

CHAPTER 4 RESULTS

This study examines the lived experiences of K-12 education leaders who serve as the technology leaders who lead their school's implementation of ~~adaptive learning technologies for mathematics~~ALT-Ms. While a technology leader can operate in a variety of job titles (~~principal, assistant/vice principal, district administrators, superintendents~~), teacher-leaders, and technology coordinators, this study will include principals and assistant/vice principals to offer increased consistency when framing and describing their experiences (Davies, 2010; Richardson et al., 2013; Richardson & McLeod, 2011; Schrum et al., 2011). Two participants worked as principals at their respective buildings whereas three served as assistant principal (AP). Four participants hold master's degrees, with Alex having earned a doctorate, Cameron currently ~~pursuing~~ a doctoral ~~candidatedegree~~, and Jordan ~~completing~~ ~~having completed~~ some doctoral coursework. The amount of experience working as a principal or AP ranged from 7 years (Cameron) to 15 years (Jordan), with an average of 11.4 years across the five participants. Four of five participants lead secondary schools with Jordan being the only leader in a high school. Regionally, the school districts in which the participants work span across the United States rather than being isolated to one region, offering an opportunity to report on broader experiences. The sizes of the participants' school districts also varied from 1,000-4,999 students enrolled to over 100,000 students enrolled.

Table 4-1. Participant and district demographics with ALT-M being implemented

Name	Principal or AP	Highest Degree	Years as Principal or AP	Grade Levels	District Region	District Enrollment	ALT-M
Cameron	AP	Masters	7	6-8	West	>100,000	Moby Max® MathIA®
Alex	Principal	Doctorate	13	6-8	Midwest	5,000-9,999	IXL®
Jordan	AP	Masters	15	9-12	Midwest	15,000-19,999	IXL®
Casey	Principal	Masters	9	K-4	Northeast	1,000-4,999	Zearn®
Riley	AP	Masters	13	5-8	Southeast	>100,000	IXL®

This study was situated at the nexus of the body of knowledge on technology leadership, standards-based teaching and learning, and adaptive learning technologies; the study and investigated four research questions about regarding technology leaders' lived experiences in leading implementations of adaptive learning technologies for mathematics ALT-Ms. The first research question looked to learn about addressed the participants' previous experiences as technology leaders. Research questions two and three explored their experiences with their current implementations. The fourth research question was designed to have participants share how their previous and current experiences would inform future implementations. The themes for each research question were generated after analyzing the transcripts and using an emergent coding strategy informed by Braun and Clarke (2006). During this process, I conducted four rounds of emergent coding (one per research question) where-in which I organized codes by research question in a spreadsheet (Appendix D), grouped codes into categories (where needed), then generated themes based on the relationship between the codes and categories. Once the themes were identified, I re-reviewed the codes and the dataset to secure additional evidence to support each theme (Creswell & Poth,

2016). Quotations from participants were added to the spreadsheet below each theme, as an additional layer of description of participants' lived experiences.

Research Question One: Previous Experiences as Technology Leaders

How do participants describe their previous experiences as technology leaders?

In interview one, leaders were asked to describe their prior experiences as an education leader, familiarity with technology leadership, and past experiences with ~~adaptive learning technologies for mathematics~~ALT-Ms. Their responses highlight unique experiences as technology leaders and ~~adaptive learning technologies for mathematics~~ALT-Ms. How participants learned to lead technology implementations was much more in sync with one another. The three themes identified from the participants' descriptions of their previous experiences with technology leadership include the following:

- Varied prior experiences
- Inconsistent training
- Self-directed learning

Table 4-2 lists these three themes including samples of the codes created from the participants' transcripts, and description of the theme. The section below provides a deeper account of the three themes that were developed from participants' descriptions of their previous experiences with ~~adaptive learning technologies for mathematics~~ALT-Ms and technology leadership.

Formatted: Normal

Formatted: Normal

Table 4-2. Themes, sample codes, and descriptions for RQ1

Themes	Sample codes	Descriptions
Varied prior experiences	Prior experiences (teacher, coach, and leader)	Participants' experiences differed with leading prior implementations with few parallels across all participants.
	Led previous implementations (ALEKs® & Study Island)	
	Little/no prior experience	
Inconsistent training	No formal preparation	Participants had no formal technology leadership training in becoming leaders.
	No formal training	
	Paired coursework with experiences	
Self-directed learning	Attended teacher PD; trial and error	Participants took it upon themselves to find learning opportunities.
	Learned "ad hoc" on own	
	Self-taught; learned from peers	

Varying Prior Experiences with Adaptive Learning Technologies for Mathematics

Before leading their current implementations, participants described various previous experiences with leading adaptive learning technology implementations for mathematics. These experiences include using and leading the same tool they use in their building currently, leadership of different, adaptive platforms, and having had no experience in leading an adaptive learning technology implementation until being in their current role. Each participant described their previous implementations, the role they played, and the experiences they, their educators, and their students had.

Cameron reported the most experience with using and leading an implementation of their adaptive learning tool, MobyMax®, when compared to others

Formatted: Normal

Formatted: Indent: Left: 0", First line: 0"

included in the study. Over ten years ago, as a teacher in a different school, Cameron used MobyMax® for mathematics, ~~and also~~ and played a role in initiating the school's adoption of MobyMax®. ~~In~~ First in a teaching role, later as an instructional coach, then as an administrator, Cameron continued to see positive student results, which helped to develop teacher buy-in until almost the entire school had adopted the platform:

What went well is when you get teachers that see the benefit in their students, that goes well. It only goes as well as providing the instructions to the teachers for the support. It was taking the time, starting small group, to promote the change and then those individuals getting buy-in from greater amount of individuals to where you get, you know, to the point where you get pretty much whole school buy-in because you started with your grassroots buy-in. So that went well. (Cameron, personal communication, November 18, 2022).

Cameron also described the importance of generating parallel buy-in with students, which was achieved when students were able to see their own growth through using the adaptive learning technology. Parents, guardians, and ~~the~~ community buy-in were also considerations as it was important that:

...they're included in the conversation so that when you have these types of adaptive instructional tools, that can be supported and used at home, that you tend to have increased growth with increased use. That means you need to have the parent and community buy-in to say, "hey, not only am I asking you to spend, you know, 15 minutes a day in class working on this, but I'd like you to do it at home." (Cameron, personal communication, November 18, 2022).

Cameron felt the comprehensive approach to engaging and supporting the various stakeholder groups helped to initiate, expand, and sustain the school's MobyMax® implementation.

Alex, Casey, and Riley also had experiences leading an adaptive learning technology mathematics implementation (ALEKs®, MobyMax®, and i-Ready®, respectively) in addition to other digital learning tools for mathematics. One key

distinguishing factor between Cameron's prior experience and Alex's, Casey's, and Riley's is that the latter group did not use adaptive learning technologies as classroom teachers. While some may have used other technologies in their mathematics classrooms, they have only had experiences with adaptive technologies in an administrative capacity as a principal or AP.

In prior years, Alex, a principal in the Midwest, had teachers use the adaptive learning technology, ALEKs®, with their students and described teacher usage as being in "pockets," where "it wasn't super consistent" and overall, ~~the~~ characterized by an implementation ~~did not go well and was not sustained~~ that neither went well nor was sustained. Alex was "not super familiar" with the tool but shared that the school's math specialists (coaches), department chairs, and some teachers appreciated it. In this implementation, the perception of how "user-friendly it is" and the amount of work and time required to use ALEKs® with students played a factor. The teachers preferred not to "do as much on their end as far as assigning..." and Alex recognized the need for PD support teachers use of the tool as intended:

~~...where~~ Where teachers don't love it is if they don't have enough PD on it, so they don't really fully understand how to utilize it. Or two, if they feel like it's too time consuming...they've got all their grading, they're planning, and then on top of it they're trying to figure out this tool. (Alex, personal communication, November 29, 2022).

This ALEKs® implementation in Alex's school was also described as more of "top-down, you have to use this" approach where teachers did not have much choice/autonomy which reduced their level of buy-in. Alex acknowledged that this likely played a factor in the quality and length of their implementation; they did not use it long enough to see if using ALEKs® garnered the results they were looking to see:

Commented [JR1]: This seems to end half-way. Do you want to add more to the quote? The long quote gives a lot of info, so maybe this short one isn't necessary?

I just think maybe we didn't wait long enough to see whether the results were there. And so, I think that what does stick is when teachers see results, right? It's easy enough that they can use it. They can use it well. Kids don't get burned out on it and then they get to see the results from it. (Alex, personal communication, November 29, 2022).

The principal from the Northeast, Casey, had ~~a~~ limited prior experience with adaptive learning technologies. The only adaptive learning technology for mathematics mentioned was MobyMax®. This tool was used “sparingly” and “when necessary,” predominantly in intervention classrooms rather than for general education (gen-ed) purposes. Khan Academy, a non-adaptive tool, was also used in a similar fashion. On the other hand, Casey described a much more robust experience with a ~~math-math-~~ intervention, non-adaptive tool, SpringMath®. School leaders and math specialists joined together, from across the state, ~~to be trained~~for training on how to use the intervention tool with targeted students.

With this tool, Casey and the building's math specialist selected a student as case-study ~~from which~~with whom they would utilize SpringMath®, monitor and track ~~their~~ usage, and adjust their strategy in real-time. With this student, the team found that through using SpringMath® and their existing “research-based” intervention strategy, the student showed minimal progress, ~~“the student”~~ almost flat-lined.” The findings “led to the student being evaluated and qualifying as having a learning disability in mathematics shortly thereafter.” In reflecting further on this experience, Casey shared that their school leadership team appreciated ~~the available data~~having data available to both base their decisions on and to illustrate that ~~to illustrate~~ the intervention process they employed ~~were was~~ working ~~and they had data sources available to make decisions about students~~:

I think just the reinforcement that at the time, what we were utilizing in intervention was working and the process that we had in place was somewhat data driven, although we wanted to transfer some of that ownership to our teachers being more invested in looking at their data and making decisions based on that just the reinforcement. (Casey, personal communication, February 27, 2023).

In this case, the student's lack of progress with the intervention, based on the data, signaled to educators that another variable influenced achievement, in this case an undiagnosed learning disability. Prior to that point, being data-driven was not a practice Casey had normalized or optimized in the building, though it would be come a focus and further developed with teachers moving forward.

Riley, from the Southeast, was excited, passionate, ~~and~~ more familiar and comfortable with their prior implementation of an adaptive learning technology for mathematics. In previous years, the school predominantly used i-Ready® but had recently discontinued its use because of state governance and changes to state standards. Like Alex and Casey, Riley also did not have classroom experience with this tool but had led the building's implementation several years before. During this time, Riley, the school's leadership team, and classroom teachers were an actively ~~a~~part of the implementation. Riley would regularly pull data reports to review usage with stakeholders to increase engagement and accountability:

When I used the other tool that we had in previous years, I was pulling reports Monday, Wednesday, Friday, having meetings, calling parents, bringing them in during lunch, after school, having challenges, and making it very competitive...and the morning announcements...It was just...it was fun. (Riley, personal communication, March 28, 2023).

Adding on, Riley described how the school would use a variety of strategies to generate student buy-in by capturing photos of the school mascot in meetings discussing usage data and calling out those classes and students that were excelled~~excelling~~. They also

got to a point where usage data became a part of their normal conversations when discussing student performance:

So, it wasn't about minutes anymore. It was about minutes and how many lessons you passed. Where are you year to date? What's the lowest data? Okay, let's look at the data...how are you going to reteach this? How are you going to reteach that? So, it just became a part of the culture of the school. (Riley, personal communication, March 28, 2023).

It was evident that Riley was familiar and comfortable with the previous tool used and had a strong desire to bring the tool back as they had not yet found a replacement that provided a comparable experience "that puts a student on their pathway and moves them along where they can see how they grow." This type of data use, for all stakeholders, will be a theme that is further described later in this chapter.

Jordan was the participant with the least amount of prior experience with leading an adaptive learning technology for mathematics implementation and other digital tools to support mathematics instruction. By training, Jordan does not have a background in mathematics instruction, but extensive experience teaching and leading secondary English fine arts and working as a district and building administrator. Until this role, Jordan had not directly led mathematics teachers but now leads the school's mathematics and science departments:

So, I didn't work with math teachers directly until this role now. And it so happens that in our school, it's because it's a very big school of almost 3000 students. Each administrator serves also as a liaison to a couple of different departments. My two departments are science and math, so now I'm working much more closely with the math teachers and the [department chair]. I'm in classrooms regularly. I'm looking at math instructional practice, I'm looking at their pedagogy, and I'm fairly familiar with their curriculum more or less. (Jordan, personal communication, February 13, 2023).

During the interview, while speaking on the lack of experience leading the mathematics departments, Jordan shared that "I guess if I reflect on my career, it was kind of a gap in

my own professional development and that I didn't work in that capacity (Jordan, personal communication, February 13, 2023)." The type of building-level leadership Jordan used was at a higher level than the daily intricacies of curriculum and instruction and "though I was an instructional leader and we talked about goals, it was very broad" (Jordan, personal communication, February 13, 2023)."

The only prior experience Jordan ~~has~~ had with leading an implementation of a technology tool for mathematics was a tool called Mastery Manager. This was an assessment platform that teachers used to collect and share student performance data. Though not adaptive, ~~this~~ their description of their experience with it and experience also alluded to the use of data by teachers and leaders for decision-making purposes.

With four of the five participants having prior experiences with ~~adaptive learning technologies for mathematics~~ ALT-Ms as a user and/or as a leader, their experiences were each unique. Cameron and Riley described positive experiences through continued use and want for the former tool, respectively. Alex and Casey offered glimpses of what they might expect moving forward when implementing a different tool as they described how they were involved in their implementations. Jordan's lack of prior experience with leading a mathematics department and an adaptive learning technology implementation was the most distinct of the group.

Inconsistent Training to Prepare Them to be Technology Leaders

As participants described their previous experiences with ~~adaptive learning technologies for mathematics~~ ALT-Ms, they reflected on their pathway to becoming technology leaders in relation to their respective implementations. ~~Like As with the variety in their~~ prior experiences with leading implementations, ~~they~~ variety was also apparent in their ~~also had an~~ array of training experiences to become technology

leaders of their schools' implementations. All participants had completed master's programs prior to becoming a principal or AP, with Cameron and Jordan having completed coursework for doctoral programs. Only Cameron mentioned learning about technology leadership in leadership coursework which he was able to ~~paired with~~ personal, prior experience with the tool itself:

The other part of it is, is just my understanding based on my own leadership classes that I've taken through my own studies that say...If we're going to understand and ensure an understanding of technology, it's got to be broad enough that it's not only the hardware but the software. And it's not only the teacher level or you know the building level, but it's all the way down to the community level and providing those systems and structures and supports. (Cameron, personal communication, November 18, 2022).

No other participant mentioned completing undergraduate or graduate coursework as a component ~~for in~~ how they operate as technology leaders of prior and current implementations, with Alex explicitly sharing, "~~...through my undergrad, no-~~" and Jordan sharing that the technology leadership skills currently possessed were learned:

~~...always~~ very ad hoc. It wasn't like I was part of an instructional technology program. So whatever knowledge I have now, I've picked up informally along the way and never through a formal program. Not that they don't..., I know they exist now, and people are pursuing them. Several people I know actually have joined innovative technology programs, whatever they might be titled. I personally have not had that exposure. (Jordan, personal communication, February 23, 2023).

When technologies (adaptive technologies of others) were introduced to the participants and their educators for adoption, ~~participants would attend~~ professional development (PD) sessions were offered by their district or the vendor. The sessions that participants attended for previous adoptions were geared towards teacher-users rather than leaders ~~with and had~~ outcomes that focused on the tool itself and how to use it rather than the leadership of the implementation. Riley was the only participant

Commented [JR2]: This quote is hard to read . Is there more you can take of it?

who mentioned previously engaging in PD designed for leaders, which was offered to train them for the implementation they were set to lead:

So, when I first started at my current location, there was no training because the previous administrators were trained, but the company wasn't aware of the turnover...But my second year, teachers received training, administration received training consistently throughout faculty meetings and professional development. So, we were trained on...This is the data you should be looking for, this is where you are on the time of the school year, this is how they should be doing their lessons. You shouldn't just be giving all blue. So, it was very in-depth training and now the district was monitoring us. So, my first year was about who has the most minutes? And then it was like, okay, now let's put minutes and passing lessons. And it was like that. But then the second year we really started from scratch and received a lot of great training. (Riley, personal communication, April 5, 2023).

Of the five participants, Riley's experience with PD for the school's previous implementation serves as the only examples ~~where of~~ one among the group who was prepared, as a leader, for their implementation.

Cameron's district provided PD in a variety of settings (in-person trainings, virtual/live webinars, asynchronous courses, ~~eteetc.~~) for users to take advantage of.

Attendees were able to "...learn about those technologies (Cameron, personal communication, November 18, 2022)." Throughout that model, ~~but~~ there was no mention of training about-on how to lead the implementation exclusively for leaders.

When reflecting on learning about new technologies to be implemented building-/district-wide, Jordan remembered being in a traditional classroom-like setting with a trainer, and learning how to use the technologies that were being adopted:

We were externally trained in the sense that we would go to an external location, sit down in a classroom, and learn from an instructor how to use those technologies. Same thing with student management systems, same things with different kinds of databases where you'd access student performance data and learn how to mine the data. All of that originally was taught to us in contexts that were very familiar, meaning classroom

environments with an instructor teaching us and giving us opportunity to practice and learn. (Jordan, personal communication, February 13, 2023).

These trainings would emphasize the features of the tool itself, rather than how one would lead an implementation in their building with their educator and stakeholders.

Commented [JR3]: Do you want the plural form here--educators?

Participants also shared that for prior implementations, they had often attended PD with their teachers in the absence of formal leadership PD. As the PD sessions were geared toward teacher-users and how to use the tool, participants would attend to gain a level of understanding about the tool to be implemented, which could be helpful in their leadership of the technology. Casey or the school's AP would make a point to of attending the teacher training as a learning opportunity about the tool and learn what their teachers were learning:

Commented [JR4]: I would cut this--it's mentioned in the long quote and already mentioned in the previous sentence

I participate in training with teachers as well. So, if there's a professional development opportunity, say for a piece of software that third grade is going to be using, either my assistant principal or myself, make it a point to be there as well. So, we develop an understanding. (Casey, personal communication, February 27, 2023).

Riley would also join teacher-focused PD and "...study before the meeting." offering an opportunity for increased engagement in the session and the ability to monitor the school's educators in attendance (Riley, personal communication, March 28, 2023).

Collaborating with and learning from others who had experience using or leading the adoption of the tool ~~tool being adopted~~ was another form of training that participants leveraged to support their leadership of their implementations. Though not pervasive across all participants, Casey and Riley described this as a learning strategy for previous implementations. Casey found value in "...surrounding yourself with others who have skills...and asking them to show you how to utilize that tool. I think you grow a better understanding of that technology." (Casey, personal communication, February 27,

2023).¹² Like the teacher-facing PD, this collaboration focused on features of the tool itself and how to use it rather than leadership of an implementation. Riley was the only participant who shared a prior experience that seemed to directly speak to leading an implementation. After taking over the school's math department as AP¹³ and recognizing the need to learn more about how to lead their i-Ready® implementation, Riley connected with a colleague who had experience as a building and district leader overseeing an i-Ready® implementation:

I called my friend who's now the chief area superintendent in another county, and in their county, they have i-Ready® meetings with the superintendent and principals. So, he taught me the basics, what I needed to know. (Riley, personal communication, March 28, 2023).

Of the training opportunities the participants described, the referenced coursework from Cameron's leadership program and Riley's 1:1 collaboration with an experienced peer who ~~was experienced in leading~~ their own adaptive learning technology implementation were the only training experiences that focused directly on leading technology implementations. Leaders who joined teacher PD or were trained about a tool's features and how to use them recognized that they still had more to learn as leaders.

Self-directed learning

In each of their previous implementations, all found it necessary to seek additional means to learn. Participants engaged in other less formal and non-traditional opportunities to learn how to better lead their implementations, beyond the training offered by vendors or their districts. Adding on to the collaboration described above (1:1 training),¹⁴ participants described instances of learning from their own experiences,

leaning on others, and even scouring the internet to feel more comfortable in their roles as technology leaders.

Participants seeking out ways to teach themselves to better lead their previous technology implementations each took it upon themselves to learn more. Jordan described this tendency of autodidacticism in leaders as becoming far more common as technologies advance:

I think that we've all become a little bit more autodidactic in the sense that rather than being told or trained by some external individual at a seminar or in a workshop, more often than not, lately, when we're confronted with a particular challenge, we have to go, usually online, to find resources that will be able to give us the information and the experience necessary to learn...So, I see a lot more kind of, again, self-directed learning going on in our role as leaders of trying to figure out how to do certain things because the technology's available to do so, number one. But also, because if we don't move quickly ourselves, we're going to get left behind. (Jordan, personal communication, February 13, 2023).

This was a similar thought shared by Cameron who described that in the event adequate training for leaders was not provided, “...then that's on me to learn it and pick it up” (Cameron, personal communication, November 18, 2022).” But rather than looking for additional coursework or formal training, Cameron looked online for more information and tools for support saying, “So, what am I going to do? I'm going to go online. I'm going to look at the web. I'm going to follow the YouTube videos...” (Cameron, personal communication, November 18, 2022).” Jordan echoed this sentiment about finding ways to become more in tune with leading an implementation:

...along the way I, like many of my colleagues, have found ways to get schooled up when we needed to as a new technology was being introduced in a particular area. Whether it was a department in a school or if as a district administrator at a particular school was embracing something, we would find a way to learn about it and if necessary to get some training. (Jordan, personal communication, February 23, 2023).

Participants also described learning on their own through an experiential lens.

Both Alex and Casey shared that they learned a great deal of what they do as leaders from doing and attempting to use technology earlier in their careers. Alex believed ~~to have~~he had developed the relevant skills needed to lead the school's implementation while working as a classroom teacher and growing as an educator with the increased use of technology:

I always joke that my first couple years of teaching, my first year I had a chalkboard and a projector. And then I think my second year I got a whiteboard and my third year I got an active board. It was hilarious the progression of how quick just in those first couple years teaching that I saw technology. So, I think I kind of came in at a time where I was growing with the technology. (Alex, personal communication, November 29, 2022).

Similar to this developmental, hands-on experience, Casey believed that trial-and-error with technology, in addition to attending teacher-PD, also played a role in the leadership of previous implementations, ~~comparing which she compares to~~ that type of learning to kids using new applications:

Other is trial and error. Many of the apps that you download, they don't come with directions. So, I think as adults, we're afraid of pushing buttons and wondering what's going to happen. And as kids, they push every button on the screen. (Casey, personal communication, February 27, 2023).

Adding on to these ideas, both participants, ~~like as~~ Riley shared above, valued tapping into the expertise of others to further their understanding in an effort to better lead their previous implementations. Alex would "lean on others who have skillsets in those areas" (Alex, personal communication, November 29, 2022). "when needing additional support in leading, which resembled Casey's thinking that "surrounding yourself with others as well who have skills...and asking them to show you how to utilize that tool. I think you grow a better understanding..." (Casey, personal communication, February 27, 2023).

These examples illustrate how participants used their own experiences and the expertise of others ~~in an effort~~ to support their own technology leadership practice.

Reflecting on their prior experiences with ~~adaptive learning technologies for mathematics~~ALT-Ms, the participants shared a variety of examples. Their experiences ranged from no past experiences ~~to a former user~~ with experience leading an implementation of the same tool. Just as their experiences differed, so too did the training ~~they had~~ received to be technology leaders. Only two of the five participants had training or received support that directly focused on leadership of a technology implementation. Leaders joining teacher-facing PD was common, but the focus of those session was about the tool itself rather than the leadership of an implementation. All participants understood that they needed something more to be successful and, on their own, found alternative training options to better lead their implementations. With the participants' past experiences described, we will look the present to learn about how they are currently leading their ~~adaptive learning technologies for mathematics~~ALT-Ms at their respective buildings.

Commented [JR5]: This sounds strange--like addiction 😊

Research Question Two: Experiences Leading an implementation of an Adaptive Learning Technology for Mathematics

After describing their previous experiences with technology leadership and leading technology implementations, Research Question 2 (RQ2) asked participants to focus on their leadership of current implementations of ~~adaptive learning technologies for mathematics~~ALT-Ms. Table 4-3 illustrates the tools being used at each school, and the grade-levels, with student groups, where appropriate. Cameron is leading two different adaptive technology implementations, and when reporting out, ~~the specific tool~~ will be named as the implementations are in different stages of adoption.

Commented [JR6]: You might want to rephrase this.

Table 4-3. Adaptive learning technologies for mathematics by participant

Participants	ALT-M	Grade Levels	Student Groups
Cameron	MobyMax®	6-8	6 th , 7 th , and 8 th (Tiers 2 & 3)
	MathIA®	6-8	All
Alex	IXL®	6-8	All
Jordan	IXL®	9-12	English Language Learners
Casey	Zearn®	K-4	All
Riley	IXL®	5-8	All

As with their previous technology leadership experiences, the participants' overall experiences with leading their current implementations were also different. These differences resulted in a vast array of data from which to draw themes. For this reason, the details from the leaders' responses were organized into categories first, and then themes were created. The following three themes were identified from analyzing the participants' interview responses:

- Varied training for and conceptualization of technology leadership
- Low familiarity of the ALT-M
- Strategies employed for current implementations

Considering the varied experiences with formal training and conceptualization of technology leadership, the categories were developed based on the training provided to lead their current implementation, what leaders described about-regarding their familiarity with ISTE standards, and how leaders conceptualized technology leadership as a construct. Next, the leaders' familiarity with the adaptive learning technology were organized into categories around the leaders' understanding of the presence of their state standards and SMPs, the presence of NCTM's effective teaching practices, and how the adaptive learning technology adapts for students. Given their level of familiarity,

the strategies used for their implementations were categorized based on strategies used for adoption, use, and maintenance of their implementations. Table 4-4 summarizes and lists the themes and categories with samples of the codes and descriptions.

To better illustrate the leaders' current ALT-M implementations, vignettes will be used to illustrate their lived experiences. Each vignette will highlight what training they received and describe how they conceptualized technology leadership of their respective implementations. The leaders' vignettes will also illustrate their level of familiarity with the ALT-M tool, specifically focused on the content used with students. These vignettes will provide a clearer look at their lived experiences and highlight the similarities and differences between the leaders.

