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The Efficacy of Online Learning Assessment Tools for COVID-19 Recovery Intervention

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Motivation and Prior Research

Given the challenges to academic recovery, coupled with the financial incentives of the federal government, states and school districts continue to seek ways to improve student performance. Among the host of strategies (e.g., intensive tutoring, extended-school-day programs, summer learning), many districts have turned to online tools to assist in student learning recovery. The rapid switch to virtual learning during the COVID-19 pandemic precipitated large-scale investments in virtual learning infrastructure, programs, and professional development that likely changed the landscape of how and in what way virtual learning will play a role in students' educational experiences moving forward. Our research seeks to assess the effect of one strategy—virtual learning—on student achievement and recovery. We investigate the use of the i-Ready Personalized Instruction platform to promote student acceleration in the wake of the pandemic. To accomplish this, we partner with a school district in metro Atlanta to leverage its staggered rollout of i-Ready, detailed administrative data, and log data from the online instructional platform to understand the impact of this popular software by student subgroup.

Prior Research

Despite substantial investments in recovery interventions, many scholars acknowledge that academic recovery remains stalled for most students.[1] Many students have experienced gradual gains in math and reading at a pace that generally meets pre-pandemic levels since fall 2020; however, most continue to perform below their pre-pandemic levels and researchers estimate that students would need a minimum of three school years to fully recover academically.[2] In response, school districts have turned to a host of online instructional tools such as i-Ready, Dreambox, and ALEKS to enhance student learning and offer additional support toward recovery. Research on online tools' effectiveness as a pandemic recovery strategy is limited, though Carbonari and colleagues find marginal effects for this intervention in one participating district of their study on COVID-19 achievement interventions.[3] Conditional on effectiveness, virtual platforms do not face many of the challenges of other recovery interventions (e.g., tutoring), such as stigma, low up-take, and requiring real-time (i.e., synchronous) instructor support. In fact, students can access the program anytime, anywhere using a web browser and their login credentials. Additionally, when integrated within the regular school day, the use of online tools can provide instructional activities for students, allowing teachers to reallocate their attention to higher-impact learning tasks, including providing

support for students who require the most remediation.[4] Such benefits have made online platforms an attractive recovery tool for school districts.

Online Instructional Tools' Effectiveness Pre-COVID-19

Research on personalized- or adaptive-learning programs, like i-Ready, is more limited.[5] However, studies of similar types of adaptive learning have found positive associations with student test scores.[6] For example, Wijekumer and colleagues established the potential of this practice for text-based literacy skills,[7] and Connor and colleagues found positive learning outcomes in math (but not reading).[8] This discrepancy may indicate that adaptive learning systems work best when focused on narrowly defined, concrete skills as more commonly observed in math or when focusing on a specific set of literacy skills.

Adaptive-learning systems also appear to work best when blended with traditional face-to-face instruction or when supplemented with teacher presence in other ways. For instance, Grade 5 students experienced significantly larger growth in math when assigned to use Math Snacks—a free online program that provides five math games—that was integrated within a traditional face-to-face classroom and supplemented with teacher-facilitated discussion and inquiry-based learning activities.[9] Additionally, Heppen et al. found that Grade 8 students randomly assigned to enroll in an online Algebra 1 course scored higher on the end-of-year math test and were more likely to enroll in higher-level math courses in high school (effect size [ES] = 0.39).[10] However, in addition to the asynchronous, vendor-developed lesson content, students had access to an online teacher and an on-site proctor to support their learning.[11]

Studies also suggest that certain students are more likely to benefit from (or struggle with) online learning and adaptive-learning programs like i-Ready. Students belonging to advantaged groups, including students with access to technology and internet access at home and with higher prior achievement levels are more likely to be successful learning online.[12] Further, most online learning tools place increased responsibility on students to manage their own learning.[13] Consequently, students with stronger self-regulation skills (including older students) or greater parental- or teacher-provided monitoring and support are also more likely to benefit from online instruction.[14] As of yet, it's unknown the extent to which these patterns may hold among learning platforms such as i-Ready.

As is the case within all institutional spaces, including face-to-face classrooms, students interact with, and experience online learning tools differently based on their socio-demographic background and identities. Consequently, studies suggest higher rates of engagement with online learning platforms and subsequent achievement among female (versus male) students.[15] Students receiving free or reduced-price meals (FRPM) and from historically marginalized racial groups were notably less likely to achieve expected learning gains when learning online (versus face-to-face) during the pandemic.[16] However, a recent meta-analysis of 36 studies found that English Learners (ELs) experienced moderate gains in literacy (ES = 0.47) when taught in technology-integrated versus fully face-to-face classrooms.[17] Nevertheless, there is evidence of consistent, positive math test score gains among Grade 2 students participating in an adaptive-learning program across poverty level, gender, and prior math test scores,[18] as well as evidence that computer-assisted platforms (versus fully virtual learning) may better support the learning of students receiving FRPM.[19]

In all, previous research on online learning demonstrates the strengths of online learning platforms and suggests positive effects on student learning, but the outcomes have been highly-context dependent (e.g., blended format, smaller scale, personalization) in less-challenging conditions. The pandemic introduces confounding factors that may also need to be considered in implementing online intervention. As such, this report advances our understanding of online platforms as an effective post-pandemic recovery tool in which many school districts have invested but fewer have empirically assessed.

