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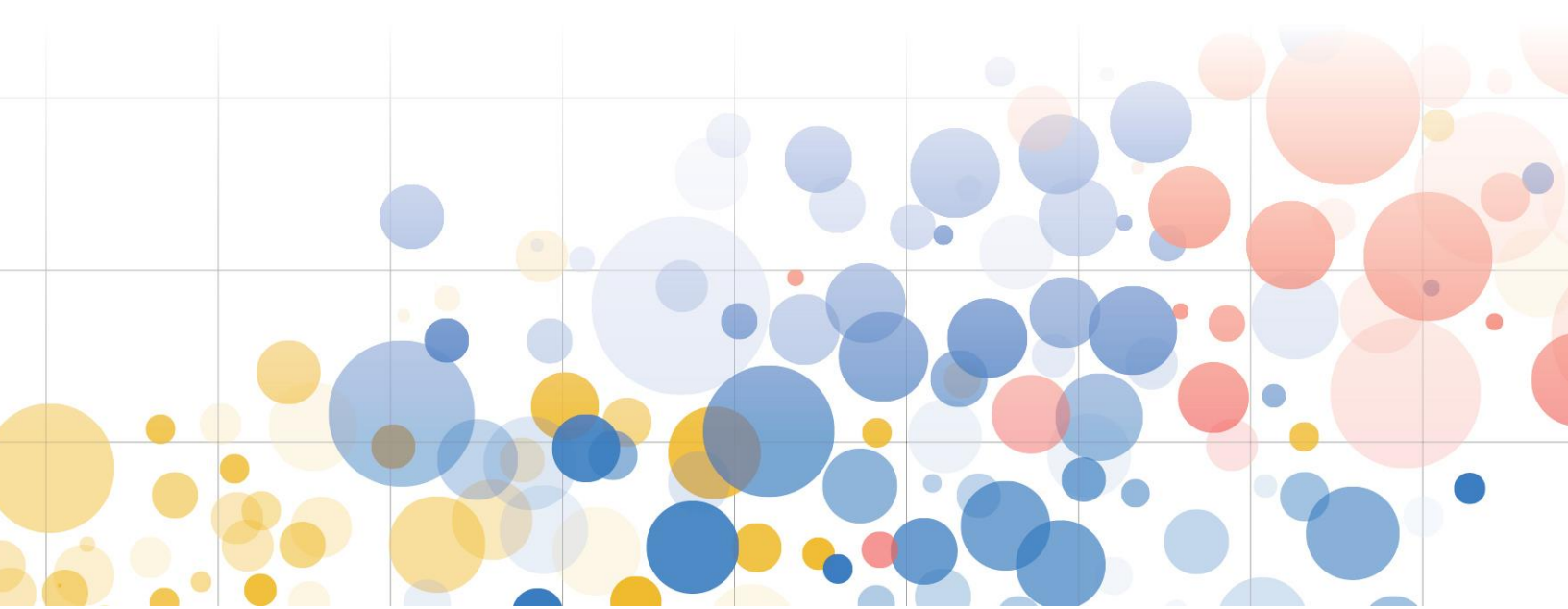
The Efficacy of Virtual Instruction in K-12 Education: A Review of the Literature

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Contents

HIGHLIGHTS

- Multiple studies find large negative effects of attending a virtual charter school (relative to a brick-and-mortar school) on student achievement.
- There is a lack of rigorous research on instructional strategies in virtual education that provide clear implications for the use of particular instructional practices.
- Evidence on the impact of teacher experience and teacher-student interactions in K-12 virtual learning environments is inconsistent.
- A prerequisite to student learning in a virtual environment is student engagement with the material. Several studies find that low-cost informational "nudges" can boost engagement.

INTRODUCTION

In the midst of the COVID-19 pandemic, school districts in metro Atlanta and across the country were forced to close their buildings and rely on remote learning strategies, including online or virtual instruction. It now appears likely that virtual instruction will be part of the overall instructional strategy for many school districts in school year (SY) 2020-21, either as a full-time option for parents who are concerned about their children participating in in-person instruction or as part of a hybrid strategy to implement social distancing measures in schools.

This brief summarizes the evidence on virtual learning in K-12 education and provides guidance on the efficacy of virtual learning as well as best practices in virtual education. An important caveat is that what is known about virtual learning is based on instruction in "normal" times when parents and teachers are not forced to work at home, are not facing the stresses resulting from a public health crisis and economic recession, and in-person instruction is a readily-available alternative to virtual learning. Findings from prior research may not translate directly to the current situation because the home and teaching environment may be substantially different during the COVID-19 pandemic, all schools are thrust into providing virtual learning, and many schools may implement a mix of virtual and in-person learning.

THE GENERAL EFFECTIVENESS OF VIRTUAL LEARNING

The literature on remote learning/virtual education in the K-12 context is relatively sparse. Pre-pandemic, the most prevalent form of online instruction was where students enrolled in brick-and-mortar schools took individual courses online to access courses not offered locally or for credit recovery. The evidence on such individual virtual course taking is mixed.[1] In an experimental study, Heppen et al. (2017) reported that students in an online credit recovery course found the course more difficult, were less likely to recover credit, and scored lower on a post-test than did their counterparts assigned to a face-to-face version of the course, but these differences in math outcomes did not persist over time. In contrast, Hart et al. (2019) studied the Florida Virtual School (FLVS) and found that, in credit recovery courses, virtual instruction was associated with a higher likelihood of taking and passing follow-on courses, whereas for first-time course taking, there were positive effects on passing the course but negative effects on taking

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[1] See the Research Alliance (2020) and NASCA & Public Impact (2015) for detailed literature reviews about virtual learning.

and passing subsequent courses. Similarly, Chingos and Schwerdt (2014) found that students who took FLVS courses had null or slightly positive results on standardized tests as compared with their peers.