Table 4-4. Themes, categories, sample codes, and descriptions for RQ2

Themes	Categories	Samples codes	Descriptions
Varied preparation for and conceptualization of technology leadership	Minimal Leadership Professional Development	High-level leadership PD	Variety of PD sources leveraged by leaders outside of formal leadership PD.
		No leader PD, joined teacher PD	
		Learns or finds experts for collaboration	
	Low familiarity of ISTE's Standards for Ed Leaders	Not familiar with ISTE Heard of ISTE standards; not considered Unsure of ISTE standards	Degree at which leaders were familiar with ISTE's Standards for Education Leaders.

Formatted: Indent: First line: 0"

	Varied Conceptualization of Technology Leadership	Leads by modeling Supports teacher development Have understanding and awareness	Unique ways leaders viewed their actions taken as technology leaders.
Low familiarity of the adaptive learning technology for mathematics	Alignment to State Standards and SMPs	Moderate familiarity with State Standards Assumes alignment No State Standards; no SMPs	Leader familiarity with how the content aligns to state standards and SMPs.
	Presence of NCTM's Effective Teaching Practices	NO NCTM Unsure of NCTM Conflates NCTM & SMPs	Leader familiarity with how the content aligns to NCTM's Effective Teaching Practices.
	How and When Adaptivity Happens	Understands that tool is adaptive (not <i>how</i>) Moderate understanding of adaptivity Minimal familiarity with adaptivity	Leader familiarity with how the tool adapts when used by students.

Table 4-4. Continued

Themes	Categories	Samples codes	Descriptions
Low familiarity of the adaptive learning technology for mathematics	Alignment to State Standards and SMPs	Moderate familiarity with State Standards Assumes alignment No State Standards; no SMPs	Leader familiarity with how the content aligns to state standards and SMPs.

Strategies employed for current implementations	Presence of NCTM's Effective Teaching Practices	NO NCTM Unsure of NCTM Conflates NCTM & SMPs	Leader familiarity with how the content aligns to NCTM's Effective Teaching Practices.
	How and When Adaptivity Happens	Understands that tool is adaptive (not <i>how</i>) Moderate understanding of adaptivity Minimal familiarity with adaptivity	Leader familiarity with how the tool adapts when used by students.
	Adoption Strategy	School-based decisions Grassroots/bottom-up Robust adoption process	Strategies used to adopt the ALT-M.
	Use Strategy	Used for RTI needs Tool supports access/equity for Algebra 1 Used with ALL students for SGI	Strategies leaders used to support student learning.
	Strategies for Maintenance	Ensures "why" is communicated. All stakeholders involved Engages stakeholders via communication	Strategies used to ensure use of ALT-M aligned with intended use.

Leader Vignettes

Cameron

Cameron led two ALT-M implementations for the school: MobyMax® and MathIA®. The decision to adopt MobyMax® was school-based, while MathIA® was adopted as part of a district-wide core mathematics adoption. Leadership-focused PD was not made available for either implementation. When asked about joining any leader-focused PD for the MathIA® implementation, Cameron recalled:

Formally not [any]...none? I mean...It was it was self... I mean...Yeah, no. None...That's the newest one [MathIA®] that's being included. And that one, you know, the teachers have been offered a lot of guided and direct instruction and formal instruction where they can go to learn how to use that. At the administrative side, it's...no... (Cameron, personal communication, November 23, 2022)

Though the district did not provide PD for leaders, the district provided teacher-facing PD as an option for those who wanted to attend. Cameron continued to describe what professional development options were available, specifically for teacher (in-person, recordings, synchronous webinars) and reiterated that with the district's MathIA® implementation, no leadership PD was made available to school leaders across the district:

...the district bought MathIA® and remember I said to you as an administrator, I did not get the professional development on the MathIA®. But all of the teachers have been provided that opportunity to attend that professional development, so that's important. (Cameron, personal communication, November 23, 2022).

To that end, the school's MobyMax® implementation looked differently than the MathIA® implementation due to Cameron's previous experience with the tool as a user and leader. To lead the MobyMax® implementation, Cameron paid for a subscription to asynchronous learning modules, learned from trial-and-error, connected with the vendor to remedy any confusion, and self-studied to be better-equipped to lead:

It's mini modules that you can go and watch...the little YouTube videos for that...you know I subscribe and have that...So I've, at this point, pretty much reviewed all of them. I've just done a lot of back-end reading up on it, learning about it, trial [and error], talking with the company...So that part of it has really been through my own delving into it and speaking with their representatives to best suit it for the school that I'm at. (Cameron, personal communication, November 23, 2022).

As technology leader, Cameron would recommend and share these “mini-modules” to teachers as needed and would join them in grade-level team meetings to watch the

videos and practice with teachers to develop their understanding of this ALT-M. This work, and almost 10 years of experience, shaped Cameron's preparation to lead the school's current MobyMax® implementation and generated results from educators' and students' use of the platform which will be described later.

Commented [JR7]: Just review this--I'm not sure how it fits with the subject "This work and almost 10 years of experience"

Recall that this leader was working on a doctorate degree at the time of the interview. When asked about ISTE's Standards for Education Leaders, Cameron alluded to having some exposure to the standards from recent coursework but could not recall what they were at the time of the interview. When describing what it meant to be a technology leader, Cameron believed that being a technology leader is where a role in which one "owns the implementation" and supports and develops the skills of their teachers and stakeholders (Cameron, personal communication, November 18, 2022). In both implementations, technology leadership also required a level of understanding of how to use the tool, or a degree of awareness about the tool. This was necessary to support users and lead the implementation. Cameron sharing-shared that as a leader, "...if I'm going to ask somebody to do something, then I better know how to do it first and then I better ensure that they understand how to do it" (Cameron, personal communication, November 18, 2022). Cameron believed that it was the leader's responsibility to know and understand what their educators knew or didn't know regarding their implementations, what they were using or were not using, and to provide professional learning opportunities to strengthen usage to further their adoption. Professional development was valued and especially when it was grounded in educator usage and experience. Cameron also felt that having a working knowledge of the tool in order to engage in conversations with others who might have a greater level of

expertise was a component of leadership, though this was not actively part of the technology leadership strategy being used with either of the two implementations.

Moving from how this leader conceptualized technology leadership to familiarity with the content presented to students with the ALT-Ms and their functionality, Cameron described an emerging, working knowledge of the state standards and the SMPs and, while admittedly unable to bring up specific state standards from memory, there was familiarity around where to access them:

I'm new at that in terms of... you know, the state standards are something that I'm familiar with. I know that they exist. Do I know them by memory? No. Do I know where to find them? Absolutely. The standards for mathematical practices, that was something that was introduced to me this year through a class, again class, that I'm taking, which is the district-offered mathematical practice, best practices for mathematical administrator... for mathematics administrators in the district. So, I'm taking that class, and they gave us the book, which happens to be right here, you know. "Mathematic coaching...everything you ever wanted to know," and it talks about those standards and mathematical practices and so yeah that's where I'm at with it. (Cameron, personal communication, November 18, 2022).

When asked to elaborate on the connection between the adaptive technologies and the state standards, Cameron did not indicate in what capacity the tools did or did not match the state standards nor was a connection to the SMPs in either platform described, though they did believe that the tool they had been using the longest, ~~did~~ have had some degree of alignment ~~to-with~~ standards or affiliated skills. Continuing to explore the ALT-M's, Cameron had some familiarity with NCTM's Effective Teaching Practices. The level of familiarity was described as introductory after recently learning about them at "a training last month" about mathematics instruction (Cameron, personal communication, November 18, 2022). With this entry level of familiarity, Cameron was not able to identify the level in which the teaching practices showed up in any of the

content presented to students and often conflated SMPs and NCTM's teaching practices when describing what was present in the content. On adaptivity, Cameron described that MobyMax® would assign content based on an area of need and adjust what is subsequently assigned based on performance. ~~In an example,~~ Cameron shared that "as they gain mastery in that standard, [MobyMax®] assigns them the next standard in which they're going to build mastery" (Cameron, personal communication, November 18, 2022).² No descriptions were shared about the content available from MathIA®, suggesting low to no familiarity.

Commented [JR8]: I think this phrase doesn't match well here--just be sure you agree with my deletion.

Alex

Alex's IXL® implementation was a school-based decision, adopted after teachers piloted the tool and advocated for a school-wide adoption. Alex was one of two leaders who recalled attending a PD designed exclusively for leaders. The training, held before the end of the previous school year, was described as a 45-minute "virtual seminar" that highlighted "~~---~~how to look at the analytics, to look at how much it's being used, [and] how they're using it" (Alex, personal communication, December 1, 2022).² The session focused more on features of the program rather how to lead the implementation. Though PD was available for teachers to launch the implementation via asynchronous video, Alex did not participate, but did plan on joining the school's teachers in their ~~upcoming, upcoming~~ PD session scheduled for the middle of the school year.

Looking at technology leadership and ISTE's Standards for Education Leaders, Alex claimed to have some exposure from other technology adoptions⁷ but could not remember what they were at the time of the time of the interview:

Now I'm going to blank on what the name of it is. I mean, for when we first went one to one, we used a framework, and if you told me, I would totally know what it is, but I can't even think about what it is now. Let me think on

that...Obviously, it's not fresh in my mind right now, so yeah, not using right now, so...Holy cow. Yeah, that's terrible. Obviously, it did not stick. (Alex, personal communication, November 29, 2022).

To lead this implementation, Alex believed technology leaders needed some level of understanding of the tool in order to support ~~teacher~~teachers' use of it with students. Alex continued saying, "I think that they do need to have a skillset on the technical side. It's hard to teach teachers how to use the technology if you don't know the technology yourself" (Alex, personal communication, November 29, 2022). This was actively being done to lead their IXL® implementation.

Commented [JR9]: What is 'this' ?

Alex had ~~stronga~~ strong handle on how state standards were featured in the tool and seemed familiar with the content presented to students in IXL®. Because IXL® was adopted by teachers first, then supported by the district, Alex confidently assumed, ~~with confidence,~~ that the tool aligned with their state standards. ~~Only after attending a A~~ webinar training confirmed ~~was~~ this assumption ~~confirmed as the PD reviewed the as~~ the tool's alignment to state standards ~~were,~~ reviewed and demonstrated how an educator could "click by standard to access the material," or view growth opportunities also by state standard (Alex, personal communication, December 1, 2022). After that session, Alex "did appreciate that it is very clearly aligned to [our] state learning standards" (Alex, personal communication, December 1, 2022). Despite this connection to state standards, there was ~~no~~ mention of neither familiarity with the SMPs nor if/how they were present in the IXL® content. This was also true of NCTM's teaching practices. From Alex's perspective, the NCTM concepts were not something being considered as other content areas were factored in ~~to~~ the IXL® adoption:

I can't say that I specifically have looked for that, especially because we're using [IXL®] across multiple content areas with ELA, math, and science.

I'm not specifically looking through a lens of math specifically. (Alex, personal communication, December 1, 2022).

How IXL® adapted was unfamiliar to this leader. The closest description was of a non-example of an adaptive technology where Alex shared that the technology “didn’t necessarily adapt or change based on how the student responded” (Alex, personal communication, December 1, 2022).

Jordan

Jordan, also leading a school-based IXL® implementation, did recall attending a virtual PD for leaders. Jordan’s experience was similar to Alex’s in that the training “...was a very simple training, which had to do with how to access information in IXL® and how to utilize it, but not much on how to actually implement the program itself for student users (Jordan, personal communication, February 23, 2023).” This leader PD focused on features of IXL® rather than strategies to lead the implementation. The EL teachers who used IXL® were provided PD opportunities, but Jordan and other leaders did not attend.

Jordan was not familiar with any technology standards for education leaders. How Jordan approached technology leadership prioritized awareness of the tool rather than a deep understanding. While supporting teachers use of IXL®, Jordan believed that having an increased awareness about the IXL® was preferred to support teachers and students using the tool:

So, I personally felt I needed to tune up my awareness of technology and how it’s used to support student learning and good instruction. So, my way of saying it is extremely important for a school leader to be technologically aware and to be able to at least engage in conversations thoughtfully with those who have more expertise so that we all can increase our learning. (Jordan, personal communication, February 13, 2023).

Though this leader had the most experience in the role as a school leader, Jordan was “...probably the least confident” with technology leadership and also acknowledged a lack of understanding and experience with the IXL® adoption:

I'm a little embarrassed that I don't know more about what's going on with that, but it's something that I should be checking in on to see if, is this something we could perhaps expand to other areas. (Jordan, personal communication, February 23, 2023).

When asked about the content presented to students, Jordan had the least familiarity with state standards, SMPs, and the degree to which those were present in the IXL® material. Jordan shared that, “I don't think I can answer that. I don't know. I really don't know...I'd just be guessing” (Jordan, personal communication, February 23, 2023).

Familiarity with the NCTM teaching practices and their presence in IXL® content was also absent. Jordan did have some understanding of how IXL® adapted, referencing the reason the EL team wanted IXL® because of the adaptive nature of the tool:

I know that there was a rationale that related to the technology being responsive to the student's level of ability...I know our EL team lead talked to us about wanting to use IXL® because it did have adaptive features to it, that it could sort of meet a kid where that student was and help provide the sort of targeted practice to help the student accelerate kind of through a continuum of skills. (Jordan, personal communication, February 23, 2023).

Casey

Casey's Zearn® implementation was part of a district-wide mathematics curriculum adoption. To lead the school's Zearn® implementation, leadership-focused PD was also ~~not made available to~~ unavailable for leadership for district leaders. Casey did join teachers in their PD saying “It's important for me to have an understanding should I need to support teachers as far as what the expectations are of the program...(Casey, personal communication, March 9, 2023).” This practice was

Commented [JR10]: Needed?

Formatted: Strikethrough

continued throughout the first year of the implementation to have a better awareness of Zearn® to better lead and guide the implementation.

Casey remembered that ISTE's standards for education leaders existed as a concept but was not able to recall any specifics when asked about standards for technology leadership. Casey described that as a technology leader, similar to others, increased levels of understanding of the tool to support users was important. Further, Casey also believed that a technology leader should have enough of an understanding about the technology to be able to model its use with educators:

I think modeling is really important. So, if I'm expecting our staff to use some type of software, it's important for me to utilize that during a data meeting or during a faculty meeting to show them the benefits of that. And also, to have that as a look for when I'm going into a classroom, even if it's just a walkthrough and I'm jotting a note down to put on someone's desk. I like the way that you're using MobyMax® in this situation, or that was a great use of Zearn® during this time period. (Casey, personal communication, February 27, 2023).

Casey also indicated that it was the leader's responsibility to have a strong sense of the teachers' and students' experiences with the ALT-M and provide opportunities for support and PD where possible. Teacher's professional development played a substantial role in elevating teacher use and proficiency with using Zearn®.

The content in Zearn® was described with confidence as having a strong alignment to state standards. Because of the thoroughness of the pilot and adoption process, their state standards were believed to be present. This was also later confirmed as Casey ~~become~~became more familiar with the tool and the data. Though Casey was familiar with the state's standard, the SMPs and their presence in Zearn®'s content was not discussed. Likewise, NCTM's presence in Zearn® content was not mentioned. Casey did use the phrase "self-adjusts based on student ability" when

describing Zearn®'s functionality as an ALT-M (Casey, personal communication, March 9, 2023).

Riley

Unlike the other two IXL® implementations, this leader did not describe attending leader-specific PD. Instead, Riley joined teacher-facing PD as it was available and learned from colleagues and peers who had more experience with the ALT-M. As shared above, this was also something done with previous ALT-M implementations.

Riley was not familiar with any sort of leadership standards and replied "absolutely not" when asked about familiarity with ISTE's standards for education leaders (Riley, personal communication, March 28, 2023). Though unfamiliar, Riley believed that as a technology leader, at the minimum, it was important for leaders ~~have to have~~ some degree of understanding and awareness of the tool to support and lead teachers in their implementation. Riley ~~described-reported~~ having an increased level of understanding of IXL® to support teachers and students. This level of understanding illustrated a high-level of involvement and deeper knowledge in the teachers' implementation that resembled a partner in their use of IXL®:

I'm there every step of the way. I'm in the classrooms. I'm watching, I tell my teachers, don't take it personal. I love being in classrooms, watching it being implemented, giving feedback, encouraging the students to use it, talking to the parents about it. So, I'm just very involved in the beginning stages...professional development, I'm taking notes with them, asking questions. And then when it's time to have my grade level meetings, you're having a talking point on that. (Riley, personal communication, April 5, 2023).

On how IXL® functioned and the content presented to students, Riley's state recently revised their standards for mathematics, which resulted ~~with-in~~ an emerging level of familiarity with the state's standards. Once the team adopted IXL®, teachers

Commented [JR11]: Check this replacement

spent time analyzing the content and making comparisons to the new standards from the content provided in IXL®. The teachers and Riley found that IXL® was semi-aligned to the new state standards, but there were some gaps:

I do know that when I do sit with the teachers I ask, “Does this match the actual standard?” And so sometimes they find it that no it doesn't...It's a gap year. So, there are a lot of gaps, especially in seventh grade, sixth and seventh. So, they sit, and they study to see is this going to...not every lesson is a perfect IXL® lesson. (Riley, personal communication, April 5, 2023).

This was the only instance where the leader and teachers analyzed the content from the adaptive technology and compared it to the state standards during the implementation. Riley did not describe any familiarity of the SMPs or their presence in IXL® content. The same was true for NCTM's effective teaching practices. Riley seemed to understand the adaptive functionality the least of the school leaders. When asked, Riley discussed how teachers would opt to choose content for students and push it out to them rather than leverage the adaptive nature of the tool. This was the most unique response from the leaders as it alluded to some educators not maximizing the adaptive feature at all.

These vignettes illustrated each leaders' experiences with their current ALT-M implementations by focusing on how they were prepared to lead and how they conceptualized technology leadership. Leaders also shared their familiarity with the content from their ALT-M and how it connected to their state standards, the presence of the SMPs, and if-whether NCTM's Effective Teaching practices were present. Leaders also described their level of understanding with-of how their ALT-M adapted content for students. Regardless of these parallels and differences, leaders used several strategies to support their implementations, which are featured and described next.

Strategies Employed for Implementations

The participants did not use a consistent process for how their adaptive learning technology tools were adopted, used with students, or maintained across the five participants' schools. Nonetheless, each participant did have a strategy in place for their implementation and were able to provide details about their rationale and experiences. The participants described the adoption processes used, how the tools were implemented in classrooms, and how the leader maintains their implementation. Table 4-5 illustrates the type of adoptions used for each participants' adoption.

Table 4-5. Adaptive learning technology, adoption-type, and strategy for use.

Names	Adaptive Technology	Adoption Type	Use with Students
Cameron	MobyMax®	Leader-led	RTI
	MathIA®	District-led	Tier 1
Alex	IXL®	Teacher-led	Small group instruction
Jordan	IXL®	Teacher-led	EL/SpEd Students
Casey	Zearn®	District-led	Small-group instruction
Riley	IXL®	Teacher-led	Small group instruction

Adoption strategy

Participants did not use a standardized process in the selection and adoption of their [adaptive learning technologies for mathematics ALT-MS](#). Though the strategies used were not consistent, there were some similarities between implementations. The strategies for adoption included [the following](#):

- Leader-led, top-down
- Teacher-led, bottom-up
- District-led, top-down

Below, the participants' experiences in relation to the strategy that they used will be described, illustrating their involvement and leadership of this phase in their implementations.

Cameron's MobyMax® implementation was the only school-based adoption that was purely initiated and led by the leader. ~~Given the Cameron's~~ prior experiences as an educator and leader with this tool, ~~its~~ their selection of this tool for the building was not a surprise. To encourage adoption, Cameron positioned MobyMax® as a supplemental tool educators could use to support their core instruction and has been pleased with educators' use and response:

I'm the new administrator at a new school. OK? And so, I'm, you know, I've got some old dogs that have done their tricks for a long time. So, coming in and saying, hey guys, here's this program that you can use in your classroom to differentiate your instruction...Um, I wasn't sure how receptive it would be, and I'm pleasantly surprised as to the positive response that I'm getting. (Cameron, personal communication, November 23, 2022).

Admittedly, Cameron's mastery with using and leading implementations of MobyMax®, paired with a positive mindset, contributed to the educators' inclusion of this tool into their classrooms and ~~use~~ of the tool to support their students' learning. Though educators report a positive experience, this adoption process and level of educator involvement contrasts all other strategies for adopting an adaptive learning technology in participants' buildings.

For three of the five participants, ~~teacher~~ teacher-users initiated the adoption, which was then supported by building and district leadership. Coincidentally, these were also the three IXL® implementations. Alex, Jordan, and Riley described the adoption of IXL®, each beginning with their schools' teachers. For Alex, two classroom teachers had purchased and used IXL® on their own in years before this implementation and were

happy with it. Alex received an advertisement for low-cost, school-wide access⁷ in the year prior to adopting IXL® for the entire school and opted to pay to give teachers access for the semester. All teachers had the option to use IXL® and after they began using it, ~~they really liked it and~~ asked to continue the implementation for the subsequent year:

Commented [JR12]: Delete? Not very academic in tone

Formatted: Strikethrough

~~...we~~ we did have some teachers on their own who were using IXL® in previous years. And so that was just kind of on their own. It wasn't a school-wide thing. And so when they sent me something last year, I don't know how it grabbed my attention, but the fact that it was only \$500 for a whole semester for math, ELA, school-wide...I'm not going to lie...the price of it and just knowing that people were happy with it before...So, it was a no pressure. Here's a resource for you if you want to use it. Teachers started using it, they really liked it. So, it was kind of a grassroots thing. Then they all requested it for this school year. So, then we decided to go ahead and purchase for this school year. (Alex, personal communication, December 1, 2022)⁸.

This type of adoption, the “grassroots thing,”⁹ was different than what had happened with previous implementations as it was driven by teachers, supported by the building, then further supported by the district:

This one, because it was kind of driven by our building, it was a little bit different than what I would say...was normal. When we implement normally, things come from, I would say our assistant superintendent of curriculum and instruction, our director of professional learning and our facilitators...district facilitators. So, this was a little bit different because it came from the building, and we ended up getting support through our central office. (Alex, personal communication, December 1, 2022)¹⁰.

Though different than what has been previously experienced with technology implementations, Alex has preferred this bottom-up approach and was interested to see what the classroom experiences and student data would be like as they continue with using IXL®.

Like Alex, Riley's IXL® implementation was also begun by the school's teacher. Here, the math department head, a seventh-grade teacher, had been using IXL® for

over six years and experienced success. With changes in state governance and learning standards, the school's previous tool (i-Ready®) was no longer supported by the district, so educators looked for an alternative. Seeing their department chair's experience and success with IXL®, they opted to adopt it for their classrooms. From there, Riley became involved in their implementation to provide support and guidance where needed.

The third IXL® implementation was also initiated by teachers, then further supported by building and district leadership. In this example, Jordan's English Learner (EL) team expressed a need for a tool to support the building's EL population with targeted material based on ~~their students'~~ current level of performance ~~and, they~~ The EL team believed IXL® would be the best tool for this:

I know our EL team lead talked to us about wanting to use IXL® because it did have adaptive features to it, that it could sort of meet a kid where that student was and help provide the sort of targeted practice to help the student accelerate kind of through a continuum of skills. (Jordan, personal communication, February 23, 2023).

During their exploratory process, the EL teachers sought direction and guidance from current district leaders with prior experience with IXL® ~~and~~ who ~~were able to~~ ~~provide~~ provided insight on what they might expect and how the tool could serve their needs. The teachers brought the relevant information to Jordan and the building's leadership team to ask if this would be something they would fund and support; they did:

~~...~~those conversations that I personally was a part of really involved our EL department and our team lead, working with a district administrator saying, this is a tool that we know is going to give us the kinds of, provide our students the kinds of experiences we think they need to get extra

Commented [JR13]: This acronym has already been used. Do you want to take the full name out here and add to the first mention?

Formatted: Line spacing: Double

practice in this iterative process. And so, they basically begged us to sponsor and fund it. And so, we did. (Jordan, personal communication, February 23, 2023)-

While this adoption, ~~like-as~~ with Alex and Riley, was initiated by the teachers, it was not based on their peers' prior experience or success. Rather, their decision was influenced by what they learned about the tool and what a district leader shared about their understanding of what IXL® could offer ~~and~~; it seemed to fit and be approved by Jordan and the leadership team for funding and support. The teacher-driven, bottom-up strategy for adoption, despite some of the differences, was the most common strategy used to adopt the adaptive learning technology for the participants.

Commented [JR14]: Re-read this: do you want it seemed to fit and WAS approved by?

The last adoption strategy used was a district level, top-down approach, ~~where-in~~ which participants' school districts adopted the tool for all schools and teachers to use. In these instances, the adaptive learning technology was part of a larger core-math textbook adoption, meaning; the district was adopting a new mathematics curriculum program, and the adaptive learning technology was a part of that program. Cameron and Casey led adoptions in their buildings which were part of a broader, district-wide adoption. Though this foundational aspect (the district wide adoption) was common for these two participants, they did have unique experiences at their local, building levels.

The adoption strategy used in Casey's district took over a year and included several stakeholder groups who contributed to the decision-making process: district leaders, school leaders, teachers, parents, board members, community members, and students. The district's director of teaching and learning assembled a committee to explore core-mathematics programs and pilot those that best fit the districts' vision and

needs. Casey noted that several years prior to this adoption, the district and community stakeholders developed their “Profile of a Graduate,” which described the goals, dispositions, and expectations for each student in the district, illustrated in Figure 4-1.

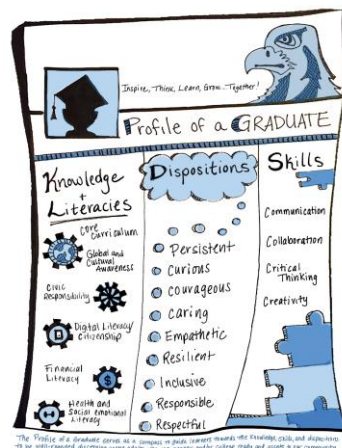


Figure 4-1. Sample from the Profile of a Graduate document from Casey's school district.

