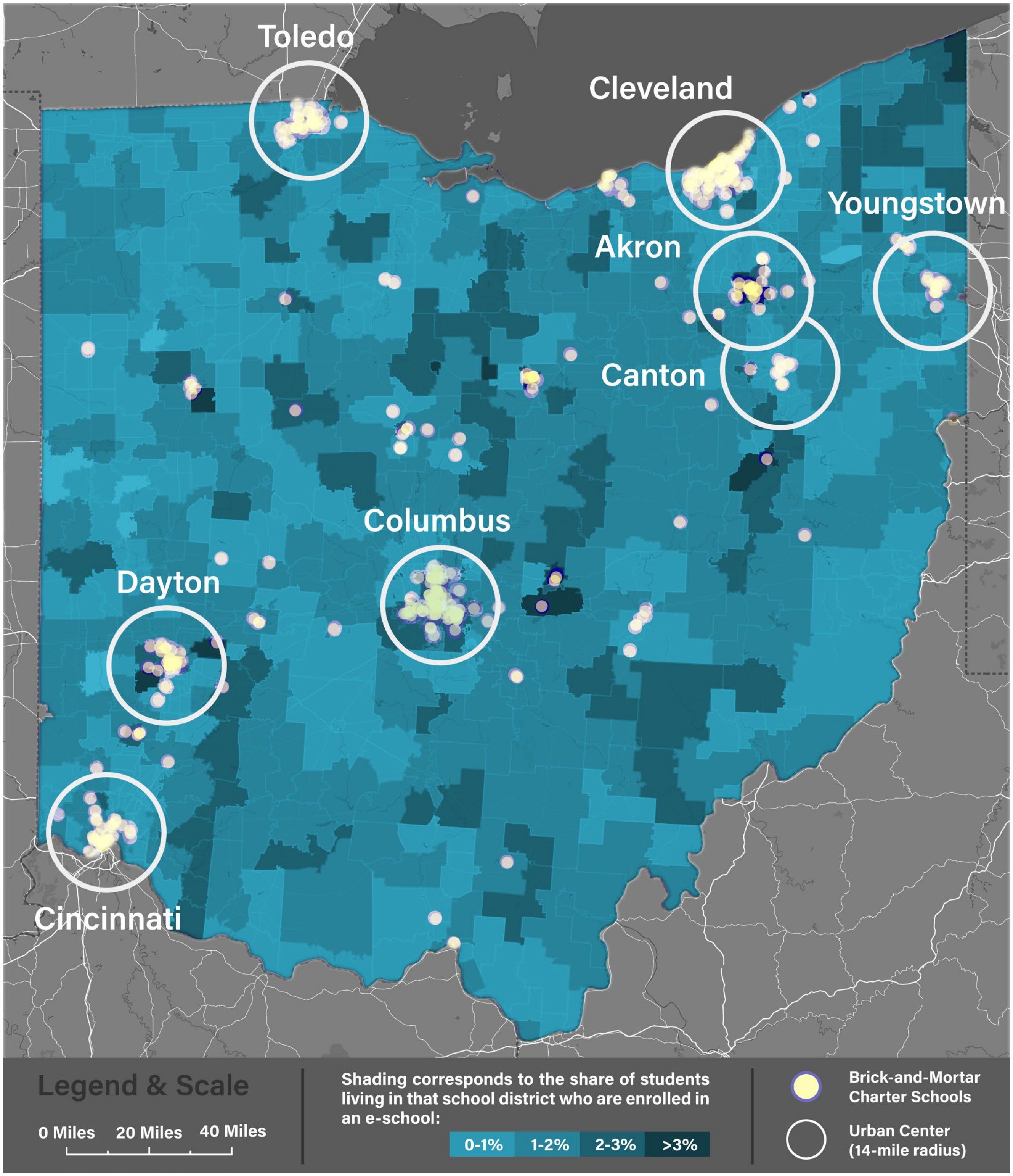
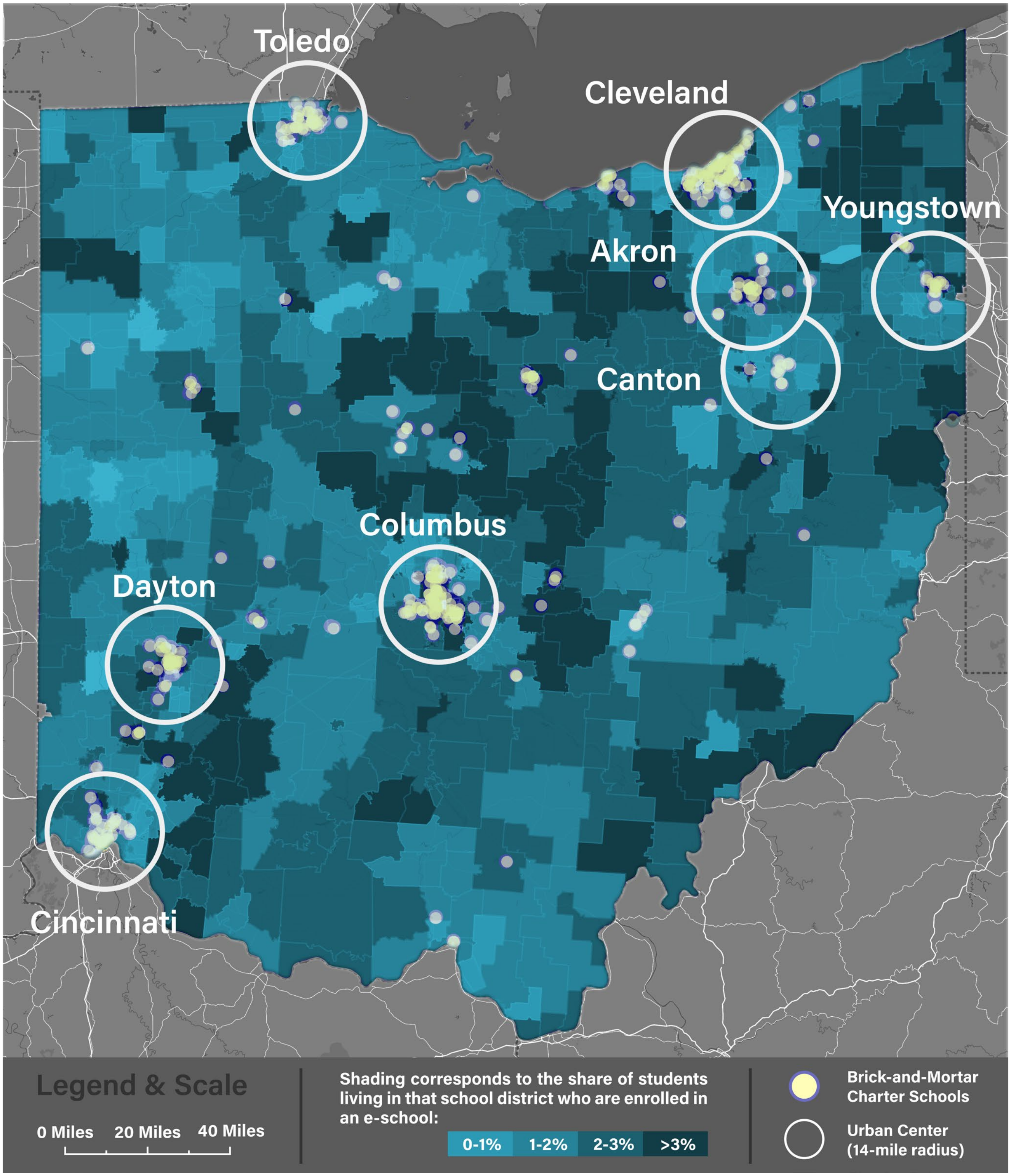


FIGURE 6. ENROLLMENT IN E-SCHOOLS BY SHARE OF A DISTRICT'S STUDENTS (2012–13)



The maps reveal that students who reside near the state's urban centers attend e-schools in greater shares. This is particularly interesting because students in those areas also have access to brick-and-mortar charters, which are clustered in and around major cities (a result of Ohio's charter school law). Some e-school students also live in the suburbs and towns in the vicinity of Ohio's major cities (for example, in the Newark and Mansfield areas, located east and north of Columbus; Middletown, which is between Dayton and Cincinnati; Lorain and Elyria, west of Cleveland; and Warren, north of Youngstown). Further, the share of students from these surrounding areas increased between 2009–10 and 2012–13.