More relevant to online instruction during the pandemic are studies of virtual charter schools, where all learning occurs remotely. Woodworth et al. (2015), Ahn and McEachin (2017), Bueno (2020), and Fitzpatrick et al. (2020) all found negative effects of attending a virtual charter (relative to a brick-and-mortar school) on student achievement. The impacts vary across subjects and grade levels but are nearly always substantial, generally in the range of −0.1 to −0.4 standard deviations (SD) of normalized test scores; these estimates are equivalent to one-fifth to more than a full year of annual learning gains that students normally experience in a brick-and-mortar environment (Lipsey et al., 2012). Likewise, annual reports on charter school performance in Georgia (Sass, various years) indicated that students enrolled in full-time virtual schools perform worse overall than students in non-virtual schools across multiple subjects, with the exception of English Language Arts.

Moreover, attending virtual schools is negatively associated with high school graduation. A descriptive report by the National Education Policy Center documented that on-time graduation rates are 27 percent lower in blended schools and 40 percent lower in fully online schools relative to the national average graduation rate (Molnar et al., 2019).[2] Specific to Georgia, Bueno (2020) found that students who ever attended a full-time virtual school were 10 percentage points less likely to graduate from high school.

VIRTUAL LEARNING STRATEGIES AND BEST PRACTICES

There is limited causal evidence on the efficacy of different virtual learning strategies for students in grades K-12.[3] Because few schools have randomized strategies like synchronous teaching, peer collaboration, and educational games across teachers and students, researchers are inferring best practices from the few virtual schools with positive effects.

A recent presentation by Bennett et al. (2020) reviewed the literature related to virtual learning and summarizes what works well in certain environments to develop recommendations for best practices. Another report by the Education Endowment Foundation (2020) summarized key findings from 60 literature reviews of descriptive and causal studies related to blended learning, computer effectiveness, and educational games.

General themes of best practices inferred from these works include

- providing clear explanations and scaffolding in the virtual setting,
- incorporating peer and teacher interactions and feedback,
- using games and simulations to help keep students engaged, and
- being sure material and technological support are available.

Some of these themes come from causal analysis while others are based on less rigorous studies. Even with causal analysis, however, determining the specific mechanism behind effective remote instruction

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[2] This report describes the full-time virtual and blended school landscape across the country for school year (SY) 2017-18. In SY 2017-18, the national average graduation rate was 84 percent.
[3] Although the causal evidence is limited, the Research Alliance (2020) provides information on personalized learning and specific virtual learning tools and programs.

that can be applied in the era of the COVID-19 pandemic is difficult for a few reasons. First, of the existing causal evidence, many studies are done in a blended-learning setting and not a fully online setting. For example, Pane et al. (2014) conducted one of the largest evaluations of blended learning across the United States with over 25,000 students from 149 schools. They examined the effectiveness of a technology-based algebra curriculum by assigning teachers in randomly selected schools to adopt Cognitive Tutor Algebra I, which uses a personalized, mastery-learning, blended-learning approach, or continue with their current curriculum. Teachers received four days of training, and the intervention lasted two years, although students were only exposed for one year. There were no impacts on algebra proficiency in the first year but positive effects in the second year. There is no clear explanation why the impact emerged in the second year, as there is not enough evidence to prove that implementation improved as teachers became more familiar with the technology. Additionally, there were not statistically significant effects in middle school—only high school—indicating that this intervention is less helpful among gifted/higher-achieving students (i.e., those that take Algebra I in middle school). Finally, it is unclear which mechanism—the personalization, mastery learning, or blended learning—drove these results, making it difficult to apply the findings from this study to the current environment.

More recently, Jackson and Makarin (2018) randomly gave 363 middle school math teachers in Virginia access to high-quality online "off-the-shelf" lessons that emphasized classroom discussions, scaffolding, and other pedagogical best practices during SY 2012-13. Teachers who received access and support increased their students' math scores by 0.09 SD. Jackson and Makarin (2018) also found that the least effective and first-year teachers experienced larger gains, which they attributed to improved quality of instruction and time savings and may have transferrable implications under the current situation.

Second, in addition to the first limitation, various studies conducted outside the United States have fewer than 100 students participating. A randomized controlled trial in Jerusalem found that fifth-grade students' problem solving skills greatly benefitted from games that incorporated scaffolding (Barzilai & Blau, 2014); a study in Turkey found that seventh-grade students in science classes benefited from animated slides as opposed to regular slides (Aksoy, 2012). A quasi-experimental study among 60 Saudi primary-school students studying English determined that gamification of web-based learning positively impacted student achievement and creative thinking (Aljraiwi, 2019). Scaffolding, animations, and gamification all seem to be potential best practices in other countries, but it is not clear if these findings would hold in the U.S. context.

Among studies within the United States, one study in central Virginia provides some evidence that synchronous learning may be an important factor in online education (Wendt & Rockinson-Szapkiw, 2014). During SY 2012-13, students in five eighth-grade science classes were either assigned to traditional face-to-face collaboration or Edmodo, an educational learning platform that enables teachers and students to collaborate for nine weeks. Students who participated in collaborative activities in the traditional classroom had fewer science misconceptions than students who participated in collaborative activities in the online environment. Moreover, the students in the experimental group acquired more science misconceptions. The authors explained that the higher rate of misconceptions may have been a result of delayed asynchronous communication. The delay in clarifying concepts in the experimental group and the

immediacy of correction in the traditional face-to-face class may have impacted students' level of understanding.

Another study in Texas found that students were more on-task and engaged with a new blended learning platform that implemented the three e-learning principles of personalization, modality, and redundancy, as opposed to the old platform that did not implement these principles (Mulqueeny et al., 2015).[4] Students using the new platform also had higher sixth-grade math scores. Assignment to treatment was not entirely random,[5] but students performed similarly on the pre-test prior to using the platform. This is one of the few studies that tested the effectiveness of online learning strategies, whereas most of the existing research tested the effectiveness of online instruction relative to in-person instruction.