Research Questions

We answer three research questions to assess the efficacy of the i-Ready platform in promoting student acceleration and pandemic-related recovery:

1. To what extent was student use of online instructional materials associated with improved student achievement growth in the post-pandemic era?

2. By how much did student achievement growth vary by i-Ready usage and whether the teacher or automated system assigned instructional materials?

3. To what extent did students experience differential rates of student achievement growth associated with i-Ready usage by prior performance level, grade level, and socio-demographic identifiers (e.g., gender, race/ethnicity, FRPM eligibility)?

Methodology

Setting, Sample, and Data

We partnered with a school district in metro Atlanta that uses the i-Ready Personalized Instruction platform as a COVID-19 recovery strategy. In addition to use during the school day, students could access the platform anytime, anywhere using a web browser and their login credentials. Our partner is a one-to-one district that provides Chromebooks to all students, with grant funding used to provide internet hotspots to students without internet access. To support this study, the district provided access to student-level administrative and log data on i-Ready usage and scores, demographics, summative assessment test scores, and school characteristics.

The i-Ready platform provides interactive lessons and nationally normed adaptive formative assessments based on the skill levels of individual students. Additionally, the district conducts fall, winter, and spring MAP assessments, allowing for the estimation of achievement growth at the semester level. We report MAP test scores as z-scores,[20] allowing us to compare across grades and subjects.

Of the 131 schools in the district, 81 used i-Ready during SY 2021-22 (Year 1). That number increased to 84 schools using i-Ready during SY 2022-23 (Year 2). i-Ready was used most often in Grades 2–5 classrooms (within 47 to 50 schools each), followed closely by kindergarten and Grade 1 classrooms (within 43 schools each). Fewer than 10 classrooms each in Grades 6–9 used i-Ready. In Year 2, the number of classrooms increased slightly across Grades K–8, but use in high school was suspended.

The district prioritized providing low-performing schools access to i-Ready. In Year 1, schools that currently or previously identified as Comprehensive Support and Improvement (CSI) (n = 35) were more likely to use i-Ready than non-CSI schools (67% versus 57%, respectively). CSI schools are an official Every Student Succeeds Act (ESSA) distinction assigned to schools requiring additional support. Schools are assigned CSI status if they are in the lowest-performing 5% of schools in the state or if a high school's four-year graduation rate is under 68% in a given year. "Horizon school" is a district-assigned status that aligns loosely, but not perfectly, with CSI status. In total, 15 schools are ever designated as both CSI and Horizon, with 10 additional schools categorized as Horizons only and 10 additional schools ever designated as CSI. For this analysis, we use both ever-CSI and ever-Horizon school indicators

as signs of priority status for i-Ready usage. Thirty-three to 35% of students attending priority schools used i-Ready, compared to 14% of students who did not attend a priority school.

Consistent with the focus on providing priority schools earlier access to i-Ready, a significantly higher percentage of i-Ready users received FRPM (67%) than non-i-Ready users (59%), as shown in Table 1. Additionally, i-Ready users achieved significantly lower fall standardized test z-scores (-0.63 vs. -0.16 in math and -0.50 vs. -0.11 in reading). i-Ready users were also significantly more likely to identify as Black and EL and significantly less likely to identify as White or Hispanic. i-Ready users were also significantly more likely to be in lower or upper elementary compared to middle and high school.

Despite differential rates of any i-Ready use by school status, students who used i-Ready completed a comparable number of lessons and had similar mean lesson duration and percentage of lessons passed whether they attended a priority school or not. On average, i-Ready users completed 26 reading and 20 math i-Ready lessons during SY 2021-22. Importantly, 99% of students who were assigned any i-Ready lesson passed at least five lessons in each subject, indicating that after being assigned to i-Ready, the vast majority of students continued to use the program for the minimum of one instructional week. Each lesson took students, on average, 20 minutes (in reading) to 25 minutes (in math) to complete, with i-Ready users passing approximately 75% of reading lessons and 81% of math lessons begun. Additionally, 16% of reading lessons and 19% of math lessons were teacher- versus i-Ready-assigned (see Table 2).

Table 1. Student Characteristics by i-Ready Usage

	Not i-Ready user	i-Ready user
Fall MAP math z-score	-0.16	-0.63*
	(1.18)	(1.11)
Fall MAP reading z-score	-0.11	-0.50*
	(1.23)	(1.12)
Asian	0.07	0.07*
	(0.25)	(0.25)
Black	0.59	0.70*
	(0.49)	(0.46)
White	0.20	0.15*
	(0.40)	(0.36)
Hispanic	0.11	0.05*
	(0.32)	(0.21)
Other race	0.03	0.04*
	(0.18)	(0.19)
Female	0.49	0.50*
	(0.50)	(0.50)
FRPM	0.59	0.67*
	(0.49)	(0.47)
EL	0.17	0.19*
	(0.37)	(0.40)
Emotional disability	0.02	0.02*
	(0.15)	(0.12)
Intellectual disability	0.02	0.01*
	(0.14)	(0.11)
Physical disability	0.00	0.00*
	(0.04)	(0.02)
Any disciplinary incidents	0.00	0.04*
	(0.02)	(0.20)
Lower elementary	0.31	0.55*
	(0.46)	(0.50)
Upper elementary	0.16	0.28*
	(0.37)	(0.45)
Middle school	0.24	0.17*
	(0.43)	(0.37)
High school	0.29	0.00*
	(0.45)	(0.01)
Observations	94,240	27,717

Notes. * Significant differences between groups at the 95% confidence level.

