

STUDY BRIEF

i-Ready in 7th Grade Math Classes

A MIXED METHODS CASE STUDY

WestEd

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SUMMARY

The landscape of programs and options that constitute “computer-aided instruction” or “computer-aided learning” has changed dramatically in recent years. Internationally, education technology (edtech) companies received \$9.5 billion in funding in 2017, with 13 percent of that going to preK–12 products (Forbes, 2018), and there is no shortage of platforms and apps available to educators looking for computer-aided materials. However, independent research of edtech products, as well as an understanding of whether and how they are being used in classrooms, has not kept pace with development.

This brief summarizes details from a larger mixed methods study that aimed to address these issues by examining the implementation and effectiveness of edtech products in 7th grade. Specifically, this brief focuses on one commonly used edtech product, i-Ready. The qualitative data in this study include data on nearly 150 7th grade students in six math classrooms located in two coastal northern Californian districts over the 2017–18 school year. The quantitative data drew from 1,759 7th grade students in the two districts.

Developed by Curriculum Associates, i-Ready is an individualized platform serving students in grades K–8 that provides diagnostic testing and scenario-based lessons in mathematics and English. In a study commissioned by Curriculum Associates, the i-Ready Diagnostic was shown to correlate highly with Smarter Balanced Assessment Consortium standardized tests (Educational Research Institute of America, 2016). Accordingly, many districts find that i-Ready Diagnostics produce useful benchmarks for students, teachers, and districts.

The districts in this study administered the diagnostic three times during the school year: at the start of school, in the mid-point, and at the end of the school year. Curriculum Associates recommends that students engage with the lesson portion of i-Ready for at least 45 minutes per week. Quantitative and qualitative data we collected showed that the use of the lesson portion of i-Ready varied in the districts, schools, and classrooms that were observed.

Overall, this study of i-Ready shows, on average, positive but differential gains for students who used the lesson portion of the tool. In addition, the field-based observations we conducted raise questions about the choice of specific edtech tools and the best practices for implementing them in schools. The quantitative and qualitative data collected in this study examine which students are best served by the technology, in what ways, and under what circumstances.

Brief Summary of Findings

In brief, in our study of 7th grade mathematics students, we found that those who used i-Ready for at least 15 minutes per week did significantly better than their peers on the state standardized test, the Smarter Balanced Summative Assessment in Mathematics (throughout this report, we use the abbreviation SBAC when referring to this math assessment).¹ Students who used i-Ready for at least 45 minutes per week saw the most impact on their mathematics achievement score — scoring an average of 24 points higher than their peers. These students' growth toward the next achievement level (i.e., growth from their 6th grade SBAC results to their 7th grade SBAC results) increased by an average of 73 percent,

landing them at the high end of the proficient achievement bracket (level 3 of 4 total levels). This degree of growth may support them toward continually meeting standards each year. When compared with the 38 percent growth achieved by a control group of their matched peers who did not use i-Ready, it appears there is a potential benefit to engaging with i-Ready lessons.

In-class observations showed differential engagement with math edtech products between more and less confident mathematics students — those who were observed to struggle with grade-level math tended to use products less frequently and less efficiently. This was true of i-Ready as well. We observed that less proficient math students had trouble navigating the product, completing lessons, and understanding what they were being asked to do. These students were often observed avoiding lessons or seeking to work collaboratively, rather than individually, as i-Ready is designed. We noted that students who need the most support in mathematics are not necessarily being served well by edtech products such as i-Ready. However, many of the students we spoke to who struggled with math preferred i-Ready over other products, suggesting that i-Ready has promise to reach struggling students.

Our observation of the differential engagement between more and less proficient students drove us to investigate how impact and usage of i-Ready varied relative to student achievement level. While students in the three usage brackets we investigated — that is, students who used i-Ready at least 15, 30, or 45 minutes per week — all did significantly better than their peers on the state standardized test, the 30- and 45-minute groups benefited the most. Upon further investigation, we discovered that 51 percent

1 The SBAC is a computer adaptive test. Scale scores from this assessment were used to ascertain impact on students' mathematics achievement for this study. <https://www.cde.ca.gov/ta/tg/ca/documents/sbsummativefactsheet.pdf>

of these students were in achievement level 3 (meeting standards) or achievement level 4 (exceeding standards).

The students in the six classrooms we observed were informed of our goal to report back to the product developers what we learned from this study and how the students thought the products could be improved. This may have influenced the overwhelmingly critical opinions that students had of i-Ready. A majority of the critiques were connected to students' lack of control and choice with the product. Students were frustrated at the inability to either speed up or slow down the experience of the product. They also railed against being forced to repeat lessons that they had either completed before or did not understand well enough to pass, even on a second or third try.