THE IMPORTANCE OF TEACHER COMMUNICATION AND CLASS SIZE IN THE VIRTUAL ENVIRONMENT

Teacher experience, particularly additional early-career experience, is one of the most consistent predictive factors of student achievement in face-to-face education (Ladd & Sorensen, 2017; Harris & Sass, 2011; Kane et al., 2008). However, the relationship between general experience and teacher effectiveness is much less clear in the virtual context. In a blended learning environment that imposed the same curriculum for various teachers and students across the country, a descriptive study showed that neither teacher experience nor educational credentials were correlated with student performance (Çakır & Bichelmeyer, 2013). Moreover, the sparse research on student-teacher interactions and student achievement is inconclusive. On one hand, correlational studies found that there was a strong positive relationship between student-teacher interactions and course completion and grades for some classes (Hawkins et al., 2013; Liu & Cavanaugh, 2012). Alternatively, Zhang and Lin (2019) did not find that student-teacher interactions were correlated with student satisfaction; however, unlike the previous studies, they only measured the quantity of interactions and did not consider quality. Finally, some of the evidence related to the effectiveness of virtual schools indicated that large student-to-teacher ratios could be contributing to the negative impacts (Fitzpatrick et al., 2020).

CHALLENGES: ACCESS AND ENGAGEMENT

As instruction is shifted to a remote environment, the first challenge is ensuring that all students have access to instructional materials. During spring 2020, most metro-Atlanta school districts utilized their existing online platforms to provide digital content to students, particularly those in upper elementary, middle-school, and high-school grades. Despite districts' efforts to provide digital devices such as laptops or tablets and increase wireless internet access, many students in the metro area still had difficulties

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[4] Personalization is more conversational, modality presents words as audio instead of text, and redundancy explains a visual with either audio or text but not both. This study took place in three schools in Texas where one-third of the students were Hispanic, and one-third were White.

[5] Principals determined which teachers and classrooms used the new platform versus the old platform.

accessing online materials (Tagami, 2020; Walker, 2020). Districts also provided workbooks for younger students or as an alternative for families without digital devices and reliable internet access.[6]

Once material is made available, the next challenge is ensuring that students and families engage with the learning environment.[7] Simply providing computers and internet connectivity or distributing workbooks may not be enough to ensure productive engagement.[8] Fortunately, targeted messages or "informational nudges" provide a relatively cheap and scalable way to increase parental online engagement and improve student outcomes (Bergman, 2019; Kraft & Rogers, 2015; Bergman & Chan, 2017). Bergman (2019) found that a simple message that reminded parents about the availability of an online learning management system (where they could track their students' progress in real time) and provided their login information increased usage and student achievement. Other studies also found that teacher-to-parent communication, such as informing parents about their child's missed assignments, increased parental involvement and academic outcomes (Kraft & Rogers, 2015; Bergman & Chan, 2017). Interestingly, providing parents with information about their child's academic performance was twice as effective as reminding parents to check on their child's performance. In other words, "pushing" information was twice as effective as "pulling" information (Bergman, 2019; Bergman, 2014). While these studies did not take place in the context of remote learning during the COVID-19 pandemic, they do provide encouraging evidence that informational nudges could be a useful tool to promote engagement in virtual learning for those who have been able to overcome impediments to access.

CONCLUSION

Overall, the evidence on virtual learning relative to face-to-face learning is less than promising. Fully online charter schools generally produce substantially smaller learning gains than do full-time brick-and-mortar schools. However, given the current public health crisis, schools may have little choice in providing some or all instruction remotely. Thus, a major concern is how to provide the best remote instruction possible under the current circumstances. Unfortunately, existing research provides little reliable evidence on which online learning practices are most effective, and the few existing causal studies yield inconsistent results. Similarly, there is a lack of consistent evidence on the relationship between teacher experience and effectiveness in an online learning environment. While the lack of guidance from prior research is disappointing, it highlights the critical need to learn from the shift to remote learning when schools closed in March 2020 and the subsequent impacts of alternative strategies on student outcomes.

One area where existing research yields strong and consistent evidence is the use of informational nudges to promote engagement in online learning. Several studies have demonstrated that simple information

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[6] Walker (2020) describes some of the strategies employed by districts in the greater Atlanta-metro area. See crpe.org/current-research/covid-19-school-closures for a nationwide summary of district responses to COVID-19 closures, including some metro-Atlanta districts.

[7] Engagement is predictive of better student performance. See Castro et al. (2015) for a meta-analysis on parental involvement and student achievement. See Handbook of Research on Student Engagement (chapters 5 and 24) for information about student engagement and academic outcomes.

[8] Two studies, Fairlie and Robinson (2013) and Vigdor et al. (2014), find that simply providing digital devices to students enrolled in brick-and-mortar schools did not boost student achievement or reduce racial achievement gaps.

messages or "nudges" can significantly boost engagement in remote learning and lead to improved student outcomes.

REFERENCES AND ABSTRACTS

Ahn, J. & McEachin, A. 2017. Student Enrollment Patterns and Achievement in Ohio's Online Charter Schools. *Educational Researcher,* 46(1): 44-57.

ABSTRACT—We utilize state data of nearly 1.7 million students in Ohio to study a specific sector of online education: K–12 schools that deliver most, if not all, education online, lack a brick-and-mortar presence, and enroll students full-time. First, we explore e-school enrollment patterns and how these patterns vary by student subgroups and geography. Second, we evaluate the impact of e-schools on students' learning, comparing student outcomes in e-schools to outcomes in two other schooling types, traditional charter schools and traditional public schools. Our results show that students and families appear to self-segregate in stark ways where low-income, lower achieving White students are more likely to choose e-schools while low-income, lower achieving minority students are more likely to opt into the traditional charter school sector. Our results also show that students in e-schools are performing worse on standardized assessments than their peers in traditional charter and traditional public schools. We close with policy recommendations and areas for future research.

