Khan Academy in 7th Grade Math Classes

A CASE STUDY

WestEd

Stacy Marple
Karina Jaquet

SVEF-iHub

Alana Laudone
Justin Sewell
Kirsten Liepmann

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TABLE OF CONTENTS

SUMMARY

Khan Academy is an organization that offers free practice exercises, instructional videos, and a personalized learning dashboard to help students study and learn material at their own pace. In its 2017 annual report, it reported a worldwide user base of over 60 million people (Khan Academy, 2018). As stated on its website, Khan Academy's goal is to offer "a free, world-class education for anyone, anywhere." However, there is little available independent research, and few critiques, of Khan Academy's effectiveness (Johnson & Peck, 2012; Kelly & Rutherford, 2017). While Khan Academy reports there are efficacy studies being conducted on the impact of their work, as of 2019 there are few available. Khan Academy's website presents two implementation studies that offer up correlative data between Khan Academy usage and student achievement (Murphy, Gallagher, Krumm, Mislevy, & Hafter, 2014; Philips & Cohen, 2015). A third, exploratory, study found no association between Khan Academy and math test scores when compared with two different control groups (Kelly & Rutherford, 2017).

Similar to other studies of Khan Academy, this is an implementation study. It was conducted in two districts, with six participating 7th grade classrooms and three teachers. The study puts forth questions about who Khan Academy is serving best and the learning affordances of different features of the product. Overall, the study found that teachers and students appreciated Khan Academy as a resource for practice and reinforcement of math learning.

Brief Overview of the Learning Features of Khan Academy

One of the strengths of Khan, according to its website, is that it is an "adaptive technology that identifies strengths and learning gaps." Participants in our study found the flexible nature of the adaptivity to be one of Khan Academy's most appealing features. For instance, students could be placed in levels by the diagnostic, and could also choose topics; teachers could simultaneously assign topics, quizzes, and lessons in levels and topics different from what students chose.

Originally oriented toward individual use or tutor-supported use, Khan Academy is growing its services to be more amenable to classroom teachers. In fact, its K–12 math curriculum is one of its most developed programs. Students can begin with a diagnostic, which places them at a specific math level — however, they are not restricted to that level, and are free to explore any topic or level of math. The teachers in this study, when setting up their classrooms, had the option to choose the 7th grade math *mission* or the Eureka Math curriculum-based 7th grade math mission (Eureka Math is a popular math curriculum in the United States). *Mission* is the term that Khan uses to designate a set of organized curricular resources. Students can also navigate Khan Academy's math material through three other categories: *classes, explore,* and *practice.*

Khan has links with Google Classroom, and it will aggregate student data automatically, import class rosters, and let teachers set assignments and content parameters for their classes. The teacher dashboard contains a progress bar to let teachers and students track their success with specific topics. Teachers in our study found Khan Academy to be a good support to their lessons, notwithstanding the challenges with functionality due to available hardware and the concerns for engaging all students equitably.

Khan, like all the edtech products we observed, has an in-product system in which work in the product provides students with a currency (e.g., points, in-product money, badges). The amount of currency that they receive depends on correct answers and completed classes and missions. This currency is then used to obtain things in the product, which often allow for personalization of their on-screen presence or avatar, access to games, and ability to skip a problem.

We planned to conduct an impact study; however, we experienced challenges gathering sufficient quantitative data. Out of a possible 1,759 7th grade students who were in the classes that we studied and observed, we obtained Khan lesson and time data for only 100 students and were only able to match 75 students to their Smarter Balanced Assessment Consortium Summative Assessment in Mathematics (SBAC) and school data. The majority of these students were in four of our six focal classes, thus for two classes we did not have enough quantitative data to include in the analysis.

The study's data are primarily qualitative in nature, drawn from over 28 Khan Academy–focused classroom observations, focus groups with over 100 students, and teacher interviews. The scant quantitative data we gathered aligned with our primary qualitative observation: students who are comfortable with grade-level math use Khan Academy with greater frequency than their peers who are struggling with math. In addition, both the qualitative and quantitative

data revealed that videos were not a frequently used resource, despite being a hallmark of the product.