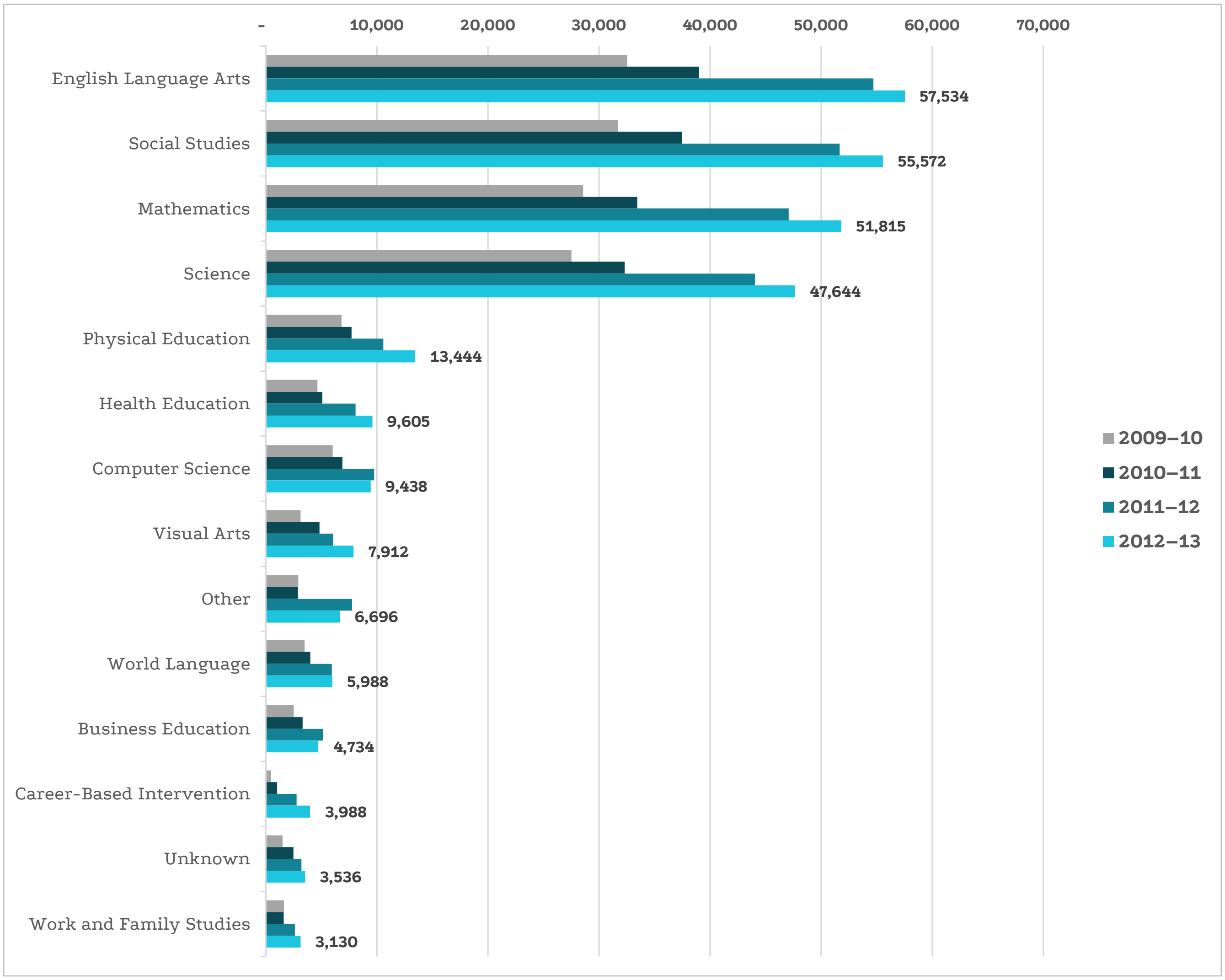
Though it is hard to pinpoint why urban and suburban students are more likely to attend e-schools, especially since they might live near brick-and-mortar charters, there are a few possibilities. Perhaps families see their local district schools struggling and perceive the brick-and-mortar charters (especially urban ones) as not providing a better alternative. These students may be better informed about their e-schooling options via advertising or through social or peer networks. Further, Ohio's urban students are more likely to switch schools than their peers in wealthier suburban or rural districts. Hence, switching to an online school may not be considered an atypical change.[34] Lastly, there is a practical reason that particular suburban areas are high-density locations for e-school enrollment: While many e-schools do not have residency restrictions, eight of the state's e-schools limit enrollment to students who live in (or sometimes near) the district that sponsors the school. These eight schools are authorized by districts near, but not immediately in, the urban centers.

There are also some rural and small-town areas that have relatively high e-school participation rates. For example, some districts in North Central Ohio and Northeast Ohio (in Lorain, Medina, Ashtabula, and Trumbull Counties) have more than 3 percent online students. In those locations, too, the e-school enrollment share has increased over time, likely for some of the same reasons that it has grown in urban and suburban areas. There are other potential reasons for the share of high enrollment specific to rural populations: Many parents who homeschool their children use virtual schools as an alternative to conventional schooling. National data on homeschooled students show that they are more likely to live in rural areas (although no more likely to be low-income) than the general student population.[35] So it isn't surprising that there is a relatively high share of Ohio's rural students enrolled in e-schools. (Homeschooled students are also more likely to be white than the general population nationally, and Ohio's rural population is over 90 percent white—which further suggests that Ohio's rural, white parents may be choosing this option for their children.) Finally, e-schools may be providing courses that are not offered in rural students' small local districts.

E-SCHOOL ENROLLMENT BY SUBJECT AREA

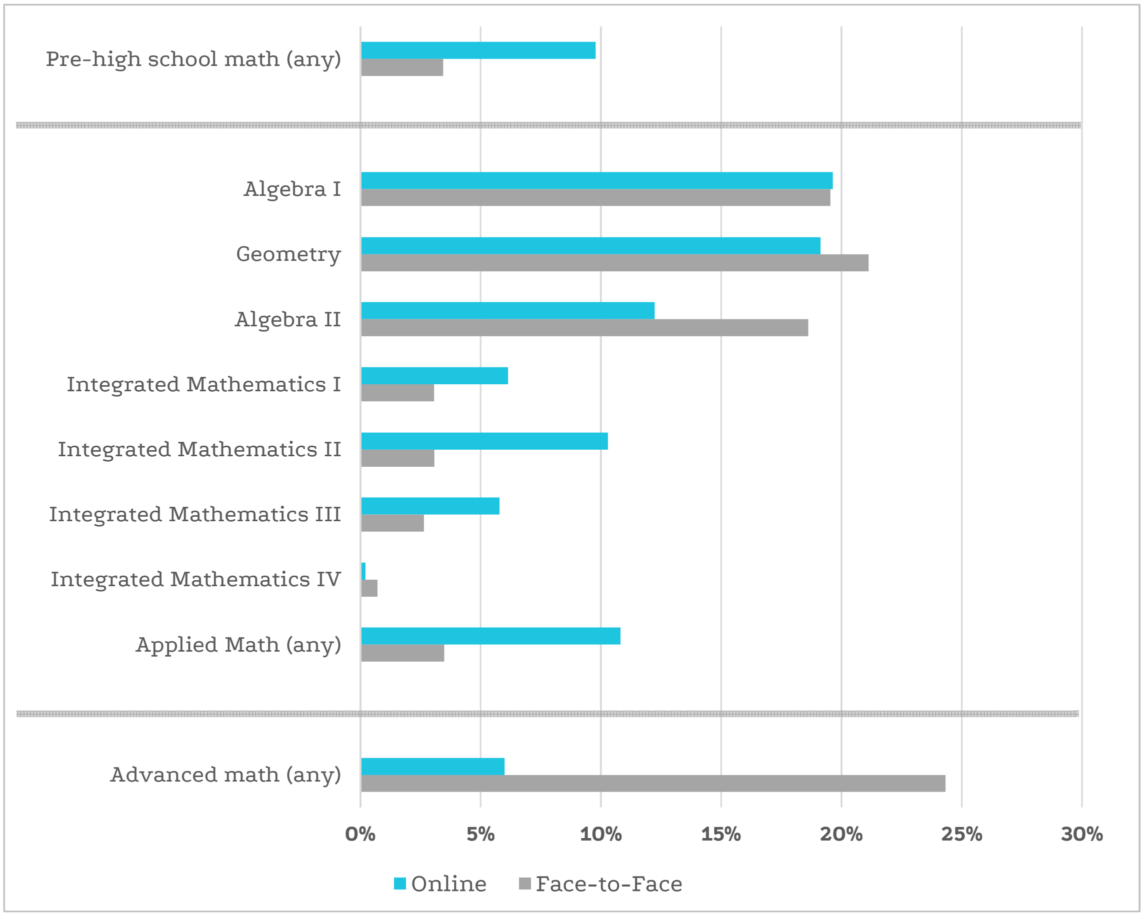
Course-level data allowed us to examine which subjects and classes are the most popular for online enrollment (Figure 7).[36] Not surprisingly, the core subject areas account for the vast majority of enrollment—and show a steady increase across the four years of study (2009–10 to 2012–13)—since by definition students take more "core" classes than electives. However, courses in physical education, health, computer science, visual arts, and world languages also have notable enrollment. (For counts of online course by subject area and year, see *Appendix: Additional Results*, Table A.7.)