Aksoy, G. (2012). The Effects of Animation Technique on the 7th Grade Science and Technology Course. *Creative Education*, 3, 304-308. DOI: 10.4236/ce.2012.33048

ABSTRACT—The purpose of this study is to determine the effect of animation technique on academic achievement of students in the "Human and Environment" unit lectured as part of the Science and Technology course of the seventh grade in primary education. The sample of the study consists of 58 students attending to the 7th grade of Erzurum MEB Yildizkent IMKB primary school under two different classes during the 2011- 2012 academic year. While the lectures in the class designated as the animation group were given with animation technique, in the class designated as the control group, PowerPoint presentations were utilized along with the traditional teaching methods. According to the findings, it was determined that animation technique is more effective than traditional teaching methods in terms of enhancing students' achievement. It was also determined in the study that the PowerPoint presentations used together with the traditional teaching methods provided to the control group significantly help the students to increase their academic achievement.

Aljraiwi, S. 2019. Effectiveness of gamification of web-based learning in improving academic achievement and creative thinking among primary school students. *International Journal of Education and Practice,* 7(3): 242-257.

ABSTRACT—Gamification is one of the most significant modern trends in educational technology. The present study aims to identify the effectiveness of gamification of web-based learning on academic achievement and creative thinking among primary school students. A learning environment was designed based on gamification of web-based learning. A quasi-experimental approach was utilized to identify the effect of the independent variable, gamification, on the dependent variables, academic achievement and creative thinking among participants. An academic achievement test and the Torrance test of creative

thinking were applied to the participants. Results revealed that there was a statistically significant difference between the means of scores of the experimental and control groups in the post-test academic achievement test and the Torrance test of creative thinking in favor of the experimental group. This suggests a high level of academic achievement and creative thinking after using gamification.

Barzilai, S., & Blau, I. (2014). Scaffolding game-based learning: Impact on learning achievements, perceived learning, and game experiences. *Computers & Education*, 70, 65-79.

ABSTRACT—One of the central challenges of integrating game-based learning in school settings is helping learners make the connections between the knowledge learned in the game and the knowledge learned at school, while maintaining a high level of engagement with game narrative and gameplay. The current study evaluated the effect of supplementing a business simulation game with an external conceptual scaffold, which introduces formal knowledge representations, on learners' ability to solve financial-mathematical word problems following the game, and on learners' perceptions regarding learning, flow, and enjoyment in the game. Participants (Mage = 10.10 years) were randomly assigned to three experimental conditions: a "study and play" condition that presented the scaffold first and then the game, a "play and study" condition, and a "play only" condition. Although no significant gains in problem-solving were found following the intervention, learners who studied with the external scaffold before the game performed significantly better in the post-game problem-solving assessment. Adding the external scaffold before the game reduced learners' perceived learning. However, the scaffold did not have a negative impact on reported flow and enjoyment. Flow was found to significantly predict perceived learning and enjoyment. Yet, perceived learning and enjoyment did not predict problem-solving and flow directly predicted problem solving only in the "play and study" condition. We suggest that presenting the scaffold may have "problematized" learners' understandings of the game by connecting them to disciplinary knowledge. Implications for the design of scaffolds for game-based learning are discussed.

Bergman, P. 2014. Parent-child information frictions and human capital investment: evidence from a field experiment. Working Paper, Teachers College Columbia University. Retrieved from columbia.edu/~psb2101/BergmanSubmission.pdf

ABSTRACT—This paper studies information frictions between parents and their children, and how these affect human capital investments. I provide detailed, biweekly information to a random sample of parents about their child's missed assignments and grades and find parents have upwardly-biased beliefs about their child's effort. Providing additional information attenuates this bias and improves student achievement. Using data from the experiment, I then estimate a persuasion game between parents and their children that shows the treatment effect is due to a combination of more accurate beliefs and reduced monitoring costs. The experimental results and policy simulations from the model demonstrate that improving the quality of school reporting or providing frequent information to parents about their child's effort in school can produce gains in achievement at a low cost.

Bergman, P. 2019. Nudging Technology Use: Descriptive and Experimental Evidence from School Information Systems. *Education Finance and Policy*. Forthcoming.

ABSTRACT—As schools are making significant investments in education technologies, it is important to assess whether various products are adopted by their end users and whether they are effective as used.

This paper studies the adoption and ability to promote usage of one type of technology that is increasingly ubiquitous: school-to-parent communication technologies. Analyzing usage data from a Learning Management System across several hundred schools and then conducting a two-stage experiment across 59 schools to nudge the use of this technology by families, I find that 57% of families ever use it and adoption correlates strongly with measures of income and student achievement. While a simple nudge increases usage and modestly improves student achievement, without more significant intervention to encourage usage by disadvantaged families, these technologies may exacerbate gaps in information access across income and performance levels.

Bergman, P. & Chan, E. 2017. Leveraging technology to engage parents at scale: evidence from a
    randomized control trial. *Working Paper.*

ABSTRACT—While leveraging parents has the potential to increase student performance, programs that do so are often costly to implement or they target younger children. We partner text-messaging technology with school information systems to automate the gathering and provision of information to parents at scale. In a field experiment across 22 middle and high schools, we used this technology to send automated text-message alerts to parents about their child's missed assignments, grades, and class absences. We pre-specified five primary outcomes. The intervention reduces course failures by 38% and increases class attendance by 17%. Students are more likely to be retained in the district. There are no effects on test scores, however. The positive effects are particularly large for students with below-average GPA and students in high school. As in previous research, the intervention appears to change parents' beliefs about their child's performance and increases parent monitoring. Our results show that this type of automated technology can improve student effort relatively cheaply and at scale.