This Profile of a Graduate led Casey's and the other committee members' decision-making as their Profile of a Graduate captured their goals and expectation for all students:

We have a “profile of a graduate”, which really led...that's our end in mind. So that was at the forefront of any of our decision making. Staff has received extensive training on our profile of the graduate through throughout the past three to four years of implementation as well. So, they have an understanding of what the goals and dispositions and expectations are of the district. And again, that input came from teachers, parents, students, and community members, board members as well, administrators. So, it encompasses our vision thoroughly as a district. After that process and preparing for that, it really was asking for staff who were on that committee if they or another team member would be willing to pilot that program. (Casey, personal communication, March 9, 2023).

During this pilot phase, Casey and other committee members would meet monthly to provide feedback and commentary on their experiences and connect with a vendor representative for clarity and guidance on any questions or challenges that existed.

Casey and team regularly communicated and shared the rationale for considering new curricula, which stemmed from the belief that their current materials lacked the rigor and alignment to state standards. Communicating “why” the change was needed to community stakeholders in easy-to-understand language was an important piece of this adoption strategy, as it seemed to develop stakeholder understanding and alleviate potential concerns:

But that was really important. I think parents, I think everybody, ultimately wants to understand the why. Why is there a need for a shift? We already have a math program, why do we need to change it? So ultimately, if you can provide that information in a way not using educational jargon and acronyms for parents to be able to understand that's beneficial and can head off any concerns it also helps to have a board member or a parent who's a math teacher or a mathematician or in some type of position that can speak positively about the program that you're considering or core standards as well, because that voice resonates with the public more than say, my voice does or another administrator. (Casey, personal communication, March 9, 2023)

This constant communication during the pilot and adoption process played a critical role in ensuring ample opportunities were available for all stakeholders to learn about the decisions being made and be part of the process should they so choose. The amount of community collaboration was new for Casey and greatly differed from experiences in previous, larger school districts. While working as an AP in one of the state's largest school districts, the adoption process seemed less inclusive, less thorough, and completed over a shorter period of time. Casey did not seem in favor of the strategy used in the previous district and was proud and more confident of the strategy used currently:

I just think that I have the benefit of being in a different ~~district~~district, a much larger district, huge, one of the biggest in [my state], and just having that viewpoint of how curriculum is launched versus a small district. And again, I was an assistant principal when I was in the larger district, so again, my involvement may have been a little bit different, but just the thoroughness and the thoughtfulness of the implementation is huge to develop an understanding. Whereas in a bigger district, it's the week before the start of the school year, you get your new materials and it's like, this is the math program that we're going to be using. You've got one professional development day, actually it's a half a day, two days before kids come back. And just the difference between those two are huge. So that's really important when you're thinking things out. (Casey, personal communication, March 9, 2023).

Through this partnership with all stakeholders, Casey believed that “we determined that Zearn® and [our math curriculum] was a better fit for us.” (Casey, personal communication, March 9, 2023).” Their adoption strategy and consistent communication with the community contributed to this experience.

The district-level, top-down approach described above contrasted with Cameron’s MathIA® adoption. With this district being one of the largest in the country, serving over 100,000 students, the strategy used for adoption aligned more so with what Casey described when working with a similarly sized district ~~rather than the~~and differed from the thoroughness of the ~~latter~~ adoption ~~process with-in~~ the smaller district. The only notable parallel between the two strategies was that the adaptive learning technology was brought ~~t~~ on in tandem with a new mathematics curriculum. For this adoption process, Cameron did not describe who was involved, nor mention community or stakeholder involvement, which ~~was-were elements common to~~in Casey’s adoption. This is not to suggest those opportunities did not happen, but that Cameron was not directly involved in that phase of the district’s adoption. The details for the MathIA® adopt ~~is~~are described here:

Yeah, so district wide, I mean, the entire [school district], which is [one of the] largest districts in the country purchased Carnegie Learning as our math curriculum and that is being used district wide thereby, MathIA® is the program that is in line with that. So that, district wide, MathIA® is what all students will be using. (Cameron, personal communication, November 23, 2022).

There were few additional specifics shared about the strategy for the adoption aside from the fact that the district bought ~~it~~, so the schools were expected to use it. When describing the two adaptive learning technologies being used and the strategies for adoption, it was clear that Cameron preferred MobyMax® to MathIA®.

A final strategy that was identified during this study and applicable to this theme, was the adoption of the adaptive learning technology as a tool to prepare students for their state summative assessment. Alex noted that when IXL® was being considered for adoption, in addition to the input and advocacy received from teachers, the team still felt the tool could also be used to prepare students for their state summative assessment. Since returning to in-person learning from school closures, they believed that IXL® would offer students additional opportunities to practice ~~te~~and, presumably, increase success on the state assessment. This strategy for adoption was an isolated idea and adds to the variety of strategies leaders used to adopt their adaptive technology.

Commented [JR15]: 'still' or 'also' ?

The different strategies for adoption, described above, illustrate how each participant's implementations of an adaptive learning technology came to be at their buildings. These experiences had their similarities and differences but resulted within the tool being a part of their school's mathematics classrooms. The teacher-led strategy was most common, followed by district-led, and leader led. With the adaptive tools in place at their buildings, we will next look at the strategies the participants leveraged ~~for~~ how to determine how these technologies would be used with their students.

Use strategy

How the adaptive learning technologies were integrated into the participants' mathematics classrooms also followed a thought-out strategy for use. Participants clearly described how the tool was being used in their buildings and what purpose it served. The strategies for use ~~did vary~~varied in that there was not a consistent use strategy across all implementations. The following were how ways in which the adaptive technologies were used in the mathematics classrooms as described by the school leaders:

- ~~For s~~Small group instruction/part of a workshop model
- ~~To increase~~For increasing equity and access
- For specific populations

Commented [JR16]: I made these parallel in construction. Just be sure you like this.

Below highlights the leaders' descriptions of their experiences with how the adaptive technology is used in their buildings, illustrating their perspective on the strategies leveraged for use with their teachers and students.

Including the adaptive learning technology as a station for small group instruction (SGI) or as part of a workshop model was the most common strategy used. Four of the five leaders described their preference for their adaptive learning technology to be regularly used this way. Alex preferred the tool to be ~~use~~used in the workshop model, whereas Cameron, Casey, and Riley each described their preference for the adaptive learning technology to be used for SGI with. The workshop model describes an instructional period where the teacher begins instruction with a short mini-lesson, students then work independently or in small groups, and then conclude the lesson with a debrief and reflection (Edutopia, 2020).

Alex was very ~~explicit-deliberate-with-about~~ ensuring teachers were using IXL® with purpose rather than ~~as an afterthoughtafterthought~~. For this implementation, the workshop model best suited this goal with IXL® used as a regular component during the independent or small group time of the math workshop:

And so really, I think where we're going to have to push is instructionally how are we using it instead of...it's not a babysitting tool. It's not, "Hey, kids go get on the computer." If we want that, we could put a TA in the classroom or put us up in the classroom and anyone could supervise that. So how to use it from an instructional lens to get the most out of it. And the example I use a lot with teachers is one of the best ways, probably the workshop model. So maybe you're working with a different group of kids with direct instruction, and you have another group of kids where they're still being held accountable for their learning through the use of the adaptive technology [IXL®]. (Alex, personal communication, December 1, 2022).

This strategy of a purposeful inclusion of the adaptive learning technology was echoed by Cameron, Casey, and Riley, ~~who all focused on through~~ the use of small-group instruction rather ~~describing the~~ than focusing on the entirety of what was expected for an entire math block. Small group instruction is described as:

~~---~~when you teach the students in small groups ranging from 2-6 students. It usually follows whole-group instruction... [and] provides opportunities for flexible and differentiated learning. With the smaller number of students, students have more chances to participate. Teachers are able to monitor the students better, thus providing better and more individualized feedback and support. (Education Week, 2021)

These leaders shared that the use of their respective adaptive ~~tool~~tools would be best suited when time was devoted for small groups. Riley reiterated that this strategy of using IXL® for small group instruction, like the IXL® adoption itself, began with their mathematics department chair, was then adopted by the other middle school teachers, and was then supported by building leadership:

So, whenever we would do our rotations, there was a teacher center station, there's an independent practice station, and then the technology

station, whether it be IXL®, or i-Ready®, or Success Maker. So, it's something...we don't have access to i-Ready® this year, so we have access to IXL®... And it's something as simple as this is what to do by Friday. I'm looking for your accountability sheets. This is what and who needs help along the way while it's being done...When you're doing your small group rotations, this is the station that they're using [IXL®]. (Riley, personal communication, April 5, 2023).

Cameron and Casey also shared similar ideas with their adaptive technologies, with the former describing MobyMax® as a “supplemental tool for small group differentiation” with the latter sharing that, in using Zearn®, they adjusted their schedules to allow all students to take advantage of the opportunities that were possible with the adaptive technology:

I think with our shift in schedules and focusing on small group instruction, and not just for students who need assistance because they're below grade level, but for all students. And I think that the adaptation of instructional materials, in the digital format, is extremely helpful for our students. (Casey, personal communication, March 9, 2023).

Casey's ~~restructure~~restructuring of the building's schedule so Zearn® could be used for SGI, illustrated the next strategy for use, ~~which was to increase~~increasing equity and access for students. Providing the majority of learners with the opportunity to engage with the adaptive learning technology was common in four of the five implementations and, for one of the leaders, was an area of particular interest.

Equity across educational experiences and access to high quality materials and technology were two focal points ~~for which~~when leaders described strategies for using their adaptive learning technologies. Alex, Casey, Riley and Jordan used their adaptive learning technology implementations to increase equity across educational experiences for all students. For each implementation, the leaders described how they used their respective adaptive ~~tool~~tools to give students a better learning experience ~~through~~by incorporating this tool into what their school offers for mathematics instruction. From an

equity perspective, Alex, Casey and Riley shared that they used the adaptive learning technology for every student ~~was within~~within their purview. This offered each student the opportunity to have the appropriate content and scaffolds in place to support their learning of grade-level material. Casey went on to describe how the tool was also proving beneficial for different sub-groups of students in the building:

That even within our subgroups of students we get differing results. And that even reaffirmed the need for our change in schedule and structure of supporting all students as well, which has been really beneficial. And we've made some pretty significant changes as well. We have students who are identified that say for reading but not in mathematics. And I mean they're brilliant in mathematics and I don't think that teachers necessarily understood that until they had this as a resource. And to be able to adjust and differentiate for those students to be successful or continue to be successful in mathematics, despite word problems where students have some and their learning disability kicks in. Progress for English second language students as well. Math is a universal language. It's not something that's limited to English only. So, I think that having this resource with some of these subgroups has been really informative. (Casey, personal communication, March 9, 2023)-

Ensuring an equitable experience for all learners seemed to be on ~~the minds when of~~the minds leaders ~~thought thinking~~thought about scheduling and programming for their schools. Their adaptive learning technology was a part of ~~this the~~this strategy to put ideas into action for their students.

Access to high-quality instructional materials and technology also played a role in leaders' strategizing for their implementations. In all instances, the buildings were one-to-one, meaning each student had their own device, which allowed for increased access to the instructional platform when and where ~~it was~~needed. Taking access to technology a step further, Cameron and Alex recognized that at-home ~~Wi-FiWi-Fi~~Wi-Fi was necessary for students to continue learning once off ~~their campuses~~campuses. Both leaders noted being able to provide families with ~~Wi-FiWi-Fi~~Wi-Fi access at home so their students would be

Commented [JR17]: APA spelling

able to stay connected, access the content, and continue learning. Cameron's strategy was described as:

The other parts of it, when you incorporate technology, you have to... ensure that students have access to internet. I mean it's become part of my repertoire when I'm talking to parents to say, you know, "Hey, I have assigned them this program we use it at school. Do you have access to ~~Internet~~internet at home? If not, let me know. We can provide it for you" because I don't want them to be without.²² The perception is I have to say yes, I have access to [internet], nobody wants to sound like they don't have access. So, I don't even give them the option to say no without me providing the option to say if no, we have this. (Cameron, personal communication, November 18, 2022).

Likewise, Alex's strategy made clearer reference to how the district was able to support families so students could access the instructional materials while at home:

We also have hotspots for any student who doesn't have ~~Wi-Fi~~WIFI access at home. We started that districtwide during COVID so that helps with the accessibility piece and then also looking at some afterschool sessions for kids who want to get some additional support and help in that area. But that's where I do see the adaptive technology being super helpful for kids who maybe don't have that person, they still have access to the curriculum and are able to move forward. (Alex, personal communication, December 1, 2022).

This recent experience was preceded by Alex's description of how IXL® would be used as part of their strategy to determine ~~Algebra~~algebra readiness upon the completion of seventh grade. Alex's district reinstated a system of "tracking" students in middle school math. This meant that, based on teacher recommendation, a student would be enrolled in either a regular seventh grade math course, to be followed by an eighth-grade math course, or a student would be enrolled in an advanced seventh grade math course, followed by an eighth grade Algebra 1 course. This model was concerning because, before now, placement was grounded in teacher recommendation rather than data which meant that in eighth grade "many of our students of color ended up in eighth

Commented [JR18]: Just be sure you like this insertion. I think it helps with clarity.

grade math and many of our white students were the ones taking algebra. (Alex, personal communication, December 1, 2022)."

Alex is now looking at a way to refine the placement process so that it is "mastery based instead of recommendation...we're trying to come up with a method that takes out the subjectivity of what we think and make it purely mastery based" through use of an algebra prognosis assessment which can better determine a student's readiness for the Algebra 1 course (Alex, personal communication, December 1, 2022). This assessment would be administered during the spring of the student's seventh grade year and test their level of mastery of eight grade standards. If they showed mastery, they would be placed in Algebra 1. If they did not show mastery, they could study and a re-take the assessment or take the eighth-grade virtual course over the summer to be placed in Algebra 1. Or the student could simply opt to take the eighth-grade math course during the regular school year, "...it would just put the ball in a student's court" (Alex, personal communication, December 1, 2022). Where IXL® comes in is to give all seventh-grade student access to eighth grade content while still in seventh grade:

So, what we're looking at with IXL® is as a seventh grader, you have access to all of the eighth-grade standards. So, at any point a student could go on and begin learning the eighth-grade standards, it gives every student that opportunity, not just the students who may have someone at home who can help them learn the material....and then also looking at some afterschool sessions for kids who want to get some additional support and help in that area. But that's where I do see the adaptive technology being super helpful for kids who maybe don't have that person, they still have access to the curriculum and are able to move forward. (Alex, personal communication, December 1, 2022).

Here, the strategic use of the adaptive learning technology increases equity for students, especially the seventh graders in this example, giving students more access

to advanced content, increasing the possibility of enrolling in the Algebra 1 course during eighth grade.

Jordan also connected the building's IXL® implementation with supporting access and equity work on campus. In returning from school closures, their team had the realization that, "...there are certain students who need a different kind of learning interface and technology provides one that is sometimes more comforting or at least less anxiety-producing than being in a classroom" (Jordan, personal communication, February 23, 2023).² With IXL®, Jordan described that students who were active users appreciated the opportunity to work independently and were more willing engage with the math content. Through the school providing this "...new and differentiated way of accessing content and practicing skills" there were taking "...a step in the right direction in terms of broadening the scope of our equity efforts" (Jordan, personal communication, February 23, 2023).³ ~~Given the user group at this building,~~ Jordan identifying how the use of this tool supported their increased ability to access content and have better, more equitable learning experiences speaks to the purposeful strategy used to support this group of students.

The final strategy used for adaptive learning technology implementations was for specific groups of the school's student body. While many chose to use the tool with all students, Cameron and Jordan narrowed the scope for a predetermined group of students in their building. ~~Below describes T~~the two leaders' strategies for using their respective tools are described below, with-including on which student groups ~~they the~~ strategies were used, and the rationale for their decisions.

Commented [JR19]: I recommend deleting this introductory phrase. It's throwing the sentence off and is repeated at the end of the sentence

Formatted: Strikethrough

Because the MobyMax® implementation was a school-based decision, Cameron had the flexibility and autonomy to use the tool as needed. Here, MobyMax® is being used as part of the school's Response to Intervention (RTI) process. Response to Intervention, as defined by The RTI Action Network (2023) **is defined as follows:**

Commented [JR20]: Do you need a page number or paragraph # for this quote?

...a multi-tier approach to the early identification and support of students with learning and behavior needs. The RTI process begins with high-quality instruction [Tier 1] and universal screening of all children in the general education classroom. Struggling learners are provided with interventions at increasing levels of intensity [Tier 2 and Tier 3] to accelerate their rate of learning. These services may be provided by a variety of personnel, including general education teachers, special educators, and specialists. Progress is closely monitored to assess both the learning rate and level of performance of individual students. Educational decisions about the intensity and duration of interventions are based on individual student response to instruction. RTI is designed for use when making decisions in both general education and special education, creating a well-integrated system of instruction and intervention guided by child outcome data.

In Cameron's school, aligning with the definition above, all students (grades 6-8) took an "initial placement assessment" followed by all sixth and seventh grade students using MobyMax® as part of their Tier 1 instructional block (Cameron, personal communication, November 23, 2022). In eighth grade, however, the adaptive learning technology was only used for Tier 2 support, where-in which a math strategist would pull out small groups of students to work through lessons, and Tier and for Tier 3 support, for which where a strategist would work with individual students. This strategy for using this tool as part of their RTI process was designed in partnership with MobyMax® representatives who provide insight and guidance on how to best leverage the tool to support this multi-tier approach:

...they've got a fantastic support where you can call and do online chat or a physical phone call and talk to a live person...to learn which aspects of the program are best suited for our middle school students in Tier 1 and then also moving on to Tier 2 and Tier 3...which type of adaptive

programs we're going to use and then what we're going to use for our benchmarking assessments, what are we going to use for our progress monitoring, what are we going to use in terms of accountability to the student's side. So that part of it has really been through my own delving into it and speaking with their representatives to best suit it for the school that I'm at. (Cameron, personal communication, November 23, 2022).

Through this partnership, Cameron and the vendor designed a strategy to support the learning and development for specific students in the building, unlike their MathIA® adoption, which was used school wide for all learners. Most evident in eighth grade, MobyMax® was used more as an intervention strategy rather than as part of Tier 1 instruction.

Jordan had less to share about the development of the school's strategy for using IXL®, but like Cameron, did agree to use the adaptive technology with a subgroup of students. As described above in the Adoption Strategy section above, the school's EL team initiated the implementation for the student population where whose native language was not English ~~was not their native language~~. The strategy for using IXL® was to provide educators and non-English speaking students a tool that would provide content based on their performance and allow them to engage with the mathematics while not being impeded by a language barrier. Though admittedly not very hands-on in the implementation, Jordan appreciated that the EL team identified a need with their students, found a possible solution in IXL®, and seemed to be having a positive experience so far. Taking this a step further, Jordan was sure to emphasize that having a vision and strategy for using IXL®, or any technology for that matter, was critical to a purchase of a tool and its adoption.

All leaders were able to describe the intention for how the adaptive learning technology was to be used on campus in their mathematics classrooms. Using these

Commented [JR21]: Agreeing on using? (not sure what the intended meaning is)—that they had this similarity or that they agreed to do something.

Commented [JR22]: English-language learners

technologies for small-group instruction, ~~to-for increase-increasing~~ equity and access, and ~~to-for providing~~ better support ~~for~~ specific sub-groups of students were the main ways that ~~showed-illustrated~~ how strategic and vision-oriented the leaders were with the use of their adaptive tools. Next, we will look at the strategies leaders use to maintain their implementations to ensure ~~how-thattheythe~~ strategies set forth for use are actualized with students.

Commented [JR23]: Can you think of a better word here?

Strategies for maintenance

The final strategy identified were those steps leaders used to maintain their implementations. Here, maintenance will refer to what the leader did to ensure the adaptive learning technology was being used ~~as intended in the way in which it was~~ and ~~was~~ positioned during the adoption ~~and intended to be used~~. The leaders described their strategies to communicate their vision and continue to engage stakeholders throughout their implementations. They each also provided professional development, which played an integral role in several of the implementations. Lastly, leaders described an ~~increased-increase in the~~ importance placed on data usage as a result of their implementations. Below, we will learn more from leaders about the strategies they used to maintain their implementations.

Establishing and communicating a vision or defining and sharing their “why” for the adaptive learning technology was common amongst the leaders. Casey, Jordan, Cameron, and Riley each shared how important it was to have a vision for using the tool ~~which acted to act~~ as a guide for what they did to lead their implementations. For Casey, the district’s Profile of a Graduate continued to provide direction for how Zearn® was used in classrooms. Described above and pictured in Figure 4-1, this tool led Casey’s ~~in deciding- decisions about~~ how and when to support teachers’ use during the

implementation of this tool. Likewise, having a vision to drive the decision-making for the use of technology strongly resonated with Jordan. Despite a lower level of involvement that other leaders, with their adoption of IXL® for EL students, Jordan emphasized that “~~we~~ we should be using [this] technology to actually elevate experiences with students in a way that couldn’t previously have been elevated” (Jordan, personal communication, February 23, 2023).² The purpose of IXL® was to increase mathematics achievement with their school’s EL population of students in a way that was not as readily possible with the traditional model of classroom instruction. As the leader, Jordan said, “So that’s where my leadership role may have an impact on the positive use of technology by just reframing the ‘why’ of it.” Jordan wanted to ensure that all were “being very mindful of whatever [technology] we’re using, serving the purpose we wanted it to serve...And then if we are not using something in a way that’s impactful enough, let’s pull back from it and redirect that energy and those resources elsewhere” (Jordan, personal communication, February 23, 2023).²

Riley and Cameron also stressed the importance of communicating expectations and constantly sharing the “why” for what they wanted to accomplish with their adaptive learning technology implementations. Riley involved teacher-users in determining baseline expectations and providing feedback on their plan for using IXL® to get consensus on how and why this tool was being used classrooms. From there, Riley and the math coaches visited classrooms, “inspecting what we expect” to offer support and guidance to their teachers and better align the use of IXL® with the vision upon which they had agreed (Riley, personal communication, April 5, 2023). Cameron also stressed the importance of communicating “why” for the respective implementations, though the

communication about MobyMax® was much more thorough and comprehensive. This level of communication served as part of Cameron's strategy to initiate and maintain buy-in with teachers who were subsequently able to connect with students to garner their buy-in with the tools. Not only was communicating "why" to teachers a priority, including students in the conversation, but this communication was also shared and reiterated with families and other community stakeholders to develop an understanding about the tool and create further buy-in from external partners.

Stakeholder engagement was also a strategy used to maintain the buildings' implementation. Leaders described how they consistently involved teachers, students, families, and/or community stakeholders in the communication of progress and updates. On several occasions, Cameron shared that with the middle school students, using incentives was a key strategy for support their buy-in and maintaining their usage of the program:

I alluded to this before ...I'm big on incentivizing things for students. So, what we have is a school wide incentive going on right now where the top three students each week for earning points, and you earn points in the program by getting correct responses. So, the top three students are receiving incentive in the form of student store money. So, they're like, yeah, student store, but so I incentivize it to really try to promote usage. And so that's how we have sort of, school wide, pushed it out. (Cameron, personal communication, November 23, 2022).

This strategy was used during the current and previous implementations with MobyMax®, which produced an overall student engagement level that Cameron felt content with., ~~which Cameron was content with the amount of engagement students showed overall.~~

To further support student usage and buy-in, leaders also turned to family and community support to bolster their implementations. During the discussion about the

strategy used for adoption, recall that Casey regularly connected with families and community members to solicit feedback and provides updates regarding the tools being considered. Once selected, this practice of having open lines of communication and meeting with families and community members was maintained to ~~continue to further~~ develop their understanding of Zearn® and how it was being used to support their students' mastery of mathematics. To accomplish this, Casey regularly hosted family nights ~~to accomplish this where~~when students, families, and community members were invited campus to learn more about current events at the school and engage in activities to mirror what was happening in classrooms. Figure 4-2.B illustrates the invitations to these events.

Commented [JR24]: Whose?

Cameron also used the strategy of communicating and engaging with families and community stakeholders to develop and maintain buy-in for the school's implementation. Weekly, a parent newsletter is sent out with building updates, ~~- which~~ ~~also~~ included language around upcoming content and at-home practice activities that featured their adaptive learning technology:

Formatted: Font: Italic

~~...also~~ I sent out a parent messages, so we do our weekly newsletter for our school and included in the weekly newsletter is "hey by the way here's this program that your students can be using to support as an academic support, at home, and they can log in and this is how they log in." So, school wide, we also pushed it out from the parents' side so that the parents were informed because I think anytime you do, you do a supplemental curriculum, which in this case, that's what it is...if you don't tell the parents about it, then you're losing a key stakeholder in the process. (Cameron, personal communication, November 23, 2022)-

This family also extended to recommendations for continued learning during the school's winter break. Communication from Cameron highlighted multiple routes families could take during the time off to continue student learning while away from campus. MobyMax® was part of this recommendation, reiterating the importance and

value placed on this tool for students and families. Figure 4-2.A and Figure 4-2.C serve as examples of the communication Cameron used to engage families and the community to further support their understanding of the adaptive learning technology and foster increased usage by their students.

Teacher engagement was the final stakeholder group that leaders discussed during their interviews as without their buy-in, the implementation would undoubtedly fail. And L leaders described a collaborative approach to maintaining their implementations. Jordan staunchly believed that the use of IXL®, and any other technology tool for that matter, must serve its intended use, or otherwise be replaced with something that does. To ensure this is-was the case, Jordan met with teacher-users to better understand their experience and solicit feedback about the IXL® implementation:

...so they're the ones who are utilizing, looking at the data on a daily basis and then targeting supports to kids are saying, "yes, this tool is use is serving the purpose that we want it to serve." And that's really where I come and say... I ask, "...is, are you getting what you need out of it? Is the data yielding the information that's going to help inform your practice? Is this tool the best way to get the data?" And if the answer is yes, yes, yes...I'm like, okay. If ever we're able to say, you know what? It's not giving us what we need. We don't know if we can count on it, we can't tell if it's reliable. Then we would say, okay, well then, we have to pull back and consider other options...So periodically checking in, is it still serving the end that we paid for it to do serve. (Jordan, personal communication, February 23, 2023)-

This perspective reaffirms Jordan's strategy for having a vision to lead the implementation rather than choosing a tool for technology's sake. This level of teacher involvement in the respective implementations was a common strategy across all implementations. Leaders described a partnership with their teachers in-as a "shared ownership" of or "shared responsibility" for their implementations. This was especially

Commented [JR25]: Would have failed? (not sure if you want to put this in past tense or express it as a general truth)

evident in those implementations ~~where-in which~~ teachers were involved in the implementations from the bottom-up and in implementations ~~where-in which~~ the leader, coaches/strategists, and teacher were all working together to elevate student learning.