Relatedly, students were unable to find additional resources for mathematical information in the product when they were stuck. When this happened, some students would use their class notes to support their work in the product, while others would just guess at answers. Many looked to try to puzzle through the problems with their peers, an important strategy that is part of current standards. While none of the edtech products we observed were conducive to collaborative work, i-Ready was particularly weak in this regard. Our observations indicate that lack of structures for collaborative work, such as lack of crumbs, lack of control over moving forward and backward through problems, and lack of other choice elements, may be more problematic for struggling students — particularly since these same missing elements made it difficult for observers to assist students in the product when confronted with a challenging problem.

The 7th grade students we spoke to found the characters and scenarios in i-Ready to be “childish” and not appropriate for their age. Despite this, struggling students appreciated the

scenario-based style. Many of these students preferred i-Ready over other edtech products in their classrooms that were not scenario-based, again showing the product's promise to reach students who are not mathematically proficient.

Teachers and field researchers were of mixed mind about i-Ready and its usefulness. The three teachers in our study all felt that their students underperformed on the i-Ready diagnostic tests. They also struggled with the amount of time — often over four weeks of the year — that was dedicated to the diagnostic testing. Only one teacher used the dashboard regularly, and she shared with us that, unlike other products, there were frustrating gaps between student activity and what was available in reports. From a data analysis perspective, i-Ready is incredibly easy to work with — allowing researchers to conduct independent studies of its effectiveness and district personnel to see exactly how it is being used, and with what effect, across schools.

We spoke at length with Curriculum Associates developers, researchers, and executives about our findings regarding i-Ready. They were engaged and responsive, and they noted that a majority of the challenge points and flaws we described were “on their to-do list.” Overall, we see i-Ready Mathematics as a product with incredible potential to support students toward math proficiency. While our study shows that it is a useful tool to support proficient students' mathematical knowledge, struggling students are not spending sufficient time with the tool. i-Ready shares this quality with the other edtech products we observed — and we hypothesize this is an edtech problem, not just an i-Ready problem. While more implementation and impact studies are necessary to ascertain exactly how to ensure that more struggling students are engaging with the edtech, we have observed that personalized learning products are not agnostic to student proficiency — that is, they

seem to favor students who are more proficient and engaged in math. To reach less proficient students, more robust product and school-based supports are necessary.

Below, we offer a summary of the study background, methods, analysis, and findings. The full report is accessible at <https://svfoundation.org/edtech-research>.

METHODS

This mixed methods study used quantitative data from 7th grade students' SBAC and from the i-Ready product. The study also used qualitative data collected from six 7th grade math classes in two districts.

Our aim was neither a comprehensive product evaluation nor a review of a product's alignment to state standards for mathematics. Rather, the goal of the study was to understand how edtech products were being used in real time by students while they were in class. We opportunistically asked to observe lessons on days when teachers would be using edtech, then chose the most consistently used math products to focus on for our case studies.

Research Questions

1. Do we see any relationship between product use and student achievement, as measured on the Smarter Balanced Summative Assessment in Mathematics (SBAC)?
2. What is the impact of i-Ready on student math achievement as measured on the SBAC?
3. How do teachers incorporate the product into their instruction? What different strategies are observed? What influence, if any, does district policy have on product usage?
4. How do students engage with the product during school? What

structures and features are in place to support student engagement? How does the product work to engage students? Is it being used in a way that supports personalized learning?

5. What do students think about the product? What do they perceive as the products' advantages and disadvantages?

To address research questions 1 and 2, data agreements were arranged with the districts to obtain student-level data on all 7th grade students, including 6th and 7th grade SBAC scale scores and 7th grade edtech product usage. To answer questions 3 and 4, we conducted 38 observations of six classrooms (observing two periods for each of the three teachers). To directly address question 5, we conducted 16 focus groups of 8–10 students from the participating classes.

Quantitative Approach

Using a quasi-experimental design, specifically a matching analysis, we first tested i-Ready's claim that using the program for 45 minutes a week would

have a positive impact on students' SBAC scores. Because there was a difference in time usage between the students in different achievement levels, the evaluation included three impact analyses, each one with different time frames — 15 or more minutes, 30 or more minutes, and 45 or more minutes per week.

The analysis included matching “treated” students to “control” students with similar characteristics. The following variables were used for the matching analysis: grade 6 SBAC math assessment score, first i-Ready interim assessment score, English learner status, special education status, gender, and ethnicity.²

The grade 7 SBAC math summative assessment (referred to in this brief as SBAC) is the outcome measure for the three impact analyses. It is administered to students during the spring semester and assesses students against grade-level standards.