Bueno, C. 2020. Bricks and Mortar vs. Computers and Modems: The Impacts of Enrollment in K-12 Virtual
    Schools. (EdWorkingPaper: 20-250). Retrieved from Annenberg Institute at Brown
    University: doi.org/10.26300/kahb-5v62

ABSTRACT—The COVID-19 pandemic has put virtual schooling at the forefront of policy concerns, as millions of children worldwide shift to virtual schooling with hopes of "slowing the spread." Given the emergency shift to online education, coupled with the large increase in demand for virtual education over the last decade, it is imperative to explore the impacts of virtual education on student outcomes. This paper estimates the causal effect of full-time virtual school attendance on student outcomes with important implications for school choice, online education, and education policy. Despite the increasing demand for K-12 virtual schools over the past decade, little is known about the impact of full-time virtual schools on students' cognitive and behavioral outcomes. The existing evidence on the impact of online education on students' outcomes is mixed. I use a longitudinal data set composed of individual-level information on all public-school students and teachers throughout Georgia from 2007 to 2016 to investigate how attending virtual schools influences student outcomes. I implement a variety of econometric specifications to account for the issue of potential self-selection into full-time virtual schools. I find that attending a virtual school leads to a reduction of 0.1 to 0.4 standard deviations in English Language Arts, Mathematics, Science, and Social Studies achievement test scores for students in elementary and middle school. I also find that ever attending a virtual school is associated with a 10-percentage point reduction in the probability of ever graduating from high school. This is early evidence

that full-time virtual schools as a type of school choice could be harmful to students' learning and future economic opportunities, as well as a sub-optimal use of taxpayer money.

Çakır, H. & Bichelmeyer, B. (2016). Effects of teacher professional characteristics on student achievement: an investigation in blended learning environment with standards-based curriculum. *Interactive Learning Environments*, 24(1): 20-32, DOI: 10.1080/10494820.2013.817437

ABSTRACT—Use of different teaching materials and curriculum for the same subjects is always a confounding factor in studies investigating teacher characteristics and student achievement. The purpose of this study is to understand the effects of different teacher qualities on student achievement in high schools with a standards-based curriculum delivered over a blended learning environment. Utilizing quantitative research approach, this study investigates the effects of teacher characteristics and teaching practices in a course offered through Cisco Networking Academy, which has a standards-oriented curriculum delivered online. Participants in the study were 226 teachers and 3,299 students from Networking Academies located in the USA. The findings suggest that certain teacher characteristics such as teaching experience, degree, and primary teaching field do not have effects on student achievement.

Castro, M., Expósito-Casas, E., López-Martín, E., Lizasoain, L., Navarro-Asenciod, E., Gaviria, J. 2015. Parental involvement on student academic achievement: A meta-analysis. *Educational Research Review,* 14:33-46. DOI: 10.1016/j.edurev.2015.01.002

ABSTRACT—This paper is a quantitative synthesis of research into parental involvement and academic achievement through a meta-analysis of 37 studies in kindergarten, primary, and secondary schools carried out between 2000 and 2013. Effect size estimations were obtained by transforming Fisher's correlation coefficient. An analysis has also been conducted of the heterogeneity of the magnitudes grouped according to different moderator variables, and a study of the publication bias affecting meta-analytical studies. The results show that the parental models most linked to high achievement are those focusing on general supervision of the children's learning activities. The strongest associations are found when the families have high academic expectations for their children, develop and maintain communication with them about school activities, and help them to develop reading habits.

Chingos, M. & Schwerdt, G. 2014. Virtual Schooling and Student Learning: Evidence from the Florida Virtual School. Working paper, Harvard Kennedy School, Taubman Center for State and Local Government, Program on Education Policy and Governance. Retrieved from econstor.eu/bitstream/10419/113202/1/VfS_2015_pid_39.pdf

ABSTRACT—Online education options have proliferated in recent years, with significant growth occurring at state sponsored virtual schools. However, there is no prior credible evidence on the quality of virtual courses compared to in-person courses in U.S. secondary education. We compare the performance of students who took core courses in algebra and English at their traditional public high school to the performance of students who took the same courses through the Florida Virtual School, the largest state virtual school in the U.S. We find that FLVS students are positively selected in terms of prior achievement and demographics but perform about the same or somewhat better on state tests once their pre-high-school characteristics are taken into account. We find little evidence of treatment effect heterogeneity

across a variety of student subgroups, and no consistent evidence of negative impacts for any subgroups. Differences in spending between the sectors suggest the possibility of a productivity advantage for FLVS.

Fairlie, R. & Robinson, J. 2013. Experimental Evidence on the Effects of Home Computers on Academic Achievement among Schoolchildren. *American Economic Journal: Applied Economics*, 5 (3): 211-40.

ABSTRACT—Computers are an important part of modern education, yet many schoolchildren lack access to a computer at home. We test whether this impedes educational achievement by conducting the largest-ever field experiment that randomly provides free home computers to students. Although computer ownership and use increased substantially, we find no effects on any educational outcomes, including grades, test scores, credits earned, attendance, and disciplinary actions. Our estimates are precise enough to rule out even modestly-sized positive or negative impacts. The estimated null effect is consistent with survey evidence showing no change in homework time or other "intermediate" inputs in education.

Fitzpatrick, B., Berends, M., Ferrare, J. & Waddington, J. 2020. Virtual Illusion: Comparing student achievement and teacher classroom characteristics in online brick-and-mortar charter schools. *Educational Researcher,* DOI: 10.3102/0013189X20909814

ABSTRACT—As researchers continue to examine the growing number of charter schools in the United States, they have focused attention on the significant heterogeneity of charter effects on student achievement. Our article contributes to this agenda by examining the achievement effects of virtual charter schools vis-à-vis brick-and-mortar charters and traditional public schools and whether characteristics of teachers and classrooms explain the observed impacts. We found that students who switched to virtual charter schools experienced large, negative effects on mathematics and English/language arts achievement that persisted over time and that these effects could not be explained by observed teacher or classroom characteristics.

Harris, D., & Sass, T. 2011. Teacher training, teacher quality and student achievement. *Journal of Public Economics* 95(7–8):798–812. DOI:10.1016/j.jpubeco.2010.11.009

ABSTRACT—We study the effects of various types of education and training on the productivity of teachers in promoting student achievement. Previous studies on the subject have been hampered by inadequate measures of teacher training and difficulties in addressing the non-random selection of teachers to students and of teachers to training. We address these issues by estimating models that include detailed measures of pre-service and in-service training, a rich set of time-varying covariates, and student, teacher, and school fixed effects. We find that elementary and middle school teacher productivity increases with experience (informal on-the-job training). The largest gains from experience occur in the first few years, but we find continuing gains beyond the first five years of a teacher's career. In contrast, we do not find a consistent relationship between formal professional development training and teacher productivity. However, this may be partly driven by estimation issues as we find more significant positive effects of formal training in the subject-grade combination where estimates should be most precise (middle school math). There is no evidence that teachers' pre-service (undergraduate) training or college entrance exam scores are related to productivity.