FIGURE 7. ENROLLMENT BY SUBJECT AREA AND YEAR



Analysis of course taking by subject area is necessarily broad, and there are surely nuances in the type of courses within each subject. For example, English language arts and math are popular subject areas for online enrollment; but are students primarily enrolling in enrolling in lower-level, core, or advanced classes? A close-up of math enrollment below provides some indication (Figure 8).

FIGURE 8. SHARE OF MATH COURSES BY DELIVERY MODEL (GRADES 9-12)



Note: Ohio requires that students take four credits of math in high school, including Algebra II or its equivalent, although students may opt out if they feel unprepared or if they are "planning a career that does not require higher-level math." [37] Pre-high school classes are those that do not contain high school content (Pre-Algebra, Intervention Mathematics, and Transition to High School Mathematics). Core courses are those considered "high school math." Advanced classes are courses more advanced than Algebra II, including Trigonometry, Probability and Statistics, Calculus, Discrete Mathematics, Transition to College Mathematics, and all AP courses.[38]

The data show virtually no differences in the percentage of students who take Algebra I or Geometry online (versus face-to-face). Algebra I accounts for about 20 percent of all online math classes and all face-to-face math classes. Geometry accounts for 19 percent of all online math classes and 21 percent of those offered face-to-face.

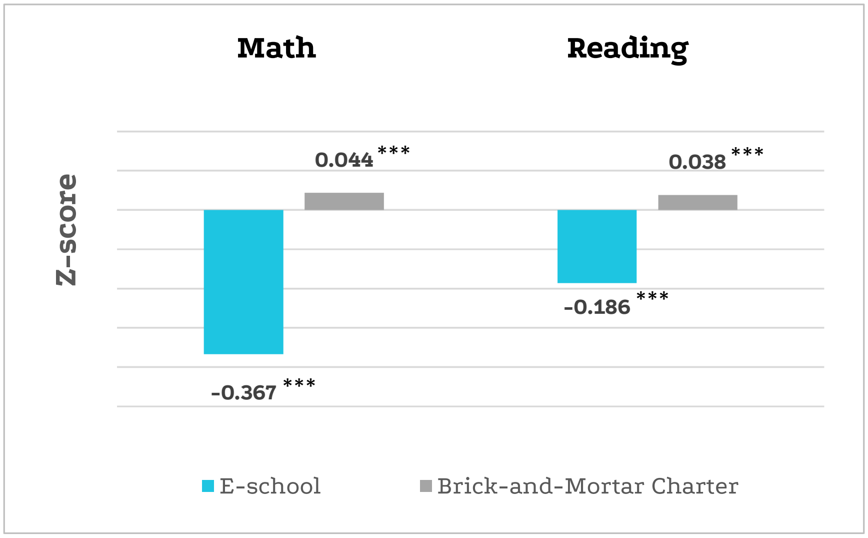
However the patterns start to diverge when we focus on other levels of coursework. **Students taking online math courses are more likely to enroll in basic and remedial math courses relative to students taking face-to-face math courses.** Specifically, students take pre-high school math online much more frequently than they did face-to-face (10 percent of all online math classes, compared to 3 percent of face-to-face math classes). These courses include Pre-Algebra, Intervention Mathematics, and Transition to High School Mathematics. At the introductory end of high school math, the first three courses in the "Integrated Mathematics" series are much more popular online than they are face-to-face. (Integrated Math is a four-course sequence that, should a student take the complete series, covers Ohio's math standards for grades 9–12; it's an alternative to the traditional three-course Algebra I-Geometry-Algebra II sequence).[39] Students also take Applied Math much more frequently online than they do face-to-face; Ohio law allows students to earn math credit "proportional to the time associated with the course," and these are designated as "applied" in course records. For example, a student who needs extra help can concurrently take geometry and a geometry "support class" for additional instruction. For the latter, the student would earn "Applied Geometry" credit proportional to the amount of time spent in the support class. Or a school may offer Algebra I content over two years; students would earn one credit for Algebra I the first year and one credit in "Applied Algebra" the second.[40]

At more advanced levels, students take Algebra II (the only class actually required for graduation) in person much more frequently than they do online (19 percent of all face-to-face math classes, compared to 12 percent of online math classes). Likewise, almost no students take advanced online courses like AP Statistics, Calculus, or Algebra II, especially compared to their peers in face-to-face settings (24 percent of all face-to-face math classes are advanced, compared to 6 percent of online math classes). State data suggest that while a number of students use online settings to complete grade-level math courses in the ninth and tenth grades (Algebra I and Geometry), the rest of the students who take advantage of online settings do so in order to take basic or remedial courses.

2 HOW ARE STUDENTS PERFORMING IN OHIO E-SCHOOLS COMPARED TO THEIR PEERS IN BRICK-AND-MORTAR DISTRICT SCHOOLS?

In this section, we compare the achievement of otherwise-similar students who attend brick-and-mortar district schools to those who attend either e-schools or brick-and-mortar charters.[41] Holding all else equal (*including prior achievement*), **e-school students perform worse than students who attend brick-and-mortar district schools. Brick-and-mortar charter school students perform slightly better in some subject areas, and slightly worse in others, than district school students.** (Figures 9 and 10).[42]

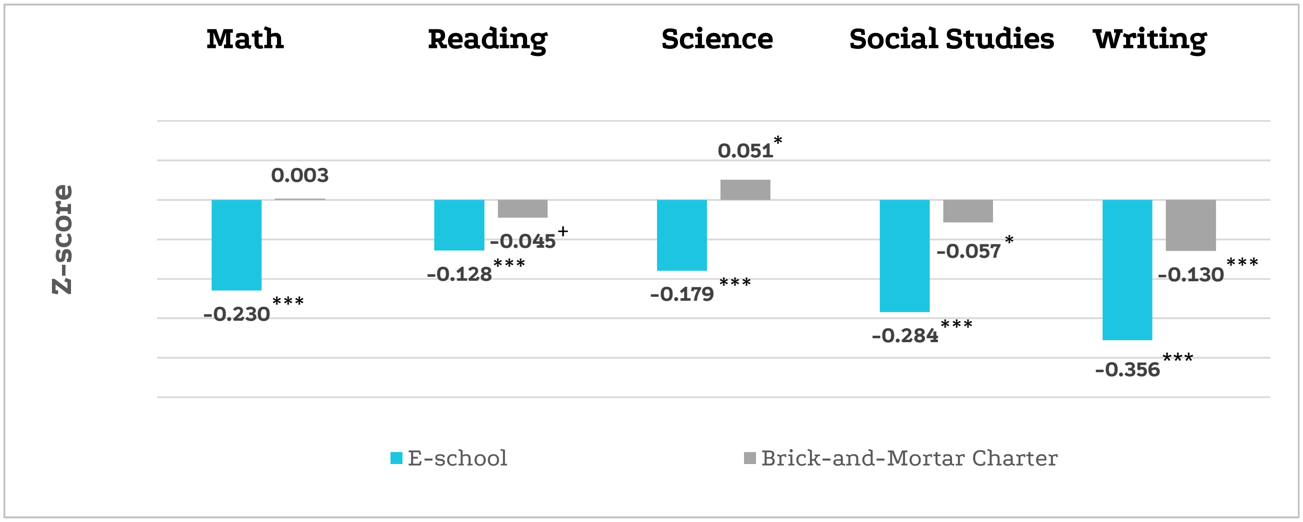
FIGURE 9. ACHIEVEMENT OF STUDENTS IN GRADES 4–8 WHO ATTEND E-SCHOOLS AND BRICK-AND-MORTAR CHARTER SCHOOLS, COMPARED TO STUDENTS IN DISTRICT SCHOOLS



Note: Analyses combine single-year OAA test scores for students in grades 4–8 in the 2010–11 through 2012–13 school years while controlling for achievement in the prior school year (+p<0.10, *p<0.05, **p<0.01, ***p<0.001).