Once we determined that use of i-Ready correlated with positive SBAC achievement, we set out to investigate the differences in engagement between low- and high-proficiency students that we observed in the classroom.

Study Sample: (n=1759)

We analyzed data on 1,759 7th grade students. The student population had the following characteristics:

- » 62 percent Latino, 22 percent Asian, 11 percent White, 6 percent other (African American, Asian Pacific Islander, Native American)
- » 26 percent English learner, 11 percent special education

Qualitative Approach

It is not enough to know that a product can work to support learning. To serve all students equitably, we need to understand implementation — how and in what ways students and teachers engage with the product. To understand implementation, we collected observational, interview, and focus-group data on the edtech products, as detailed in Table 1.

Analysis of field notes, interviews, and focus group transcripts was completed utilizing an integrated approach — drawing from both deductive and inductive coding methods. Following Miles and Huberman (1994), the team defined a series of code categories related to personalized learning, user interface, and math learning and assessment. With these categories as a structure, the team applied the principles of inductive reasoning and the constant comparative method (Corbin & Strauss, 1990) to identify emergent themes and refine deductive codes.

Field-note data was coded by a single researcher. Focus group transcripts were coded by a team of three and followed standard intercoder reliability process (Miles & Huberman, 1994).

Focal Classrooms

The two district partners, districts A and B, are public school districts located in Silicon Valley. Both districts are predominantly Latino (79 percent and 48 percent, respectively). District A has a larger percentage of students who qualify for free and reduced-price lunch (90 percent vs. 45 percent) and a larger percentage of students classified as English language learners (44 percent vs. 29 percent).

² A baseline equivalence test was conducted on the final analytic sample for the three models using the grade 6 SBAC math summative assessment. A standardized mean difference of 0 was found for the 45- and 15-minute model. A mean difference of 1 was found for the 30-minute model. A mean difference of 1 or less signifies that both treated and control groups are similar.

Table 1. Qualitative Data on i-Ready Gathered for the Study

i-Ready specific data	District A, Teacher A	District A, Teacher C	District B, Teacher B
Observation field notes	34	17	28
Teacher interviews	3	2	4
Student focus groups	6	3	8

District staff selected participating classrooms based on the teachers' engagement with technology. In addition to various edtech products, all participating classes used College Preparatory Mathematics as a primary textbook. All three teachers used numerous edtech products in their classes and were constantly on the lookout for new products to support their students' learning. During the course of our study, every teacher introduced at least one new edtech product.

Both districts mandate administration of the i-Ready diagnostic and recommend use of the i-Ready lessons for 45 minutes per week. Among the classrooms, there was a good degree of variation in time spent on i-Ready and average proficiency in math, as measured by the SBAC. Most of our i-Ready observations occurred in two classes where students spent an average of 30 minutes per week on i-Ready. These students' 7th grade SBAC scale score average was level 1 (mean=1.76, Standard Deviation .76); they were the least mathematically proficient students in our observations.

The most vocal and nuanced critiques of i-Ready came from the students in District B, Teacher B's classes, perhaps because they were such heavy users of i-Ready (averaging 78 minutes per week). In addition, their project-oriented curriculum likely prepared them to speak critically in group settings. Teacher C's students were low users of i-Ready, but high users (in our observations) of other edtech math products.

The overarching patterns of critique from students, usage patterns observed, and teacher views remained similar across the schools and classrooms, despite the implementation differences laid out below.

District A, Teachers A and C

Teacher A used i-Ready in class regularly, while Teacher C did not. Both teachers used a blended classroom model in which there were three stations: a direct-instruction station, a station where students could collaborate/learn individually, and a station where they used edtech products. In Teacher A's class, students could choose between three edtech products. Teacher C directed students to a variety of products and required students to write every problem in a notebook.

District B, Teacher B

In Teacher B's classroom, edtech product work was expected to be done individually. Teacher B used notebooks in conjunction with edtech but did not require students to copy all of their problems in the notebook.

Teacher B assigned i-Ready lessons as homework and students were held accountable each month to have completed the assigned lessons. Teacher B also allowed us to observe during the first day of the interim i-Ready diagnostic testing.

Teacher B's students performed better in the SBAC and spent significantly more time on i-Ready than the rest of the 7th graders in the study sample from both districts. These differences were statistically significant.

QUANTITATIVE FINDINGS

When comparing the impact of the 45- and 30-minute dosages, we found that a higher percentage of students improved their SBAC achievement level from 6th to 7th grade when using i-Ready for 45 minutes or more compared to students using it 30 minutes or more. Students using i-Ready for 15 minutes per week saw the least impact.