To further engage teachers and support their buy-in and use of the adaptive learning technology, all leaders provided some form of professional development (PD) opportunities for their teachers. In all cases, PD was a critical piece in preparing teachers for success with their implementation. In both of Cameron's implementations, PD played a substantial role and the variety of options provided supported teachers well:

I mean it's big role if you don't have it... then you have to... If I don't provide it, then I have to make the assumption, and that's never good to do, that...that they will be self-motivated, self-starters, self...you know. So, I...I guess if I didn't provide them the professional development then I would be adding an additional thing that I would have to say to them, "Oh, now you also need to go figure out and find how to use it. And that... I don't think that's appropriate for me as a leader to ask of a teacher. I just don't. I think that that's our role and responsibility in all of this." (Cameron, personal communication, November 23, 2022).

Teachers were offered a variety of opportunities to learn for the MobyMax® and MathIA® implementations. Having previous experience with MobyMax® and purchasing the video module, Cameron provided and recommend modules for teachers to watch, followed by leading PLC meetings to better utilize the tool saying, "And the piece that I do have mastery of, the MobyMax®, I'm the one that's going in and during their PLC time providing guided lesson and instruction on how to use it and support it." For the MathIA® implementation, the district provided synchronous in-person and virtual PD options with access to recordings of the virtual sessions, ~~each-both~~ of which were optional for all teachers. As an added layer, each school had access to a consultant four

times per year during their professional development days which ~~that~~ Cameron had already taken advantage of:

We have staff development days or professional development days that are offered. There's four in a year...And then we, as I said to you, I bring in the, the consultant at the site level. We are permitted to contact or call in that consultant once a quarter for an 8-hour block and we can split it into "two fours" or an 8. My teachers have now taken advantage of that both quarters. So, I've brought her in...Um...the two... first quarter and then again second quarter. So, I mean I think in terms of that...that it's...They have the ability to participate in that. (Cameron, personal communication, November 23, 2022).

With the MathIA® implementation, Cameron reiterated that because PD was optional, not everyone participated. "It's not a requirement, but it's there as a tool for them to use if they feel that they need it" (Cameron, personal communication, November 23, 2022). Still, taking a blended approach to PD, having in-person, virtual synchronous and also recorded, asynchronous options, was a common strategy leaders used to maintain teacher proficiency with their implementations.

Casey, Jordan, and Alex likewise reported PD being valuable for their staff, who each took part in virtual and in-person options. With Casey's implementation, the school initially offered in-person PD, which was shifted to virtual with school closures due to the pandemic. School schedules were changed to account for at-home learning, and teachers were afforded "up to two hours each day to collaborate as a team, which was really beneficial" (Casey, personal communication, March 9, 2023). During this time, virtual PD options were offered and attended allowing teachers to better engage with the PD provider, ask questions, and work with their team members to further their understanding of Zearn®. As schools reopened, PD was still prioritized, and teachers were given multiple opportunities to learn and collaborate:

That was huge in our implementation to make sure that we had time carved out on our professional development calendar for those types of professional development opportunities for our staff. Not only bringing in representatives from Zearn® or Eureka, but also having an opportunity for our teachers to collaborate together and ask questions either of that individual or of me and our director of teaching and learning to follow up on. (Casey, personal communication, March 9, 2023).

Professional development for Zearn® users was prioritized during the first formal year of the implementation “...that first year of implementation, it was every professional development day. (Casey, personal communication, March 9, 2023). There was some component of professional learning or collaboration that was built in for mathematics” (Casey, personal communication, March 9, 2023). This was reduced during their second year as the focus shifted from their math adoption to ELA.

Alex and Jordan launched their IXL® implementations with virtual-only PD, post-school closures. They both reported the recorded session being moderately helpful as, in Alex’s case, “...the first one [PD] was a video so I don’t know who watched it and who didn’t” (Alex, personal communication, December 1, 2022). The video was used for teachers who were not part of the pilot and did not attend the formal in-person PD during that time. Content-wise, the PD was more of an overview as many teachers had a limited experience with IXL®. This matched Jordan’s initial webinar PD, describing the content as **very high-level**:

This is how you log on, this is how you get at the data. If you want to get a report, you go over here, here’s how you run an example. Very simple of how to get at it. This is what these numbers mean. This is what this nomenclature means, terminology. (Jordan, personal communication, February 23, 2023).

The IXL® implementation leaders (Alex, Jordan, and Riley) felt that PD was needed to ensure their teachers were able to use the tool as intended, but Alex and Jordan approached vendor-provided PD with some reservations. For their IXL®

Commented [JR26]: Very high level or not very high level? Just checking--it seems like the quote is saying 'very simple'

implementations, the timing and content of subsequent PD caused some concern.

~~When~~ The PD ~~that~~ was offered ~~for~~ to Alex's teachers seemed not to ~~not~~ consider the amount of time in between sessions, which did not give teachers enough experience with IXL®. At the time of the interview, there was an upcoming session scheduled which would give teachers more time with IXL® to have a more informed perspective:

~~---~~it's a fine balance between forcing that professional learning and then also letting it drive from what people feel at the time. Because sometimes when you have the PD too early, they don't even know what questions yet that they want to ask. So, I'm interested to see how this one goes in January just because I think teachers have more questions now as they've kind of gotten into it. (Alex, personal communication, December 1, 2022).

The two teacher-leaders who initiated the IXL® adoption at Alex's school also worked with teachers across campus, consistently "sharing what they know to help other people feel comfortable implementing in the classroom" (Alex, personal communication, December 1, 2022). Jordan took a similar approach to supporting teachers with PD in that while the initial sessions were delivered by "the company" they moved to get "in-house people up to speed to coach people along the way" (Jordan, personal communication, February 23, 2023). The rationale for this was that the subsequent, vendor-provided PD continued to be "broad and distracting" to what teachers were looking to learn (Jordan, personal communication, February 23, 2023). When moved in-house, the teacher-trainers were able to customize and tailor content to be something "teachers can actually use based on what they're really doing with it in class" (Jordan, personal communication, February 23, 2023). Riley valued PD for teachers but reported it being difficult to access and provide for this implementation. The schedule, location, and timing of these session proved to be a barrier to these IXL® users:

Teachers don't want to go to a training after you've taught or been up and taught from eight to two and then PD and then leave and go to another

school to get... people are tired... So, have the teachers truly been trained? No. Gone are the days where you could train during the day, so it wasn't double work. You could go and [get approval] do an online training or go face-to-face but [now]... It's difficult. (Riley, personal communication, April 12, 2023).

To overcome this hurdle, Riley also used teacher-leaders who attended trainings in the past to work as in-house trainers to lead PD for their peers. Like Alex and Jordan, the timeliness and specificity of content to the teachers' needs was seen as valuable in ensuring that the usage aligned with expectations.

While PD, in the traditional sense, was a strategy used to maintain all implementations, three leaders had their teacher collaborate with other schools to increase their educators' understanding of how to best use the adaptive learning technology in their mathematics classrooms. As with during the adoption process, Casey also gave teacher-users the opportunity to connect with and learn from educators in other schools who were experienced d with Zearn® to ~~strengthen their understanding with~~ understand how ~~to~~ best to use the tool with students. Alex also took this approach as teachers seemed to struggle with how to use IXL® in a workshop model for math instruction. These middle school teachers visited an elementary school to observe and learn how to structure their math blocks to better incorporate the adaptive tool:

I feel like elementary tends to do workshop models much better than sometimes, we do at the secondary level. And so, we had really good conversations of just looking at what that looks like in the classroom. The classes that we visited at that time weren't necessarily using it but previously I had observed in one of them that was using IXL®, it was a third grade classroom, which kind of gave me the idea of, Hey, I need to bring some teachers here with me so we can watch and see some other instructional structures and systems that are in place that we might borrow and use here. (Alex, personal communication, December 1, 2022).

With the challenges shared above about accessing PD, Riley also arranged for teachers to connect with neighboring teachers to learn from their experiences with IXL® to increase their own proficiency with the tool. Whether through collaboration and learning from existing users and/or more formal training about the adaptive learning technology, PD and training teachers ~~was~~ were the main ~~strategy~~ strategies that the leaders used to maintain their respective implementations.

Commented [JR27]: Just confirming, these are two different strategies? Does my correction work?

The last strategy ~~that~~ the leaders used ~~to~~ maintain their implementations was ~~to~~ monitor ~~monitoring~~ program usage and ~~place~~ placing value on the data generated as a result. All leaders described how they looked at data ~~and~~ , met with their teachers to assess student progress , and used ~~d~~ the data to support decision-making. In some implementations, the leader recognized the importance of accessing and using the data, but the systems for this were in the early stages of being developed. Jordan shared that with their IXL® implementation, their team was accustomed to looking at data, but with this particular program, they were designing the best process:

I think the one process that we've been nurturing, if you will, involves just the looking at student data on a regular basis to inform are we being effective. Are interventions having a positive impact? Are teachers...are we able to inform teachers of the growth that's occurred? So, we, by virtue of that, need to look at data on a regular basis. We're using that technology with fidelity, and we're going to probably continue using it with increasing complexity over time as we all master...if more people master how to use it. We do have to find a process for I guess, revealing the pros and cons. (Jordan, personal communication, February 23, 2023)-

While this was a work in progress for Jordan, Alex seemed to have a clearer picture on what data was to be used and how, though ~~it was~~ it was also early in leading the IXL® implementation. At the time of the interview, plans were already made to track student growth data, compare growth data, based ~~d~~ fidelity of use, in addition to ~~considerations~~ considering ~~for~~ how this tool, based on data, would be used in the long-term:

It's really the mindset of growing every student from where they are. And I like that fact that our kids on the upper end also don't have a ceiling and they can continue to learn and grow too. But I think we probably, from my standpoint, need to do a better job of defining what this is going to look like in a three to five year plan...And once I kind of see our growth data through that, that'll also kind of inform me. Cause I would like to look at the teachers who are using it the most, how are their kids growing compared to the others. And that's part of the reason I haven't really like top down pushed like a certain amount of usage is because I want to be able to compare from classroom to classroom just to see what it looks like. (Alex, personal communication, December 1, 2022).

Figure 4-3, growth data from Alex's benchmark assessment, paired with state summative data, will be used to support the comparison between students who are using the adaptive technology well and those who are not to inform later steps in the implementation.

Cameron and Riley, because of prior experiences, already had processes and routines in place to access data to gauge use and support their teachers with using the data. Cameron with the school's data strategists consistently monitored usage. Many of these data points supported the school-wide incentive program described above and were also a part of topics discussed during PLC meetings. In Riley's case, there was already a system in place ~~where usage for using~~ data and ~~pulling~~ progress reports ~~were pulled then used to be used~~ as discussion topics during grade-level meetings during "lesson planning, collaborative planning, ...and next steps" for usage and instruction. (Riley, personal communication, April 5, 2023). Riley described that monitoring and using the data from the adaptive learning technology became an important part of how ~~school was done~~ for the middle school teachers and stressed that "~~What-what~~ you make important, is important" (Riley, personal communication, March 28, 2023).

Commented [JR28]: Seems like an odd expression--but maybe something from the field

Casey also prioritized the data generated from using the adaptive learning technology. As described above, as this platform was adopted during school closures,

teachers had an additional amount of time dedicated to planning and collaboration. Zearn® data became a consistent agenda item during these sessions and teachers became comfortable ~~with~~-engaging in data discussions and providing feedback about how the implementation was going. Now, with schools back in-person, Casey can only meet with teachers for 45 minutes a month, but these “collaborative team planning session” have become a “non-negotiable” timeslot on everyone’s calendars. (Casey, personal communication, March 9, 2023). Through these data meetings, decisions were made to change the school schedule and programming to better support all students in mathematics, “which has really been beneficial” (Casey, personal communication, March 9, 2023). As we will see, the results from these changes were a positive outcome for Casey’s school and community.

The strategies leaders used to initiate and support their adaptive learning technology implementations ~~were~~ are described above. The themes identified from their shared experiences in leading their implementations centered around strategies employed for the adoption of the technology, use of the tool, and maintenance of the implementation. Though individual leader experiences differed, each articulated ~~their~~ the strategies used, though not officially named, to support their teachers, students, and overall implementation.

This section reported on the school leaders’ lived experiences as technology leaders of their current adaptive learning technology implementations. With the variety of experiences, the identified themes centered on preparation for and conceptualization of technology leadership, their familiarity with the adaptive learning technology itself, and the strategies they employed for their implementations. Similarities and differences

were present in each of these themes with leaders' descriptions included to better illustrate the findings. ~~Next~~The next section will report the successes and challenges that the school leaders, their teachers, and students experienced while leading their adaptive learning technology for mathematics.

Research Question Three: Successes and Challenges Experienced with Implementing the Adaptive Learning Technologies for Mathematics

With the variety of experiences shared above, leaders were asked to describe the experiences they considered as successes and challenges from their current implementations. The successes cumulatively outnumbered the challenges and the themes generated from the leaders' descriptions of these two categories of experiences were:

- Stakeholder engagement
- Equity, access, and digital citizenship
- Data usage and improved results
- Professional development

The leaders' responses for stakeholder engagement described all who were a part of the implementation: teachers, student, and families. Leaders' interactions with these groups were a feature of the experiences described in this theme. Increasing equity, access, and digital citizenship were concepts experienced by each of our leaders. The responses featured in this theme highlight the successes ~~they leaders~~ experienced with their implementations and reiterated the strategies and vision for use that guided their implementations as shared earlier. Increased data usage and positive results was a third theme generated from the leaders' successes. This theme was based on leaders' descriptions of increased proficiency with teacher and student use of data from the adaptive learning technology and, for some, increased student performance.

Commented [JR29]: Just confirm you like this insertion

Professional Development served as the final theme for RQ3. Leaders predominantly spoke of PD as a challenge and illustrated pain-points experienced by leaders. In Table 4-6, the themes for RQ3 are listed with sample codes and a description of the respective theme.

Table 4-6. Themes, sample codes, and descriptions for RQ3

Theme	Sample codes	Descriptions
Stakeholder engagement	Teachers engaged in ownership More engaged parents	Stakeholders (teachers, students, and families) were increasingly engaged with the implementation.
Equity, access, and digital citizenship	Students setting/reaching goals Increased equity/access as used for all students Clear use to increase equity/access (Alg 1 example) Noticeable increase in student responsibility	Through regular use of the adaptive learning technology for mathematics efforts to promote equity for all learners, increase access to high-quality, grade-level content, and develop digital citizenship were achieved.
Data usage and improved results	Real-time data use Increased educator proficiency with discussing and using data Growth in student performance/proficiency	Data became a more common tool used for planning and increased achievement results were described through using the tool.
Professional development	Monitoring PD (challenge) Amount was cost/time prohibitive PD was a HUGE factor	Professional development was often described as a challenge that leaders attempted to work through.

Below highlights the successes and challenges leaders, their teams, students, and communities experienced throughout their adaptive learning technology implementations.

Stakeholder Engagement

Teachers, families, and their students were the stakeholders that leaders mentioned as those who experienced successes and challenges during their implementations. Leaders shared the progress their teachers made with their implementation, how students responded to using this adaptive learning technology, and how parent and family engagement was affected for good. More often than not, leaders' engagement with these stakeholders were seen as valuable, which contributed to successes in the implementations.

Teacher engagement and changes to instructional practice

Leaders viewed increases in teacher engagement with the ALT-M, as evidenced by the progress their teachers had made ~~with~~ using the tool, as a success at the time of their interview, but not without a few challenges along the way. Though some were further along than others, all reported increased levels of engagement via teacher buy-in, usage, and ownership of the implementation, serving as indicators of success. Jordan was a strong proponent of ensuring that the technology teachers used was serving its intended purpose. When asked about progress, Jordan referenced conversations from meetings with teacher-users and was "satisfied that we are learning and teaching each other of what we need to know about that product to keep using it...we're all being very mindful of whatever we're using, serving the purpose we wanted it to serve (Jordan, personal communication, February 23, 2023)." Alex indicated that teacher confidence was up with using the adaptive tool and further described why it mattered with these types of implementations:

~~...~~we were kind of talking yesterday about that piece of getting teachers to be the leaders. I think that single action, that shared ownership, is probably with anything that you're implementing, probably the most

important part. Because if you don't have teacher buy-in, then either they're going to not use it, act like they're using it, and not use it, or just hope that it quickly goes away. And I mean, I really believe that when teachers feel good about a resource or something that they're using in their classroom, that's when you're going to see the most student growth. (Alex, personal communication, December 2, 2022).

Cameron's implementations had a slower start. The MobyMax® implementation began two months into the school year. The MathIA® implementation began with the start of school, but most educators were off to a "late start" due to the newness of the curriculum and adaptive tool (Cameron, personal communication, November 23, 2022). Cameron described a "shared responsibility" when reflecting on teacher engagement with MobyMax®, describing ~~that~~ how teachers demonstrated increased buy-in and usage of the tool in alignment with the expressed expectations (Cameron, personal communication, November 23, 2022). Recall that MobyMax® was the tool that Cameron had the most experience ~~with~~ using and supporting and had framed it as a preferred supplemental tool to use for RTI. This may have contributed to the increase in teacher buy-in and use. Casey shared that "80 to 85% of our teachers adapted well" to their implementation of Zearn® and those that had not "were forced to because of the pandemic" (Casey, personal communication, March 9, 2023). The Zearn® adoption coinciding with school closures was viewed as "a blessing" because of how the tool could be used to during at-home learning (Casey, personal communication, March 9, 2023). This was something Casey, the adoption committee, and teachers ~~did not~~ had not anticipate during the adoption process but were glad to have access to it when they did.

Commented [JR30]: To what? What is it here?

Another indicator for increased teacher engagement was the level at which teachers had integrated the adaptive learning technology into their mathematics

instructional practice. Each leader shared how they intended the adaptive technology to be used in the strategies for use section above. These strategies included the use of adaptive learning technology for small-group instruction, as part of the buildings' RTI process, and ~~to support~~ as part of supporting the building's EL population. Leaders described what they noticed in their teachers' experiences with respect ~~ed~~ to changes ~~to~~ in instructional practice with the adaptive tool.

Cameron's teachers worked to include the adaptive technologies MobyMax® and MathIA® as part of their RTI process for Tier 1, Tier 2, and Tier 3 instruction, where when appropriate. Cameron noted that educators worked to balance MobyMax® for RTI, which was difficult, but doable:

Time management is always a struggle and a challenge in ensuring that you're balancing your time with your supplemental curriculum versus your, you know, Tier 1 instruction. So how are you balancing your Tier 1 instruction versus your Tier 2 and your Tier 3 and it's the Tier 2 and Tier 3 that are predominantly with the supplemental. (Cameron, personal communication, December 3, 2022).

Teachers showed increased engagement with MobyMax® based on observation and management of usage data in the tool. MathIA® was a much slower adoption and more of a challenge as teachers ~~struggled to grapple~~ grappled with when to use the tool during their math block. Because it was part of their core-math adoption, which began this school year, Cameron was less familiar with the tool, while teachers felt it was an added thing to do and struggled with the best way to balance the different resources they had at their disposal.

Continuing, Riley noted that teachers more readily engaged with coaches, and administrators during common planning time to better leverage IXL®. Administrators and coaches would observe teachers in practice, provide feedback, and discuss ways

to strengthen usage in classrooms. Riley noted that “just having that back and forth, open dialogue consistently has been good” and increased teachers’ comfort and use of the tool (Riley, personal communication, April 5, 2023). Riley noted that getting teachers to this level of engagement with IXL® would have been a challenge had mutual trust not existed with the teachers.

Through increased engagement during their implementation, Casey’s teachers further developed their understanding of the rigor required per their state standards. As part of their adoption strategy, the committee agreed that there was a need to change their curriculum as what they were using was not sufficient. Once decided, getting teachers on board was the next step by clarifying why it was important:

I think the biggest success is going from “...why do we have to change? We already have a math program in place and our students are doing okay...” to developing understanding that no, based on the assessments in this program, it shows you that our students are doing okay. However, if you take a look at the expectations of the standards and how our students are performing on some of these other benchmark assessments and standardized assessments, we’re not doing okay. And if anything, the rigor of this program is not in place and many of our staff weren’t there. (Casey, personal communication, March 9, 2023).

Casey’s teachers got to a place where they were able to teach their students at the level of rigor required and were seeing their students’ increase proficiency as teachers continued to engage with the ALT-M platform and use the data it provided:

...some of them were shocked how the students were rising to the occasion of rigor and higher expectations, and yet still meeting those expectations as well, and what some of our students were capable of as far as more intense instruction that they weren’t used to. That first year was tough, but eventually they got to the point where they’re like, yeah, they can do this, and we understand it. Each year we’re progressing a little bit further through the curriculum and achieving more. (Casey, personal communication, March 9, 2023).

Teachers used Zearn® in their classrooms, as part of the strategy to better leverage the tool for small group instruction as that was its intended use in the building; Zearn® was used off campus as an additional tool students could use.

Many of the adaptive learning technology implementations were well-received by teachers in that they engaged with and used the tool as intended and incorporated the respective tools into the mathematics classrooms. The leaders' descriptions of how the adaptive technologies were being used demonstrated increases in teacher engagement with the technology through increased usage and a shift in instructional practice, particularly with small-group instruction and RTI. The successes experienced by the teachers also led to increased engagement and success with students.

Developing Student Engagement

After teacher progress, student engagement ~~also~~ stood out as result from the leaders' implementations. How students were engaged with the adaptive technology differed between implementations, but how each leader described their students' experiences was as a success.

Getting students to engage with the respective platforms can be a challenge, especially in secondary schools. Cameron and Riley both experienced difficulty ~~with~~ motivating students, with Cameron describing the middle-schooler mindset as, "~~...~~they're not as intrinsically motivated to want to see gains. And if they don't think that you care, they don't" (Cameron, personal communication, December 3, 2022). Both leaders opted to use an incentive program to develop generate and sustain student buy-in with their adaptive learning technology. Cameron elaborated on the structure of an incentive program being used with students to increase usage and buy-in with students:

I'm big on incentivizing things for students. So, what we have is a school wide incentive going on right now where the top three students each week for earning points, and you earn points in the program by getting correct responses. So, the top three students are receiving incentive in the form of student store money. So, they're like, "Yeah! Student store!", but so I incentivize it to really try to promote usage. And so that's how we have sort of, school wide, pushed it out. (Cameron, personal communication, December 3, 2022).

Incentives were also a component of what Riley used to motivate students and increase their buy-in and use with the program:

When students meet their goals...when they meet their goals, they are recognized for it, and they receive an incentive. And then so some teachers, they've made it a class competition with hanging certificates around the wall in the classroom and recognizing those students at awards assemblies. When other students see that, wow, [they] got an award for that and [they're] actually performing at the top of the group, maybe this is something I should do. (Riley, personal communication, April 12, 2023).

Incentives were only part of what these two leaders did to further student engagement.

Conferencing with students and goal setting also played a role ~~to-in~~ further ~~motivate~~ motivating students. Both leaders reported that they, their coaches, and their teachers would regularly meet with students to set goals, discuss usage and progress towards their goals, work through any difficulties students might have, and celebrate incremental successes along the way. Riley actively participated in these efforts to keep students engaged and motivated:

I really sit down and explain to the students one-on-one, the coaches and I, how to go through the program, how to make it work for you. What is your "aha" moment? Are you still struggling? Okay. Then I do need to pull you into a small group to reteach. (Riley, personal communication, April 12, 2023).

Cameron's experience with students was similar and took motivation a step further with incentivizing growth milestones during the year:

Well, when you have an adaptive technology curriculum like MobyMax® and you put them on that mathematics initial assessment and it's assessing them as a seventh grade student at a third grade level, then you're going to work with them and say, "Hey, kiddo, if you just spend 15 minutes a night on this, we're going to check each week and we're going to see how your growth is." and they can start to see that little incremental growth and you're incentivizing that growth, you're supporting that growth, you're celebrating that growth. (Cameron, personal communication, December 3, 2022).

Both had normalized the practice of conferencing with students to keep them motivated and engaged ~~and motivated~~ with their progress using the adaptive learning technology, in addition to using incentives to reward and celebrate the growth. While other leaders used different approaches to engage students in their implementations, conferencing and incentivizing seemed to be the most thought-out approach for the adaptive learning technology.

Alex and Casey relied more on their teachers to ensure student engagement with IXL® and Zearn®, respectively. Because the IXL® implementation was ~~a~~ grassroots, bottom-up effort, Alex's teachers were more inclined to use the tool with their students as they advocated for it to be made available for them. The tool increasingly became a part of their math classrooms as teachers felt good about their decision and what they saw with students. As shared above, students could also take advantage of IXL® to better prepare themselves for Algebra 1 eligibility. Likewise, the comprehensive approach Casey took with adopting Zearn® and the steps used to develop teachers' use of the tool in their classrooms also promoted student engagement. Most notably, student use of Zearn@Zearn, inside and outside of the classroom, better acclimated them to the level ~~of~~ required by their state standards, which was ~~a~~ one of the main highlights for Casey and the school's families.

Parents and families were more aware

The ~~students' families~~ increased awareness of and engagement with the adaptive learning technology by students' families was also viewed as a success. This stakeholder group was able to support usage and learning outside of school; as a result ~~from of~~ leaders' work to regularly communicate what the adaptive learning technology was for, why it mattered, and how students should be using the tool while at home. Cameron, Alex, and Casey earlier shared how their families were looped in to support ongoing work while off-campus. Cameron and Casey also shared how they continued to connect their usage initiatives with families via newsletters, family emails/messages, and on-campus parent nights.

Commented [JR31]: Increased awareness in parents and families (if you don't want to use a complete sentence for your heading)



Suggestions for learning activities over winter break

1) families, please take a moment and check out the great learning opportunities offered by the . The videos and other digital resources provide families with informational materials to support academic achievement, navigation of the school system, and digital literacy. These videos are accessible in English and Spanish to be used by both families and school staff.

2) Moby Max over winter break: Over the 2-week break, students will continue to have access to the Moby Max Learning Suite. This program offers students the opportunity to work on supplemental math and language skills to help them build their knowledge in the content areas and also helps to fill gaps where students may have forgotten/or not received fundamental skills. Students can access their Moby Max account through their CLEVER

C account.