How to read this figure: The figure shows average Z-scores of students in grades 4-8 who attend e-schools or brick-and-mortar charters, compared to students who attend district schools. Test scores are "normalized" to a mean of zero and a standard deviation of one. A Z-score of zero means that, on average, that group of students scored at the overall state average. A positive Z-score indicates performance above the state average, and a negative score is performance below average. The first blue bar shows that, all else equal, students in grades 4–8 who attend e-schools perform 0.37 standard deviations worse on their OAA math exam than similar students who attend district schools. The first grey bar shows that, all else equal, students in grades 4–8 who attend brick-and-mortar charters had average math scores 0.04 standard deviations higher than their district school peers.

FIGURE 10. ACHIEVEMENT OF STUDENTS IN GRADE 10 WHO ATTEND E-SCHOOLS AND BRICK-AND-MORTAR CHARTER SCHOOLS, COMPARED TO STUDENTS IN DISTRICT SCHOOLS



Note: Analyses combine student single-year OGT scores for tenth graders in the 2011–12 and 2012–13 school years while controlling for eighth-grade achievement (+p<0.10, *p<0.05, **p<0.01, ***p<0.001).

How to read this figure: The figure shows average Z-scores of tenth grade students who attend e-schools or brick-and-mortar charters, compared to students who attend district schools. The first blue bar shows that, all else equal, grade 10 students who attend e-schools perform 0.23 standard deviations worse on their OGT math exam than similar students who attend district schools. The first grey bar shows that, all else equal, grade 10 students who attend brick-and-mortar charters had average math scores 0.003 standard deviations higher than their district school peers.

Achievement differences vary by age group and subject. Students in grades 4-8 in e-schools have lower achievement in math (–0.37 standard deviation) and reading (–.019 SD) than their brick-and-mortar district school peers (Figure 9, blue bars). The math results are equivalent to the difference between scoring at the fiftieth percentile in the test score distribution versus scoring at the thirty-sixth percentile. The reading effect is equivalent to the difference between the fiftieth and the forty-third percentiles.

We see similar negative results for e-school students' tenth-grade achievement on the math, reading, science, social studies, and writing OGT assessments (Figure 10, blue bars). The difference in achievement between e-school and district school students ranges from –0.13 SD in reading to –0.36 SD in writing (a five-percentile difference in reading and a fourteen-percentile difference in writing).

In contrast, there are smaller, and sometimes positive, differences between brick-and-mortar charter and district students. Charter students in grades 4–8 perform slightly better in math and reading than district students—approximately 0.04 SD in both subjects, or a two-percentile difference (Figure 9, grey bars). In tenth grade, brick-and-mortar charter school students perform slightly better than their district peers in science; slightly worse in reading, social studies, and writing; and about the same in math (Figure 10, grey bars). Equivalently, the achievement difference is two percentiles higher in science, two percentiles lower in science and social studies, and five percentiles lower in writing. (See *Appendix: Additional Results*, Tables A.9-11 for demographics and Table A.12 for full results).

Conclusion

Online education is reconfiguring the delivery of schooling and the activities that students experience on a daily basis. However, our analyses show (in line with other recent reports, such as CREDO's) that Ohio's e-school students are not achieving at the same level as their peers in brick-and-mortar district schools.[43] The analyses also support what charter advocates have long suspected: that e-schools drag down the impact of the state's charter sector. Our findings reveal some important considerations for Ohio policy makers as they consider the future place of online learning within K–12 education. They also highlight key questions and challenges that policy makers, advocates, and educators ought to bear in mind, and properly address, as the adoption of technology in education increases in the coming years.

1 **E-schools serve challenging student populations, by their own design and by the choice of those who attend them. Many of these students may not be well suited or well supported to succeed in online learning environments that require independent learning and self-direction. E-schools must figure out how to do better by this population.**

Students in Ohio appear to self-select into different education options. Compared to students in brick-and-mortar district schools, e-school students are lower-achieving, more likely to participate in the federal free and reduced price lunch program, more likely to be designated as special education, more likely to have repeated the prior grade, and less likely to participate in gifted education.

These differences are not particularly surprising if we consider that students who choose fully online schools may already be failing out of the brick-and-mortar K–12 system, or (especially in the case of special education students) students for whom a traditional classroom and school just isn't a good fit. These students may be best poised to *benefit* from the advantages offered by a virtual school—flexible hours and pacing, a safe and comfortable learning environment, a way for students with social or behavioral problems to focus on academics, increased engagement since students can choose from a vast array of elective courses based on their own interests, and the chance to develop advanced virtual communication skills. On the other hand, some e-school students may actually be *least suited to thrive* in an online learning environment. If they failed in brick-and-mortar schools because they lack self-motivation, independent learning skills, parental support, and/or a quiet, stable place to do schoolwork, they are even less likely to do well in a virtual school.

The bottom line is that online providers need not use their unique student population as an excuse for their performance. Instead, they must tailor the way they deliver content and provide academic supports to maximize student success.

2 If e-schools can't effectively educate the students who choose to enroll, consider utilizing them more strategically—specifically, by targeting students who are well suited to benefit most from online delivery.

While charter schools in Ohio cannot, under current law, practice selective admission, other public schools can. District-run magnet schools have specialized academic focuses or themes. They also use a competitive enrollment process, often involving entrance exams, interviews, or auditions, to select students most suited to their programs (and most likely to benefit from them). Policy makers might consider allowing e-schools to do the same, enabling them to target their unique delivery system to students who would get the most out of them. Some might worry that selectivity violates the principle of self-selection that guides school choice, but the choice process also requires that students have enough information to determine whether they fit in a particular program. In the case of e-schools, this information is not about a special program or curriculum, but rather about the specific demands of the virtual instructional configuration. At the very least, e-schools should actively recruit students most likely to succeed in a fully online learning environment (or students who the schools believe they can sufficiently orient and support).

3 Rethink the "all-or-nothing" nature of enrolling in e-schools. Instead, allow students to combine high-quality fully online and face-to-face classes (without making them jump through hoops to earn credit, or pay tuition).

One positive aspect of online courses in general is that they can supplement what is offered at a student's local school. This could be especially impactful for gifted and advanced students who wish to take Advanced Placement or other college-level coursework; students interested in "niche" electives (such as less popular world languages, advanced music or art, or specialized career and technical education); those who attend small schools with limited course offerings; and those living in rural areas whose district only has one high school. Yet in order for an Ohio student to take *one* online course at an e-school, he must take *all* of his courses there (and withdraw from his brick-and-mortar school). So in practice, e-schools do not supplement brick-and-mortars, but rather supplant them.

In theory, there is another option. Students can take independent study—or one-off—courses online while remaining enrolled at their current brick-and-mortar school. In the past, this option was partially facilitated by a system called iLearnOhio, which catalogued independent study courses offered by a number of external providers. It was also tasked with determining whether each course met Ohio's educational standards—a necessary step since these courses are not administered by the state's own e-schools.[44] Further, the courses are fee-based, and it is the responsibility of a student's family to pay.[45] Currently, while students can still take single, fee-based independent study courses from external providers, there is not a central clearinghouse for courses, a requirement that they be aligned to Ohio's standards, or a mandate that course providers be reviewed and approved.