In all of the classes that we observed, Khan Academy was used primarily for the *practice* feature, which is organized as a series of problem sets. We did not observe any students using the lesson feature. Teachers assigned specific problem sets or parameters within Khan Academy's 7th grade mission for students to complete. Teachers rarely made the tutorials and videos mandatory. While students said they used hints and watched videos, we saw little evidence of this in our observations. For the most part they used Khan Academy for practice, essentially an interactive digital worksheet.

Using Khan Academy mainly for practice was in part due to the penalties associated with using Khan Academy's learning tools — hints and videos. Students in all classes wanted to achieve the highest score they could, and if they did not receive at least a 70 percent, they would have to repeat the problem set. As a result, most students that we observed and spoke to chose to guess at challenging problems rather than using Khan's tools such as hints and videos, because using those tools results in docked points, thus lowering students' scores.

While there were a few descriptions offered by students about learning from Khan Academy in Teacher C's class, all students we spoke with said they learned math best from their teacher and few felt they learned new content from Khan Academy.

In conclusion, the study findings show that Khan Academy is a useful tool for teachers and students. Students told us, and we observed, that the immediate feedback and flexible adaptivity of Khan Academy are very motivating for students. At the same time, we also have concerns about the potential of edtech products like Khan Academy to, unintentionally, exacerbate the achievement gap. We hope this study will be a call for additional research into how to best support struggling learners, and that developers integrate that research into their product designs.

We spoke with representatives from Khan Academy's Research and Design staff about our findings regarding the use of Khan Academy in 7th grade math classes. They were aware of many of the critiques we presented and were working to make improvements.

METHODS

This implementation study sought to understand 7th grade students' engagement with edtech math products, absent any intervention. The point of the study was to understand how products were being used in real time by students while they were in class. Our aim was neither a comprehensive evaluation of a product and its full suite of capacities nor a review of whether the product was aligned to state standards for mathematics. Rather, we opportunistically asked to observe lessons on days when teachers would be using edtech and then chose the most consistently used math products to focus on for our case studies. Khan Academy Math was both of interest to district staff and present in all focal classrooms, and thus became one of the products we focused on.

We collected all participating 7th grade students' demographic data, as well as their data from the Smarter Balanced Assessment Consortium Summative Assessment in Mathematics (referred to in this brief as SBAC). Our aim was to connect students' mathematics assessment data to their Khan usage data. Additionally, we collected qualitative data from six 7th grade math classes in the two districts.

Research Questions

1. Do we see any relationship between Khan Academy use and student achievement as measured on the SBAC?
2. What is the impact of Khan Academy on student math achievement as measured on the SBAC?
3. How do teachers incorporate Khan Academy 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 Khan Academy 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 Khan Academy? What do they perceive as the product's advantages and disadvantages?

To address questions 1 and 2, data agreements were arranged with the districts to obtain student-level data

on all 7th grade students, including SBAC scale scores and Khan Academy usage. To answer questions 3 and 4, we conducted a total of 59 observations in six classrooms, two periods for each of the three teachers. 28 of these observations focused on Khan Academy. To directly address question 5, 13 focus groups of 8–10 students from the participating classes were conducted at the end of the study.

Quantitative Approach

Khan Academy was initially designed as a tutor-directed or student self-directed product. As such, it has useful data for individual users of the product on their own learning. Khan Academy has begun to develop features oriented toward teachers. However, unlike other products, it is not set up for easy data access to look at groups of students, which is essential for research projects and district-level analytics.

Gathering relevant student data. All Khan Academy data are connected to the specific user, and access to users' data can only be obtained by coach(es) to whom the user chooses to connect their account. The first step for our research team to gather Khan Academy user data was having all participants accept a research account as a coach. This step was not a problem for students in our observation classes because we were in direct contact with them, but there were very few other students in the districts who added the research account as a coach. Once the students accepted the research account, that account was then used to access user data. This was done through the Khan Academy API (Application Programing Interface) and required hiring a programmer to write code specifically for the desired data. Accessing the data presented a series of challenges, most significant being regular timeouts when downloading data and a need to rewrite the script between data download attempts, due to changes in the platform.

Another significant hurdle was connecting students to the study, even after they had agreed to participate. The first challenge was getting students to log in to Khan Academy for each session. Some classes were set up through other technologies (e.g., Clever, Google Classroom) to seamlessly log in; others were not. The matching mechanism was also a challenge. The only way to match students' Khan Academy data to their SBAC and demographic data was by their email addresses. Some students used personal rather than school emails to create their Khan Academy accounts, which kept them from being matched to the district data. Accordingly, this level of personally identifiable information required additional data handling management.