Hart, C., Berger, D., Jacob, B., Loeb, S., & Hill, M. 2019. Online learning, offline outcomes: online course taking and high school student performance. *AERA Open,* 5(1): 1-17.

ABSTRACT—This article uses fixed effects models to estimate differences in contemporaneous and downstream academic outcomes for students who take courses virtually and face-to-face—both for initial attempts and for credit recovery. We find that while contemporaneous outcomes are positive for virtual students in both settings; downstream outcomes vary by attempt type. For first-time course takers, virtual course taking is associated with decreases in the likelihood of taking and passing follow-on courses and in graduation readiness (based on a proxy measure). For credit recovery students, virtual course taking is associated with an increased likelihood of taking and passing follow-on courses and being in line for graduation. Supplemental analyses suggest that selection on unobservables would have to be substantial to render these results null.

Hawkins, A., Graham, C., Sudweeks, R., & Barbour, M. K. (2013). Course completion rates and student perceptions of the quality and frequency of interaction in a virtual high school. *Distance Education*, 34(1): 64-83.

ABSTRACT—This study examined the relationship between students' perceptions of teacher-student interaction and academic performance at an asynchronous, self-paced, statewide virtual high school. Academic performance was measured by grade awarded and course completion. There were 2269 students who responded to an 18-item survey designed to measure student perceptions on the quality and frequency of teacher-student interaction. Quality of interaction was subdivided into three constructs representing feedback, procedural, and social interaction. A confirmatory factor analysis helped to establish the fit of the statistical model for teacher-student interaction. Hierarchical logistical regression indicates that an increase in the quality and frequency of interaction resulted in an increased likelihood of course completion but had minimal influence on grade awarded. The estimated effect for quality and frequency composite items on completion was .83 and .56, respectively. Low practical significance of student-teacher interaction on grade awarded may be the result of mastery-based teaching approaches that skew grades for the completers toward the high end.

Heppen, J., Sorensen, N., Allensworth, E., Walters, K., Rickles, J., Taylor, S., & Michelman, V. 2017. The Struggle to Pass Algebra: Online vs. Face-to-Face Credit Recovery for At-Risk Urban Students, *Journal of Research on Educational Effectiveness*, 10:2, 272-296, DOI: 10.1080/19345747.2016.1168500

ABSTRACT—Students who fail algebra are significantly less likely to graduate on time, and algebra failure rates are consistently high in urban districts. Identifying effective credit recovery strategies is critical for getting students back on track. Online courses are now widely used for credit recovery, yet there is no rigorous evidence about the relative efficacy of online versus face-to-face credit recovery courses. To address this gap, this study randomly assigned 1,224 ninth graders who failed algebra in 17 Chicago public high schools to take an online or face-to-face algebra credit recovery course. Compared to students in face-to-face credit recovery, students in online credit recovery reported that the course was more difficult, were less likely to recover credit, and scored lower on an algebra posttest. There were no statistically significant differences by condition on any outcomes measured during the second year of high school

(standardized mathematics test and algebra subtest scores, likelihood of passing subsequent math classes, cumulative math credits, or on-track rates). The benefits and challenges of online learning for credit recovery are discussed in light of the findings to date.

Jackson, K. & Makarin, A. 2018. Can Online Off-the-Shelf Lessons Improve Student Outcomes? Evidence from a Field Experiment. *American Economic Journal: Economic Policy*, 10 (3): 226-54.

ABSTRACT—Many websites now warehouse instructional materials designed to be taught by teachers in a traditional classroom. What are the potential benefits of the new resources? We analyze an experiment in which we randomly give middle school math teachers access to existing high-quality, off-the-shelf lessons, and in some cases, support to promote their use. Teachers receiving access alone increased students' math achievement by a marginally significant 0.06 of a standard deviation. Teachers who received access and support increased students' math achievement by 0.09 of a standard deviation. Weaker teachers experience larger gains, suggesting that these lessons substitute for teacher skill or efforts. The online materials are more scalable and cost effective than most policies aimed at improving teacher quality, suggesting that, if search costs can be overcome, there is a real benefit to making high-quality instructional materials available to teachers on the Internet.

Kane, T. J., Rockoff, J. E. & Staiger, D. O. 2008. What does certification tell us about teacher effectiveness? Evidence from New York City. *Economics of Education Review* 27(6):615–631. DOI:10.1016/j.econedurev.2007.05.005

ABSTRACT—We use six years of panel data on students and teachers to evaluate the effectiveness of recently hired teachers in the New York City public schools. On average, the initial certification status of a teacher has small impacts on student test performance. However, among those with the same experience and certification status, there are large and persistent differences in teacher effectiveness. Such evidence suggests that classroom performance during the first two years is a more reliable indicator of a teacher's future effectiveness. We also evaluate turnover among teachers by initial certification status and the implied impact on student achievement of hiring teachers with predictably high turnover. Given modest estimates of the payoff to experience, even high turnover groups (such as Teach for America participants) would have to be only slightly more effective in each year to offset the negative effects of their high exit rates.

Kraft, M., & Rogers, T. 2015. The underutilized potential of teacher-to-parent communication: evidence from a field experiment. *Economics of Education Review,* 47: 49-63.

ABSTRACT—Parental involvement is correlated with student performance, though the causal relationship is less well established. This experiment examined an intervention that delivered weekly one-sentence individualized messages from teachers to the parents of high school students in a credit recovery program. Messages decreased the percentage of students who failed to earn course credit from 15.8% to 9.3%—a 41% reduction. This reduction resulted primarily from preventing drop-outs, rather than from reducing failure or dismissal rates. The intervention shaped the content of parent–child conversations with messages emphasizing what students could improve, versus what students were doing well, producing the largest effects. We estimate the cost of this intervention per additional student credit earned to be less than one-tenth the typical cost per credit earned for the district. These findings

underscore the value of educational policies that encourage and facilitate teacher-to-parent communication to empower parental involvement in their children's education.