If e-schools were allowed to partially enroll students so that they could take single online courses, they might greatly expand students' access to quality coursework aligned to state standards. Florida is one example: The state-run Florida Virtual School offers online courses that are available to students enrolled in brick-and-mortar public schools. Florida students can also take fully online courses offered by any district in the state, or by a handful of approved external providers (who must demonstrate prior success with online courses), as long as they remain enrolled in their home brick-and-mortar school and district. There is no fee for students and no limitation on the types of courses they can take (as long as they are academically qualified), and districts are not allowed to restrict students from enrolling. In other words, the system functions as one giant online school. The Course Choice program in Louisiana is another example, although it only allows students to take courses that are not offered at their current brick-and-mortar school (unless they attend a low-achieving school). Ohio policy makers should consider adjusting the structure and rules of its virtual education system so that all public school students can take high-quality, credit-bearing, free online courses.

4 Harness the potential of e-schools to better understand how students learn online.

We know so little about the practices and resources that are most effective to teach K–12 students in virtual schools. For starters, if students with lower prior achievement scores are enrolling in e-schools, what types of academic support do they need to succeed there? How much should they interact with teachers, and how many students can one teacher effectively serve? How much support do students need from parents or other family members, and how do we prepare families for that role? At an even more basic level, how do students and teachers really spend their time? These are questions that are largely unexplored in the research literature.

E-schools can act as labs to answer these questions, and the answers would have an enormous benefit not only to them, but to the entire field of education. We already know that merely sitting students in front of a computer with an online curriculum isn't the best way for them—or anyone else—to learn. Research on distance learning in higher education has found that more is needed besides access to a computer in a distant room; even adults are seldom motivated and disciplined enough to succeed that way. E-schools can facilitate an understanding of how to leverage online curricula—along with richer and deeper learning environments—for the neediest and most underserved high school (and younger) learners. From this potential evidence base, providers then need to be held to high standards of practice relative to the populations they serve.

Though the age of online *learning* has dawned, it's evident that there is much room for improvement as far as online *schooling* goes—especially in Ohio. There is great opportunity in the state, and others, to provide a high-quality education to students via fully online schools (and online courses, and blended learning), especially for students who don't have what they need in the school building closest to home. This is good news for advocates of online learning, and educational choice more generally. But to take advantage of that opportunity, policy makers and educators would be wise to determine how virtual schools are similar to and different from brick-and-mortar ones, and then treat each accordingly. Supporting high-quality online learning requires a dedication to adopting and continuously improving promising practices. It also calls for a willingness to completely overhaul those that are consistently demonstrated to be ineffective.

Appendix:

Additional Results

TABLE A.1: E-SCHOOL STUDENT DEMOGRAPHICS OVER TIME (GRADES K-8)

	2009-10		*2010-11*		*2011-12*		*2012-13*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.001	0.025	0.0004	0.019	0.001	0.032	0.002	0.041
Gifted	0.004	0.066	0.006	0.079	0.024	0.154	0.025	0.154
Free and Reduced Price Lunch Program	0.569	0.495	0.596	0.491	0.638	0.481	0.623	0.485
Special Education	0.129	0.336	0.139	0.346	0.148	0.355	0.145	0.352
Male	0.514	0.500	0.516	0.500	0.505	0.500	0.506	0.500
Discipline Incidents	0.014	0.206	0.016	0.233	0.023	0.338	0.021	0.271
Retained in Prior Grade	0.030	0.171	0.025	0.157	0.023	0.150	0.019	0.135
Black	0.096	0.295	0.109	0.312	0.110	0.313	0.112	0.316
Hispanic	0.027	0.162	0.030	0.170	0.032	0.176	0.030	0.171
White	0.820	0.385	0.808	0.394	0.810	0.392	0.808	0.394
Lives Within a City School District	0.245	0.430	0.244	0.430	0.242	0.428	0.219	0.413
Lives Within a Suburban School District	0.337	0.473	0.323	0.468	0.331	0.471	0.390	0.488
Lives Within a Town School District	0.159	0.366	0.161	0.368	0.157	0.364	0.156	0.363
Lives Within a Rural School District	0.259	0.438	0.272	0.445	0.270	0.444	0.235	0.424
N	10,018		11,344		13,283		14,846	

TABLE A.2: E-SCHOOL STUDENT DEMOGRAPHICS OVER TIME (GRADES 9–12)

	2009-10		*2010–11*		*2011–12*		*2012–13*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.001	0.024	0.001	0.026	0.001	0.035	0.002	0.044
Gifted	0.004	0.066	0.003	0.059	0.021	0.143	0.018	0.133
Free and Reduced Price Lunch Program	0.614	0.487	0.668	0.471	0.642	0.479	0.636	0.481
Special Education	0.180	0.384	0.184	0.388	0.186	0.389	0.181	0.385
Male	0.435	0.496	0.438	0.496	0.440	0.496	0.441	0.496
Discipline Incidents	0.029	0.289	0.027	0.309	0.026	0.353	0.025	0.318
Retained in Prior Grade	0.095	0.293	0.189	0.392	0.151	0.358	0.165	0.371
Black	0.115	0.319	0.125	0.331	0.133	0.339	0.123	0.329
Hispanic	0.023	0.151	0.031	0.173	0.036	0.187	0.041	0.198
White	0.809	0.393	0.795	0.404	0.780	0.414	0.786	0.410
Lives Within a City School District	0.284	0.451	0.281	0.449	0.286	0.452	0.265	0.441
Lives Within a Suburban School District	0.354	0.478	0.337	0.473	0.351	0.477	0.388	0.487
Lives Within a Town School District	0.156	0.363	0.154	0.361	0.145	0.352	0.148	0.355
Lives Within a Rural School District	0.205	0.404	0.228	0.420	0.219	0.413	0.200	0.400
N	12,155		14,566		18,567		20,666	

TABLE A.3: BRICK-AND-MORTAR CHARTER STUDENT DEMOGRAPHICS OVER TIME (GRADES K-8)

	2009-10		*2010-11*		*2011-12*		*2012-13*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.030	0.171	0.038	0.190	0.043	0.204	0.045	0.208
Gifted	0.008	0.090	0.011	0.103	0.011	0.102	0.013	0.114
Free and Reduced Price Lunch Program	0.771	0.420	0.780	0.414	0.797	0.402	0.843	0.364
Special Education	0.141	0.348	0.142	0.349	0.143	0.350	0.143	0.350
Male	0.503	0.500	0.500	0.500	0.503	0.500	0.500	0.500
Discipline Incidents	0.261	0.943	0.229	0.866	0.281	1.010	0.344	1.100
Retained in Prior Grade	0.016	0.127	0.022	0.145	0.021	0.142	0.020	0.138
Black	0.624	0.484	0.615	0.487	0.622	0.485	0.633	0.482
Hispanic	0.069	0.254	0.074	0.261	0.076	0.265	0.081	0.273
White	0.244	0.429	0.248	0.432	0.236	0.425	0.220	0.414
Lives Within a City School District	0.767	0.423	0.768	0.422	0.774	0.418	0.790	0.407
Lives Within a Suburban School District	0.202	0.402	0.201	0.401	0.196	0.397	0.193	0.394
Lives Within a Town School District	0.012	0.111	0.012	0.108	0.010	0.101	0.007	0.086
Lives Within a Rural School District	0.018	0.133	0.020	0.138	0.019	0.136	0.010	0.098
N	44,265		46,193		52,121		55,812	

TABLE A.4: BRICK-AND-MORTAR CHARTER STUDENT DEMOGRAPHICS OVER TIME (GRADES 9–12)