Students Who Used i-Ready for 45 Minutes or More

Students who used i-Ready for 45 minutes or more each week constituted 12 percent (n=212) of the sample. The study found the following for these students:

- » 62 percent scored meeting or exceeding standards, 23 percent nearly meeting standards, 16 percent not meeting standards
- » Of those not meeting standards, 52 percent moved to nearly meeting standards
- » Of those nearly meeting standards, 48 percent moved to meeting standards
- » On average, these students gained 24 points more on the SBAC than their peers (statistically significant at the 1 percent level with a .22 effect size)
- » On average, showed a 35 percent growth in achievement level 3, 29 percent more than control students

Students Who Used i-Ready for 30 Minutes or More

Students who used i-Ready for 30 minutes or more each week constituted 22 percent (n=388) of the sample. The study found the following for these students:

- » 51 percent scored meeting or exceeding standards, 23 percent nearly meeting standards, 26 percent not meeting standards
- » Of those not meeting standards, 34 percent moved to nearly meeting standards
- » Of those nearly meeting standards, 43 percent moved to meeting standards
- » On average, gained 19 points more on the SBAC than their peers (statistically significant at the 1 percent level with a .169 effect size)
- » On average, showed a 73 percent growth towards achievement level 4, 35 percent more than control students

Table 2. Student Math Achievement Growth, by Time Spent Using i-Ready Each Week

Achievement level on Smarter Balanced math assessment	45 minutes	45 minutes	45 minutes	30 minutes	30 minutes	30 minutes
	Number of students	Number who moved to the next achievement level	Percentage who moved to the next achievement level	Total students	Number who moved to the next achievement level	Percentage who moved to the next achievement level
Level 1: Standard not met	33	17	51.5%	99	34	34.3%
Level 2: Standard nearly met	48	23	47.9%	90	39	43.3%
Level 3: Standard met	51	32	62.8%	89	52	58.4%
Level 4: Standard exceeded	80	0	0.0%	110	0	0.0%
Total students	212	72	34.0%	388	125	32.2%

Students using i-Ready for 45 minutes or more scored 24 points higher than similar students who used i-Ready for less than 45 minutes. As i-Ready usage decreased, the differences between the treated and control groups decreased; there was a 19-point difference for the 30-minute impact analysis and a 7-point difference for the 15-minute impact analysis.

For a deeper understating of these point differences, we performed a growth analysis comparing students' 6th grade SBAC scores to their 7th grade SBAC scores. When examining the growth of the control group to the growth of the treated group who used i-Ready for 45 minutes or more, the treated students' growth showed an increase of 73 percent toward achievement level 4 compared to the control group's growth, which showed an increase of 38 percent (The calculation for percent growth toward the next

achievement level is provided in Appendix A in the full report.) Similarly, for students who used i-Ready for 30 minutes or more, the treated students' growth showed an increase of 35 percent toward achievement level 3 compared to the control group's growth, which showed an increase of 6 percent.

Since we were particularly interested in how growth was occurring for lower achieving students who were using i-Ready, a further analysis based on students' 6th grade SBAC achievement level was conducted, the results of which are in Table 2. As shown by the 45- and 30-minute growth analyses, a percentage of students in all levels moved up an achievement level from 6th to 7th grade. However, a higher percentage of students moved levels when using i-Ready 45 minutes or more compared to students using it 30 minutes or more. Also, in both analyses the

growth was higher for students who were higher achieving in 6th grade; a higher percentage of level 3 students moved up than level 2, and a higher percentage of level 2 students moved up than level 1. The students using i-Ready 15 minutes or more per week saw the least growth (this information is provided in Appendix A of the full report).

This pattern of findings suggests that i-Ready is an important edtech product to be

used in the classroom, but there must be an increase in usage for students in lower achievement levels. This is supported by our finding that students in achievement level 1 (standards not met) spend significantly fewer minutes on i-Ready than students in achievement level 4 (standards exceeded). A further analysis needs to be conducted to understand the reasons why students in achievement level 1 spend fewer minutes on i-Ready and how they can be supported.

DISCUSSION OF QUALITATIVE FINDINGS

Scenario-Based Lessons

i-Ready is a scenario-based product — each lesson begins with a math-integrated story narrative. For some students and some lessons, the stories worked well, as described below:

Student 1: Okay, so the reason why I've been adding and subtracting integers is because I remember this lesson[...] The lesson kind of went like watching a football game and then they were eating the typical football game food like hot wings and celery and they were just laying it out. There was an equation; they were laying out the negative hot wings and the positive celery and like putting it into zero pairs and seeing what the result is.