Ladd, H. & Sorensen, L. 2017. Returns to Teacher Experience: Student Achievement and Motivation in Middle School. *Education Finance and Policy,* 12(2): 241-279.

ABSTRACT—We use rich longitudinally matched administrative data on students and teachers in North Carolina to examine the patterns of differential effectiveness by teachers' years of experience. The paper contributes to the literature by focusing on middle school teachers and by extending the analysis to student outcomes beyond test scores. Once we control statistically for the quality of individual teachers using teacher fixed effects, we find large returns to experience for middle school teachers in the form both of higher test scores and improvements in student behavior, with the clearest behavioral effects emerging for reductions in student absenteeism. Moreover, these returns extend well beyond the first few years of teaching. The paper contributes to policy debates by documenting that teachers can and do continue to learn on the job.

Liu, F. & Cavanaugh, C. (2012): Factors influencing student academic performance in online high school algebra. *The Journal of Open, Distance and e-Learning*, 27(2): 149-167
DOI:dx.doi.org/10.1080/02680513.2012.678613

ABSTRACT—This paper describes the effect of teacher comments, students' demographic information and learning management system utilization on student final scores in algebra courses in a K–12 virtual learning environment. Students taking algebra courses in a state virtual school in the Midwestern U.S. region during 2007–2008 participated in this study. Student final scores on these courses were collected using tests administered at the end of semester in the virtual school courses. The hierarchical linear modelling technique was used for data analysis to account for the influence of school characteristics on student final scores. The results show these factors have different influences on student final scores in different algebra courses. The discussion of the findings addresses the implications for teaching.

Molnar, A., Miron, G., Elgeberi, N., Barbour, M.K., Huerta, L., Shafer, S.R., Rice, J.K. (2019). Virtual Schools in the U.S. 2019. *Boulder, CO: National Education Policy Center.* Retrieved June 24, 2020 from nepc.colorado.edu/publication/virtual-schools-annual-2019

ABSTRACT—In 2018, virtual schools continued to be a focal point for policymakers. As proponents continued to make the case that virtual education can expand student choices and improve the efficiency of public education, full-time virtual schools (also sometimes referred to as virtual charter schools, virtual academies, online schools, or cyber schools) have attracted a great deal of attention. Many argue that online curriculum can be tailored to individual students more effectively than curriculum in traditional classrooms, giving it the potential to promote greater student achievement than can be realized in traditional brick-and-mortar schools. These claims are not supported by the research evidence; nonetheless, the promise of lower costs—primarily for instructional personnel and facilities—continues to make virtual schools financially appealing to both policymakers and for-profit providers. This report provides disinterested scholarly analyses of the characteristics and performance of fulltime, publicly funded K-12 virtual schools; reviews the relevant available research related to virtual school practices;

provides an overview of recent state legislative efforts to craft virtual schools policy; and offers policy recommendations based on the available evidence.

Mulqueeny, K., Kostyuk, V., Baker, R., & Ocumpaugh, J. 2015. Incorporating effective E-learning principles to improve student engagement in middle-school mathematics. *International Journal of STEM Education,* 2(15).

ABSTRACT—Background: The expanded use of online and blended learning programs in K-12 STEM education has led researchers to propose design principles for effective e-learning systems. Much of this research has focused on the impact on learning but not how instructional design impacts student engagement, which has a critical impact both on short-term learning and long-term outcomes. Reasoning Mind has incorporated the e-learning principles of personalization, modality, and redundancy into the design of their next-generation blended learning platform for middle-school mathematics, named Genie 3. In three studies, we compare student engagement with the Genie 3 platform to its predecessor, Genie 2, and to traditional classroom instruction. *Results:* Study 1 found very high levels of student engagement with the Genie 2 platform, with 89% time on-task and 71% engaged concentration. Study 2 found that students using Genie 3 spent significantly more time in independent on-task behavior and less time off-task or engaged in on task conversation with peers than students using Genie 2. Students using Genie 3 also showed more engaged concentration and less confusion. Study 3 found that students using Genie 3 spent 93% of their time on-task, compared to 69% in traditional classrooms. They also showed more engaged concentration and less boredom and confusion. Genie 3 students sustained their engagement for the entire class period, while engagement in the traditional classroom dropped off later in the class session. In both study 2 and 3, Genie 3 students showed more growth from pre- to post-test on an assessment of key concepts in sixth-grade mathematics. *Conclusions:* The incorporation of evidence-based e-learning principles into the design of the Genie 3 platform resulted in higher levels of student engagement when compared to an earlier, well-established platform that lacked those principles, as well as when compared to traditional classroom instruction. Increased personalization, the use of multiple modalities, and minimization of redundancy resulted in significant increases in time on-task and engaged concentration but also a decrease in peer interaction. On the whole, this evidence suggests that capturing students' attention, fostering deep learning, and minimizing cognitive load leads to improved engagement, and ultimately better educational outcomes.

Pane, J. F., Griffin, B. A., McCaffrey, D. F., & Karam, R. (2014). Effectiveness of cognitive tutor algebra I at scale. *Educational Evaluation and Policy Analysis*, 36(2), 127–144. DOI:10.3102/0162373713507480

*ABSTRACT—*This is article examines the effectiveness of a technology-based algebra curriculum in a wide variety of middle schools and high schools in seven states. Participating schools were matched into similar pairs and randomly assigned to either continue with the current algebra curriculum for 2 years or to adopt Cognitive Tutor Algebra I (CTAI), which uses a personalized, mastery-learning, blended-learning approach. Schools assigned to implement CTAI did so under conditions similar to schools that independently adopt it. Analysis of posttest outcomes on an algebra proficiency exam finds no effects in the first year of implementation but finds evidence in support of positive effects in the second year. The estimated effect

is statistically significant for high schools but not for middle schools; in both cases, the magnitude is sufficient to improve the median student's performance by approximately eight percentile points.