	2009–10		*2010–11*		*2011–12*		*2012–13*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.009	0.092	0.008	0.087	0.010	0.098	0.017	0.129
Gifted	0.011	0.102	0.013	0.111	0.017	0.131	0.019	0.137
Free and Reduced Price Lunch Program	0.667	0.471	0.712	0.453	0.728	0.445	0.725	0.446
Special Education	0.212	0.409	0.221	0.415	0.229	0.420	0.248	0.432
Male	0.503	0.500	0.508	0.500	0.508	0.500	0.499	0.500
Discipline Incidents	0.218	0.797	0.230	0.802	0.277	1.010	0.288	0.949
Retained in Prior Grade	0.107	0.309	0.107	0.309	0.071	0.258	0.025	0.157
Black	0.551	0.497	0.566	0.496	0.560	0.496	0.509	0.500
Hispanic	0.038	0.191	0.041	0.199	0.042	0.200	0.054	0.226
White	0.362	0.481	0.347	0.476	0.344	0.475	0.374	0.484
Lives Within a City School District	0.731	0.443	0.735	0.442	0.732	0.443	0.735	0.441
Lives Within a Suburban School District	0.165	0.371	0.160	0.367	0.164	0.370	0.175	0.380
Lives Within a Town School District	0.056	0.230	0.062	0.241	0.059	0.235	0.050	0.218
Lives Within a Rural School District	0.048	0.213	0.043	0.204	0.045	0.208	0.040	0.197
N	14,784		15,352		17,053		7,356	

TABLE A.5: BRICK-AND-MORTAR DISTRICT STUDENT DEMOGRAPHICS OVER TIME (GRADES K–8)

	2009–10		*2010–11*		*2011–12*		*2012–13*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.026	0.159	0.025	0.155	0.026	0.159	0.028	0.164
Gifted	0.188	0.390	0.184	0.388	0.162	0.369	0.164	0.370
Free and Reduced Price Lunch Program	0.440	0.496	0.454	0.498	0.469	0.499	0.477	0.499
Special Education	0.137	0.344	0.136	0.343	0.135	0.342	0.134	0.341
Male	0.515	0.500	0.514	0.500	0.514	0.500	0.514	0.500
Discipline Incidents	0.166	0.943	0.167	0.924	0.173	0.918	0.173	0.940
Retained in Prior Grade	0.009	0.093	0.008	0.090	0.007	0.082	0.007	0.084
Black	0.137	0.344	0.135	0.342	0.135	0.341	0.135	0.341
Hispanic	0.037	0.188	0.039	0.193	0.042	0.200	0.045	0.208
White	0.765	0.424	0.762	0.426	0.758	0.428	0.753	0.431
Lives Within a City School District	0.171	0.376	0.169	0.374	0.166	0.372	0.156	0.363
Lives Within a Suburban School District	0.417	0.493	0.408	0.491	0.414	0.493	0.469	0.499
Lives Within a Town School District	0.153	0.360	0.149	0.356	0.149	0.356	0.147	0.354
Lives Within a Rural School District	0.259	0.438	0.275	0.446	0.271	0.444	0.228	0.419
N	1,098,135		1,086,463		1,088,414		1,059,234	

TABLE A.6: BRICK-AND-MORTAR DISTRICT STUDENT DEMOGRAPHICS OVER TIME (GRADES 9-12)

	2009-10		*2010-11*		*2011-12*		*2012-13*	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.015	0.121	0.013	0.111	0.012	0.109	0.013	0.112
Gifted	0.228	0.420	0.232	0.422	0.233	0.423	0.234	0.423
Free and Reduced Price Lunch Program	0.334	0.472	0.349	0.477	0.365	0.481	0.380	0.485
Special Education	0.134	0.341	0.133	0.340	0.132	0.339	0.132	0.339
Male	0.509	0.500	0.510	0.500	0.511	0.500	0.510	0.500
Discipline Incidents	0.403	1.460	0.398	1.470	0.386	1.440	0.374	1.420
Retained in Prior Grade	0.023	0.151	0.020	0.138	0.015	0.121	0.013	0.114
Black	0.158	0.365	0.155	0.362	0.150	0.357	0.149	0.357
Hispanic	0.026	0.160	0.029	0.168	0.032	0.175	0.034	0.182
White	0.771	0.420	0.768	0.422	0.767	0.423	0.761	0.426
Lives Within a City School District	0.172	0.377	0.168	0.374	0.164	0.371	0.151	0.358
Lives Within a Suburban School District	0.438	0.496	0.432	0.495	0.433	0.496	0.489	0.500
Lives Within a Town School District	0.144	0.351	0.139	0.346	0.139	0.346	0.138	0.345
Lives Within a Rural School District	0.247	0.431	0.261	0.439	0.263	0.440	0.222	0.416
N	471,014		459,181		453,224		438,844	

TABLE A.7: ENROLLMENT IN ONLINE COURSES BY SUBJECT AREA AND YEAR

Subject Area	*2009–10*	*2010–11*	*2011–12*	*2012–13*
English Language Arts	32,532	39,022	54,698	57,534
Social Studies	31,695	37,485	51,652	55,572
Mathematics	28,580	33,434	47,075	51,815
Science	27,518	32,312	44,041	47,644
Physical Education	6,799	7,731	10,592	13,444
Health Education	4,643	5,086	8,092	9,605
Computer Science	6,021	6,897	9,749	9,438
Visual Arts	3,124	4,823	6,060	7,912
Other	2,931	2,908	7,775	6,696
Foreign Language	3,511	4,027	5,956	5,988
Business Education	2,508	3,319	5,170	4,734
Career-Based Intervention	489	1,029	2,765	3,988
Unknown	1,498	2,490	3,207	3,536
Work & Family Studies	1,642	1,621	2,619	3,130

TABLE A.8: DISTRIBUTION OF ONLINE MATH COURSES (GRADES 9-12)

Course	*Online*		*Face-to-Face*	
	N	Percent	N	Percent
Pre-High School				
Advanced Mathematics/Pre-Algebra 6–8	38	0.15%	1,705	0.29%
Intervention Mathematics	935	3.58%	17,052	2.91%
Transition to High School Mathematics	1,570	6.02%	1,407	0.24%
"Core" High School				
Algebra I	5,109	19.58%	114,582	19.53%
Geometry	4,976	19.07%	123,910	21.12%
Algebra II	3,183	12.20%	109,163	18.60%
Integrated Mathematics I	1,597	6.12%	17,973	3.06%
Integrated Mathematics II	2,677	10.26%	17,993	3.07%
Integrated Mathematics III	1,506	5.77%	15,439	2.63%
Integrated Mathematics IV	54	0.21%	4,151	0.71%
Applied Algebra	1,252	4.80%	7,957	1.36%
Applied Geometry	387	1.48%	6,229	1.06%
Applied Mathematics	1,173	4.50%	6,215	1.06%
Advanced Courses				
AP Statistics	38	0.15%	8,510	1.45%
Advanced Mathematics	336	1.29%	34,921	5.95%
Calculus	42	0.16%	27,302	4.65%
Calculus AB	8	0.03%	10,787	1.84%
Calculus BC	-	0.00%	2,878	0.49%
Discrete Mathematics	4	0.02%	2,260	0.39%
Other mathematics course	977	3.74%	19,117	3.26%
Probability and Statistics	66	0.25%	9,949	1.70%
Transition to College Mathematics	45	0.17%	10,515	1.79%
Trigonometry	42	0.16%	16,370	2.79%
N	26,015		586,385	

TABLE A.9: DEMOGRAPHICS OF STUDENT SAMPLE BY SCHOOL TYPE (GRADES 4-8 AND 10)

	Brick-and-Mortar District				***Brick-and-Mortar Charter***				***E-school***			
	Grades 4–8		Grade 10		Grades 4–8		Grade 10		Grades 4–8		Grade 10	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Limited English Proficient	0.014	0.117	0.013	0.113	0.029	0.167	0.026	0.159	0.001	0.028	0.006	0.077
Gifted	0.248	0.432	0.270	0.444	0.012	0.110	0.063	0.242	0.029	0.168	0.150	0.357
Free and Reduced Price Lunch Program	0.428	0.495	0.351	0.477	0.814	0.389	0.745	0.436	0.600	0.490	0.591	0.492
Special Education	0.132	0.338	0.117	0.321	0.181	0.385	0.242	0.429	0.158	0.365	0.154	0.361
Male	0.509	0.500	0.501	0.500	0.493	0.500	0.504	0.500	0.502	0.500	0.347	0.476
Number of Disciplinary Actions	0.252	1.120	0.224	0.979	0.388	1.080	0.521	1.410	0.005	0.089	0.455	1.490
Repeated Prior Grade	0.003	0.055	0.002	0.049	0.015	0.122	0.005	0.068	0.017	0.130	0.005	0.069
Black	0.125	0.331	0.113	0.317	0.623	0.485	0.485	0.500	0.106	0.308	0.076	0.266
Hispanic	0.033	0.178	0.029	0.168	0.071	0.257	0.075	0.263	0.028	0.165	0.037	0.189
White	0.783	0.412	0.807	0.395	0.246	0.431	0.371	0.483	0.821	0.384	0.846	0.361
Lived in a City School District	0.142	0.349	0.128	0.334	0.793	0.405	0.710	0.454	0.224	0.417	0.183	0.387
Lived in a Suburban School District	0.446	0.497	0.459	0.498	0.179	0.383	0.206	0.404	0.352	0.478	0.384	0.487
Lived in a Town School District	0.146	0.353	0.151	0.358	0.011	0.106	0.045	0.207	0.158	0.365	0.177	0.382
Lived in a Rural School District	0.267	0.442	0.262	0.440	0.016	0.126	0.039	0.193	0.266	0.442	0.255	0.436
N	1,312,219		161,188		47,216		1,312		14,523		1,691	