[...]

Student 2: Yeah, they talk a lot, most of the beginning and then they give you a few problems, but it gets off topic sometimes, like they just start talking about the game.

— *Focus group transcript: District B, Teacher B's classes*

The zero pairs lesson embedded in a football game described above was mentioned in a number of focus groups, and in many ways encapsulates the paradox of i-Ready's structure for the 7th graders. Often the lessons have

catchy elements, which help concepts stick; however, the lessons feel long to the students. Students frequently mentioned that the characters talked too much and that the story was over-embellished.

Desire for Control

Being able to test out of a lesson more quickly was a commonly proposed remedy by students who indicated that the i-Ready lessons sometimes felt redundant and time consuming.

Student 1: You take a test and they give you lessons based on what they think you know and you don't know. But let's say you learned that concept in class, and then you go to i-Ready, and you're going to go to i-Ready and it gives you the same thing that you learned in class, and then you just have to work for an hour on something that you already know how to do, it's just really repetitive.

Student 2: Yeah, or if they had something before like, "Let's see how good your knowledge is on this beforehand..."

— *Focus group transcript: District B, Teacher B*

Educators know that practice in math is useful. If this is the logic behind having students complete lessons regardless of their proficiency

in the topic, it is important that teachers and products make this clear to students.

i-Ready has some features that allow students enough control in the way they use the product that they were able to overlook the “childish” or distracting storyline in a scenario. Below, students describe an app, nested inside a larger storyline, that allowed them the type of control over their learning that they desired.

Student 2: It helps to have more [time] obviously. You don’t feel like you’re being rushed to understand so you can move on.

Student 3: They let you just play around with it, see if you could figure it out on your own.

Student 1: They let you choose when you want to leave so if you understand the topic, you can leave it early and if you don’t, you can use as much time as you need on it.

Student 4: [...] This time, it’s not just like set questions with set answers. It is still a set question, but the way you find that answer is changing and you can find a better way to represent it. Also, another thing I like with that lesson is how if you do get that answer wrong, it brings you back to the app but with restricted access to make you focus more on the result it wants you to see.

— Focus group transcript: District B, Teacher B

i-Ready has a strict progression from lesson to lesson. At the end of each lesson is a quiz. If a student gets less than 70 percent on the quiz, they need to re-do the lesson (which often takes more than an hour) and then take the quiz again. Frustration with this arrangement was expressed in nearly every focus group, as exemplified below:

Student: Well, I don’t like it when i-Ready... like, you failed a lesson and it makes you do it over and over again until you get it, and sometimes I’ll be doing that for like weeks up to a month until I get it.

Facilitator: Until you get it right and is it the same exact same lessons or do they change the problems?

Student: It’s the exact one.

Facilitator: It’s the exact same one, okay. Has anyone else faced that problem?

Students: (in unison) Yeah.

— Focus group transcript: District B, Teacher B

Students explained that they often did not know which problems they got wrong, what in the lesson they did not understand, or why they failed. One thing they realized: if they failed enough times, they would not be forced to repeat the lesson. Thus in our focus groups, students discussed planned repeated failure as one tactic for progressing out of a lesson.

Students also expressed frustration with the obtuse nature of the reporting of how they performed on the diagnostics. For students, just knowing that they went down in points on problems dealing with fractions was not enough information. Universally, they wanted to know exactly which answers they got wrong. Or, as one group suggested, they at least wanted to see a selection of their wrong answers.

In summary, the scenario-based format in i-Ready has benefits for students and is at its best when students can interact with how they move through the scenarios.

Supporting Mathematic Vocabulary

Almost every classroom-observation field note contains a description of a student struggling with the vocabulary presented in a problem, such as the following:

[A penguin] introduces the problem by saying “using the principles of equivalency and inverse operations, isolate the

variable” and then puts up the screen where the student needs to choose what operation to use. I watch as Danielle clicks through the operations and ask her:

Observer: Do you know what it is asking you?

Danielle: Umm, not really.

Observer: Well what does it mean when it says isolate the variable?

Danielle: Subtract?

Observer: No but, um, what does isolate mean? Do you know what isolate means, the word?

Danielle: No.