Table 2. i-Ready Usage by School Type During SY 2021-22

	Ever CSI	Horizon school	Neither	All
Any i-Ready use	0.33*	0.35*	0.10	0.14
	(0.47)	(0.48)	(0.29)	(0.35)
Number of reading lessons	26.46*	22.88*	25.81	25.83
	(24.50)	(20.42)	(23.03)	(23.60)
Mean reading lesson duration	18.41*	17.76*	21.46	19.51
	(10.89)	(10.90)	(14.29)	(13.04)
Reading lesson passed (%)	0.74	0.74	0.74	0.75
	(0.22)	(0.22)	(30.29)	(0.22)
Reading lessons assigned by teacher (%)	0.16	0.18*	0.13	0.16
	(0.26)	(0.29)	(0.26)	(0.27)
Number of math lessons	16.61*	16.93*	20.09	19.56
	(15.83)	(17.25)	(20.25)	(19.92)
Mean math lesson duration	23.27*	23.60*	26.37	24.48
	(10.44)	(10.37)	(14.14)	(12.13)
Math lesson passed (%)	0.80*	0.79*	0.83	0.81
	(0.22)	(0.22)	(0.20)	(0.21)
Math lessons assigned by teacher (%)	0.18	0.20*	0.15	0.19
	(0.28)	(0.29)	(0.27)	(0.29)
Observations	15,359	15,393	13,123	27,717

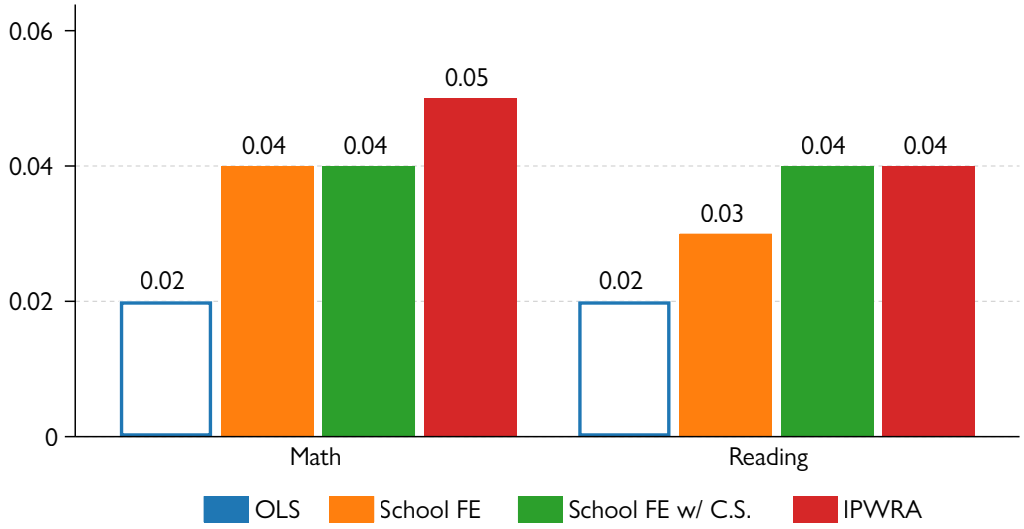
Notes. * Significant differences between ever CSI or Horizon status and the rest of the sample at the 95% confidence level.

Analysis

We estimated four models (ordinary least square [OLS] regression, school fixed effects, school fixed effects limited to common support,[21] and matching with regression adjustment [IPWRA]) to examine the relationship between any i-Ready usage and achievement test scores, as well as the relationship between the use of the manual teacher-assigned lesson feature and achievement test scores. Lastly, we examined how achievement growth varied by the number of i-Ready lessons a student was assigned.

We estimated separate models for math and reading scores. All models control for the number of days between the beginning- and end-of-semester test, baseline test scores from tests administered at the beginning of the school year, grade, year, and several student characteristics (including race/ethnicity, gender, FRPM status, EL status, identified disability status, and whether the student received any disciplinary referrals). More detailed information about the analytic methods used is available in the Appendix.

Figure 1. Associations Between Any i-Ready Usage and MAP Z-Scores



Notes. Filled bars indicate statistical significance at the 95% confidence level.