TABLE A.10: ACHIEVEMENT OF STUDENT SAMPLE BY SCHOOL TYPE (GRADES 4–8)

	Brick-and-Mortar District		*Brick-and-Mortar Charter*		*E-school*	
	Mean	SD	Mean	SD	Mean	SD
Math OAA (Z-score)	0.083	0.939	-0.515	0.842	-0.517	0.896
Reading OAA (Z-score)	0.073	0.908	-0.439	0.901	-0.241	0.958
Prior Math OAA (Z-score)	0.083	0.934	-0.511	0.857	-0.388	0.905
Prior Reading OAA (Z-score)	0.080	0.882	-0.406	0.871	-0.152	0.914
N	1,312,219		47,216		14,523	

TABLE A.11: ACHIEVEMENT OF STUDENT SAMPLE BY SCHOOL TYPE (GRADE 10)

	Brick-and-Mortar District		*Brick-and-Mortar Charter*		*E-school*	
	Mean	SD	Mean	SD	Mean	SD
Math OGT (Z-score)	0.085	1.020	-0.678	0.948	-0.575	0.921
Reading OGT (Z-score)	0.040	0.977	-0.579	1.050	-0.373	1.010
Science OGT (Z-score)	0.089	0.833	-0.492	0.848	-0.431	0.802
Writing OGT (Z-score)	-0.018	0.971	-0.677	0.991	-0.610	0.930
Social Studies OGT (Z-score)	0.071	0.847	-0.498	0.854	-0.503	0.873
Pass Math OGT	0.894	0.308	0.694	0.461	0.742	0.438
Pass Reading OGT	0.914	0.281	0.784	0.411	0.839	0.368
Pass Science OGT	0.836	0.370	0.601	0.490	0.644	0.479
Pass Social Studies OGT	0.908	0.289	0.768	0.423	0.796	0.403
Pass Writing OGT	0.875	0.330	0.682	0.466	0.679	0.467
Pass all Five OGTs	0.765	0.424	0.482	0.500	0.514	0.500
Prior Math OAA (Z-score)	0.177	0.826	-0.478	0.727	-0.197	0.742
Prior Reading OAA (Z-score)	0.167	0.770	-0.327	0.737	-0.072	0.731
N	161,188		1,312		1,691	

TABLE A.12: ACHIEVEMENT DIFFERENCES AMONG STUDENTS IN E-SCHOOLS AND CHARTER SCHOOLS, COMPARED TO DISTRICT PUBLIC SCHOOLS

Elementary and Middle School (Grades 4–8)					
	Math	Reading			
E-school	-0.367***	-0.186***			
	-0.008	-0.013			
Charter School	0.044***	0.038***			
	-0.009	-0.008			
R-squared	0.642	0.573			
# of Student/Years	1,376,803	1,378,630			
# of Schools	2,925	2,926			
High School (Grade 10)					
	Math	Reading	Science	Social Studies	Writing
E-school	-0.230***	-0.128***	-0.179***	-0.284***	-0.356***
	-0.015	-0.019	-0.016	-0.020	-0.016
Charter School	0.003	-0.045+	0.051*	-0.057*	-0.130***
	-0.024	-0.024	-0.024	-0.024	-0.027
R-squared	0.648	0.529	0.560	0.510	0.476
# of Student/Years	186,800	187,522	187,284	187,201	187,357
# of Schools	1,160	1,164	1,170	1,162	1,164
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001					

Endnotes

1. J. Watson et al., *Keeping Pace with K–12 Digital Learning,* (Durango, CO: Evergreen Education Group, 2015), http://www.kpk12.com/wp-content/uploads/Evergreen_KeepingPace_2015.pdf.

2. Center for Research on Education Outcomes (CREDO), *Online Charter School Study 2015*, (Stanford, CA: 2015), https://credo.stanford.edu/pdfs/OnlineCharterStudyFinal2015.pdf.

3. Similarly, CREDO (2015) found that across all the states included in their study, the achievement of online charter school students on average grows significantly less than that of students in brick-and-mortar district schools.

4. M. Bienkowski et al., *Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics: An Issue Brief,* (Washington, D.C.: U.S. Department of Education, Office of Educational Technology, 2012); M. Madden et al., "Teens and Technology 2013" (Washington, D.C.: Pew Internet & American Life Project, 2013), http://www.pewinternet.org/2013/03/13/teens-and-technology-2013/; K. Purcell et al., "How Teachers Are Using Technology at Home and in Their Classrooms" (Washington, D.C.: Pew Internet & American Life Project, 2013), http://www.pewinternet.org/2013/02/28/how-teachers-are-using-technology-at-home-and-in-their-classrooms/; P. Burch and A. G. Good, *Equal Scrutiny: Privatization and Accountability in Digital Education*, (Cambridge, MA: Harvard Education Press, 2014); J. Carolan and V. Murali, "A closer look at K12 edtech venture funding in 2013," NewSchools Venture Fund, December 18, 2013, http://www.newschools.org/blog/closer-look-2013; *Virtual Schools in the U.S. 2013: Politics, Performance, Policy, and Research Evidence*, A. Molnar, ed. (Boulder, CO: National Education Policy Center, 2013), http://nepc.colorado.edu/files/nepc-virtual-2013.pdf.

5. J. Watson et al., *Keeping Pace with K–12 Digital Learning*.

6. Recent research focuses on online charter schools—as does this study by default, because all full-time online schools in Ohio are charter schools. See B. Gill et al., *Inside Online Charter Schools* (Cambridge, MA: Mathematica Policy Research, 2015) and CREDO, *Online Charter School Study 2015*. Depending on the state, there could also be district- and state-operated online schools. For example, the Florida Virtual School is operated by the Florida Department of Education, and the School District of Philadelphia Virtual Academy is operated by that district.

7. B. Gill et al., *Inside Online Charter Schools*.

8. Editorial Board, "Six ways to make Ohio's online charter schools more accountable" *The Plain Dealer*, June 20, 2016, http://www.cleveland.com/opinion/index.ssf/2016/06/six_ways_to_make_ohios_online.html; J. Siegel and C. Candisky, "ECOT leader: State attendance audit could force us to close," *The Columbus Dispatch*, July 11, 2016, http://www.dispatch.com/content/stories/local/2016/07/11/ecot-leader-state-attendance-audit-could-force-us-to-close.html.

9. See B. Tucker, E. Dillon, and P. Jambulapati, *Ohio E-Schools: Learning From Their Experience* (Education Sector, 2011), http://www.educationsector.org/sites/default/files/publications/OhioE-SchoolsBlogSeries_RELEASE.pdf for an earlier description of Ohio e-schools.

10. B. Means, M. Bakia, and R. Murphy, *Learning Online: What Research Tells Us About Whether, When and How* (New York, NY: Routledge, 2014).

11. C. E. Finn and D. R. Fairchild, eds., *Education Reform for the Digital Era* (Washington, D.C.: The Thomas B. Fordham Institute, 2012), http://www.edexcellencemedia.net/publications/2012/20120425-education-reform-for-the-digital-era/20120425-Education-Reform-for-the-Digital-Era-FINAL.pdf; D.K. Lautzenheiser and T. Hochleitner, *Blended Learning in DC Public Schools: How One District is Reinventing Its Classrooms*, (Washington, D.C.: American Enterprise Institute, 2014), http://www.aei.org/files/2014/01/30/-blended-learning-in-dc-public-schools_084713921628.pdf; H. Staker and M.B. Horn, *Classifying K-12 Blended Learning* (San Francisco, CA: Innosight Institute, 2012), http://www.innosightinstitute.org/innosight/wp-content/uploads/2012/05/Classifying-K-12-blended-learning2.pdf.