— *Fieldnote 171010, District A, Teacher A’s class*

We applaud i-Ready’s use of the type of math discourse students will see on assessments like the SBAC, but vocabulary issues like the one above were common in our observations of all edtech products. In this instance, as in many instances, words only appeared on the screen while the penguin was speaking. Students were not able to find a place in i-Ready to look up unknown vocabulary or find mathematical facts. Although the observer reported helping Danielle in developing a definition of “isolate,” and in understanding the problem, it was clear from the next interactions around this lesson (described in the full report) that neither Danielle, nor the other students next to her, were working with the mathematical principles that were being targeted by the particular lesson, as is clear from their subsequent actions, described above in Table 3.

Collaboration and Persistence Doing Algebra

On the day described in the field notes below, three students struggled together to understand an algebra problem. They were not unfamiliar

with this type of problem, having had a worksheet with similar problems the day before. Yet the descriptions below show that the three students struggled to complete the task on i-Ready.

In Teacher A’s class, we observed two types of students — those who regularly looked to collaborate and problem solve with their peers and those who worked through the problems relatively independently. In general, students who were collaborating were struggling with the math and seeking help. The example in Table 3 displays a number of challenges for students with i-Ready. The lack of “crumbs” means that students are unsure of what they did last, and how it connects to what is on the screen currently. Here, it resulted in students being unclear as to where they were in the problem and why different numbers appeared to work as answers. In several field notes, observers described students pressing the wrong button either to finish a module or to try and go back a screen, resulting in them having to re-do the entire lesson. They bemoaned the time lost (anywhere from 45 minutes to an hour) and what this meant. In the example in Table 3, Ignacio, trying to get on the same page as Danielle, ends up at the estimation screen no less than four times, each time more confused than the last.

While i-Ready is designed to be used individually, struggling students need additional supports to successfully move through this and the other edtech products we observed. Changes to the structure that would allow students more control would also facilitate their ability to collaborate and compare work. These sort of changes would also support any sort of tutor or adult assistance. At the same time, giving students more control could also satisfy their expressed desire to be able to move through the product with more freedom and at a self-chosen pace.

Table 3. Field Notes: Students Struggling with an Algebra Problem

Field note text (Fieldnote 171010, District A, Teacher A)	Additional description and analysis
<p>The girls are all on the same screen for a moment and are looking over at each other's computers. The problem is $140=m+80$.</p>	<p>The girls are being asked to use the principles of equivalence and inverse operations to isolate the variable.</p>
<p>They try out possible answers, talking to each other about them. However, they quickly discover that the same number does not seem to work as an answer for everyone. Since I am watching all the screens, I notice that what has happened is that they started on the same problem, but as they enter numbers to try, i-Ready calculates using that number, and then has them continue with the problem, in the way that the number they entered altered the problem.</p>	<p>Often when students saw this type of problem (which was frequent during this set of observations) students would put a number in the answer box, and i-Ready would then subtract that number from both sides, resulting in a new problem. Then, this "new" problem was at the top of the screen and their prior work was wiped away. This caused confusion for students, even when they were not collaborating. Often, they treated these as separate problems. Or they tried to go back to understand what happened.</p>
<p>As a result (see conversation below) Danielle, who is moving the quickest, asserts the answer is 20. What she did is as follows:</p> <p>Types in subtract 40 from both sides. The work is shown:</p> $140=m+80$ $-40=-40$ $100=m+40$ <p>Then it clears all this work and puts at the top of the screen</p> $100=m+40$ <p>Danielle enters 20 two times and it shows $m=60$. However, since she entered 20 as the last number in the box, she asserts to her classmates that the answer is 20, 20 is the number to put in the box.</p>	<p>What many students tended to do when they saw these problems was to try to find the variable value and enter that into the box.</p> <p>In this instance, Danielle entered 20 three times to get successive new problems, and eventually the product showed the result of $m=60$. However, she understood the answer to be 20.</p>
<p>[...]Ignacio again expresses confusion. He backs out of his screen and goes to start again.</p>	<p>Ignacio started back at the estimation screen no fewer than four times over the course of the period, trying to go back to the last screen, or get to the same spot as Danielle.</p>

Writing, Computation, and Edtech Products

It can be difficult to think mathematically, perform computations, understand geometric shapes, and set up algebraic problems “in your head,” without some sort of representation, either through writing or using a calculator or both. Yet, we often observed students doing math work in their head when working with the edtech products. We observed a complicated and somewhat fraught interaction between the edtech products and other implements that students use to do math work, such as paper

and pencil, calculators, and trackpads used to interact with the computer. Even the physical space in the classroom could be an impediment, as desk space was often insufficient for a student’s keyboard and notebook to comfortably sit together. We describe all these issues in the full report. Here, we provide examples of some students’ resistance to writing out computational problems, which illuminates a, perhaps unexpected, problem with edtech.