As a result, we did not obtain enough quantitative data to do an impact analysis. The following section presents descriptive data for the 64 students from two teachers' classes whom we were able to connect to their district and SBAC data. As we were only able to match eight students from the third teacher's classes, we left those data out.

Qualitative Approach

The flexible and free-of-cost nature of Khan Academy has made it a very popular platform for teachers to engage with. The product's popularity cannot be equated with equitable impact and uptake by students. To understand how students were engaging with the product, we collected observational, interview, and focus-group data on Khan Academy Math, as detailed in Table 1.

Analysis of field notes, interviews, and focus-group transcript data was completed utilizing an integrated approach — drawing from both deductive and inductive coding methods. Following Miles and Huberman (1994), our

Table 1. Qualitative Data

Data type	District A, Teacher A	District A, Teacher C	District B, Teacher B
Observation field notes	8	14	6
Teacher interviews	3	2	4
Student focus groups	4	3	6
Students who were observed	52	34	65

research 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 were coded by a single researcher. Focus group transcripts were coded by a team of three and followed a 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 largely Latino (79% and 48%, respectively). District A has a larger percentage of students who qualify for free or reduced-price lunch (90% vs. 45%) and a larger percentage of students classified as English language learners (44% vs. 29%).

District staff selected classrooms to participate in the study, 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 our study, every teacher introduced at least one new product.

District administrators were aware that their teachers used Khan Academy. However, neither district had a policy around Khan Academy usage. One district explained this was because it participated in the California Student Data Privacy Alliance and, as such, only works with technologies that have signed on to this agreement. Khan Academy has its own student data privacy pledge, and is not part of the Alliance. For the participating districts, this meant they could not support use of the product at the district level. Administrators of both districts were very interested in how Khan Academy was being used in their classrooms and curious if it was having a positive impact on student outcomes. This study was unable to address the districts' primary interests due to the lack of quantitative data acquired.

DESCRIPTIVE FINDINGS

Below, we describe the three implementation settings and the themes that emerged from the qualitative data related to these settings. For each site, the highlighted themes are ones that were most prevalent at that site. When relevant, we indicate the way in which a particular theme was similar or different to what was observed at other sites.

Study Sample

This study's findings are presented for each of the three teachers that welcomed us into their classes for observation. Table 2 on page 8 outlines the demographics of the focal classes taught by these teachers.

District A, Teacher A

Teacher A used a blended learning model with three stations: a direct instruction station, a station where students could collaborate or learn individually using a worksheet, and a station where students used edtech products. At the edtech station, students had the opportunity to choose among three edtech products, providing a unique opportunity to observe student product preference. Teacher A assigned topics on the products that had been covered during whole-class or small-group instruction. On Khan Academy, students had a choice in how to engage with the topics — they could go through the tutorials and videos or move to the problem sets. We did not observe any students using the tutorials.

Students in this class were organized into heterogeneous groups with a variation in mathematic proficiency. At the station for collaborating or learning individually, we observed more proficient students supporting less proficient students. At the edtech station, students tended to group by product used, which at times also meant they were grouping by proficiency level. In this class, Khan Academy was not a first-choice product, although when the favored product had a glitch, students chose Khan Academy as a replacement. Students who regularly chose Khan Academy in this class typically worked independently. These were also students who were observed working on more complex math.

The students in Teacher A's classroom were the least mathematically proficient in our study, with a mean achievement level of 1.76 on the 7th grade SBAC, which was

Table 2. Demographic Data for Focal Classes

	District A, Teacher A's students *(all students)* Number of students	District A, Teacher A's students *(all students)* Percentage of total enrollment	District A, Teacher C's students *(quantitative data)* Number of students	District A, Teacher C's students *(quantitative data)* Percentage of total enrollment	District B, Teacher B's students *(quantitative data)* Number of students	District B, Teacher B's students *(quantitative data)* Percentage of total enrollment
Total enrollment	43	100	34	100	33	100
Ethnicity/race						
African American	1	2.33				
Asian	3	6.98	4	11.76	6	18.19
Hispanic or Latino	37	86.05	29	85.29	7	21.21
White, not Hispanic	2	4.65	1	2.94	16	48.48
Other					4	12.12
English learner status						
English learner	21	48.84	13	38.24	32	96.97
Non-English learner	22	51.16	21	61.76	1	3.03

Note: Data for Teachers C and B are limited to the quantitative data set. Data forTeacher A are for all students in the two classes we observed.

significantly[1] worse than the rest of District A. We were only able to match eight students to their demographic and SBAC data, so no quantitative information is presented for this class.