Figure 4-2. Samples from leaders' communication to families and stakeholders. A) Cameron's weekly math newsletter, B) Casey's flyer for a family night on campus, and C) Screenshot of Cameron's email communication to families and stakeholders.

Further, Casey shared that after sitting down with their student who was working on Zearn®, family members had an increased understanding and respect for the rigor of the coursework and the value of the tool:

Our [set of state standards] in general has a pretty bad rap on social media, at least when I see friends of mine posting and they don't really have any background when it comes to that. And I think that when parents are sitting side by side with their student, and they have exposure to a program that self-adjusts based on student ability, they see the benefit of that as well. It's a highlight. (Casey, personal communication, March 9, 2023).

This increased understanding strengthened the support of their student and the work being done in the schools for mathematics instruction.

The leaders viewed the level of engagement of the schools' stakeholder groups as an overall success with few challenges. Teachers, students, and families were active participants in their respective capacities, which contributed to increases in student usage and a broader sense of content with the implementations by leaders. This communal involvement contributed to additional successes experienced at each school with their implementations.

Equity, access, and digital citizenship

Each leader reported experiencing successes with supporting equity, access, and digital citizenship ~~as a result of~~because of their adaptive learning technology implementations. In this section, equity refers to students having the devices and connectivity required to use the adaptive learning technology, while access relates to the ability for students to engage with high-quality, grade-level mathematics content, and digital citizenship describes the responsible use of technology in an in-person and/or online setting. Leaders described how these concepts were addressed through using their adaptive learning technology as part of their teachers' mathematics classrooms.

Increasing equity for students was achieved on all campuses and viewed as a success. Four of the five leaders used their adaptive learning technology for all learners, ~~and with~~ Jordan using the tool exclusively for the EL population. Every leader ~~described~~ reported that each student had a device for their exclusive use, connected to the school's WIFI, and an account for the adaptive learning technology implementation, as informed by the strategy for the implementation. Going a step further, Cameron and Alex both provided hotspots to families in need, so students were able to continue to learn and engage with the platform while away from campus. Alex shared that the district began this practice during school closures to mitigate connectivity issues between students and school. This practice continued after students returned to school to ensure the lack of internet connectivity was not a barrier. When asked, all leaders viewed their implementations as a component of their equity efforts across their campuses as use of this technology became compulsory in their mathematics classrooms.

Student access to high-quality, grade-level content has been highlighted as a critical component of increasing student achievement (TNTP, 2018). Since returning to school from closures due to the COVID-19 pandemic, schools have been encouraged to focus on “learning acceleration” (p. 1), ~~where-which requires~~ educators lead instruction with grade-level content and build in timely, strategic supports so students are better equipped to access and master grade-level content (TNTP, 2021). In each of the leaders’ implementations and through the strategy of use they described, their teachers used the adaptive learning technology to support student access to grade-level content. This was evident in Casey’s implementation ~~where-of~~ Zearn® and their core-math adoption, which notably raised the level of rigor of grade-level content to what was required by the state and students “rose to the occasion of rigor and higher expectations” (Casey, personal communication, March 9, 2023).² Teacher’s’ use of Zearn® for small-group instruction contributed to this success as students accessed content that expedited their ability to engage more readily with grade-level content ~~more readily~~ as described by their state standards. Shared above, Alex’s use of IXL® to give to all students access to more advanced content ~~to increase preparedness for in preparation for algebra-Algebra~~ 1 ~~also~~ illustrates how leaders used their adaptive learning technology to increase student access to grade-level content, and in this case, content that was above grade-level. These experiences ~~were-occurred~~ across all implementations for those students using the adaptive learning technology.

Success with digital citizenship was described by these leaders. In their experiences, leaders noticed increased accountability and responsibility with using the adaptive learning technology and beyond. The most direct connection to digital

citizenship was in Riley's school where "~~There~~there is a course that [students] had to take on what digital citizenship is about and if they violate it, there are consequences for that" (Riley, personal communication, April 5, 2023). Jordan also reported an increase in student accountability as school continued to use tools that had an online/web-based component:

Also, I think students know that the online environment is one in which they are held accountable, even though it seems and is different than the real environment of brick and mortar...that when they're on an online platform, they are being...they're still held accountable for what they say, what they're write, what they share, what they post, all that stuff.

And so, we're seeing students more or less embracing the responsibilities in that space regarding those concerns too. We also see students who violate it and then they're held accountable, and they realize, oh yeah, I guess whether it's done virtually or in person, it's still, if it's an infraction, it's an infraction. (Jordan, personal communication, February 23, 2023).

Further, Jordan noticed students being more responsible and prepared for school with devices ready, which was celebrated as an increase in digital citizenship:

So, one aspect of being a citizen is being responsible for yourself within that context. And so, we are seeing kids recognize they have to come to school with a Chromebook in hand charged and ready to go. We're seeing that happening more frequently...I see that as progress in a sense because more students seem to be embracing their responsibilities. (Jordan, personal communication, February 23, 2023).

Looking at digital citizenship through the lens of student accountability, Casey noticed teachers more readily conferring with students about their progress and quality of work

~~to~~as a way increase student ownership ~~with~~ using Zearn®:

The teachers having control of adjusting if they see that a student has just gone through and clicked and gotten most of the responses incorrect to be able to have that data to sit down with a student and confer with them and say, "I think you can do better than this. I see you completed this in a minute and 13 seconds, and I don't think that you gave it your best effort" is really powerful as well. (Casey, personal communication, March 9, 2023).

Commented [JR32]: Not sure this is the right preposition, but not sure what you mean by this. "while using Zearn," "when using Zearn" "of using Zearn"

These conversations led to students better interacting with the adaptive learning technology in the desired manner during small group instruction time. Riley echoed this increase as well, ~~describing with~~ teachers leveraging “accountability sheets” for students to use when working with IXL® (Riley, personal communication, April 5, 2023). This layer increased academic integrity and student ownership of their work and progress with using the tool.

Leaders indicated equity, access, and digital citizenship as successes they observed during their adaptive learning technology implementations. These three concepts played a mutually supportive role in the leaders’ implementations as, when present, students were well-positioned to appropriately engage with mathematics content as required by their respective grade levels. The described successes with equity, access, and digital citizenship ~~which~~ will continue to serve leaders in their implementations and strengthen usage with teachers and students.

Data usage and improved results

The use of student data was experienced across all implementations with positive student achievement results viewed as a success by all but one leader. The only challenge stemmed from the leader not ~~yet being~~ able to ascertain ~~if-whether~~ the use of the tool increased student achievement in mathematics, ~~yet~~. The adoption was new, and they did not have more formal assessment data to serve as an indicator. The other leaders detailed increases in ~~how the ways in which~~ teachers used the data available from the adaptive tool; ~~they attributed~~ ~~=and~~ their students’ positive results ~~leaders attributed~~ to the use of the adaptive tool.

Teachers’ use of student data was described as a success across all implementations. Data from the adaptive learning technology was used to motivate and

engage students and ~~for as a basis for~~ instructional decision-making. Cameron firmly believed in incentivizing students as part of their implementation strategy, ~~and~~ as mentioned above, student usage and completion data were pulled on a weekly basis to celebrate successes and highlight those meeting or exceeding the predetermined usage metrics. During the interview, Cameron described the process ~~that was~~ used to monitor and track class and different students' progress within the MobyMax® data reports:

This is how I, you know, just a very quick snapshot of an accountability piece. You know, previous beginning grade level 2.8, ending grade level 3.0. Already we've had an increase of, you know, .2. Already we've had an increase of .2, .1, .8. So, I mean this, so this is how we can kind of track it .7 and start to see some of that growth. 1.6...this student has passed 41 standards. So that's the progress monitoring piece. (Cameron, personal communication, December 3, 2022).

Likewise, Riley was a self-described “report puller” and often looked at usage data to highlight teachers and students who were using the tool well during the week (Riley, personal communication, April 5, 2023). These data points also became a part of the data conversations teachers had with their students about growth and goal setting. This increased teacher and student buy-in and ownership of the data.

Leaders additionally described increases in their teachers' proficiency with leveraging usage data to make instructional decisions as ~~being~~ a success. Jordan valued the real-time availability of student data to inform instructional decisions:

So, the data that those technologies provide in an immediate fashion help us to tune the machine that we're constantly trying to evolve. Without that technology, we would be guessing on the basis of summative experiences or maybe summative data, but that the technologies provide essentially formative data that then informs how we proceed with our plan on even a weekly basis. So, it allows for real-time adaptation and change that makes sense for students, again, relative to our academic priorities. (Jordan, personal communication, March 1, 2023).

Riley also appreciated the almost immediate turnaround time from data to instructional planning. These data reports became part of the teachers' lesson and collaborative planning periods to discuss appropriate next steps for their students. With a longer implementation at the time of the interview, Casey also reported teachers having a noticeable increase in proficiency and familiarity with reviewing student usage data and student performance data to make instructional decision. This frequent data use was something that Casey noted as a practice that took time taking time for teachers to that point, but being happy they were increasingly fluent with this practice after providing ample observations, feedback, and support.

Commented [JR33]: This phrasing is a little confusing

Commented [JR34]: I would eliminate this time phrase

Commented [JR35]: Who is happy here--Casey or the teachers?

Leaders also highlighted improved achievement results from using the adaptive learning technology as being a success. These results were experienced in the growth of student performance and student proficiency as indicated by their state summative and/or benchmarking assessments. At the time of the interview, Cameron's school had just completed their second benchmark assessment at the mid-year point. In reviewing the data from their mid-year assessment, Cameron was pleased with the progress in growth and "assumed proficiency on the SBAC [state summative assessment]" as informed by this benchmarking data:

Our [benchmark] data just pushed out...When you see math growth... In our 6th grade we went up 4%. We had 4% growth from fall to winter in...assumed proficiency on the SBAC testing. So based on our students' growth, we assumed increased proficiency on SBAC testing will grow by 4% in 6th, 5 almost 6% in 7th grade, 8th grade was skewed because of how we tested students, so I don't have a valuable number on that, but school wide we've got an 8% growth. So that's going from fall to winter. That says a lot when I look at my teachers and I have, you know, 24 classrooms and of those 24 classrooms... 25% of them were below 50% growth. And those 25% that were below 50% growth, the lowest number was 37%. Then I had a 40, 45, 45, 46 and 47% growth, so...And that's in each classroom...So when I look at the data, we're seeing strong growth

in our students...And I have classes, you know, 75% of my classes are at 50% or above. I'll take it. And that's where you know the proof is in the pudding is when you look at secondary data to support the, not only the curriculum, but then, in this case, the supplemental curriculum, which is the MobyMax®...that we're that we're touting, I see it there. (Cameron, personal communication, December 3, 2022).

MobyMax® was considered a contributing factor to the growth demonstrated from fall to winter. In past experiences, Cameron has “seen growth as much as two grade levels when they’re using it with fidelity and we’re targeting really within our RTI program” illustrating a connection between the strategy of use, described above, with successes experienced in student results (Cameron, personal communication, December 3, 2022).

In a similar experience, Casey ~~described~~ attributed increases in student growth on state summative and benchmark assessments as a success ful result from of changing programming for mathematics. Because of the changes made, “each year, we’re progressing a little further bit further through the curriculum and achieving more. And our data is showing that our students are making progress.” (Casey, personal communication, March 21, 2023). Casey was happy with the positive results that students experienced through the adoption and changes made for their mathematics classrooms:

I love it! I think those first two months were shock, oh my gosh, this is intense, this is rigorous. And some worry, I think, from our teachers as well, “are our students prepared for this?” But ultimately when it came to looking at our data and the progress that students were making feedback from parents that they love the program and then feedback from teachers that they love the program as well. Yeah, I think ultimately, we're very happy with the growth that our students have made. Not only on our benchmark assessment data, but even on the state assessment as well, which I don't think would've been possible utilizing the previous program that we had. (Casey, personal communication, March 21, 2023).

Cameron and Casey had the most experience with their implementations, which may have allowed them to have a clearer sense on how the adaptive learning

technology influenced their students' mathematics achievement data. Riley, Jordan, and Alex were earlier in their adoptions and had initial observations of increases in student achievement data as gained through their benchmark assessments. Though the middle school teachers all were using IXL® during the year of the interview, Riley recounted how the seventh-grade teacher who had used IXL® in past years experienced success with increasing student performance on their state assessment, "especially in the lowest 30%." (Riley, personal communication, April 12, 2023). This success with IXL® had been this teacher's "claim to fame with those lower levels, being able to get them to the next level" and Riley looked forward to seeing this type of progress in other grade levels and students in future assessment results. (Riley, personal communication, April 12, 2023).

Reflecting on the experiences with IXL® last year and this year, Alex noted that those teachers whose students had the most usage on IXL® did perform better on their state summative assessment and was interested to see how usage data connected to growth on their winter benchmark assessment, which was upcoming. Alex was hopeful that the benchmark data, reported outside of IXL®, would show positive progress and performance in alignment with student usage:

I'll probably know more next week, honestly, after we get our next round of benchmarking data it is hard to say. I will say from last spring, our teachers who used it the most last spring had the best results on our state assessment. It's not really significantly researched, but just on my end, from what I could see, not to say that there's no other factors that played into that. That's why I would rather look at the growth piece, because that was just purely based on percent proficient or advanced on our state test, as opposed to maybe what was a really just strong group of kids that came in and happened to be stronger. So, I want to look more at the growth data on this next round of benchmarking. We have our next round of benchmarking next week, so we do fall, winter, and spring

benchmarking through FastBridge®. So out totally outside of IXL®. (Alex, personal communication, December 2, 2022).

While some teachers piloted last year and experienced successes with their students, Alex was cautiously optimistic with these results and would continue to monitor usage in connection to benchmark and state summative achievement data to make a formal commitment to whether or if IXL® would be a “long term tool” in the school. Further, should the results pan out, Alex would be incorporating IXL® data into the school’s mission, vision, and strategic plan. Figure 4-3 is a screenshot Alex shared of the school’s winter benchmark data from their FastBridge® assessment.

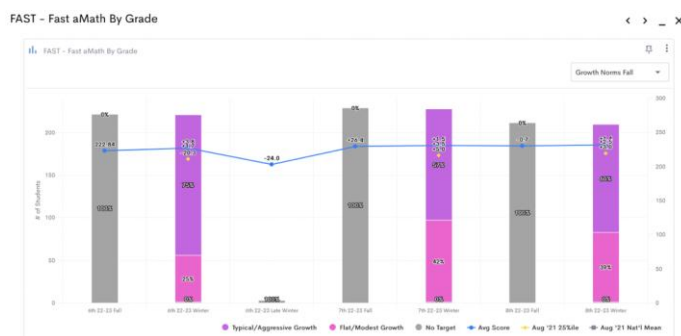


Figure 4-3. Alex's students' Winter growth data as measured by their FastBridge® benchmark assessment.

Jordan shared a similar want to have a process in place that involved “looking at student data on a regular basis to inform” a degree of efficacy (Jordan, personal communication, February 23, 2023). This was considered a challenge as there had not yet been a consensus on how to use the different data sources available to determine if the IXL® users were making the progress they expected or and to what degree. Once its efficacy was established, this would align with their strategy for using IXL®, in that which Jordan emphasized that the technology should be serving the specific needs of

Commented [JR36]: Need to clarify what 'this' is here.

the school. The data would support or refute the intention for their IXL® adoption and support future decision, grounded in data.

With the data sources available from the adaptive learning technology, the use of these data points for instructional decision making was viewed as a success across each implementation. Leaders described how they, along with their and teachers, had become more fluent with using the data from their implementation to inform next steps in their classrooms, in real time. The results generated through using the adaptive learning technology were considered positive in four of the five implementations. Leaders described examples where student growth and performance had increased, or appeared to increase, through the use of their ALT-M. Jordan was the only leader where-who did not name student performance and growth data were-not-named as a success as they were in the midst of developing a process to-that would enable them to be-able-to illustrate a connection between usage data and another data point. Because of how-the degree to which Jordan stressed the importance of the tool showing efficacy to meeting-theirmeet their “academic priorities,” they were actively working on developing a system to compare results for this purpose at the time of the interview (Jordan, personal communication, February 23, 2023).

Professional development

The final theme is drawn from the successes and challenges experienced in their implementations centered around professional development (PD). Aside from the lack of leadership PD described previously, teacher-facing PD also proved to be a pain-point in four of the five implementations with Casey being the sole leader who viewed the PD provided for their Zearn® implementation to be a success. The other leaders experienced challenges with PD that dealt with difficulties in ensuring and managing

attendance, no district support, and challenges with the perceived cost and time requirements. Despite these challenges, leaders described how they prepared their teachers, as best they could, for their implementations.

Both Cameron and Alex experienced difficulties with ensuring that all teachers were fully trained for each of their implementations. In each case, attendance ~~to-at~~ the PD sessions was strongly encouraged, though not required. In the MobyMax® implementation, to support teachers learning about the platform, Cameron would recommend and share video modules for teachers to use as a training tool. Cameron could not guarantee or monitor completion outside of viewing the videos side-by-side during a PLC time, which was an option, but not efficient. MobyMax® was a school-based implementation, so PD and support was provided by the school. With the district wide MathIA® implementation, “all of the teachers have been provided that opportunity to attend that PD”, but Cameron experienced a similar challenge to that of the MobyMax® implementation where the PD was not required and there were few to no systems in place to monitor who attended and who did not; it was optional (Cameron, personal communication, December 3, 2022). While the IXL® PD was not optional for Alex’s teachers, there was not an available way for teacher attendance to be reported. Their initial PD was in video form, and it was possible teachers did not join that first touchpoint. Looking ahead, Alex indicated the upcoming PD session would be a synchronous webinar, which would allow for more management of attendance and engagement:

The first one was a video, so I don't know who watched it and who didn't. In January, it will be a virtual session, but it will be a live virtual session. And so, everyone [all teachers] will...be on that one. (Alex, personal communication, December 1, 2022)-

Alex expressed concerns with requiring teachers to attend PD because “they don’t always love it.” but acknowledged an increased confidence with using IXL® in those teachers who reported attending the PD sessions (Alex, personal communication, December 1, 2022).

The challenges Jordan and Riley experienced differed from those Cameron and Alex shared. Their difficulties with PD dealt with ~~no a lack of~~ district support ~~with for the amount of PD and the amount of PD needed to consume more time and money than was expected that would consume more time and money than was expected but was needed~~. In both of these IXL® implementations, their respective school districts ~~did not~~ provided ~~no~~ local support to those using the adaptive technology, ~~for for neither~~ teachers nor leaders. While a shared experience, Jordan articulated ~~why that~~ district support for PD did not reach the school level ~~was~~ because there was no district vision for PD:

So, I think one of the challenges we have in this district is that we don't have a real robust professional learning program. We don't have a person who is setting an agenda or identifying goals and priorities in a global way. And so, most of our professional learning is determined by what we in the building see as an immediate need...It's very present focused, present driven, present need driven. We don't really have a future oriented professional development plan that I know of in this district. And it's something that we've been frustrated by...we are essentially building the airplane as we're lifting off the runway. (Jordan, personal communication, February 23, 2023)-

Riley also experienced no district PD support with their IXL® implementation, which was a recent change. In previous years, and with previous implementations, the district would provide training for teachers to take ~~a part of~~ part in throughout the school year, providing coverage so attendees could join trainings during the school day. With changes in leadership and funding sources, those opportunities were no longer

Commented [JR37]: Just review this change and see if it captures your idea.

available, and Riley shared, “Gone are the days where you could train during the day, so it wasn’t double work” (Riley, personal communication, April 5, 2023).²

Both leaders valued PD and believed that it was necessary for teachers to maximize the use of their adaptive learning technologies. Without district support, Jordan and Riley relied on their schools’ budget and calendar to provide PD for their teachers. Unfortunately, devoting funds and time were challenges that were difficult to overcome for both leaders, with Jordan describing their school’s challenge as follows:

We just don’t have a lot of time, nor do we have a lot of resources to devote to training all people that we would want to be trained as thoroughly as we would want them trained. So, we see the potential of the technology serving our ends if we could get more and more people up to speed on them and comfortable utilizing them, but I’m not sure we’re able to execute that plan because of just time and monetary resources being constraints that we have to work within. (Jordan, personal communication, March 1, 2023).

With the IXL® implementation, Jordan continued to share that the amount of PD required for teachers to have a more comprehensive experience with the tool required more time and financial resources than they were able to provide and that a “relatively superficial utilization is what we can achieve through minimal training...” Riley’s teachers had a similar experience as they engaged with minimal, formal PD and learned more ~~so~~ from their department chair and Riley, who was self-taught (Jordan, personal communication, March 1, 2023).

Commented [JR38]: Jordan or Riley?

Another component to Jordan’s experience with the IXL® PD was the misalignment in PD outcomes with what the educators needed through vendor-provided PD. Teachers perceived a gap between what the vendor provided and what they needed to learn, which resulted with-in Jordan and school leaders using the school’s teacher-leaders rather than vendor-supplied PD team members to train their users.

These PD sessions were not well-received by teachers and leadership opted to move subsequent trainings in-house:

And that disconnect caused us to decide that we were going to do all the training that we could possibly do and not include them because we can't waste time like that. Getting teachers together in a room to learn for a few hours is not so easy to do. So anyway, sometimes the corporate training model doesn't really work with schools, even if they have former educators on the team, I felt there was sometimes a misunderstanding of our constraints and our priorities during those training sessions. And with all the right intentions, they sometimes miss the mark. (Jordan, personal communication, March 1, 2023).

Casey was the only leader who viewed PD as a successful part of the adaptive learning technology implementation, as initially described in the [previous](#) section above about Casey's strategy to maintain their Zearn® implementation. Ongoing PD during the first year of the implementation was made a priority with a variety of learning options made available to teachers:

I think it's huge. I mean, naturally teachers want to do a good job and I think that if they have questions that has to be embedded within that. And as an administrator being removed from the classroom at this point for a number of years, it's important for me to have an understanding should I need to support teachers as far as what the expectations are of the program. So, I think it's really important and I think ongoing professional development's important as well. (Casey, personal communication, March 9, 2023).

As evidence of this, time was allocated to the school calendar throughout the year and Casey made a point to be present and available in classrooms to gather observational data to inform subsequent PD and solicit and provide feedback to teachers in real time:

I think being present in the classrooms is really important and knowing that teachers can share that feedback with you. And then creating professional development around what the needs are and what has been observed and what teachers are asking you for. And sometimes it's indirect, some, sometimes teachers don't know what they need. And I think by offering to come in and say, well, how about I come in informally, no judgment, and I come in and just take a look at this topic that you're going to be instructing on and give you some feedback and we can go

from there. And I think that's beneficial knowing that I'm coming in still as an administrator, but not in the capacity of and being an observation that's counting towards your evaluation. (Casey, personal communication, March 9, 2023).

The time committed to PD and the feedback provided between Casey and the teachers, which then informed the content of subsequent PD session, worked well for this implementation. As Casey reported, teachers became increasingly proficient with using the adaptive learning technology and discussing data, which translated to the additional successes referenced above, ~~concerning relating to their adjustments~~ adjustments to their instruction made their instruction based on student data; something Casey had wanted to accomplish for some time.

Leaders highlighted several successes throughout their respective adaptive learning technology implementations, while describing intermittent challenges. Stakeholder engagement, spanning the school with teachers and students, then into the community with family engagement was seen as success, particularly with Casey's implementations where parents were noticeably engaged with their learners. Equity, access, and digital citizenship were successes with all five leaders, with each highlighting how the use of their adaptive learning technology better served their students and families. With the amount of data available when using these technologies, data usage by teachers and the positive results generated through their use were predominantly seen as a success at the time of the interviews. Jordan had not yet gotten to that point but was working on a system to view and compare usage data and student results. Professional development was the biggest challenge for the leaders. They experienced difficulties in monitoring and ensuring teacher attendance and allocating time and financial resources to have PD happen at all. Casey was the

only leader who viewed PD as a success ~~for in~~ the implementation. Next, leaders will describe how their current experiences with these implementations will influence and inform future implementations of adaptive learning technologies for mathematics ALT-Ms.

Research Question Four: Current Experiences Informing Future Implementations

The final research question asked leaders to consider how experiences leading their current implementations would influence their leadership of subsequent implementations of adaptive learning technologies for mathematics ALT-Ms. During their interviews, leaders reflected on the processes they used for their implementations, data use to drive decision-making, and the role professional development would play. The themes created from the interviews were:

- ~~Refine~~ Refining processes for implementation
- Data informed decision-making
- Better and more professional development

The leaders further described how they might accomplish these steps as they moved onward in the current year and ahead into subsequent implementations.

During the analysis, responses focused on leaders wanting to adjust and refine their processes used around and during their implementation. This theme was developed from their intention to increase communication to stakeholders about why the adaptive learning technology was being used and processes in response to feedback. Data usage and how data points would be used to make decisions were also identified to develop the data-informed decision-making theme. With this theme, like the theme that was viewed as a success, leaders shared what data they would like to see their educators and themselves start or continue to use for implementation and instructional

Commented [JR39]: Do you think this is clear to the reader?

decisions. Lastly, to overcome what was predominantly described as a challenge, leaders shared how better, and more professional development was needed to strengthen their implementations. This theme highlighted how PD needed better to better connect with the leaders' vision and goals for the implementation. Table 4-7 lists the themes for RQ4 with sample codes and a description of each theme.

Table 4-7. Themes, sample codes, and descriptions for RQ4.

Theme	Sample codes	Descriptions
Refine processes for implementations	Continuously connect "why" for stakeholders.	Leaders plan to elevate processes used to lead their implementations.
	Learn, reflect, and share experiences more.	
	Continue to include stakeholders	
Data informed decision-making	Increase processes for recording and accountability.	Use of data to inform instructional and implementation <u>decisions, decisions</u>
	Data to inform next steps.	
	Data showing increases in achievement.	
Better and more professional development	Tailored PD to school-specific needs.	Preferred timely PD connected and aligned to vision for use.
	Train new teachers; connect to WHY.	
	More PD on how to use w/workshop.	

Commented [JR40]: Note, I took the periods off here. The first item in the column is a full sentence (so it could have a period) but the other items are not. I would suggest leaving the period off all three items in the column

Refine Processes for Implementations

The processes leaders used to adopt and implement their adaptive learning technologies was where they were most reflective when considering what they would do differently for their current and future implementations. Their thoughts on next steps with on implementing adaptive learning technologies focused on the processes used to select and adopt the tool followed by maintaining teacher and student fidelity of use in

alignment with an intended purpose or vision. Below describes the leaders' reflections on how they would refine the processes used for moving forward with adaptive learning technology implementations.