In a few field notes, observers watched students who seemed to be guessing at problems. Sometimes this guessing was confirmed by the

student when asked. Many times, observers would interrupt the student and encourage them to show their work on paper, often providing the writing materials, as in the following case:

I asked a student if she could do the work in her head. I said, “Let’s just do this together.” It was $15 + 3(f-13)$. At first, she got the equivalent expression incorrect [...] I had the student complete the work on a separate sheet of paper where she distributed the 3 to f and to the 13. She didn’t need any additional help other than a piece of paper to show her work.

— *Fieldnote 171011: District A, Teacher A’s class*

A few other field notes describe students being resistant to writing:

Student: I don’t like writing in general. If I do a question, I do it in my head and I finish it, I look back before I go to the next one and then I look for any mistakes and I start saying it out loud to myself and I find if there is anything wrong with it.

Observer: I’m watching it here, and you know the math, you definitely know the math, but you make simple mistakes you might not if you wrote it on the paper.

— *Fieldnote 171115: District A, Teacher A’s class*

In an effort to focus students and make them more accountable for their work, two teachers required students to write out the problems that they did on the edtech products. All the products we observed provided the ability for students to do work on the screen, but none worked with the implements and technologies available in these classes. Teachers and the observers saw the importance of writing out work. So, the question becomes: How can edtech products encourage students to look at and show their math, outside of the product? To write out their work, when it is appropriate? This seems particularly important as students move toward more complicated math and as products work to become more contained and independent of teacher support.

Interim Diagnostic Tests

While not in our observation plan, Teacher B invited us to observe while her classes began their i-Ready interim diagnostic test. Teacher B hypothesized that the students went into “game mode” with the test, and stopped being as thoughtful and careful as she knew they could be, instead treating it like a video game. Students themselves said that they became fatigued and they reported just guessing at times. Asking students to show their work or mathematical reasoning for each problem was a strategy that Teacher B decided to try in order to counteract these tendencies and help students stay focused. She was, however, concerned that requiring student to show their reasoning for each problem would extend time to completion for testing — which was already scheduled for six class periods.

Timing

i-Ready states that the diagnostic test should take 45 minutes. However, all the teachers we spoke to allotted five to seven class periods for testing. Despite being an adaptive test, students moved at widely varied paces in the test. For example, at the end of the first class period, approximately 40 minutes into the diagnostic testing, an observer recorded the following range in the number of problems that students had completed on the diagnostic test:

2, 3, 3, 3, 3, 3, 4, 4, 5, 5, 5, 7, 7, 9, 10, 10,
11, 11, 11, 15, 17

Teacher B bemoaned the difference in students’ completion times for the interim diagnostic from an instructional standpoint. Usually, she has a few students who are not behind in their mathematical understanding, but just very slow at test taking. They end up missing days of instruction trying to finish the interim diagnostic so they can continue their i-Ready lessons.

Desire for Feedback

Teacher B had a small selection of students who, before beginning the i-Ready diagnostic were going to retake a quiz. This quiz was delivered through another math edtech product, which we'll call Product X, and provided an opportunity to observe students' behaviors in the test environment of two different products. From the day's field notes:

Nicolas, the student sitting to the left of Walt, was still through the test, sitting noticeably upright. He wrote slowly and carefully on scratch paper, even though Teacher B was not collecting work for the [Product X] test. He took about 5 minutes more than Walt to finish the 7 problems and when he finished the [Product X] quiz I noticed that he received 100 percent; I did not notice any visible nor audible acknowledgement of this achievement.

[Nicholas'] first question on the i-Ready diagnostic was:

The graph below represents the depth of the water as it runs out of the bath. What does the slope represent?

As [Nicholas] reads the problem [on the i-Ready diagnostic], he slowly begins to sink under the desk, until his body is a straight line, his back on the seat of the chair and his head hovering above the chair back. He pauses like that for a bit (less than a minute but more than a moment) then, clicks an answer and sits back up. He bends over to write something on his paper; I cannot see without feeling I am imposing.

— *Fieldnote 120717: District B, Teacher B's class*

It was interesting to note the postural and affective differences in students as they transitioned from quiz in Product X to the i-Ready diagnostic. In their own ways, students showed how they were more engaged with Product X than with i-Ready. For instance, Nicolas went from the often-thought-of-as-perfect school posture

while doing the Product X quiz, to trying to disappear under his desk by the third question on the i-Ready diagnostic.