Videos

One of the hallmarks of Khan Academy is the instructional videos. The majority of students in the study stated that they found the videos helpful. However, we observed very few videos being watched, and from the quantitative data we were able to collect from other classes, videos were the least used resource.

We observed the most videos being watched in Teacher A's classes, despite a few confounding factors: (1) students did not use Khan Academy as frequently as students in other classes we observed; (2) students rarely had headphones and did not like using the subtitles; and (3) students in these classes described the videos as too long and often confusing. A number of Teacher A's students agreed with the sentiment below:

> In the video, if they [don't] explain it that good, you don't get it. After you're

1 Significant difference from zero at the .05 level, two-tailed test.

> watching it, you don't know what you're doing. You don't get the problem solved.
>
> *— Focus Group: Teacher A's Students*

As one observer reflected when thinking about these classes:

> The videos do not seem to be used often — in any of the three [edtech products]. Even Dolores, (a student who seems relatively high in math [working at or above grade level]) who said they were useful, was "watching" hers, she was more interested in moving the subtitles all over her screen. The videos seemed to be somewhat distracting — a way to use up class time — for some students.
>
> *— Fieldnote171113k, Teacher A's class*

These observations are in line with Teacher C's concern that his struggling students used the videos as a way of passing time, rather than a resource for knowledge building.

Vocabulary

In almost every class we observed in all three schools, at least one student was stumped on a problem due to their math vocabulary knowledge. An observer in Teacher A's class noted:

> It seems that math vocabulary is a struggle for many students. Several questions intentionally are "testing" vocabulary — ones like "how many expressions have 2 terms" or "what is the constant/coefficient/variable . . ." I was asked for help several times on such questions.
>
> *— Fieldnote171113km, Teacher A's class*

At times, the words and phrases that students did not understand had more to do with test taking than with math, as in the case below:

> [After an incorrect answer,] Joseph chose "none of the above" and another answer. I asked him what "none of the above" meant. He was quiet, and I explained it to him. He answered the question correctly.
>
> *— Fieldnote17114j, Teacher A's class*

We often observed students struggling with mathematic terms. Learning math discourse is important for students, and we applaud that Khan Academy integrates these into their lessons. However, we wonder if there could be more resources to support the development and understanding of mathematical discourse in the product.

District A, Teacher C

Teacher C also employed a blended learning model using a direct instruction station; a station with problem sets or other resources accessed through Google Classroom; and an edtech station, at which Khan Academy was the most frequently assigned technology. The classroom was equipped with enough Chromebooks for every student.

Students were organized into groups by proficiency level. Students at the Khan Academy station would discuss problems and solutions with each other but primarily worked individually on their problem sets. This was especially true of students in the highest proficiency group, who tended to collaborate the least.

Of all the teachers in the study, Teacher C showed the most concern about edtech and equitable access for his students. In interviews, he mentioned the difference in engagement with edtech between students of different proficiency levels. He explained that his low-performing groups tended not to use technology well — particularly when they did not feel confident in the content. When on Khan Academy, he reported noticing them just staring at a screen or having videos open, without engaging with their content.

Teacher C's students made the largest gains over the school year on the SBAC, with many students moving from nearly meeting standards

Table 3. Time (in Minutes) on Khan Academy for Teacher C's Students, by SBAC Achievement Level

			Mean time, in minutes, spent per school year on Khan Math (standard deviation)			
Grade 7 SBAC achievement levels	Number of students	Percentage of students	Total time	Exercises	Videos	Math not part of 7th grade
All students * (mean achievement level: 3)	32	100	478 (289)	297 (210)	15 (24)	166 (88)
1 (standard not met)	8	25.0	271 (127)	163 (101)	4 (10)	105 (56)
2 (standard nearly met)	11	34.38	386 (190)	237 (122)	6 (9)	143 (72)
3 (meeting standards)	4	12.5	466 (249)	286 (188)	4 (8)	176 (71)
4 (exceeding standards)	9	28.12	780 (292)	495 (250)	40(31)	245 (84)

*Outlier students (two students who spent over 2,000 minutes) were removed from this data set.