Limitations

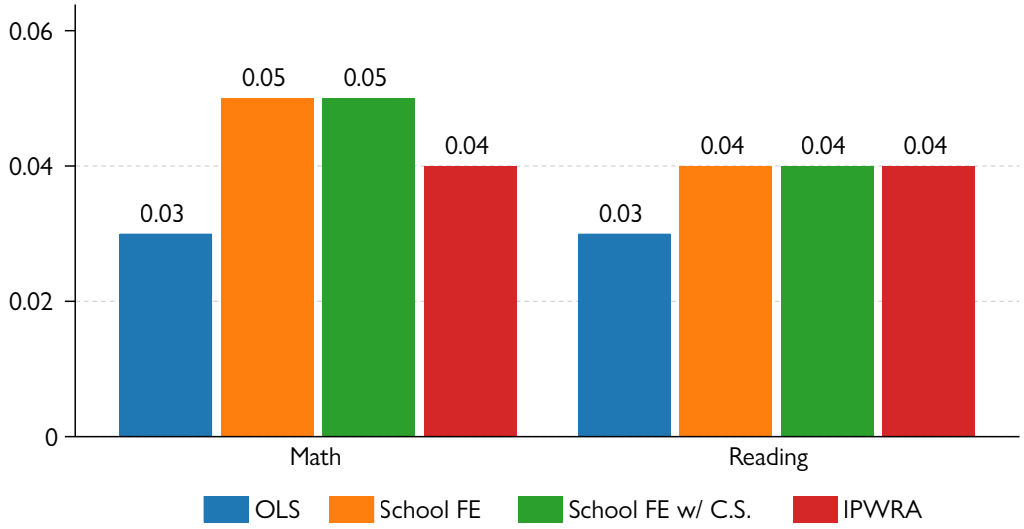
Findings are based on data from one metro-Atlanta-area district, which has its own unique contextual and demographic factors that may not generalize to all settings. Additionally, we were unable to collect data on or account for other recovery interventions occurring during the same period that might have been targeting similar schools. Lastly, our analyses are descriptive versus causal as we cannot fully account for endogenous variation.

Finding 1: Students Using i-Ready Experienced Larger Test Score Growth

Average math and reading standardized test score growth was higher among students who used i-Ready than students not assigned to use i-Ready.

Student use of online instructional materials is associated with a 0.04 to 0.05 standard-deviation increase in student achievement growth (in our preferred IPWRA models). This is particularly important given that i-Ready users in our sample are more likely to fall into categories that remain furthest behind nationally during the recovery. Specifically, students using i-Ready tended to have lower fall standardized test scores in math and reading and were more likely to attend a priority school than peers in the district not using i-Ready.

Figure 2. Associations Between Any Teacher-Assigned Lessons and MAP Z-Scores



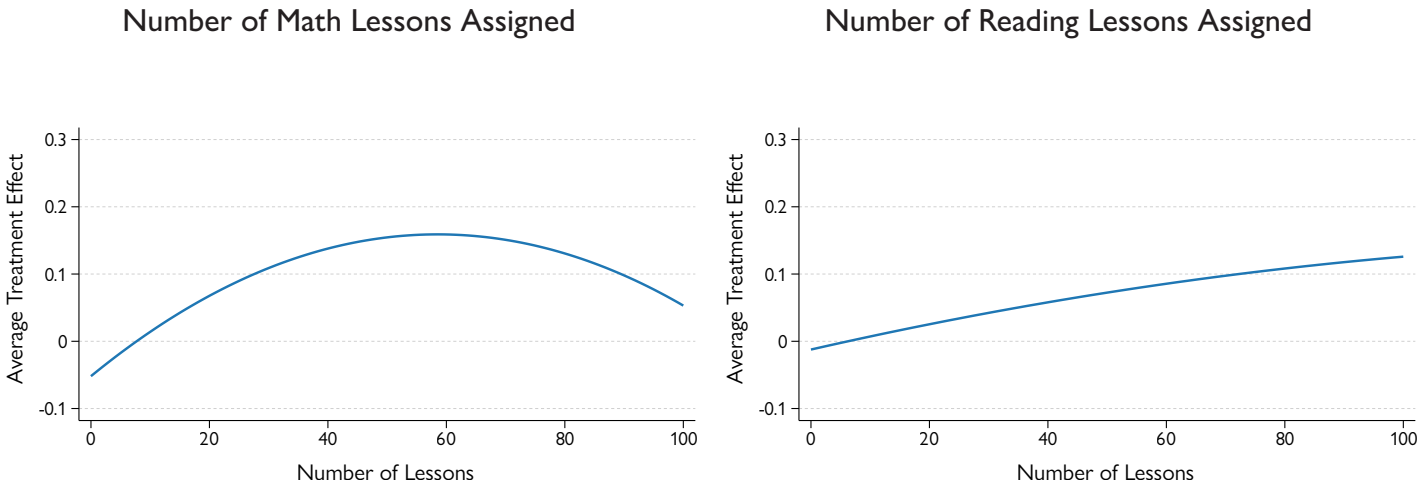
Notes. Filled bars indicate statistical significance at the 95% confidence level.

Finding 2: Teacher-Assigned i-Ready Lessons Were Associated with Higher Achievement Growth

The use of the manual teacher-assigned lesson feature is associated with higher test scores than students with only computer-assigned lessons. Students with lower prior achievement, prior disciplinary incidents, who identified as male, and/or were younger appeared the most likely to benefit from some teacher-assigned lessons.