On the Product X quiz, students knew whether they got an answer correct or not, and even though they would not get credit, they could work to discover the correct answer before moving on. One student had to be told to stop retaking the quiz — he had completed it four times with an aim of getting 100 percent. Even though it was a quiz, students were still actively working to figure problems out, using the Product X quiz as a learning space. In contrast to the Product X quiz, during focus groups and informal discussions during observations, students at all sites lamented the lack of transparency with i-Ready diagnostics and end-of-unit tests. With i-Ready, there are no hints and no acknowledgement of whether or not the answer was correct. The i-Ready tests were just pure evaluation for evaluation's sake.

Teachers also indicated a desire to know how students are doing in real time and in greater detail than i-Ready currently provides. Teacher B explained that all the other edtech products she used provided detailed immediate feedback. However, with i-Ready, there was often a lag of multiple hours in reporting on student activity and she did not have access to all the information she wanted, such as the actual problems that students received in their tests. The desire to know which problems students received was highlighted during a post-lesson interview, after observers shared with Teacher B that one of her students received a trigonometry problem on the diagnostic (which she had not known):

Teacher B: I find that really interesting, because last year when I was doing i-Ready with my 8th graders I had a large group, 6-7 students that were really mathematically gifted students...and some of the high schools are looking for the title in your course that says Compacted Math. Our title

says Math 8 because I teach grade level. But [these gifted students] already knew...

Observer 1: They were ready for pre-calc.

Teacher B: They really were. So one of the frustrations they shared with me was that i-Ready maxes out, i-Ready doesn't give them harder problems. Or, if it does, it doesn't show me so... So if i-Ready is giving them trig questions, what would be helpful would be rather than in my report saying "max score" it said "9th grade, 10th grade" and then this is a report I can print out, give to that parent who can take it to that private school or wherever they end up going, so yeah they were in math 8, but really this is their performance, beyond just the state test.

— *Post-observation interview transcript*
120717, District B, Teacher B

As shown in this interview transcript, Teacher B also would like to have more access to information about what exactly her students are seeing in the test so that she can support their learning and their placement in future math courses. Teacher B would also like to provide more information to the students and their families as to exactly where they are in their mathematical ability to augment SBAC scores.

EdTech products share the modern problem of data — that is, how much data should be offered, to whom, and in what ways. As discussed above, i-Ready is an excellent platform at the district level and for researchers to work with. Some teachers feel the reporting is overwhelming as it's currently structured, while others like Teacher B crave more detail on what their students' tests look like.

CONCLUSION

A meta-analysis conducted in 2017 of randomized controlled trials and regression discontinuity studies on technology-based approaches in education highlighted two promising models within a select body of 29 studies on computer-assisted learning (CAL) (Escueta, Quan, Nickow, & Oreopoulos, 2017). The authors suggest that math edtech products can improve student achievement when they provide “customized practice,” including immediate feedback to the student and/or the teacher, as a student works through a problem (Escueta et al., 2017). One of the review’s authors shared in a blog post about the work that, “CAL was most effective when used as an in-class tool or as mandatory homework support, essentially providing personalized tutoring on an individual level” (Quan, 2017).

Our study of i-Ready also showed this to be the case. Students who used i-Ready for more than 30 minutes a week had a significant increase in their standardized test scoring, and even those who used it for only 15 minutes a week on average saw a significant improvement when compared with their peers. During our observations, we noted that two classes of students in District B had time to use i-Ready in class and had access to use it outside class time for homework. These students used i-Ready significantly more than their peers, and had significantly higher SBAC scores on average. Of the other four classes we observed, in-class time with i-Ready was limited, and teachers did not assign i-Ready as homework due to limited technology access at home for their students.

Our analysis also complicates the notion that edtech is a ready solution to student learning. The study revealed that edtech products such as i-Ready are not student agnostic — different students engage with edtech differently to different ends. Our qualitative observations revealed that struggling students were not efficiently using edtech products, including i-Ready. This was confirmed by our quantitative analysis, which showed that students who are not meeting standards on the SBAC are least likely to spend the time on i-Ready necessary to improve their assessment scores. This is in spite of the fact that, in our discussions with and observations of students who were struggling with mathematics, we learned that they often preferred i-Ready to other edtech products. Students in the two classes we observed

in which the majority of students were meeting or exceeding standards on the SBAC had more criticisms of i-Ready than of other edtech products during the course of the study.

Ultimately, struggling students need more than just access to individualized learning products such as i-Ready. They need individualized supports to reap the benefits that these products

can confer. We see this as a flag and a call to edtech product developers and researchers to look closely and specifically at the use patterns of struggling students to understand, and better meet, their needs. Unless product developers and educators up and down the system find ways to design for struggling students and their teachers, edtech products stand to exacerbate rather than ameliorate achievement gaps.

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