(level 2) to meeting standards (level 3). Teacher C's students performed significantly[2] better than other students in District A, with a mean achievement level of 2.54 on the 7th grade SBAC. We observed the most Khan Academy lessons in Teacher C's classes.

Trends in Quantitative Data

We present the quantitative data with many caveats, due to a very low *n* (32 out of a possible 50 students matched, out of a total potential *n* of 100 students) and an incredibly high standard of deviation. These data indicate a great variation in how students in different achievement levels used the product, given that Khan Academy was assigned during class time. In many cases, one explanation for students' different usage of the product during class might relate to students' usage of Khan outside of class. Teacher C informed us that he refrained from giving technology-based assignments as homework because of poor access to home computers among his students.

While no conclusions can be drawn from this quantitative data, we present it for two reasons. One, much of this data is in line with what we observed and what teachers noted in terms of usage patterns. Two, it provides an example of a potential future line of inquiry: the relationship between edtech usage, academic growth, and academic proficiency level.

Videos and Proficiency

The two patterns in the data presented in Table 3 that line up with our observations are video usage and variation based on proficiency level.

As shown in Table 3, videos constitute a very small percentage of students' usage of Khan Academy. Since videos are a primary teaching

2 Significant difference from zero at the .001 level, two-tailed test.

mechanism for Khan Academy, this may indicate the product was used for practicing content the students had already learned, rather than for teaching students new material. When asked directly, students described the videos as a positive feature of the product. However, these data and our observations show little engagement with videos in the classroom setting.

All observers, as well as Teacher C and Teacher B, noted that students who were more proficient in math were also more efficient in using edtech products. As shown in Table 3, students who were meeting or exceeding standards on the SBAC used Khan Academy far more than students who were not meeting standards.

Again, these data are presented for discussion and to encourage further study into the relationship between student proficiency in math and engagement with edtech, as well as what features are needed to move products like Khan Academy from the realm of practice to that of knowledge building when used in the classroom.

Points and Hints

All the students we spoke to and observed were hesitant to use hints or watch videos while completing problem sets because they did not want to lose points or lower their score. This was particularly the case with students in Teacher C's class. In field notes, the only time that students in Teacher C's class were observed using hints or watching videos was when an observer encouraged it, as a first line of support when a student was stuck. The hints are generic and work in a linear fashion, revealing a line of work at a time. This can become quite frustrating if the student's mistake is in the last line of work, as in the case below:

> I noticed a student who was neither writing nor typing, just sort of staring at the screen, so I went over to see what was going on. He had entered the answer 2/18 and was struggling to understand why the program told him that he needed to try again. I asked him about the hints and the video and he said he did not want to lose points. I directed him to his work on his paper, and asked him to walk me through it. Once he did, he said, "I definitely did the right work, I don't know why it isn't working." Then he entered 2/18 again, and again was told he was close. I think it also suggested he take a hint. So he did. The first time he pressed *hint*, it gave him the first line of the math — flipping one of the fractions so he could multiply. He checked against his work. Then he got the next line, the same as his work, 2/18. Then he clicked hint again, and it showed him 1/9. He said, "aaah," and then went to the next problem.
>
> *— Fieldnote171018s, Teacher C's class*

This student lost all the points for this problem because he used three hints to get to the answer, despite doing most of the problem correct. In addition, he then got his next two problems incorrect because he continually tried to reduce fractions that were already in their simplest form. Once the observer explained to him the principle behind reducing fractions, he completed his next problems correctly.

Paper and Tech

Teacher C expected all students to copy every problem into their notebooks and neatly show their work. He did this in part to dissuade students from using the Khan Academy-provided workspace designed for a touch screen and stylus, as the technologies available in the classroom (Chromebooks with trackpads) did not facilitate its use. Teacher B also required students to use a notebook to show work at times and, like Teacher C, hoped this would also encourage students to be thoughtful when using edtech, and not just guess at answers.

To do mathematical work, writing is critical. Yet the back and forth between paper and

screen, keyboard and pencil, was slow and created room for numerous transcription errors, a theme in our field notes from all classes. There were also students, discussed more below, who were so determined to stay on the computer that they refused to use a paper and pencil, creating other problems.