12. In K–12 schools, students occasionally take online courses at the physical location of their school campus and under the supervision of a school employee. For example, one math instructor may supervise a group of students independently enrolled in virtual courses. The students all report to the same classroom at the same time, but each student may not be enrolled in the same course—one may be in Algebra I, another in Calculus, and each has a different teacher of record. The supervising instructor answers student questions and assists them with content. This is one form of "blended learning," meaning a combination of in-person and online learning activities.

13. Students at brick-and-mortar schools can also take blended learning courses that have both face-to-face and online components; students at e-schools cannot, as there is no central location for them to do so.

14. For more on the configuration, enrollment numbers, and demographics of online charter schools, see B. Gill et al., *Inside Online Charter Schools*.

15. Results are mixed on the impact of blended learning and technology in the classroom as well. See G. Bulman and R. Fairlie, *Technology and Education: Computers, Software, and the Internet*, NBER Working Paper No. 22237 (Cambridge, MA: NBER, 2006), http://www.nber.org/papers/w22237.

16. CREDO, *Online Charter School Study 2015*.

17. J. Ahn, "Policy, Technology, and Practice in Cyber Charter Schools: Framing the Issues," *Teachers College Record* 113, no. 1 (2011), 1–26.

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22. H. Gilman et al., Ohio Legislative Service Commission Final Analysis of H.B. 2, https://www.legislature.ohio.gov/download?key=2821&format=pdf.

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25. There is a bit of noise in the data because a handful of students started and ended the analysis window at the same school but actually transferred out of—and then back into—the same school during a single school year. However, these students represent a miniscule fraction of the 1.7 million students in each year of the sample.

26. A. Angrist et al., *Leveraging Lotteries for School Value-Added: Testing and Estimation*, NBER Working Paper No. 21748, (Cambridge, MA: NBER, 2015), http://www.nber.org/papers/w21748.

27. Put another way, their research question is this: "What is the average impact of attending an online charter school on the academic growth of students relative to brick-and-mortar district school students?" We ask, "What is the average impact of attending an e-school on the academic performance of students relative to brick-and-mortar district school students, and how does that compare to the average impact of attending a brick-and-mortar charter on the academic performance of students relative to brick-and-mortar district school students?"

28. While including multiple course designations in the ODE database is an important step, capturing the range of digital learning requires that states both create clear definitions for what different course designations mean and train local staff to reliably report on them. For example, definitions and procedures must allow staff to accurately report students taking a fully online course at their home brick-and-mortar school that is supervised by a live instructor, then differentiate it from one in which the teacher of record is physically in the classroom but using a software platform to facilitate parts of the instruction.

29. These trends open up myriad questions. Aside from individual case studies, we know very little about how online education is implemented for younger children and even less about how it impacts student learning over time. This information is key to understanding how online curricula should be combined with other educational resources (e.g., teacher practices, parent practices, home resources, school resources) to create effective learning environments for students at different developmental stages.

30. A recent study on the universe of online charter schools found that across ten states, online charter schools had approximately the same proportion of special education students as other public schools (see B. Gill et al., *Inside Online Charter Schools*). The overrepresentation of special education students in Ohio online charters could indicate that e-schools are providing specialized services to these students, that brick-and-mortar schools are not serving them well, or both. (Or it could indicate that parents at least perceive one or both of these to be the case.)

31. Note that this applies only to students in grades 4–8 and 10 during the 2012–13 school year, for whom prior test scores are available (see Table 1).

32. There have been concerns about designating some e-schools as dropout prevention schools (and waiving their participation in accountability regulations), since it may create an incentive for districts to send their lower-performing students there. This is particularly problematic because virtual schools provide negligible in-person supports (see B. Tucker, E. Dillon, and P. Jambulapati, *Ohio E-Schools: Learning From Their Experience*). While the achievement of all e-school students is not lower than those in brick-and-mortar charters, there are, in fact, some e-schools (notably, dropout prevention schools) where prior achievement is markedly lower.

33. Start-up brick-and-mortar charters can be located only in "challenged" districts—meaning those that score in the lowest 5 percent on the state's performance index, as well as Akron, Canton, Cincinnati, Cleveland, Columbus, Dayton, Toledo, Youngstown, and the former Lucas County pilot area. As of the 2014–15 school year, there are a total of thirty-nine districts (out of more than 611) in which brick-and-mortar charters can be located.

34. Thomas B. Fordham Institute, "Student Nomads: Mobility in Ohio's Schools," Ohio Student Mobility Research Project (Columbus, OH: Community Research Partners, 2012), http://edexcellence.net/publications/student-nomads-mobility-in-ohios-schools.html.

35. National Center for Education Statistics Table 40, *Digest of Education Statistics* (Washington, D.C.: 2011), http://nces.ed.gov/programs/digest/d11/tables/dt11_040.asp.

36. The findings reported in this section refer to all courses that are recorded as "online" as opposed to "face-to-face," as determined by course records. The "online" designation captures not just courses taken by e-school students, but also those taken by students from brick-and-mortar charter and district schools. Because this section uses course records rather than student enrollment records, we do not separate out only those online courses taken by e-school students. Ideally, we would pull out the e-school students and analyze only their courses. In some

early years, however, a few e-school students (defined by the school code registered as their base school) appear to have taken only courses designated as "face-to-face," and we do not know whether the enrollment or course records are in error. Likewise, we are not sure whether districts are recording "online" courses of their brick-and-mortar students accurately. Therefore, to analyze online courses, we use course records only, not enrollment records.

37. Ohio Department of Education, Math Graduation Requirements, http://education.ohio.gov/Topics/Ohios-Learning-Standards/Mathematics/Math-Graduation-Requirements.

38. Ohio Department of Education, https://education.ohio.gov/getattachment/Topics/Teaching/Educator-Licensure/Additional-Information/Certification-and-Licensure-Dictionary/Mathematics.pdf.aspx and Math Graduation Requirements.

39. Ohio Department of Education, https://education.ohio.gov/getattachment/Topics/Teaching/Educator-Licensure/Additional-Information/Certification-and-Licensure-Dictionary/Mathematics.pdf.aspx.

40. (See Ohio Department of Education, Math Graduation Requirements.) For both Integrated and Applied Mathematics, the rigor and content of these courses depends on the curriculum (which, especially in the case of applied courses, will vary across students and schools). However, a student might fulfill his graduation requirement with Algebra I, Applied Algebra, Integrated Math I, and Integrated Math II (having opted out of Algebra II), with minimal exposure to content more advanced than basic algebra.

41. The comparison of achievement between charters and district schools is well-known: See CREDO, *Charter School Performance in Ohio* (Stanford, CA: 2014), https://credo.stanford.edu/pdfs/OHReport12182014_FINAL.pdf). That report found Ohio's charter students performing worse on average than students in traditional district schools (with slight variations by urban area). However, the study aggregated e-schools with other charter schools when making that determination. By comparing e-school students to brick-and-mortar district school students, and then brick-and-mortar charter students to brick-and-mortar district school students, we are able to examine the impact of each type of charter school separately, an important distinction.

42. Similarly, CREDO (2015) found that across all the states included in their study, the achievement of online charter students on average grows significantly less than that of students in brick-and-mortar district schools.

43. CREDO, *Online Charter School Study 2015*.

44. However, due to funding cuts, the iLearnOhio course catalog has not been updated since June 30, and it will go fully offline September 30, 2016. Prior to the cuts, iLearn staff reviewed and rated online course providers and courses and designated whether the latter met the state's educational standards. However, at the time iLearn stopped updating, only 9 percent of all the courses listed there had actually been reviewed.

45. As of 2015–16, there was an available fee waiver. However, numerous hurdles prevent its widespread use (e.g., supply is limited, applies only to AP courses, and can be used just once; the student's school or district must agree to accept the grade and credit for the course; and a school official must complete the waiver application on the student's behalf). Further, it is unclear whether/how the waiver will continue, since it is administered by iLearnOhio.