Tagami, Ty (2020). "Time will tell the toll on schools closed for virus," *Atlanta Journal Constitution*, April 12, 2020, p.1.

Vigdor, J., Ladd, H., & Martinez, E. 2014. Scaling the Digital Divide: Home Computer Technology and Student Achievement. *Economic Inquiry*, 52 (3): 1103-1119.

ABSTRACT—Does differential access to computer technology at home compound the educational disparities between rich and poor? Would a program of government provision of computers to early secondary school students reduce these disparities? We use administrative data on North Carolina public school students to corroborate earlier surveys that document broad racial and socioeconomic gaps in home computer access and use. Using within-student variation in home computer access, and across-ZIP code variation in the timing of the introduction of high-speed Internet service, we also demonstrate that the introduction of home computer technology is associated with modest, but statistically significant and persistent negative impacts on student math and reading test scores. Further evidence suggests that providing universal access to home computers and high-speed Internet access would broaden, rather than narrow, math and reading achievement gaps.

Walker, Marlon A. (2020). "Some students locked out of virtual classes," *Atlanta Journal Constitution*, April 26, 2020, p.1.

Wendt, J. L., & Rockinson-Szapkiw, A. (2014). The effect of online collaboration on middle school student science misconceptions as an aspect of science literacy. *Journal of Research in Science Teaching*, *51*(9), 1103–1118. DOI:10.1002/tea.21169

ABSTRACT—This quantitative, quasi-experimental pretest/posttest control group design examined the effects of online collaborative learning on middle school students' science literacy. For a 9-week period, students in the control group participated in collaborative face-to-face activities whereas students in the experimental group participated in online collaborative activities using the Edmodo educational platform. Students at a public middle school in central Virginia completed both a pretest and a posttest consisting of the Misconceptions-Oriented Standards-Based Assessment Resources for Teachers (MOSART) assessment to measure science misconceptions as an aspect of science literacy. Results indicated that the students who participated in collaborative activities in the traditional classroom had fewer science misconceptions than students who participated in collaborative activities in the online environment. Moreover, from pretest to posttest, the students in the experimental group increased in their science misconceptions. Suggestions for practice and future research are discussed in light of these results.

Woodworth, J., Raymond, M., Chirbas, K., Gonzalez, M., Negassi, Y., Snow, W., & Donge, C. 2015. Online charter school study. *Center for Research on Education Outcomes.*

ABSTRACT—Purpose of Study: The Center for Research on Education Outcomes (CREDO), Mathematica Policy Research, and the Center on Reinventing Public Education (CRPE) have undertaken a collection of studies to contribute more extensive information on the landscape and operation of online charter

schools and their impact on students' academic growth than has been available to date. Our aim was to deliver an unbiased, data driven examination of online charter schools. The intent of this report is to present to lay-readers and policy decision makers information based on advanced statistical models of student growth in a manner which is accessible and useful for the promotion of deeper discussion of the role of online schools in the K-12 setting. This report presents the findings about impacts of online charter enrollment on the academic progress of students.

Zhang, Y. & Lin, C. 2019. Student interaction and the role of the teacher in a state virtual high school: what predicts online learning satisfaction? *Technology, Pedagogy, and Education.* DOI: 10.1080/1475939X.2019.1694061

ABSTRACT—As online K–12 education continues to expand, concerns about its quality have taken center stage. This study utilized online learning satisfaction as an outcome indicator for the success of online learning and investigated student- and teacher-level factors that affected it among 226 high school students taking online world language courses from 15 teachers at a Midwestern virtual school in the U.S. Hierarchical linear modelling revealed that, at the student level, learner–content interaction was the only significant predictor of satisfaction; while at the teacher level, satisfaction was positively and significantly correlated with teachers' adoption of pedagogical roles, but negatively predicted by their adoption of managerial ones. The findings particularly highlight the importance of content-based teaching and learning in the context of K–12 world language learning.

ABOUT THE AUTHORS

Alexa Prettyman is an economics doctoral student at Georgia State University studying labor, public, and urban/regional economics and a graduate research assistant with the Georgia Policy Labs. Her research evaluates and develops interventions and evidence-based policies that overcome the disparities of educational attainment for vulnerable youth, such as chronically absent students and children in foster care. She is also interested in the short and long-run effects of non-instructional services offered by schools and the community that can improve school quality. Alexa earned her B.S. in mathematical economics from the University of Kentucky, and she expects to graduate with her Ph.D. in May 2021.

Tim R. Sass is professor of economics at Georgia State University. He is also the faculty director of the Metro Atlanta Policy Lab for Education (MAPLE). Specific areas of interest include teacher labor supply, the measurement of teacher quality and school choice. His work has been published in numerous academic journals and has been supported by grants from the U.S. Department of Education, the Gates Foundation, the Smith Richardson Foundation, the Laura and John Arnold Foundation, and the Spencer Foundation. He has acted as a consultant to school systems in New York City, Washington, D.C., Charlotte, NC, the state of Florida, and the state of New York. He is also a senior researcher at the Center for Analysis of Longitudinal Data in Education Research (CALDER).

ABOUT THE GEORGIA POLICY LABS

The Georgia Policy Labs (GPL) is a collaboration between Georgia State University and a variety of government agencies to promote evidence-based policy development and implementation. Housed in the Andrew Young School of Policy Studies, GPL works to create an environment where policymakers have the information and tools available to improve the effectiveness of existing government policies and programs, try out new ideas for addressing pressing issues, and decide what new initiatives to scale. The goal is to help government entities more effectively use scarce resources and make a positive difference in people's lives. GPL has three components: The Metro Atlanta Policy Lab for Education works to improve K-12 educational outcomes; the Career & Technical Education Policy Exchange focuses on high-school-based career and technical education in multiple U.S. states; and the Child & Family Policy Lab examines how Georgia's state agencies support the whole child and the whole family. In addition to conducting evidence-based policy research, GPL serves as a teaching and learning resource for state officials and policymakers, students, and other constituents. See more at gpl.gsu.edu.