A benefit of teachers having their students use notebooks when working with Khan Academy was that students had their notes ready to occasionally use them, as noted by an observer:

> A few times I saw students looking back through their notebooks on how to do problems. One student, when faced with -6/7 x (-3/8), spent some time first looking through notes on how to multiply fractions, and then on how to multiply negative numbers. The student painstakingly flipped back and forth in the notebook on their lap, writing and erasing attempts on their paper perched beside the laptop, before finally arriving at an answer to enter into the box.
>
> — *Fieldnote101718s, Teacher C's class*

Students' notes are an important resource, and one that was not supported by Khan Academy, either by creating a space for easy note taking or by prompting students to look at their own notes.

District B, Teacher B

In Teacher B's classroom, edtech product work was expected to be done individually. Teacher B regularly used Khan Academy in her classroom and occasionally assigned it for homework. Teacher B was constantly on the lookout for new technology and, on the day Khan Academy rolled out its quiz feature, she employed it in her classroom. While we did not observe many Khan Academy lessons in Teacher B's class, she and her students were very articulate about the benefits of the product during interviews.

Of the three teachers, Teacher B used the most features of the dashboard, and was the only teacher that we observed using the features in real time, to monitor student progress and struggle.

Teacher B's students performed significantly[3] better than other students in District B, with a mean achievement level of 3.28 on the 7th grade SBAC.

Trends in Quantitative Data

Here again, while we have quantitative data to present, they are not robust enough to draw conclusions. Rather, the data are shared as a complement to our observations and discussions with teachers and students. We were able to match data for 33 students out of a possible 66 students. Of those students, six used Khan for over 3,000 minutes in the year and another three for over 2,000. As shown in Table 4, even when removing the top six users, the standard deviation is quite large, indicating that the variation in use was great. Teacher B's students used Khan on average for 1,147 minutes over the school year, 140% more than Teacher C's students. Yet the patterns of usage remain the same — lower-performing students used Khan Academy less and, across all students, videos were not engaged with at the level we might expect, given Khan Academy's model. The high degree of variation is curious, given that students were all assigned the same amount of Khan Academy by their teacher. We know that students in this class regularly completed homework on edtech platforms, and thus have access to technology outside of class on a consistent basis. This may account for the higher overall usage and wide distribution of usage across students.

3 Significant difference from zero at the .001 level, two-tailed test.

Table 4. Time (in Minutes) on Khan Academy for Teacher B's Students, by SBAC Achievement Level

			Mean time, in minutes, spent per school year on Khan Math (standard deviation)			
Grade 7 SBAC achievement level	Number of students	Percentage of students	Total time	Exercises	Videos	Math not part of 7th grade
All students * (mean achievement level: 3)	27	100	1147 (643)	884 (456)	59 (34)	203 (158)
1 (standard not met)	1	3.71	583	500	36	46
2 (standard nearly met)	5	18.52	1009 (467)	745 (388)	67 (52)	197 (103)
3 (meeting standards)	3	11.11	1390 (1333)	1150 (1095)	41 (19)	199 (224)
4 (exceeding standards)	18	66.66	1177 (580)	901 (503)	61 (32)	215 (159)

* Outlier students (six students who spent over 3,000 minutes) were removed from this data set.

Choice, Control, and Pacing

While all students we spoke with appreciated the choice and control that Khan Academy provided, Teacher B's students were the most vocal about this feature. They appreciated exploring math that was beyond the level of their classroom and assignments and the ability to redo problem sets for a higher score, as well as the immediate feedback they received to support this action. Another feature they often used was that they could pause in a video or problem set and return to the same spot. As one student explained:

> Khan seems much more simpler because it's way faster because you don't have to listen to other characters talk. Because the video, they're super short and the quizzes are like really fast. Also, for Khan, you don't have to read the tutorial again or the video, you could just keep trying the quiz until you get it 100 percent.
>
> *— Focus Group, Teacher B's students*

This student also underscores the tension around points described earlier. Many students' desire to get 100 percent was strong. Being able to redo a problem set until the desired score is achieved is a benefit, but in many cases, students would rather do that than use the teaching features of Khan Academy — hints and videos — so they would not lose points.