Teacher-assignment of any i-Ready math lessons was associated with 0.02 to 0.04 standard-deviations-higher test scores than students who used i-Ready with only computer-assigned lessons. Students across demographic groups, ability level, and grade level appear to benefit from teacher-assigned online assignments, indicating that teacher input is critical to the effectiveness of online learning platforms. However, the largest magnitude associations were observed among students from the lowest-third prior achievement level (in math and reading) and from the middle-third prior achievement level (in math only). Additionally, having any teacher- versus solely i-Ready-assigned lessons was associated with significantly higher student achievement growth in both subjects among students who identified as male, with disciplinary incidents, and/or in a lower elementary grade across both subjects.

Figure 3. Dose-Response Function for MAP Z-Scores by Number of Lessons Assigned



Finding 3: Students Saw Maximum Gains When Assigned 60 or More Lessons

Student gains associated with i-Ready usage increased based on the amount of time they spent in the program, with maximum average treatment effects of 0.18 observed in math among students assigned 60 or more lessons. Average treatment effects continued increasing the more students used i-Ready—up to at least 100 assigned lessons.

When examining by subgroup, students experience diminishing returns in math after completing around 50 or more lessons (between the fall and winter MAP testing window)—apart from students who perform amongst the middle third of the district's math test score distribution. Conversely, students continue to experience gains in reading beyond this point and up to at least 100 assigned lessons, but, here, students in the middle third of the district's reading test score distribution begin to experience diminishing returns after completing roughly 70 lessons. Similar trends emerge when we observe the dosage effects for FRPM recipients. Overall, the findings are consistent with previous research that suggests 40 to 100 hours of usage are key thresholds for positive learning outcomes for students;[22] however, they also reveal that expanding beyond the thresholds may not be a wise investment of instructional time or student effort.

Table 3. Associations Between Any i-Ready Usage and MAP Z-Scores by Subgroup

	Math		Reading	
	N	IPWRA	N	IPWRA
Lowest 3rd prior achievement	39567	0.04	33621	0.03*
		(0.03)		(0.02)
Middle 3rd prior achievement	33146	0.06***	30440	0.02
		(0.02)		(0.02)
Highest 3rd prior achievement	30998	0.01	30473	0.03*
		(0.01)		(0.02)
Asian	7254	0.03	6554	-0.00
		(0.03)		(0.04)
Black	56366	0.05**	53423	0.05***
		(0.03)		(0.02)
White	11779	0.04	10682	0.05
		(0.04)		(0.05)
Hispanic	24724	0.05	20586	0.03
		(0.03)		(0.02)
Other race	4504	-0.02	4071	0.00
		(0.04)		(0.05)
Female	50553	0.03**	46311	0.02
		(0.02)		(0.01)
Male	53158	0.05**	48223	0.05**
		(0.03)		(0.02)
FRPM	60166	0.05**	54623	0.04***
		(0.02)		(0.01)
EL	23267	0.04	19506	0.02
		(0.04)		(0.02)
Emotional disability	1702	0.14	1549	0.09
		(0.09)		(0.10)
Intellectual disability	1009	0.18**	919	0.20***
		(0.09)		(0.07)
Physical disability	110	1.22	103	0.59
		(0.83)		(0.39)
Any disciplinary incident	5768	0.00	5215	-0.05
		(0.05)		(0.06)
Lower elementary	43050	0.05**	39316	0.02
		(0.02)		(0.02)
Upper elementary	21663	0.03	19440	0.05*
		(0.02)		(0.03)
Middle School	29747	0.02	26779	0.03
		(0.03)		(0.02)

Notes. * Significant differences between groups at the 95% confidence level.

Finding 4: Students From Historically Marginalized Groups Benefited the Most

When examining test score gains by student subgroup, students belonging to historically marginalized groups (i.e., Black, FRPM-eligible, with an identified intellectual disability) and males experienced the largest average growth.

We find that students experience differential rates of achievement using the i-Ready platform, largely by socio-demographic versus prior achievement or grade-level characteristics. When we examine who benefits most from using the platform, we find that students who identify as Black, male, FRPM-eligible, or with identified intellectual disabilities experience more significant improvements using the online learning platform than their peers. While these findings do not align with our expectations and previous research that more-advantaged groups are more likely to benefit from online learning, they seem to suggest that i-Ready can best assist populations of greater need and of fewer resources. One potential reason why we did not find inequitable outcomes may be due to the district's investment in one-to-one devices and hotspots for students to mitigate disparities in access. i-Ready users in our sample are more likely to identify as Black, an English Learner, and FRPM-eligible in an elementary grade, so the findings may also reflect the unique demographics of study context. Nevertheless, the gains of students from historically marginalized groups while using i-Ready offers insight into its usefulness in addressing both pandemic-related achievement recovery and historical demographic-related achievement gaps.