In implementations where the leaders had full autonomy, the processes that leaders used to select their adaptive learning technology warranted refinement. In these school-based decisions, leaders described wanting to have increased clarity on the problem they were attempting to solve through ~~using the~~ adaptive learning technology prior to considering a tool. Both Jordan and Riley emphasized that looking at future implementations, it would be important to identify the problem first, and then explore what different technologies had to offer as potential solutions. Jordan, as described above during RQ2, was highly committed to the concept of the vision or intention leading the decision. This held true with considering future adoptions of adaptive learning technologies:

We would want to make sure that we were clearly defining what it is that we expected to get out of the technology so clearly and so accurately that we could really interrogate the product very thoroughly before we made a commitment to contract. Because I think sometimes, we think we know what we want, but then we really haven't defined it. We maybe haven't even defined our problem that we're trying to solve with the technology. So, we're not even sure what solution we need since we haven't really identified the problem specifically enough to even search for a specific solution. So, I think we have learned that the more time and energy and mental effort we put into the definition of the problem will save us in lots of frustration and time down the road once we identify what we think will be the solution. (Jordan, personal communication, March 1, 2023)-

In similar fashion, Riley agreed that in looking ahead and clearly identifying why the program is needed, followed by exploring solutions, would be a preferable process:

It's always about planning ahead and having a solid reason as to why this program... So, knowing that when I'm searching for different programs that are going to enhance [instruction], I can go ahead and do my

research ahead of time to see which program fits the most or what's going to fill in the gap. (Riley, personal communication, April 12, 2023).

In those implementations that were district-wide, the leaders' involvement in the adoption process played a role in what considerations were shared for future implementations. Because of the smaller size of the district, Casey was more hands-on in the district's adoption of Zearn® compared to Cameron's adoption of MathIA®. ~~HA~~
~~coming~~Having come in from a larger school district, Casey reflected on the two processes and when asked about lessons learned shared a key difference:

The timeline for one, just because I kind of had a skewed view. I came from a very large, as a teacher and assistant principal, I came from a very large school district with a number of elementary schools. So, when there's a curricular change, it has to be, it's very controlled from the top down and very much like, "this is what we're doing and here's the timeline for implementation." Whereas I have a different perspective now. (Casey, personal communication, March 21, 2023).

The adoption timeline for Casey's most recent adoption was almost a year, whereas the timeline referenced for Cameron's MathIA® adoption was much shorter because of the district-managed process, which may have influenced the implementation. Although proud of the process used for their adoption, Casey would have liked it to been completed faster:

Well, hindsight's 2020, it would be really nice to narrow down programs a little bit quicker, but what going through that process is really valuable and you have to do it. We had some individuals who were like, oh, this program is what they're using in the neighboring school district. They're experiencing excellent results with it. This is what we need to do. Despite our independent research and information gathering on the program, and we knew it didn't necessarily meet the criteria based on our rubric, we still went ahead, I think more to appease that individual than anything. And ultimately, they even realized like, no, this isn't going to meet our needs...And if I had to change anything, it would be really nice to narrow sooner to get to the end in mind a little bit quicker, but you can't skip that process. (Casey, personal communication, March 21, 2023).

Because of how thorough the district's process was, and the multitude of stakeholders involved, Casey understood that the amount of time devoted fundamentally required time.

Commented [JR41]: ?

Learning from other schools' implementations was a concept mentioned above when exploring the strategies used for implementations in RQ2. This idea also came up when making considerations for future implementations. As part of their adoption processes, Alex and Casey and their teachers visited other schools to learn from current users and confirm their final decision. This was a practice which would be continued for future implementations. Casey also shared that because of the successes they had experienced with their adoption, neighboring schools and districts were reaching out to schedule time to meet with teachers to learn about their experiences and help them make a final decision:

It's a really good feeling too, selecting our program that we went with and now other districts around us were, were using that at least in our county. And now as a result of that, there's two or three that are reaching out to us and saying, "Hey, we're hearing really good things, and we'd like to come and visit your school and come into some of the classrooms." (Casey, personal communication, March 21, 2023).

Along the same lines, Jordan would like to learn from other schools' implementation prior to deciding for future implementations:

But I will say we seem to learn best as educators, at least when we see examples that are familiar to us that are where they're using that particular tech solution. So, we can check with our colleagues as to their experience, not just in terms of utilization, but in terms of whether or not it's effectively achieving the desired outcome. So, looking for testimonials that are accessible in our immediate area would be a priority for us going forward with any new tech acquisition...before we make any decisions, you need to tell us several schools that are using this. You need to put us in contact with the prime users, or at least coordinators of this initiative at those districts so we can spend time talking it through with them. That's where we really tend to learn much more accurately than a sales pitch or even a detailed presentation by a trainer. It's still going to be kind of colored

favorably on behalf of the business plan. But if we talk to actual users and can really ask them to be brutally honest, that will lead us to a better decision more quickly. (Jordan, personal communication, March 1, 2023).

When considering future implementations, leaders sought to ensure the technology addressed a specific school need and that there was a thoughtful process used for selection that included collaborating with current users to learn from their experiences.

Post-adoption, leaders shared how their experiences would change how they approached leading their current and future implementations. At the time of the interviews, participants were well into their school years with students and teachers using the adaptive learning technology in the mathematics classrooms. Leaders described possible changes they would make for this school year, strategies they would continue to leverage for current and upcoming implementations, and proposed ideas for their next school year another implementation.

For the current school year, based on lessons learned at the time of the interview, leaders looked to better support teachers and students with understanding why they were using the adaptive learning technology. “The why” frequently came up as a point of emphasis. Cameron and Riley, both thought it necessary to reiterate to teachers and students why the tool was being used. Riley continuously felt the need to remind teachers that IXL® was to be used to support mathematics instruction, and that “it doesn’t replace good teaching.” Cameron looked to take this a step further and planned to reiterate and reset expectations more formally. Once back from ~~Winter~~ winter Breakbreak, teachers would dedicate time during their math block ~~devoted to~~ re-teaching how to use MobyMax® and set level ~~set~~ expectations:

So, we’re doing a reset day for our students when they come back from break. And one of the things that that we’re actually doing in math, specifically in math, is the teachers are going to do two 35-minute blocks,

and in that time, they're going to re-teach how to use the programs that were implementing and we're utilizing in the classroom. So, they're doing a reteach on MobyMax®: How to login, how to check your progress for the individual students. Like in other words, taking the students back to day one. How did you do this? How did you check to see your progress? Why is this an important tool to be using. (Cameron, personal communication, December 3, 2022)²

Cameron continued and described that although teachers may have taught students how and why MobyMax® was being used, there was not a formal, consistent process in place to ensure clarity for students and teachers. Upon their return from ~~Winter-winter~~ ~~Break-break~~ and moving forward in subsequent school years, Cameron would have a formal lesson ~~to be used~~ to teach students and teacher how MobyMax® would be leveraged:

...it's something that they did informally in September and I'm creating it as a formal lesson in January that I think next year looking at it, I want them to do it formally in September...So it was never an assigned, structured lesson for the teachers to teach how to use the programs because it was simply an assumed, and I hate that word, but that they learned from the previous year or that they learned it from peers or that...But there was never any direct instruction...And/or they would do instruction as they were doing the lesson or utilizing the program. (Cameron, personal communication, December 3, 2022)²

In reflecting on and refining processes for this and future implementation, Riley shared that, to better monitor and manage use, the practice for using “accountability sheets” would ~~begin-start~~ at the beginning of the school year ~~and~~ with regular and consistent monitoring of usage for teachers and students:

Well, my first year I didn't have the accountability sheet where they (students) had to mark and write. It was kind of just free for all. But seeing that I need to be consistent with these groups...The next time I push this out, I need to let them know that I'm [monitoring] them. So, my first year I wasn't as obsessed with it as I was when I saw the results of just doing it without the full fidelity. But then it made me aware that this year going in, not only do the teachers have to be aware of it and monitor it, but I also have to be accountable to making sure the teachers are doing it and

letting the students know I'm watching as well. (Riley, personal communication, April 5, 2023).

Riley realized that the processes they used in their previous implementation of a different program (i-Ready®) with success, would also be the preferred practice for their current and future IXL® implementations.

The final process that leaders focused on for processes of future implementations dealt with connecting with stakeholders, in and around the school, to solicit feedback and continuously communicate the rationale for the implementation. Of the five leaders, Casey had the most stakeholder involvement as part of the implementation process. From the adoption process through implementing Zearn®, teachers, students, family, and community members were ~~part of the implementation~~ ~~and~~ had a voice. This concept was something Casey looked to refine and would continue to use for future implementations:

Commented [JR42]: I struck this bc it seemed redundant

So, I just think the involvement of a team of teachers and how important their input is into selection of that, not just them, but parents and community members as well. And making sure that's aligned with our end in mind, which is our Profile of a Graduate was really, really important. And maybe it was just because of my role previously being a teacher or an assistant principal and not being involved in that curricular process. But I found that to be very valuable. And regardless of what I'm going to do, whether I remain the principal here for the rest of my career or do something else, that's very valuable to gather that input and not just input from those who are on board with the program and feel that it would be successful. But some of the individuals who don't want change or are the devil's advocates, so to speak, of that program as well, to hear their concerns. (Casey, personal communication, March 21, 2023).

At a more local level, Cameron described missing the opportunity to launch their MobyMax® implementation in tandem with establishing “the why” for teachers and students. When asked about lessons learned and opportunities to make changes, Cameron said, “Lessons learned is we pushed this out, but we forgot to...We forgot to

push out the why" (Cameron, personal communication, December 3, 2022).² Going further, when asked who the preferred audience was, teachers or students, Cameron went on to say, "Both...Both! I mean, I think that...I think it was lost in translation. And so, we need to explicitly include that information" (Cameron, personal communication, December 3, 2022).³ This led to Cameron's plan to have teachers directly reteach students how to use MobyMax® and the rationale for using MobyMax^{it}® and launch the next school year with the same type of lesson, described earlier in this section.

Commented [JR43]: Same as what?

The leaders recognized that the processes used to adopt and implement their adaptive learning technologies were not perfect. Given their experiences with adoption adopting and using the technology in classrooms, leaders were able to provide clarity on what they would change as they moved forward in the year and as they moved into subsequent years and new implementations. Alex's take on their processes used for their IXL® implementation could extend to all leaders as they increased their familiarity with leading their implementations:

So, I feel like it's always, the more we know, the better we do. So probably just more dedicated time to learn and reflect on it and share experiences.
(Alex, personal communication, December 2, 2022)

Given more time and opportunities to learn, leaders would be able to reflect, adjust, and refine as needed.

Data Informed Decision-making

Data from varying sources factored into decision-making for each leaders' ALT-M implementation. These data, comprehensively, were or would be used to bolster the decision to continue the current use of the adaptive learning technology or to adjust the approach for the implementation. All leaders planned to consider ed data as part of the conversation when deciding next steps for their implementations. The sources of data

included state summative assessments, benchmark assessments, and data from the adaptive learning technology itself. These data sources, in isolation or in ~~combination~~combination, contributed to the decisions leaders made about their adaptive learning technology implementations moving forward.

The use of IXL® implementation on Jordan's campus was the newest implementation of the group as the EL teachers did not have a formal pilot or adoption process and ~~they~~ were wrapping up their first year of adoption. During this time, Jordan and the teacher-users found value in the real-time data IXL® provided that allowed them to adjust instruction and use of the tool to better serve the needs of their students:

It provides real-time opportunities for the use of data to inform our service to students and our decision making in terms of how programs should be amended going forward. So, the data that [IXL®] provides in an immediate fashion help us to tune the machine that we're constantly trying to evolve. Without that technology would be guessing on the basis of summative experiences or maybe summative data, but that the technology provides essentially formative data that then informs how we proceed with our plan on even a weekly basis. So, it allows for real time adaptation and change that makes sense for students, again, relative to our academic priorities. (Jordan, personal communication, March 1, 2023).

Providing an additional layer, Jordan described how their leadership team and teachers would plan to collaborate, review usage data, use feedback from educators, and make decision about how to proceed with the implementation:

So, we gathered data from the teachers, the instructional technology coach and I looked at the survey responses...we would get together, look at usage data, get information from teachers, evaluate it, determine what we have, whatever conclusions we could reach from that analysis, and then make a decision. That's kind of how it works more or less. (Jordan, personal communication, February 23, 2023).

At the time of the interview, they had not yet done this for IXL®, but planned on doing this in the upcoming months to determine their next steps.

Similarly, Alex, in the first formal year of adoption, had not yet committed to moving forward with a multi-year implementation. Alex wanted to see what the data had to say before deciding and looked forward to seeing the school's winter benchmarking data, spring data, and state summative results as data points:

I'll probably know more next week, honestly, after we get our next round of benchmarking data it is hard to say. I will say from last spring, our teachers who used it the most last spring had the best results on our state assessment. It's not really significantly researched, but just on my end, from what I could see, not to say that there's not other factors that played into that. That's why I would rather look at the growth piece, because that was just purely based on percent proficient or advanced on our state test, as opposed to maybe that was a really just strong group of kids that came in and happened to be stronger. So, I want to look more at the growth data on this next round of benchmarking. (Alex, personal communication, December 2, 2022).

Alex also planned to include qualitative data as part of the decision-making process for their implementation. Classroom observations paired with student growth data would best inform Alex with-on how to proceed with IXL® moving forward:

I look at it from two sides. One's the data side. I think data will drive whether we continue to use it, whether kids are showing growth, if they're showing that they're growing, especially the kids that are using it more heavily. And then I would say from the more, it's a little bit more subjective, but just from my observations and classrooms of how it's being utilized is another key factor. I think I said this in a previous interview, but if I'm seeing that teachers are using it as a babysitting tool, "Hey, it's Friday, 45 minutes, everyone get on IXL®..." and while the teacher's sitting at their desks, obviously that's not going to be a favorable outcome for me. And so that would definitely shift. I am not seeing that currently, which is good but that would definitely play into it. (Alex, personal communication, December 2, 2022).

For those leaders with more experience with the ALT-M, they also made connections between success with their adaptive learning technology and observable growth in student performance on state summative and/or benchmarking assessments, which informed continued use. Whereas Alex and Jordan wanted to see what their data

indicated, the others felt confident, based on prior experiences, that the use of their adaptive learning technology positively impacted their students' performance. Although Riley's teachers were in their first year of a full implementation, the success ~~the seventh grade~~seventh-grade teacher had experienced in previous years, particularly ~~in~~with their "lowest 30%" student population, was attribute to using IXL®:

So, her numbers are shrinking. The teacher in the middle that uses, the seventh-grade teacher, she's used it for all long years and that's been her our claim fame with those lower levels, being able to get them to the next level. (Riley, personal communication, April 5, 2023).

This year, a sixth-grade teacher is also seeing progress in student performance in using IXL® as intended, as measured by their benchmark assessment:

So, I can say with the sixth-grade teacher who uses it with fidelity, who holds the kids accountable, these lessons are due at this day, I need to see your work...She's made some gains from the first assessment for the second assessment, and she says it's due to IXL®. (Riley, personal communication, April 5, 2023).

This progress further supported Riley's intention to refine their processes and expectations for use of IXL® in classrooms to have that type of growth achieved with more of their students.

Cameron and Casey, each with 2+ years of implementation experience, also cited increases in student performance from using the adaptive learning technology, which supported their decision for continued use. ~~As Featured~~featured in the findings for RQ3, Casey was "very happy with the growth that our students have made" and that growth was illustrated on their benchmark and state summative assessment results (Casey, personal communication, March 9, 2023). Casey did not "think [the results] would have been possible utilizing the previous program" (Casey, personal

Commented [JR44]: Plural or singular here?

communication, March 9, 2023).² These improvements in student data supports Casey and team's continued use of Zearn® in the mathematics classroom.

At the time of the interview,³ Cameron had just administered their midyear benchmark assessment and reviewed and voiced-over some of their results. During the discussion, Cameron highlighted increases in grade-level "presumed proficiency" on their state summative assessment and individual class growth from their fall and winter benchmarks:

So based on our students' growth, we assumed increased proficiency on SBAC testing will grow by 4% in 6th, 5- almost 6% in 7th grade...school wide we've got an 8% growth. So that's going from fall to winter. That says a lot when I look at my teachers and I have, you know, 24 classrooms and of those 24 classrooms...25% of them were below 50% growth. And those 25% that were below 50% growth, the lowest number was 37%. Then I had a 40, 45, 45, 46 and 47% growth...And that's in each classroom. So, when I look at the data, we're seeing strong growth in our students. You know...is it the 90% growth rate that you wanted in your school? No, but we're talking math standards that across our district are very low and for us to see 50% percent of students who met or exceeded their projected score on [the benchmark] ...And I have classes, you know, 75% of my classes are at 50% or above. I'll take it. And that's where, you know, the proof is in the pudding. It's when you look at secondary data to support the, not only the curriculum, but then, in this case, the supplemental curriculum, which is the MobyMax®...that we're that we're touting, I see it there.⁴ (Cameron, personal communication, December 3, 2022)-

These increases in student performance data illustrate why Cameron continues to invest in MobyMax® as a supplement to the school's core mathematics curriculum. With these experiences in increased achievement, on benchmark and summative assessments, Cameron felt confident that the adaptive learning technology ~~it~~was contributing to the positive changes in mathematics performance.

With the amount of data available to the leaders inside and outside of their adaptive learning technology, leaders looked to use a combination of data sources to make decisions about their implementations. Earlier in their IXL® implementations, Alex

and Jordan planned to ~~de~~-review the data they had at their disposal to determine whether or not to proceed with continued adoption. The other leaders, with increasingly more experience, continued to look at benchmark and state summative assessments to demonstrate a rationale for their continued use of the adaptive learning technology and cited growth and increased student performance that resulted from its use. Leaders seemed comfortable, fluent, and confident with discussing these data-informed decisions about their implementations, indicating this was something they had previously given much thought.

Better and More Professional Development

The need for better professional development (PD) was the third theme identified ~~from~~by the leaders in their reflections on how their current implementations would influence those that they might lead in future opportunities. Although most leaders viewed PD as a challenge with their current implementation, they still considered it an important area of focus for future implementations. As an additional layer for PD in subsequent implementations, some leaders preferred to better ensure that the outcomes of the PD trainings were more closely connected to their vision. They also wanted to ensure that and intended use of the adaptive learning technology was used as intended and that the frequency of PD increased to be and increase the frequency of PD to be timelier within the school year.

All participants discussed PD as needing to be a part of future adaptive learning technology implementations. Casey indicated that the amount of PD offered during their first year of implementation was critical to what they described as a success. Though the amount of PD offered waned during subsequent years of the implementation,

because of changes in priorities, Casey believed that investing in PD during the first year of an implementation was a critical step:

This year, not as much, just because our focus has been English language arts...So that's really been our focus this year. But that first year of implementation (with Zearn®), it was every professional development day. There was some component of professional learning or collaboration that was built in for mathematics. (Casey, personal communication, March 21, 2023)

Riley would also plan to include additional PD for leaders and teachers. Around the time of the interview, the district announced plans support ~~with~~ PD opportunities in the upcoming year for schools' IXL® implementations:

Because I'm just finding out now, we had to buy [PD]...Like I told you, they [district teams] weren't offering it. It was turned down from the secondary department. So, we had to write a grant, but now they have pilot schools, so we were able to purchase only a certain amount. So just the same way that we were provided with that professional development, with our other programs that we've used in the past, we'll be having a lead, and somebody showing us really how it works. (Riley, personal communication, April 12, 2023)

While these leaders provided a broader description of what ~~of~~ next steps with PD they preferred, the other had more specific considerations for how PD would look ~~for in~~ subsequent implementations.

In reflecting on the PD offered for their current implementations Cameron, Alex, and Jordan described their preference for PD session outcomes to better connect to their visions for their respective implementations. The previous trainings provided, in whichever modality (in-person/virtual, synchronous/asynchronous), seemed to be either too high-level or detached from what the leaders² felt their educators needed to elevate their implementations. Further, the ~~leaders'~~leaders described their want for PD outcomes that extended beyond the features of the product to ~~narrow in~~focus on how to use the product in the way that they envisioned.

Cameron's experience with using MobyMax® and leading an adaptive learning technology implementation was the longest of the leaders in the study. They already had systems in place to train teachers about how the product functioned and a strategy for using the tool with ~~student~~students. What was missing for Cameron, and particularly for new teachers, was training on the school's vision for using MobyMax®; they needed to know the "why." Cameron shared that looking ahead, to better strengthen teachers' use of the tool, like with students, teachers would need formal training on why this tool would be valuable to their students:

...ensuring that as new teachers roll in, we provide direct instruction to those new teachers and don't let it be peer-to-peer instruction because what you have when you get that peer-to-peer it's the same thing that we see in students: You lose fidelity of the why. (Cameron, personal communication, December 3, 2022).

Professional development that better connected to the leaders' vision was also a priority for Alex's IXL® implementation. Recall, Alex was interested in having teachers use IXL® for small-group instruction as part of a workshop model framework for their mathematics block:

What I have learned is that I think we need more professional learning on the instructional models to go with it. That sometimes teachers just struggle to see how they can utilize it to differentiate for kids. If that makes sense... So it's not about the product itself, it's more about the whole instructional model and how it's enhancing the instruction. (Alex, personal communication, December 2, 2022).

To better achieve this, Alex believed this would require a different focus of PD than what was traditionally offered and ~~be better aligned~~better alignment with the vision for using the adaptive learning technology in classrooms.

Jordan aligned with Cameron and Alex's needs to have PD tailored to ~~have~~having learning outcomes support the use of the adaptive learning technology to

support their vision for use in future implementations. To accomplish this, Jordan advocated for training ~~to be tailored~~that was tailored to the specific needs of the teachers and also for training that was timelier ~~those trainings be timely~~ to better support teachers ~~where they were with~~during their implementations during the year:

Commented [JR45]: Necessary phrase?

We want to make sure that the training that's provided is going to be dynamic and responsive to our questions and our other needs in real time. I would also want to make sure that we had a did a better job as institutions stating what our immediate needs are within a certain defined timeframe, and then ask for the support to be provided relative to those time-bound needs and priorities. (Jordan, personal communication, March 1, 2023)-

Knowing this would not be an easy feat, with costs and time continuing to be barriers, Jordan also proposed that using in-house, teacher-leaders to facilitate these PD sessions could be a viable option for upcoming implementations with IXL® or other solutions they might adopt.

From leading their adaptive learning technology implementations, the leaders' responses for RQ4 looked to refine themes and concepts from the previous research questions to elevate stakeholder experiences to generate improved student achievement results. ~~To better~~Improving the processes used to lead their implementation, ~~leverage~~leveraging data sources to inform implementation decisions, and ~~improve~~improving PD opportunities for their teachers stood out as the lessons learned that would be focal points for future leadership of adaptive learning implementations. These themes trended across the research questions and appeared to be reflective points throughout their experiences and the interviews. In the next section, I will discuss these findings from this analysis and share implications for my professional practice and the knowledgebase.

CHAPTER 5 DISCUSSION

This chapter discusses findings from the study of participants' lived experiences as technology leaders of ALT-M implementations. ~~We will~~ ~~Beginning begin~~ with a summary of findings, ~~and then address~~ each research question ~~will then be addressed~~ to highlight connections and contributions to the current research base grounded in the results from this study. Implications will follow and organized into three sections: personal, vendors, the field.

Summary

This study was designed to understand leaders' lived experiences as technology leaders of ~~adaptive learning technologies for mathematics~~ ALT-Ms implementations. With the increasing popularity and efficacy of these platforms (Wang et al., 2020), learning from those who have led these types of implementations can inform next steps and provide guidance for technology leaders who will be leading ALT-M implementations in the future.

With this study positioned at the intersection between the concepts of technology leadership, standards-based teaching and learning for mathematics, and adaptive learning technologies, the conceptual framework, shown in figure 5-1, guided the course of study with the participants. Through this framework, the first research question looked to understand participants' previous experiences as technology leaders. The second and third explored their leadership of their current ALT-M implementations and ~~their~~ ir respective successes and challenges ~~they experienced, respectively~~. The fourth research question sought to learn how leaders' current experiences would inform their approach future implementations.

Commented [JR46]: with this type of sentence, the two subjects need to match. In this case, the chapter begins with a summary of findings...

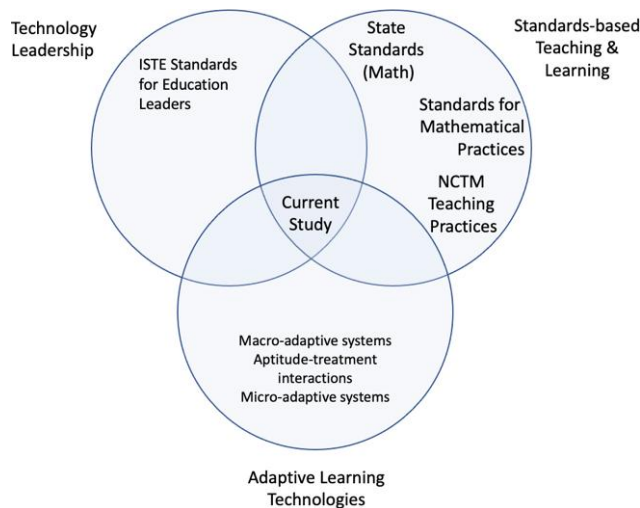


Figure 5-1. Conceptual framework for this study.

Five leaders from across the country participated in this exploratory qualitative study. As described in Chapter 3, the interview protocol followed guidance ~~from~~from Seidman's Three-Interview series, which ~~that~~ allowed for a better sequence and organization of questions (Seidman, 2006). Where possible, participants also shared artifacts to better ~~illustrated~~illustrate their experiences.

Thematic analysis was used to analyze the data and make meaning from the interview transcripts. Through emergent coding for each research question, themes were generated, organized, and described in Chapter 4. The following describes how these themes relate and contribute to existing scholarship in the knowledgebase.

Discussion of RQ1

How do participants describe their previous experiences as technology leaders?
Previous experiences varied across participants, and this section focuses on the

participants' prior experiences as technology leaders and ~~discusses~~ their varied prior experiences, inconsistent training, and self-directed learning experiences that helped them to become more proficient.