Teacher B's students also appreciated Khan Academy's error cycle and feedback. When a student got a problem wrong, Khan Academy generally provided additional similar problems until they got them correct — or they decided to move onto a new topic. For these students, this was the level of adaptivity they wanted. They found software that fed them lessons based on a diagnostic cumbersome and often unable to keep up with where they were in math day-to-day.

Teachers also appreciated the control they had over Khan Academy. All teachers pushed topics to students through the product. Teachers B and C also assigned specific lessons and problem sets for students. To do this, they created links in Google Classroom, though there were some glitches when they tried to

assign them to the class directly. Furthermore, teachers appreciated the immediate feedback on student work that Khan Academy provided.

Desire to Interact With the Problems

Many students in Teacher B's class, as well as a few students in Teacher C's highest proficiency group, showed a strong desire to interact with the problems. This arduous and painstaking process is described below:

> Amber is labeling the deconstructed shapes on her screen within the program. It is the first time I have seen this, but the female student next to her is also doing so. Amber adds numbers inside the boxes or pieces of the deconstructed shape, and hand-draws calculations on the screen in a blank space next to the shape. Her calculations are made in a vertical line: 12, 12, . . ., . . ., underline, 54. She does not have a touchscreen device but controls the trackpad to choose the color of her ink from a choice of at least 10 colors and write the numbers where she wants them.
>
> — *Fieldnote180125a, Teacher B's Class*

The designers of Khan Academy seem to understand the need for students to be able to annotate problems and write out their computational work. However, they have put teachers and students in a difficult position by creating this possibility, as the most compatible technology — namely, a touch screen and stylus — is not commonly seen in schools. As with the discussion above, it might behoove edtech products to recognize the need to use paper and pencil in conjunction with their product and prompt students to do so.

In-Product Awards

One way in which progression through lessons was tracked and rewarded for students was through a point system. Students were aware of what points could do for them in Khan Academy and were able to show observers, primarily personalizing avatars, whenever asked. They did not, however, engage with the avatars in meaningful ways, nor seem particularly motivated by them. In one focus group, students had this to offer:

> **Student 1:** So, the badges is something that says what you have accomplished and you know what you've learned, what you've mastered.
>
> **Student 2:** Like Oscar said I like the badges. You can show it to your friends, your family members. Just show them what you have learned . . . Currency [in product money] really doesn't matter anymore because you can't tell them, "Oh, I did this." You don't know how many lessons you've actually done.

Students in this group wanted to be able to connect their progress to others, and perhaps to their overall development as a math student, more than to create a well-dressed avatar.

CONCLUSION

Khan Academy was a popular product with the teachers and students in this study, particularly those in the higher-performing classes. Teachers and students appreciated the balance that the product has struck between adaptivity and control. The immediate feedback that students were given on their math problems worked as a motivator for students as well as a support for teachers in planning. Students in the study did not use Khan Academy to learn new material; rather, they used it to consolidate knowledge through practice and performance.

However, being a popular product does not make Khan Academy an excellent learning tool. As researchers and experienced algebra teachers Johnson and Peck (2012) point out:

> There exists better mathematics education than what we currently find in Khan Academy. Such an education would teach slope through guided problem solving . . . These practices are recommended by researchers and organizations such as the NCTM.

We observed an awkwardness in the interactions between student thinking captured in notebooks and their work on the computer screen, between pencil and keyboard, that Khan Academy needs to address. For edtech products like Khan Academy to be supportive of the elements of learning that involve student production of meaning — not just of consumption and display of knowledge — students need ways to easily interact with the problems presented. They need to be encouraged to puzzle and reflect on their own thinking. We saw little of this in our observations of students working on Khan Academy. Then too, there is the struggle around the degree of containment: Should the product provide everything related to math learning, such as glossaries, workspaces, and multiple forms of explanation? Or should products actively promote students to engage with other resources online and in their classrooms, such as their textbooks, notes, and peers?

Most importantly, we are concerned about the product's reach. This preliminary research indicates a need to examine how struggling students are engaging with Khan Academy. To promote and support equitable access to knowledge and contribute to closing the achievement gap, Khan Academy needs to look at the engagement of struggling students and needs to design for them.

The challenges we had collecting quantitative data from Khan Academy limited the scope of this study. We hope Khan Academy continues to improve access for districts and researchers as other products have done.

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