Conclusions and Policy Recommendations

The COVID-19 pandemic forced a rapid shift in learning delivery and expanded the role of virtual learning in students' educational experiences. Online learning platforms such as i-Ready have become a part of schools' and teachers' instructional toolkit to serve students across Grades K–8 and ability levels. Our findings suggest that online learning platforms are valuable tools that school districts should maintain or adopt to aid in COVID-19 achievement recovery. We recommend that schools and districts allocate funds to support and/or expand their infrastructure for online learning platforms that utilize adaptive-

learning features. Schools and districts that serve large historically marginalized populations could especially benefit from the investment, as our findings show that the platforms bode well for these students as long as device and home internet access are ensured. The platforms may provide opportunities for historically marginalized students to both recover from pandemic-related learning challenges and undercut long-standing disparities.

However, we caution districts against using online platforms as an "auto-pilot" replacement for classroom instruction. Adaptive, personalizing learning is a key feature of the i-Ready system and likely contributes to the achievement gains we observed; however, extending the adaptive learning beyond threshold points may not benefit students. What's more, students with the lowest and strongest math ability and median reading ability may begin to lose the academic benefits of the platform before their peers, so it is important that schools and districts support teachers in using the online platforms as complementary tools to in-person instruction in which teachers use their discretion to assign online lessons. Our findings also show that students perform better when teachers monitor frequency of use and assign lessons strategically. Supporting teachers through additional training on how to best assign lessons and the strengths and weaknesses of the platforms could also aid in achievement recovery for students.

Scholars and practitioners alike have been critical of the progress and pace of academic recovery of students post-COVID-19. Some scholars and practitioners are optimistic that students are beginning to meet and exceed their pre-pandemic learning levels, while others are more skeptical—arguing that students will need much more time and support to meet such outcomes. Online adaptive learning platforms like i-Ready appear well-equipped to support recovery goals, with several logistical advantages over other recovery interventions such as high-dosage tutoring and extended school time (both of which tend to have higher costs and struggle with low uptake and participant stigma).

Acknowledgments

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Endnotes

1. Carbonari, M. V., Davison, M., DeArmond, M., Dewey, D., Dizon-Ross, E., Goldhaber, D., Hashim, A. K., Kane, T. J., McEachin, A., Morton, E., Patterson, T., & Staiger, D. O. (2022). *The challenges of implementing academic COVID recovery interventions: Evidence from the Road to Recovery project*. Working Paper No. 275-1222. National Center for Analysis of Longitudinal Data in Education Research (CALDER).

Lewis, K., & Kuhfeld, M. (2023). *Education's long COVID: 2022-23 achievement data reveal stalled progress toward pandemic recovery*. Center for School and Student Progress at NWEA.

Curriculum Associates Research. (2023). *State of student learning in 2023: Reading and mathematics research summary*. Curriculum Associates Research.

2. Carbonari, M. V., Davison, M., DeArmond, M., Dewey, D., Dizon-Ross, E., Goldhaber, D., Hashim, A. K., Kane, T. J., McEachin, A., Morton, E., Patterson, T., & Staiger, D. O. (2022). *The challenges of implementing academic COVID recovery interventions: Evidence from the Road to Recovery project*. Working Paper No. 275-1222. National Center for Analysis of Longitudinal Data in Education Research (CALDER).

Lewis, K., & Kuhfeld, M. (2023). *Education's long COVID: 2022-23 achievement data reveal stalled progress toward pandemic recovery*. Center for School and Student Progress at NWEA.

Kuhfeld, M., & Lewis, K. (2022). *Student achievement in 2021–2022: Cause for hope and continued urgency*. NWEA.

Sass, T., & Goldring, T. (2022). *Student achievement growth during the COVID-19 pandemic: Fall 2021 update*. Georgia Policy Labs.

Curriculum Associates Research. (2023). *State of student learning in 2023: Reading and mathematics research summary*. Curriculum Associates Research.

Amplify. (2023). *With end-of-year data showing continued academic recovery in early literacy, worries remain for third grade students*. Amplify Education, Inc.

Fahle, E., Kane,T.J., Reardon, S.F., & Staiger, D. O. (2024). *The first year of pandemic recovery: A district-level analysis*. Center for Education Policy Research, Harvard University, and Educational Opportunity Project, Stanford University.

3. Carbonari, M. V., Davison, M., DeArmond, M., Dewey, D., Dizon-Ross, E., Goldhaber, D., Hashim, A. K., Kane, T. J., McEachin, A., Morton, E., Patterson, T., & Staiger, D. O. (2022). *The*

challenges of implementing academic COVID recovery interventions: Evidence from the Road to Recovery project. Working Paper No. 275-1222. National Center for Analysis of Longitudinal Data in Education Research (CALDER).

4. Darling-Aduana, J., Good, A. G., & Heinrich, C. J. (2019). Mapping the inequity implications of help-seeking in online credit-recovery classrooms. *Teachers College Record*, *121*(11), 1–40.

5. i-Ready provides personalization through its use of adaptive learning systems, which assign students to different lessons based on their achievement on previous assessments within the system.