Varied prior experiences

All participants described having prior experiences as ~~a~~ technology leaders, with some having experiences leading ALT-M implementations. The length of their previous implementations and tools that their teachers used were different than what they were implementing at the time of the study, except Cameron's MobyMax® implementation. Each of these leaders' prior experiences contributed to how they approached technology leadership, corroborating early research that claimed technology leaders often rely on personal experiences and observation to further their skillsets (Kearsley & Lynch, 1992; Dexter, 2011). Though prior personal experiences did influence how the participants led their implementations, the length of their prior experiences, with which tool(s) they had prior experience, and in what capacity(ies) they had experience also played a factor. Jordan, who had the least prior experience as a technology leader, felt the least amount of proficiency and confidence with their current implementation, while Cameron's, who had experiences with launching and leading an ALT-M implementation as a teacher-leader, leading as a strategist (coach), and leading as an AP, was much more confident and proficient as a technology leader.

Though the literature considers personal experiences as contributors to ~~their~~ technology leadership, the length of time, in what capacity, and with which tool(s) ~~they~~ ~~had those experiences~~ were not mentioned. In this study, ~~these~~ factors mattered ~~with~~ with regards to how leaders approached their current implementations. Those with

Formatted: Strikethrough

Commented [JR47]: check this deletion. You are still talking about the literature here, right?

the most amount of time and experience with the same tool, or a comparable solution, appeared more confident in the leadership of their current implementation.

Inconsistent training

The participants' experiences with no formal training nor preparation as technology leaders also tracked with the knowledge base. Kearsley & Lynch (1992), Ermter et al (2002), McLeod and Richardson (2013), Metcalf and LaFrance (2013), Schrum et al (2011), and Wu et al (2015) reported on the importance of technology leadership yet found deficiencies and inadequacies in the preparation of school leaders to lead technology implementations from ~~the~~-national down to ~~the~~-local levels. In this study, none had been introduced to the concept of technology leadership nor formally trained to lead technology implementations ~~as they worked to become education leaders~~ as their master's and doctoral programs did not include any type of technology leadership coursework. Prior to this study, the concept of technology leadership was foreign to all leaders. This came as a surprise as the knowledgebase has been reporting on the importance of technology leadership for those who oversee technology implementations for decades with little evidence of progress made in the collegiate environment for advanced degrees. More concerning, quantitative data suggests that the amounts and types of technology training leaders receive can, with statistical significance, influence the technology implantation (Dawson & Rakes, 2003). Epslin et al (2018) further reiterated that those who did not develop technology leadership skills, as education leaders, could reduce the potential impact that the tool being implemented had on education outcomes.

Self-directed learning

The lack of formal preparation in their academic careers was also mirrored in their reporting of not having leader-focused PD to prepare them ~~to lead prior~~ lead prior to ~~their~~ implementations. Dexter (2011) described that in these instances, it was common for leaders to rely on their own observations and personal experiences ~~on which to~~ base as a base for technology leadership decisions. Though leaders had varied previous experiences with technology leadership and no preparation via schooling and PD, they took it upon themselves to learn.

The leaders' report of actively finding opportunities to learn about their technology and how to implement it did not appear in the literature. As such, the avenues they took were also an interesting addition to knowledgebase. As leaders attending teacher-facing PD was the primary route, I wondered how much of what the leader learned in teacher-facing PD would benefit their work as a technology leader and ~~into~~ what degree. Dogan (2018) affirms the importance of leaders ~~to~~ understand understanding the tool they are implementing, yet Dawson and Rakes (2003) highlighted ~~the fact~~ that leaders who receive training focused on integrating technology ~~was~~ ere preferred to "basic training" (p. 3).

Self-study, trial-and-error, and collaborating with peers were also strategies the participants used as avenues to learn how to lead in previous implementations. While these were trends from prior implementations, they were also used for their current implementations, but not readily mentioned in the technology leadership knowledgebase. Rather, in the absence of formal preparation and training, leaders would outsource their technology leadership responsibilities to a technology coordinator, another AP, a coach/teacher-leader or department head (Davies, 2010; Dexter, 2011;

Richardson et al., 2013). This was not referenced for prior implementations, suggesting the leaders did not dole out ownership of their previous implementations.

Discussion of RQ2

How do participants describe their experiences related to leading the implementation of ~~adaptive learning technologies for mathematics~~ ALT-Ms? This research question brought the line of questioning to the leaders' current implementations. The findings feature each participants' unique experiences in leading their buildings' ALT-M implementation. Leaders' experienced variability in their training for and conceptualization of technology leadership, had low familiarity with the ALT-M tool being implemented, ~~but~~ nonetheless, were strategic in how they led their implementations.

Varied preparation and conceptualization of technology leadership

Like in the leaders' previous experiences with technology leadership, the participants received ~~very little~~ scant training, if any at all. This echoed findings from Kearsley & Lynch (1992), ~~who found that where~~ when training for leaders was available, the learning outcomes focused on the operational functions of the technology rather than the skills and techniques to lead their educators' adoptions of technology tools. Also ~~like as~~ in their previous implementations, these leaders used alternative means to equip themselves ~~with a~~ better approach ~~to~~ technology leadership, which, again, was not ~~a~~ common component ~~to in~~ the knowledgebase. ~~Teachers~~ Engagement in PD, self-study via videos and manuals, and ~~connecting with other~~ with other, experienced leaders were ~~where ways in which~~ leaders spent time to develop their understanding and conceptualization of technology leadership.

As leaders did not have formal technology leadership PD or training, when asked how they would describe technology leadership, leaders said that technology leadership meant having a degree of awareness of the ALT-M to support teachers and understand it enough to engage in discussion and conversations with others, which was an important factor ~~to-in~~ technology leadership that leaders were working toward (Dogan, 2018). Supporting teachers with their adoption of the tool and even modeling what that looked like were how leaders practiced technology leadership and ~~was-were~~ practices supported by the literature (Dawson & Rakes 2003; McLeod & Richardson, 2013). However, leaders, as they described their conceptualizations of technology leadership, stopped there and did not consider any additional skills or competencies that contributed to how they viewed the technology leadership of their implementations, nor were they able to cite or reference ISTE's Standards for Education Leaders as part of their conceptualization.

Commented [JR48]: I wanted to add a noun here--just be sure you like this choice

Low familiarity of ALT-M

The concepts of state learning standards for mathematics, the SMPs, and NCTM's Effective Teaching Practices served as components of the conceptual framework for this study along with concepts for adaptive learning technologies. Leaders were asked to describe their familiarity with those concepts and how they then presented themselves in the ALT-M. Overall, leaders had low familiarity at best. Leaders believed that it was important for technology leaders to have an understanding and awareness ~~about-of~~ the tool being implemented. Collectively, there was a gap in their understanding about their ALT-M and the material that was included with-in it. On adaptivity, aside from referencing basic definitions (the platform adjusting based on what the student does), leaders were unfamiliar with when and how their ALT-M

adapted and in what capacity. The classifications of adaptive instructional systems introduced in Chapter 3 were ~~not~~ part of neither leaders' understanding nor their lexicon (Ennoumani & Mahini, 2017; Park & Lee 2008).

The technology leadership knowledgebase is not expansive when considering a leader's depth of understanding of the tool they are implementing or supporting, though that was how leaders conceptualized technology leadership. The leaders' variability in understanding how their state learning standards for mathematics and SMPs were reflected in the ALT-M content presented to students, the tool's connection to best instructional practices, and the general function of adaptivity was both interesting and concerning. Though the participants collectively shared that it was important for them ~~have to have~~ an understanding and awareness ~~about of~~ the tool they implemented as a technology leader, their responses suggested they had much lower levels of familiarity. Without a clear picture and understanding of how closely the ALT-M's content aligned to state standards and SMPs, how it reflected best practices for math instruction, and ~~from a functionality standpoint, how it truly functioned and truly~~ adapted to account for their students' performance, how could one be certain that the tool did, in fact, meet the needs of their students and teachers? Further, how could one lead others with this uncertainty?

Commented [JR49]: What? This pronoun not well-defined

Strategies employed for current implementation

In chapter two, technology leadership was described as the unique skills, competencies, and attitudes needed to initiate and support technology implementations, while managing the changes that occur, to reach agreed upon goals and outcomes (Akci et al, 2016; Chang et al, 2008; Ertmer, 2002; Kearsley & Lynch, 1992; Strudler & Wetzel, 1999). Per their descriptions of their experiences, leaders conceptualized part

of what was considered technology leadership in that their descriptions focused on supporting their teachers with the implementations. ~~Further examining the~~ When the actual strategies participants used to lead their implementations are further examined, ~~their participants'~~ actions tell a different story.

Leaders were asked about their familiarity with ISTE's Standards for Education Leaders. Though some had heard of ISTE, none actively considered their Standards for Education Leaders when making decisions and taking actions for their implementations. ISTE's Standards for Education Leaders were used to better conceptualize technology leadership and frame this study. These Standards for Education Leaders ~~are~~ include the following:

1. Equity and citizenship advocate
2. Visionary planner
3. Empowering leader
4. Systems designer
5. Connected learner (ISTE, 2018)

In analyzing the strategies participants used to lead their ALT-M implementations, the actions they took aligned with many of these standards. The participants were simply not aware of it.

Chapter four described the strategies these leaders used to oversee their ALT-M implementations. In comparing the actions leaders took with the ISTE standards, each leader did address some of the five standards for their implementations ~~to~~ in various capacities. Appendix E lists and defines each of the five Standards for Education Leaders. The Equity and Citizenship Advocate and Visionary Planner standards were where the leaders' actions most closely addressed the standards with Visionary Planning being the standard that leaders' actions aligned the most. All leaders

described how the use of their ALT-M increased equity, access, and/or digital citizenship. Leaders also took actions that aligned with the Visionary Planner standard. Each leader shared their vision for how their ALT-M was to be used in their building and was outlined in Table 4-5. Likewise, all leaders were able to describe the progress they had made with their implementation and, could either describe the impact the ALT-M had on student performance or planned to do so once other data sources were available. The Empowering Leader, Systems Designer, and Connected Learner standards were also addressed through the leaders' actions, but in noticeably less of a capacity.

Commented [JR50]: Can we change this phrasing? "To a lesser extent in that capacity" ?

These findings differ from previous research that studied principal competencies as technology leaders and principal perceptions of technology leadership preparedness through the use of ISTE standards (Banoglu, 2011; Metcalf & LaFrance, 2013). These studies, grounded in NETS-A standards, the earlier iteration of ISTE's Standards for Education Leaders, found that leaders were least competent and perceived themselves to be least prepared for the standard now identified as Visionary Planner. Interestingly, Metcalf and LaFrance (2013) reported leaders as perceiving themselves as most prepared with leading the standard now known as Equity and Citizenship Advocate, which is also an area the leaders of this study shared as a proficiency.

Table 5-1 illustrates which ISTE Standards for Education Leaders the participants addressed and in what capacity. While leaders did not consider these standards when planning and making decisions for leading their implementations, they did take actions that aligned, in varying degrees, with the Standards for Education Leaders. However, because of not-being-aware a lack of awareness of these standards,

they could not be intentional with taking actions that aligned. Without explicitly connecting their technology leadership actions to best practices, they risked reducing the possible impact and efficacy of the ALT-M being used.

Table 5-1. Degree to which participants' leadership actions met ISTE Standards for Education Leaders

Participant	Equity and Citizenship Advocate	Visionary Planner	Empowering Leader	Systems Designer	Connected Learner
Cameron	Partial	Partial	Minimal	Partial	Minimal
Alex	Partial	Full	Minimal	Partial	Minimal
Jordan	Partial	Partial	Minimal	Minimal	Minimal
Casey	Partial	Full	Minimal	Partial	Partial
Riley	Partial	Partial	Minimal	Minimal	Minimal

Discussion of RQ3

How do participants describe the successes and challenges they have faced when implementing [adaptive learning technologies for mathematics ALT-Ms](#)? Despite leaders' lack of intentionality with taking actions [that were](#) explicitly connected [to](#) the Standards for Education Leaders, they all experienced a degree of success with their ALT-M implementations. ~~More stakeholder engagement~~, [More stakeholder engagement](#) increases in equity, access, and digital citizenship, and increases in proficiency ~~with~~ using data with improved student results were [successes that were](#) highlighted ~~as successes~~ through their implementations. Professional development was the biggest challenge the leaders faced in their implementations.

Stakeholder engagement

Teacher, student, and/or family engagement was increased through the leaders' ALT-M implementation and was viewed as a success. The Visionary Planner standard

calls for education leaders to include stakeholders in the process used to develop and adopt the vision for an implementation and for educational leaders to communicate with stakeholders to solicit information and feedback on progress (ISTE, 2018). Though previous scholarship noted leaders being the least proficient with this standard, that was not the experience of the leaders of this study (Banoglu, 2011; Metcalf & LaFrance, 2013). All leaders conferred with various stakeholder groups to gauge how their implementation was progressing ~~and, and~~ some consulted their students for further insight. Through their leadership, these stakeholders were considered to be valuable partners in the implementation, ~~who provided~~providing additional information and insight with which leaders could make implementation decisions.

Equity, access, and digital citizenship

Increasing equity, access, and digital citizenship were all seen as successes through the ALT-M implementations, which aligns with what researchers found on how principals perceived their preparedness to lead their technology implementations (Metcalf & LaFrance, 2013) Through the lens of the Equity and Citizenship Advocate standard, each leader described actions they took to ensure teachers using the ALT-M had the necessary skills to meet the needs of their students. While not necessarily due to the ALT-M implementation, leaders did note that all students had a device to use (they were 1:1), at least while on campus, ~~also which illustrating illustrates how that~~ these leaders provided these tools so that all students could engage with the ALT-M content. While not intentionally taking these actions to address these standards, leaders did note these as successes from their implementations, nonetheless.

Though access, in the scope of the Equity and Citizenship Advocate standard, relates to technology, leaders also conceptualized access to mean access to

instructional content. All leaders used their ALT-Ms to increase access to student-appropriate content, which was described as a success in and of itself. The use of the ALT-M to increase access to content, though a different form of access from the context of the standard, still was an important, and potentially highly impactful approach to the Equity and Citizenship Advocate standard.

Data usage and improved results

The third success leaders described from their ALT-M implementations was in teachers' increased use of data and improved results from student users. All leaders reported their appreciation for the amount of usage and performance data that was available from the ALT-M and the speed at which it was made available in the platform. Leaders then engaged with their teachers to interpret and use the data to further engage and motivate students and inform next steps for instruction. In relation to the Standards for Education Leaders, these practices connect with the Visionary Planner in that through this data, leaders and stakeholders are able to better use the technology to "transform learning" through a "continuous improvement" cycle to achieve learning outcomes by assessing progress with the implementation, determining the impact and efficacy of the ALT-M, and making best-practices scalable (ISTE, 2018, p. 7).

Four leaders cited improvements made in student performance through using their ALT-M; one was waiting for additional data sources to confirm or refute ~~that~~ whether the use of the tool was having a positive effect on the student-users' performance in mathematics. Each shared instances ~~where-in which~~ students' increased levels of performance ~~as were~~ evidenced by data from ALT-M, benchmarking assessments, and or state summative assessments. Their positive improvements in increased student performance align with the scholarship reviewed in Chapter 2 that

highlighted the statistically significant results ALT-Ms can have on students' mathematics achievement (Brasiel et al., 2016; Cook, et al., 2022, Curriculum Associates, 2021; Swain et al., 2020; VanLehn, 2011; Wang et al., 2020). This further strengthens the argument that with focused technology leadership, the implementation of tools such as ALT-Ms can have a positive effect on student learning outcomes for mathematics.

Professional development

All but one leader described professional development (PD) as a challenge to their implementation. The remaining four leaders described the amount of time required, costs, and the specificity of content for teachers ~~to be as being~~ a barrier. ISTE's Empowering Leader and Connected Learner ~~standards, standards~~ both reference PD (professional learning) as components to the standards. Interestingly, ISTE's Empowering Leader and Connected Learner standards ~~both of these standards were the standards that where~~ the leaders collectively had addressed ~~the standards~~ the least proficiently and demonstrated an opportunity for growth. This reinforces an increased need for technology leaders to be more intentional with aligning their technology leadership actions to standards to strengthen their leadership of the implementation.

In this space, I noticed that although leaders recognized they had not had sufficient training, in their description of PD being a challenge, only one participant mentioned the lack of leadership PD as part of the challenge. Four leaders, who received little to no leadership training nor support, did not consider PD for themselves as part of ~~that the~~ challenge with providing PD, although data suggests that with increased training comes increases in quality of implementations (Dawson & Rakes, 2003).

Discussion of RQ4

How have participants' experiences with leading implementations of adaptive learning technologies informed future plans and processes? Leaders were reflective and readily able to share lessons learned and ~~what~~ their next steps ~~would be~~ for their current and future implementations. Refining the processes surrounding their ALT-M implementations was a key takeaway in addition to using data to determine and support next steps. Increasing and elevating professional development opportunities for themselves and their ~~teache~~teachers was also shared as a priority.

Refine processes for implementation

With each adoption type (leader-led, teacher-led, and district-led), the participants described updates to the processes they used to select the ALT-M and continually support teachers and students throughout the implementation. Increasing stakeholder clarity on the intended vision for using the ALT-M, or "the why", came up for three of the five leaders, while one looked to maintain the level of stakeholder involvement, ~~and~~ hoped to expedite the overall process.

Each of these leaders' reflections highlighted a degree of thoughtfulness and planning to further support their current implementations and adjust for those in the future. These reflections illustrated components of ISTE's Visionary Planner standard, ~~and~~ further supporting my assertion that these technology leaders did, in fact, excel this this area leadership. First, leaders evaluated their progress with their implementations, adjusted where necessary, and measured (or planned to measure) the impact and effectiveness of their tool. They also connected with stakeholders (teachers, students, and families) to solicit feedback and celebrate successes. One leader ~~went~~had already

~~gone~~ deeper into the standard ~~and already had~~ by shared-sharing lessons learned and best practices with other leaders to influence their adoptions and implementations.

Data informed decision-making

Leaders valued the data provided from their ALT-M and, where available, the data showing increased results from benchmark and state summative assessments ~~and; they~~ cited examples that connected the use of their ALT-M with increases in student achievement as measured by benchmark and state summative assessments. For those that did not have performance data from their ALT-M, they were waiting for benchmark and state summative data to better confirm what was being reported. Leaders seemed to have developed or were developing a system to analyze and compare data sets to monitor student progress and predict and/or confirm achievement results.

Leaders' consideration of these data sources connects with components of the Visionary Planner standard in that leaders are determining the progress being made in the implementation through measuring the impact of the ALT-M being ~~adopts~~ adopted. This could also connect with the Empowering Leader standard as the ALT-M inherently provides a real-time look at student performance. In connection with other data sources, leaders are able to ~~both~~ make informed decisions both about their schools (scheduling, programming, etc.) and ~~about~~ their ALT-M implementations.

Better and more professional development

As professional development was a challenge that they experienced in teacher-facing PD and ~~practically non-existent for~~ even more so in the non-existent PD for themselves, it is of no surprise that when thinking about future implementations, leaders described the need for better and more PD. For their teachers, leaders envisioned PD

that was timely and tailored to their teachers' needs and designed to meet the specific needs of the teacher-users rather than offering content that is too high-level and disconnected from where teachers are in their learning and the school's strategy for use (e.g., small-group instruction and workshop model). Further, leaders wanted their teacher-facing PD to continue to emphasize why using the ALT-M mattered for their school, their students, and their community.

Leaders providing these types of learning opportunities for their educators address components of the Empowering Leader and Connected Learner standards. While it seemed that these two standards were addressed the least during the leaders' current implementations, it is interesting that, in looking ahead to future implementations, their reflections place more focus on the Empowering Leader and Connected Learner standards. Because the ISTE standards were not being considered in their decision making, the leaders were not aware of this connection between how they were leading and how they planned to lead in future implementations. It was as if they knew where they were lacking in their implementations and planned to do something about it.

In looking ahead to future implementations, only one leader verbalized a want to have formal, leader-focused PD. Though three of the five leaders had no training on how to use their ALT-M, ~~none~~ none of them had leadership training explicitly for their ALT-M implementations, and none had any formal training to be a technology leader. When sharing ~~about~~ next steps ~~with~~ for PD for future implementations, their responses focused on their teachers rather than themselves.

This was a surprise given the leaders initial naivete ~~with~~about leading their ALT-M implementations and paired ~~by~~with the piecemeal approach they took to become more competent as a technology leader. One would have expected that in wanting more PD for their teachers the leaders would have also planned to have PD for themselves, to expedite their learning, and increase the quality of their implementations (Dawson & Rakes, 2003). Only one leader advocated for leader-focused PD for future implementations.

Implications for Personal Practice

This section describes implications for personal practice as one who leads a team of professional development consultants (PDCs) ~~who work~~working with and developing technology leaders. The participants' experiences highlighted several concepts to consider as recommendations to enhance leader, teacher, and student experiences with ALT-Ms. For leaders, the unintentionality of their actions aligned to ISTE's Standards for Education Leaders, scarcity of professional development opportunities for technology leaders, and their lack of clarity ~~of~~on their ALT-M's alignment to standards and best practices demonstrated the greatest areas for growth. Below describes how ways PDCs can partner with technology leaders to strengthen their leadership practices of ALT-Ms to support better implementations and student achievement outcomes.

ISTE Standards for Education Leaders

In describing how they led their ALT-M implementations, many of the leaders took actions that connected with ISTE's Standards for Education Leaders. For each implementation, there were instances where leaders' actions met each standard, ~~into~~ some degree. Table 5-1 illustrated how these standards were covered based on

leaders' descriptions. Without the intentionality of taking explicit, aligned actions, leaders ~~did not~~ regularly meet neither the full scope nor depth of the standards. Having an awareness and deeper understanding of these standards to inform deliberate actions in their leadership could strengthen their ALT-M implementations and better support usage and student outcomes.

In practice, PD consultants (PDCs) could first expand their own understanding of ISTE's Standards for Education Leaders to be more equipped to support the education leaders with whom they work. Through this framing, PDCs could next confer with leaders to better understand which standards are being met and in what capacity. They can then suggest appropriate next steps and strategies to increase the alignment of the leaders' actions ~~alignment~~ to these standards and strengthen their implementation. Through this work, the PDC would support the leader with a more deliberate and focused approach to taking action with their implementation, one that ~~that~~ considers the leaders' context, opportunities for growth, and is better aligned to ISTE's standards.

Planning Professional Development

The leaders' varying experiences with professional development demonstrated a need for increased frequency, strategy, timeliness, and focus. There was a clear need for leader-focused professional development for each of the ALT-M implementations, though leaders described learning through various means (joining teacher PD, self-study, trial-and-error, etc.) Even those who were able to attend a leader-focused PD found it to be insufficient.

Teacher-focused PD, in many cases, was not much better. Leaders described asynchronous webinars for teachers that were difficult to monitor for teacher engagement/completion and vendor-led PD that did not consider the needs of the

teachers, nor where they were in their implementations. Casey's Zearn® implementation was the only example ~~where PD of PD that~~ was prioritized throughout the school year, ~~and teachers allowed teachers to took take~~ away what was intended from the PD, and ~~were able to~~ transfer it to practice.

With this in mind, PDCs must be an active and consultative partner to leaders when proposing and planning professional development opportunities and learning outcomes for the year. These PD opportunities should account for the needs of teachers, leaders, and other stakeholders (e.g., Paraprofessionals, teacher assistants, etc.) who would also be a part of the implementation. Professional development consultants should confer with leadership at the start of year and throughout the implementation ~~and to~~ confirm and adjust PD opportunities and outcomes ~~to that~~ allow for continued alignment to where all stakeholders are ~~with in~~ their implementation. This would ensure that the PD offered to teachers, leaders, and stakeholders was timely, aligned to each groups' specific needs, and at a frequency to be of support.

Understanding and Alignment to Standards and Best Practices

The leaders in this study lacked a thorough understanding of their state's standards for mathematics and SMPs, NCTM's Effective Teaching Practices, how their ALT-M adapted and how these concepts were reflected in the ALT-M being implemented. While leaders described the successes they experienced, these oversights can diminish the quality of their implementations and limit possible student achievement results. Below describes how, through PD, leaders' increased understanding of and alignment to these concepts could elevate the quality of the leaders' respective implementations.

State standards and SMPs

Participants' understanding of their state's mathematics standards and SMPs was mixed. Recall that some leaders were able to explicitly describe how the content from their ALT-M connected to their state's standards. Others could not, and no leader could describe how the SMPs were present. It was very surprising how little familiarity the leaders had with their state standards for mathematics, SMPs, and more importantly how those concepts were addressed in the ALT-M being used to support their mathematics classrooms. I was also surprised how leaders made decisions to adopt the ALT-M based on assumption and rather than their own knowledge and how some planned to assess efficacy of use at the conclusion of the school year. It seemed odd, even risky, to implement a tool where one was not confident that the content being used with students addressed the state's learning standards and SMPs. This was experienced in several of the implementations of this study as outlined Chapter 4.

Ideally, leaders would be more familiar with the mathematics standards and SMPs required for instruction by their respective states to better lead their teachers and implementations. Through professional development, PDCs can work with leaders to strengthen their understanding of their state's standards and SMPs to better assess how well the ALT-M's content is aligned and how, given what is known, to implement the tool more strategically. In some instances, like Riley's IXL® implementation, there could be a disconnect between what the state requires and the ALT-M. Through PD, the PDC can develop leaders' understanding, ~~that-which~~ can then allow them to make more informed decisions ~~with-about-how-to-guide~~guiding their teachers' use of the tool or ~~provide-providing~~ direction to supplemental resources or tools to ensure a more comprehensive approach to the implementation. Additionally, if there are gaps in the

standards covered, the PDC can refer leaders to options within the ALT-M (where available) to strengthen their competency ~~with~~by providing their teachers with solutions to supplement.

NCTM's Effective Teaching Practices

As with the state standards and SMPs, leaders also had a limited familiarity to NCTM's Effective Teaching Practices. These practices are recommended to teach to the level of rigor required for state mathematics:

1. Establish mathematics goals to focus learning
2. Implement tasks that promote reasoning and problem solving
3. Use and connect mathematical representations
4. Facilitate meaningful mathematical discourse
5. Pose purposeful questions
6. Build procedural fluency from conceptual understanding
7. Support productive struggle in learning mathematics
8. Elicit and use evidence of student thinking (NCTM, 2014)

Without such a low degree of familiarity, I wondered how leaders could strategize and make recommendations for use of the ALT-M with full confidence. Alex's IXL® implementation exemplifies this. Holistically, the teachers were encouraged to use IXL® as part of a workshop instructional model, ~~where~~in which small-group instruction was prioritized. It would be a station that students rotated through during their math block.