6. Connor, C. M., Mazzocco, M. M., Kurz, T., Crowe, E. C., Tighe, E. L., Wood, T. S., & Morrison, F. J.. 2018. Using assessment to individualize early mathematics instruction. *Journal of School Psychology*, *66*, 97–113.

Wijekumar, K. K., Meyer, B. J. F., & Lei, P. (2012). Large-scale randomized controlled trial with 4th graders using intelligent tutoring of the structure strategy to improve nonfiction reading comprehension. *Educational Technology Research and Development*, *60*(6), 987–1013. https://eric.ed.gov/?id=EJ986753

Wijekumar, K., Meyer, B. J. F., & Lei, P. (2017). Web-based text structure strategy instruction improves seventh graders' content area reading comprehension. *Journal of Educational Psychology*, *109*(6), 741–760. https://eric.ed.gov/?id=EJ1149967

Wijekumar, K., Meyer, B. J., Lei, P. W., Lin, Y. C., Johnson, L. A., Spielvogel, J. A., Shurmatz, K.M., Ray, M., Cook, M. (2014). Multisite randomized controlled trial examining intelligent tutoring of structure strategy for fifth-grade readers. *Journal of Research on Educational Effectiveness*, *7*(4), 331–357. https://eric.ed.gov/?id=EJ1041354

7. Wijekumar, K. K., Meyer, B. J. F., & Lei, P. (2012). Large-scale randomized controlled trial with 4th graders using intelligent tutoring of the structure strategy to improve nonfiction reading comprehension. *Educational Technology Research and Development*, *60*(6), 987–1013. https://eric.ed.gov/?id=EJ986753

Wijekumar, K., Meyer, B. J. F., & Lei, P. (2017). Web-based text structure strategy instruction improves seventh graders' content area reading comprehension. *Journal of Educational Psychology*, *109*(6), 741–760. https://eric.ed.gov/?id=EJ1149967

Wijekumar, K., Meyer, B. J., Lei, P. W., Lin, Y. C., Johnson, L. A., Spielvogel, J. A., Shurmatz, K.M., Ray, M., Cook, M. (2014). Multisite randomized controlled trial examining intelligent tutoring of

structure strategy for fifth-grade readers. *Journal of Research on Educational Effectiveness*, *7*(4), 331–357. https://eric.ed.gov/?id=EJ1041354

8. Connor, C. M., Mazzocco, M. M., Kurz, T., Crowe, E. C., Tighe, E. L., Wood, T. S., & Morrison, F. J.. 2018. Using assessment to individualize early mathematics instruction. *Journal of School Psychology*, *66*, 97–113.

9. Wiburg, K., Chamberlin, B., Valdez, A., Trujillo, K., & Stanford, T. (2016). Impact of Math Snacks games on students' conceptual understanding. *Journal of Computers in Mathematics and Science Teaching*, *35*(2), 173–193. https://eric.ed.gov/?id=EJ1095367

10. Heppen, J. B., Walters, K., Clements, M., Faria, A. M., Tobey, C., Sorensen, N., & Culp, K. (2011). *Access to Algebra I: The effects of online mathematics for grade 8 students* [NCEE 2012-402]. Washington, DC: National Center for Education Evaluation and Regional Assistance. https://eric.ed.gov/?id=ED527394

11. Heppen, J. B., Walters, K., Clements, M., Faria, A. M., Tobey, C., Sorensen, N., & Culp, K. (2011). *Access to Algebra I: The effects of online mathematics for grade 8 students* [NCEE 2012-402]. Washington, DC: National Center for Education Evaluation and Regional Assistance. https://eric.ed.gov/?id=ED527394

12. Heinrich, C. J., Darling-Aduana, J., Good, A. G., & Cheng, H. (2019). A look inside online educational settings in high school: Promise and pitfalls for improving educational opportunities and outcomes. *American Educational Research Journal*, *56*(6), 2147–2188.

Munoz-Najar, A., Gilberto, A., Hasan, A., Cobo, C., Azevedo, J. P., & Akmal, M. (2021). *Remote learning during COVID-19: Lessons from today, principles for tomorrow*. World Bank.

Warschauer, M., & Matuchniak, T. (2010). New technology and digital worlds: Analyzing evidence of equity in access, use, and outcomes. *Review of Research in Education*, *34*(1), 179–225.

Wijekumar, K. K., Meyer, B. J. F., & Lei, P. (2012). Large-scale randomized controlled trial with 4th graders using intelligent tutoring of the structure strategy to improve nonfiction reading comprehension. *Educational Technology Research and Development*, *60*(6), 987– 1013. https://eric.ed.gov/?id=EJ986753

Wijekumar, K., Meyer, B. J., Lei, P. W., Lin, Y. C., Johnson, L. A., Spielvogel, J. A., Shurmatz, K.M., Ray, M., Cook, M. (2014). Multisite randomized controlled trial examining intelligent tutoring of structure strategy for fifth-grade readers. *Journal of Research on Educational Effectiveness*, *7*(4), 331–357. https://eric.ed.gov/?id=EJ1041354

13. Jacob, B., Berger, D., Hart, C., & Loeb, S. (2016). Can technology help promote equality of educational opportunities?. *RSF: The Russell Sage Foundation Journal of the Social Sciences*, *2*(5), 242–271.

14. Darling-Aduana, J. (2021). Authenticity, engagement, and performance in online high school courses: Insights from micro-interactional data. *Computers & Education*, *167*.

Borup, J., Chambers, C. B., & Stimson, R. (2019). K-12 student perceptions of online teacher and on-site facilitator support in supplemental online courses. *Online Learning*, *23*(4), 253–280.

Heinrich, C. J., Darling-Aduana, J., Good, A. G., & Cheng, H. (2019). A look inside online educational settings in high school: Promise and pitfalls for improving educational opportunities and outcomes. *American Educational Research Journal*, *56*(6), 2147–2188.

Heissel, J. (2016). The relative benefits of live versus online delivery: Evidence from virtual algebra I in North Carolina. *Economics of Education Review*, *53*, 99–115.

Liao, Y. C., Ottenbreit-Leftwich, A., Zhu, M., Jantaraweragul, K., Christie, L., Krothe, K., & Sparks, K. (2021). How can we support online learning for elementary students? Perceptions and experiences of award-winning K-6 teachers. *TechTrends*, *65*(6), 939–951.

15. Darling-Aduana, J., Woodward, H. T., Sass, T. R., and Barry, S. S. (2022). Preferences, engagement, and achievement during crisis schooling in the COVID-19 era. *AERA Open*, *8*.

Lowes, S., Lin, P., & Kinghorn, B. R. (2016). Gender differences in online high school courses. *Online Learning*, *20*(4), 100–117.

Mann, B., Li, W., & Besnoy, K. (2021). Digital divides: K-12 student profiles and online learning. *Education Policy Analysis Archives*, *29*(112).

16. Darling-Aduana, J., Woodward, H. T., Sass, T. R., and Barry, S. S. (2022). Preferences, engagement, and achievement during crisis schooling in the COVID-19 era. *AERA Open*, *8*.

Mann, B., Li, W., & Besnoy, K. (2021). Digital divides: K-12 student profiles and online learning. *Education Policy Analysis Archives*, *29*(112).

17. Lee, S., Kuo, L. J., Xu, Z., & Hu, X. (2022). The effects of technology-integrated classroom instruction on K-12 English language learners' literacy development: a meta-analysis. *Computer Assisted Language Learning*, *35*(5–6), 1106–1137.

Canbolat, Y., & Arndt, R. (2024). *Can computer-assisted instruction help schools to close the achievement gap: Evaluation of a district-wide reading intervention* (Working Paper #24-938). Annenberg Institute at Brown University.

Darling-Aduana, J, & Heinrich, C. J. (2018). The role of teacher capacity and instructional practice in the integration of educational technology for emerging bilingual students. *Computers & Education*, *126*, 417–432.

18. Connor, C. M., Mazzocco, M. M., Kurz, T., Crowe, E. C., Tighe, E. L., Wood, T. S., & Morrison, F. J.. 2018. Using assessment to individualize early mathematics instruction. *Journal of School Psychology*, *66*, 97–113.

19. Canbolat, Y., & Arndt, R. (2024). *Can computer-assisted instruction help schools to close the achievement gap: Evaluation of a district-wide reading intervention* (Working Paper #24-938). Annenberg Institute at Brown University.

20. We calculated standardizing scale scores by grade and subject, so that the mean of each test score (by grade and subject) is zero with a standard deviation of one. Z-scores were calculated based on the national distribution of pre-pandemic scale scores. Standardizing the variables in this manner

21. Cases on common support are included in the matching model, indicating that there are comparable treatment and comparison within the sample. Removing cases off common support reduces the extent to which underlying differences between students who did and did not receive treatment are likely to bias estimates.

22. Heinrich, C. J., Darling-Aduana, J., Good, A. G., & Cheng, H. (2019). A look inside online educational settings in high school: Promise and pitfalls for improving educational opportunities and outcomes. *American Educational Research Journal*, *56*(6), 2147–2188. doi:10.3102/0002831219838776

Darling-Aduana, J, & Heinrich, C. J. (2018). The role of teacher capacity and instructional practice in the integration of educational technology for emerging bilingual student. *Computers & Education*, *126*, 417-432. doi:10.1016/j.compedu.2018.08.002

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About the Georgia Policy Labs

The Georgia Policy Labs is an interdisciplinary research center that drives policy and programmatic decisions that lift children, students, and families—especially those experiencing vulnerabilities. We produce evidence and actionable insights to realize the safety, capability, and economic security of *every* child, young adult, and family in Georgia by leveraging the power of data. We work alongside our school district and state agency partners to magnify their research capabilities and focus on their greatest areas of need. Our work reveals how policies and programs can be modified so that every child, student, and family can thrive.

Housed in the Andrew Young School of Policy Studies at Georgia State University, we have three components: the Metro Atlanta Policy Lab for Education (metro-Atlanta K–12 public education), the Child & Family Policy Lab (supporting children, families, and students through a cross-agency approach), and the Career & Technical Education Policy Exchange (a multi-state consortium exploring high-school based career and technical education).

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