For seventh graders though, IXL® was being used as a tool to increase access to eighth grade content so they could demonstrate a level of mastery, which would qualify them to take Algebra 1 in eighth grade. Without knowing if the content in IXL® followed best practices for mathematics instruction, how would one know if it was the right tool for that purpose? Increasing student access to advanced grade-level content seems to be only part of the solution. In addition to access, instruction would also need to be part of the tool to ensure students can learn the more advanced content.

Developing leaders' proficiency with NCTM's Effective Teaching Practices and exploring how these concepts are reflected in the ALT-M's content is another area where PDCs can support these leaders. Preferably before the implementation begins, PDCs can work with leaders to strengthen their understanding of NCTM's guidance for mathematics instruction and review the ALT-M's content to highlight and assess alignment. From there, PDCs can further partner with leaders in developing their vision for use and to plan their implementation to maximize the functionality of the ALT-M. In this model, leaders would be clearer on what the ALT-M can offer students, so that their teachers are able to use it in the best way possible.

Adaptivity

Defined in ~~chapter~~ Chapter two2, adaptivity in this context ~~is~~ the ability for the technology to adjust the level and type of instruction being delivered to a learner, in response to data and information collected from learner interaction and input, to better accommodate and meet their individual needs (Oxman & Wong, 2014; U.S. Department of Education Office of Educational Technology et al., 2013). Researchers Park and Lee (2008) also described five approaches to adaptivity that have been used to classify these adaptive learning technology systems:

- Macro-adaptive instruction
- Aptitude-treatment instruction (ATI)
- Micro-adaptive instruction
- Adaptive hypermedia systems
- Adaptive instructional systems

While some participants provided a high-level definition of what adaptivity in the context of ALT-M, none were able to clearly describe when and how their tool adapted, nor were they aware of any classification for these types of tools.

~~Like above, deepening~~ Deepening leaders' understanding of the adaptive

Commented [JR51]: This doesn't grammatically work as a transition phrase, can we just delete?

function of their ALT-M is valuable in that it can allow leaders to better develop a vision for use, and lead stakeholders in the implementation. Prior to starting the implementation, PDCs can collaborate with and train leaderss to have more clarity on the functionality of the tool, allowing them to better develop a vision for their implementation, a clearer strategy for its use, and a plan for leading their implementation. Without this understanding and ~~lack of~~ clarity, leaders risk misuse and/or reducing the effect that the ALT-M can have on student learning of mathematics.

The findings of this study provide ample guidance for my professional practice as leader of a PD team. In increasing the PDCs' depth of understanding of ISTE's Standards for Education Leaders, the team members can be better strategic partners to technology leaderss. With these standards in mind, PDCs can support leaders ~~with~~by taking ~~intentional~~, deliberate actions to lead their implementations. The PDC team members can also be consultative partners with leaders to plan professional development for stakeholders and themselves ~~to be in a manner that is~~ timely, tailored to their needs, and at an appropriate frequency to provide continued learning opportunities throughout the year. Lastly, PDCs can then provide PD to leaders that deepen their understanding about the ALT-M tool to develop a vision that aligns with its capacity and connection to standards to elevate the use of the tool with stakeholders. In this approach, PDCs can support leaders ~~with in their effort to be~~ing more explicit with their leadership actions to increase their success with their ALT-M implementations and the possible positive effects on student mathematics achievement.

Commented [JR52]: We can keep as is, but it's an awkward sentence

Implications for Technology Leaders

Given the themes identified from the data analysis, implications became apparent for technology leaders themselves. Holistically, technology leaders must be deliberate with the steps they take to lead their ALT-M implementations. The steps they take, grounded in this study's findings include taking deliberate actions that align with ISTE's standards for education leaders, increase their product knowledge, and increase their involvement in leading their ALT-M implementation. The following describes how technology leaders can strengthen their leadership of ALT-Ms on their campuses based on the findings from this study.

Intentionality with Actions

Technology leaders must be intentional with the actions ~~the~~they employ as they lead their implementations. The leaders in this study experienced several successes with their ALT-M implementations, despite varying conceptualizations of technology leadership and no familiarity with ISTE's Standards for Education Leaders. Table 5-1 illustrates the degree to which each participant met the respective standard for Education Leaders. Akin to teachers' use of NCTM's Effective Teaching Practices to increase the quality of their mathematics instruction, and CCSS or state learning standards to identify what is to be taught to students, technology leaders should increase their understanding of ISTE's Standards for Education Leaders and have those standards serve as their guide for the actions they take in leading their ALT-M implementations. With more intentional actions taken, technology leaders can better, and more efficiently lead their teachers' and students' experiences with the ALT-M, resulting with increased success and achievement.

Increase Product Knowledge

Technology leaders much increase their product knowledge of the ALT-M being ~~use~~used with their students. It is critical ~~that~~ technology leaders know how the tool functions, how it adapts, its alignment to CCSS or state standards, and how the content aligns to instructional best practices. Recall that in this study, leaders had a strategy in place that identified which students would be using their ALT-M and when. Technology leaders will be able to better schedule and support programming decisions for teachers and students with an increased knowledge of the ALT-M being implemented. Further, in having a clear understanding of the ALT-M and how the content used with students aligns to standards and best practices, technology leaders will be better equipped to lead their implementations through supporting their teachers with the inclusion and use of the tool in their mathematics classrooms, which was an area most felt was an important component of how they conceptualized technology leadership. Through better use of the ALT-M via scheduling and programing, paired with being better equipped to support teachers, this has the potential to maximize student outcomes through an elevated experience and use of the tool.

Be Involved in the Implementation

The final implication for technology leaders is to be involved in the implementation. As part of their leadership, technology leaders will want to take an active role in their ALT-M implementations. This could take the form of monitoring usage, reviewing data reports, facilitating data conversations with stakeholders, developing teachers, overseeing incentive programs, ~~ete~~and other types of involvement. Many of these examples were seen as successes scattered across the participants' implementations, but each leader had areas to increase their level of involvement. In

instances where technology leaders were more involved in their ALT-M implementations, they reported successes with teacher and student usage, which led to better student achievement results.

The three implications described can guide technology leaders with next steps in leading ALT-M implementations. Being intentional with their actions to align to standards, knowing more about the product being implemented, and being actively involved in their implementation are concepts technology leaders can use to increase teachers' use of the tool with their students resulting with increases in student learning of mathematics. Recognizing these as a ~~challenge, the~~challenge, the implications for vendors suggests ways the makers of ALT-Ms can also support technology leaders with better leaders of their respective implementations.

Implications for Vendors

Vendors, the companies who make and support ALT-Ms, play a critical role in supporting leaders with their implementations. In addition to creating and supporting the ALT-M tool itself, they might also serve as experts and strategic partners to the technology leaders overseeing their implementations. Insights from this study can provide guidance to vendors looking to strengthen their implementations through stronger, ~~building-~~level leadership followed by possible increases in student outcomes.

Aligned Materials

Prior to an adoption of the ALT-M, vendors should provide marketing materials, promotional collateral, and additional literature that clearly communicates the tool's alignment to standards and best practices. Not all states follow the same standards for mathematics. With this being the case, vendors should either develop ALT-Ms that address states unique standards (e.g., New York, Florida, Texas, etc.) or communicate

to what degree their platform aligns to the state in which the ALT-M is being adopted. Further, and especially in the context of mathematics, vendors should also share to what degree their ALT-Ms consider guidance from NCTM in its content. Curriculum Associates (2020), for example, published an executive summary that shared the research base for its i-Ready Personalized Instruction® tool. Research from both NCTM and the CCSS Initiative were considered in the development of the content presented to students. It is critical that the tools used to support teaching and learning align to what is required by the state and what is ~~consider~~considered best practice by the field; to promote the best possible outcomes for students.

Support With Adoption

Three strategies for adoption were shared in this study. These include:

- Leader-led, top-down
- Teacher-led, bottom-up
- District-led, top-down

Regardless of the strategy being used to adopt the ALT-M, vendors should provide guidance and support wherever possible and not assume that the leaders of the implementation are clear on best practices. No strategy was found to be more successful than another, and as such vendors will want to be flexible and dynamic to support leaders (Anderson & Dexter, 2000). As vendors support substantially more school and district leaders in ~~adoption~~adopting ALT-M tools, their partnership and insight can provide significant value.

During this study participants shared several ideas about information they wish they' had had as they began their adoption process. Evidence of success via achievement data and/or case-studies was an example. To be of support vendors

should have research and case-studies available to illustrate what type of success is possible with using the ALT-M with integrity. Leaders also ~~shared~~shared that they wanted to be connected with local schools and districts to learn ~~the~~ directly from those using the ALT-M with students and hear about their experiences. To support this, vendors should have well-established partnerships with school and district users and should facilitate this networking and learning opportunity. While learning from a vendor employ~~ee~~ is one thing, learning from an actual user can almost immediately create a high level of buy-in

Professional Development for Leaders

From this study, vendors should prioritize creating and offering leader-focused PD ~~that are~~ designed for leaders and informed by ISTE's Standards for Education Leaders (Metcalf & LaFrance, 2013). The minimal amount of PD leaders received, only at the start of the school year, was alarming. This was coupled by their description that ~~it-the PD that they had~~ merely provided an overview of the ALT-M rather than any sort of support and insight with leadership, which did not appear to support them with leading their ALT-M implementations. As the knowledgebase has reported on the absence of technology leadership training, ~~though~~ there has been a need for over three decades, ~~and~~ vendors of ALT-Ms should create and offer ongoing PD (throughout the duration of the implementation) that addresses the specific and unique needs of these leaders. While leaders experienced varying degrees of success with their current leadership, formal PD that directly ~~connected-connects~~ learning outcomes with ISTE's standards could elevate and/or accelerate the success of their implementations. This would allow for more common language and informed practices to be used to lead ALT-

M implementations, while providing guidance ~~that was~~ informed by an international community of educational technologists, ISTE.

As an additional layer, vendors should also consider PD that supports leaders with better understanding how their ALT-M ~~connect~~connects to standards and best practices. A deeper understanding of the tool can allow leaders to better develop a vision for using the tool in their buildings and increase their support for the stakeholders using the tool. Without this understanding, leaders and stakeholders risk misuse or in a way that does not ~~align~~align with their intended vision.

Implications for the Field

Courville (2011) described that while educational leadership skills are important for the overall function of a school, technology leadership is essential ~~to~~for meeting the needs of teachers and students who use technology on campuses and in classrooms, supporting the idea that the construct of technology leadership resides within the construct of educational leadership. Further illustrating this point, Dogan (2018) said, “good educational leadership is not enough” (p. 53) when commenting on how technology leadership is critical to positively affect technology adoptions and implementations. To do this, technology leaders must have a deep “understanding of the key leadership practices” that create an environment where stakeholders can effectively use technologies in schools (Dexter & Richardson, 2020, p. 18).

While the academic community posits that technology leadership is needed, ~~they~~but has~~have~~ not yet agreed on what key leadership practices are for technology leadership. I propose that ISTE’s Standards for Education Leaders provide a sufficient framework for future scholarship. When using these standards as part of the conceptual framework for this study, the actions ~~that~~ the leaders took inadvertently aligned with the

standards in varying degrees. Additionally, ISTE's Standards for Education Leaders are research-based standards that were created and agreed upon by a trusted organization in the educational technology space. It would make sense to use these standards to better frame leadership actions to support technology leaders with their implementations.

Looking more at the technology leadership knowledge base, this study reaffirmed findings from the past three decades as related to leaders' preparedness to lead technology implementations. No leader had formal training at the collegiate level despite the amount of schooling these leaders had received: two ~~masters~~master's degrees, one doctorate degree, one having completed some doctoral work, and one a doctoral candidate. This was also mirrored in the professional development options (or lack thereof) for previous and current implementations. With scholarship touting the importance of technology leadership as part of educational leadership, it would be interesting to learn if the field had made any progress with its newest batch of leaders.

Narrowing the scope to the leaders of ALT-M implementations, this study made connections between research on technology leadership, standards-based teaching and learning, and adaptive learning technologies. There was ~~noticeable~~a noticeable gap in understanding of standards and best practices for mathematics. Further research could ~~take a look~~look at leaders' proficiency and competency with standards and best practices for mathematics to explore the possible effect on their implementations.

While this study had five participants, the experiences they described and actions they took can be useful to those looking for guidance on leading and ALT-M implementation. The need for increasing the intentionality of technology leadership

actions to explicitly connect to ISTE's Standards for Education Leaders, increasing the frequency, specificity, and timeliness of leader-focused PD, and elevating the leaders' understanding of how their ATL-M connected to standards and best practices were key takeaways from this study.

Conclusion

While research has been done ~~explore~~to explore the individual components of the conceptual framework of this study, my goal was to consider each of the three and situate this study where they intersected. Leadership matters on school campuses, and as investments in technology and ALT-Ms continue to increase, the return on these investments must increase as well. With ALT-Ms, increases in student achievement is possible (Aleven et al., 2016; Brasiel et al., 2016; Liu et al., 2017; Oxman & Wong, 2014; Wang et al., 2020).

As previous scholarship suggests, ~~and also confirmed in this study~~and this study confirms, our building leaders are not being formally prepared to lead these ALT-M implementations (Kearsley & Lynch 1992; Ertmer et al. 2002; Schrum et al., 2011; Wu et al., 2015). They also are not learning how to lead ALT-M implementations during the adoption ~~throug~~ht PD.

Although it might be easy to assume educational leadership skillsets are transferrable to technology leadership, what the participants in this study did to lead their respective implementations took time, trial and error, and additional collaboration for a better chance at experiencing success. My hope is that with the descriptions of the participants' lived experiences, distilled into the findings above, those leaders who plan to adopt and lead ~~an~~ ALT-M implementation can learn from what has been shared.

and more quickly experience what is possible as a success with their teachers and students more quickly.

Commented [JR53]: I thought it was nice to end with this phrase 😊

|

|

LIST OF REFERENCES

- Akcil, U., Aksal, F. A., Mukhametzzyanova, F. S., & Gazi, Z. A. (2016). An examination of open and technology leadership in managerial practices of education system. *EURASIA Journal of Mathematics, Science and Technology Education*, 13(1), 119-131. doi:10.12973/eurasia.2017.00607a
- Aleven, V., McLaughlin, E. A., Glenn, R. A., & Koedinger, K. R. (2016). Instruction based on adaptive learning technologies. *Handbook of research on learning and instruction*, 2, 522-560.
- Anderson, R. E., & Dexter, S. L. (2000). School technology leadership: Incidence and impact.
- Anderson, R. E., & Dexter, S. (2005). School technology leadership: An empirical investigation of prevalence and effect. *Educational administration quarterly*, 41(1), 49-82.
- Amiel, T., & Reeves, T. C. (2008). Design-Based-based Research-research and eEducational Technologytechnology: Rethinking Technology-technology and the Research-research Agendaagenda. *Educational Technology & Society*, 11(4), 29-40.
- Banoglu, K. (2011). School Principals'-principals' Technology-technology Leadership leadership Competency-competency and Technology-technology Coordinatorshipcoordinatorship. *Educational Sciences: Theory and Practice*, 11(1), 208-213.
- Brasiel, S., Jeong, S., Ames, C., Lawanto, K., Yuan, M., & Martin, T. (2016). Effects of Educational educational Technology-technology on Mathematics-mathematics Achievement-achievement for K-12 sStudents in Utah. *Journal of Online Learning Research*, 2(3), 205-226.
- Brown, B., & Jacobsen, M. (2016). Principals' Technology-technology Leadershipleadership. *Journal of School Leadership*, 26(5), 811-836. doi:10.1177/105268461602600504
- Cook, M., Grant, A., & Ross, S. (2022). The Impacts of i-Ready Personalized personalized Instruction-instruction on Student-student Math-math Achievement achievement in Multiple-multiple School-school Districtsdistricts. Center for Research and Reform in Education.
- Chang, I. H., Chin, J. M., & Hsu, C. M. (2008). Teachers' Perceptions-perceptions of the Dimensions-dimensions and Implementation-implementation of Technology technology Leadership-leadership of Principals-principals in Taiwanese Elementary-elementary Schoolsschools. *Educational Technology & Society*, 11(4), 229-245.

Cheung, A. C. K., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. *Educational Research Review*, 9, 88–113.
<https://doi.org/10.1016/j.edurev.2013.01.001>

Common Core State Standards Initiative. (2009). *About the Standards*.
<http://www.corestandards.org/about-the-standards/>

Courville, K. (2011). Educational Technology: Effective Leadership and Current Initiatives. *Online Submission*

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

Curriculum Associates. (2020). *Research ~~base~~-Base for i-Ready Personalized Instruction*. https://www.curriculumassociates.com/-/media/mainsite/files/i-ready/i-ready-research-foundations-mathematics-executive_summary-2020.pdf

Dawson, C., & Rakes, G. C. (2003). The influence of principals' technology training on the integration of technology into schools. *Journal of research on Technology in Education*, 36(1), 29-49.

Davies, P. M. (2010). On school educational technology leadership. *Management in Education*, 24(2), 55-61.

Dexter, S. (2011). School ~~Technology~~~~technology~~ ~~Leadership~~~~leadership~~: Artifacts in ~~Systems~~~~systems~~ of ~~Practice~~~~practice~~. *Journal of School Leadership*, 21(2), 166-189. doi:10.1177/105268461102100202

Doğan, I. (2018). Examination of the technology leadership self-efficacy perceptions of educational managers in terms of the self-efficacy perceptions of information technologies (Malatya Province Case). *Participatory Educational Research*, 5(2), 51-66. doi:10.17275/per.18.9.5.2

EdTech Evidence Exchange (2021). *U.S. ~~k~~K-12 public ~~education~~ technology ~~Spending~~~~spending~~*. https://edtechevidence.org/wp-content/uploads/2021/07/FINAL-K12-EdTech-Funding-Analysis_v.1.pdf

Ennouamani, S., & Mahani, Z. (2017, December). An overview of adaptive e-learning systems. In *2017 eighth international conference on intelligent computing and information systems (ICICIS)* (pp. 342-347). IEEE.

- Ertmer, P. A., Bai, H., Dong, C., Khalil, M., Hee Park, S., & Wang, L. (2002). Online professional development: Building administrators' capacity for technology leadership. *Journal of Computing in teacher Education*, 19(1), 5-11.
- Esplin, N. L., Stewart, C., & Thurston, T. N. (2018). Technology leadership perceptions of Utah elementary school principals. *Journal of Research on Technology in Education*, 50(4), 305-317.
- Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of Educational Administration*, 41(2), 124-142.
- Gedik, N. (2017). Examining the Conceptualization of ~~Instructional-instructional~~ ~~Technology-technology~~ in Turkey. *Contemporary Educational Technology*, 8(1), 76-98.
- Gençer, M. S., & Samur, Y. (2016). Leadership styles and technology: Leadership competency level of educational leaders. *Procedia-Social and Behavioral Sciences*, 229, 226-233.
- ISTE. (2023) *Essential conditions for effective tech use in schools*. <https://www.iste.org/standards/essential-conditions>
- ISTE. (2018) *Standards for education leaders*. <https://www.iste.org/standards/for-education-leaders>
- ISTE. (2023) *The ISTE story*. <https://iste.org/our-story>
- Kearsley, G., & Lynch, W. (1992). Educational leadership in the age of technology: The new skills. *Journal of research on computing in education*, 25(1), 50-60.
- Lee, J., & Park, O. C. (2008). Adaptive instructional systems. In *Handbook of research on educational communications and technology* (pp. 469-484). Routledge.
- Metcalf, W., & LaFrance, J. (2013). Technology ~~Leadership-leadership~~ ~~Preparednesspreparedness~~: Principals' ~~Perceptionsperceptions~~. *Journal of Research in Education*, 23(1), 58-75.
- McLeod, S., & Richardson, J. W. (2011). The dearth of technology leadership coverage. *Journal of school leadership*, 21(2), 216-240.
- McLeod, S., & Richardson, J. W. (2013). Supporting effective technology integration and implementation. *Principal*, 2, 249-272.
- Means, B., & Anderson, K. (2013). Expanding ~~Evidence-evidence~~ ~~Approaches~~ ~~approaches~~ for ~~Learning-learning~~ in a ~~Digital-digital~~ ~~Worldworld~~. *Office of Educational Technology, US Department of Education*.

National Equity Project. (2022). *Equity in Education*. <https://www.nationalequityproject.org/education-equity-definition?rq=Equity>

Formatted: Font: Italic

National Council of Teachers of Mathematics. (2014). *Principals to action: Ensuring mathematical success for all*. NCTM.

National Council of Teachers of Mathematics. (2011). *Strategic use of technology in teaching and learning mathematics*. <https://www.nctm.org/Standards-and-Positions/Position-Statements/Archived-Position-Statements/Strategic-Use-of-Technology-in-Teaching-and-Learning-Mathematics/#:~:text=NCTM%20Position&text=Effective%20teachers%20optimize%20the%20potential,to%20mathematics>

Formatted: Font: Italic

Oxman, S., & Wong, W. (2014). *Adaptive learning systems* [White paper]. DeVry Education Group.

Formatted: Font: Italic

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

Plass, J. L., & Pawar, S. (2020). Toward a taxonomy of adaptivity for learning. *Journal of Research on Technology in Education*, 52(3), 275-300.

Ribiero, J. (2016). Educational ~~Technology~~ ~~technology~~ ~~Decision~~ ~~decision~~ ~~Making~~ ~~making~~: Technology ~~Acquisition~~ ~~acquisition~~ for 746,000 Ontario Students. *Canadian Journal of Educational Administration and Policy*, (176).

Formatted: Font: Italic

Richardson, J. W., Bathon, J., Flora, K. L., & Lewis, W. D. (2012). NETS• A scholarship: A review of published literature. *Journal of Research on Technology in Education*, 45(2), 131-151.

Richardson, J. W., Flora, K., & Bathon, J. (2013). Fostering a ~~School-school~~ ~~Technology~~ ~~technology~~ ~~Vision~~ ~~vsion~~ in ~~School-school~~ ~~Leader~~ ~~leader~~. *International Journal of Educational Leadership Preparation*, 8(1), 144-160.

Richardson, J. W., & McLeod, S. (2011). Technology leadership in Native American schools. *Journal of Research in Rural Education*, 26.

RTI Action Network. (2023). *What is response to intervention*. <http://www.rtinetwork.org/learn/what/whatisrti>

Formatted: Font: Italic

Schmeltzer, T. (2001). Training administrators to be technology leaders. *Technology & Learning*, 21(11).

Schrum, L., Galizio, L. M., & Ledesma, P. (2011). Educational |Leadership and ~~Technology~~ ~~technology~~ ~~Integration~~ ~~integration~~: An ~~Investigation~~ ~~investigation~~ into

Formatted: Portuguese (Brazil)

~~Preparation~~preparation, ~~Experiences~~experiences, and ~~Roles~~roles. *Journal of School Leadership*, 21(2), 241-261. doi:10.1177/105268461102100205

Formatted: Font: Italic

Sincar, M. (2013). Challenges ~~School-school~~Principals-principals Facing-facing in the ~~Context-context~~ of ~~Technology-technology~~ Leadershipleadership. *Educational Sciences: Theory & Practice*, 13(2), 1273-1284.

Formatted: Font: Italic

Strudler, N., & Wetzel, K. (1999). Lessons from exemplary colleges of education: Factors affecting technology integration in preservice programs. *Educational technology-Technology research-Research and developmentDevelopment*, 47(4), 63-81.

Swain, M., Randel, B., & Norman Dvorak, R. (2020). *Impact Evaluation-evaluation of Mathematics-mathematics "i-Ready Instruction" for Elementary-elementary Grades-grades Using-using 2018-19 Data-data*. (Final Report. No. 106). Human Resources Research Organization (HumRRO).

Formatted: Font: Italic

Formatted: Font: Not Italic

TNTP. (2018). *The opportunity myth: what students can show us about how school is letting them down—and how to fix it*. https://tntp.org/assets/documents/TNTP_The-Opportunity-Myth_Web.pdf

TNTP. (2021). *Accelerate, don't remediate: new evidence from elementary math classrooms*. https://tntp.org/assets/documents/TNTP_Accelerate_Dont_Remediate_FINAL.pdf

Toh, Y. (2016). Leading sustainable pedagogical reform with technology for student-centered learning: A complexity perspective. *Journal of Educational Change*, 17(2), 145-169. doi:10.1007/s10833-016-9273-9

Formatted: Font: Italic

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist*, 46(4), 197–221. <https://doi.org/10.1080/00461520.2011.611369>

Wang, S., Christensen, C., Cui, W., Tong, R., Yarnall, L., Shear, L., & Feng, M. (2020). When adaptive learning is effective learning: Comparison of an adaptive learning system to teacher-led instruction. *Interactive Learning Environments*, 31(2), 793–803. <https://doi.org/10.1080/10494820.2020.1808794>

Wu, A., Yang, H. H., Shi, Y., & Zhu, S. (2015). *Development of School-school Technology-technology Leadershipleadership: Cases in the United Kingdom and United States*. International Symposium on Educational Technology.

Xie, H., Chu, H.C., Hwang, G. J., & Wang, C.C. (2019). Trends and development in technology-enhanced adaptive/personalized learning: A systematic review of Journal Publications from 2007 to 2017. *Computers & Education*, 140. <https://doi.org/10.1016/j.compedu.2019.103599>

BIOGRAPHICAL SKETCH

Mark Ophaug is a ~~Senior-senior Manager-manager~~ of a ~~Professional-professional Development-development~~ for Curriculum Associates, and a former teacher and instructional specialist for secondary mathematics. He earned an Ed.D. from the University of Florida (2023) in curriculum and instruction, with a concentration in educational technology, a Master of Arts from the University of Central Florida (2013) in educational technology, and a Bachelor of Arts from the University of Florida (2004) in Business Administration. His academic interests and practical experiences include professional development for leaders of technology implementations, enhancing teacher-use of technology in mathematics classrooms, and elevating pedagogical practices of K-12 mathematics.