Teachers’ beliefs and practices of technology integration at a school for students with dyslexia: A mixed methods study

Holli Bice1 · Hengtao Tang1

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Abstract
The amount of technology available in schools has increased steadily over the past two decades, but higher-level uses have not followed, and many teachers continue to struggle integrating technology in their classrooms. The purpose of this study was to describe teachers’ beliefs about technology in the classroom and identify whether their beliefs are reflected in practices of integrating technology at a small, private school for students with dyslexia. A convergent mixed methods action research study was conducted to understand how teachers’ beliefs may be affecting technology integration at the school. Quantitative data was collected through a survey administered to all 55 teachers at the school to describe how technology was being used throughout the school. From this sample, six participants were selected for three rounds of follow-up interviews and observations. Quantitative data revealed more teacher-centered beliefs and practices of teachers at the school. Qualitative findings showed teachers with more student-centered beliefs integrated technology more in their classrooms. Findings also revealed the school culture influenced teachers’ beliefs about the role of technology. Implications are provided on offering professional development adapted to teachers’ levels of technology integration.

Keywords Teachers · Technology integration · Belief · Alignment · Action research

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### 1 Introduction

The past three decades have seen a tremendous increase in the technology available in schools. In 1995 only 8% of public schools contained a computer with Internet access for instructional purposes, yet that number had increased to 98% by 2008 (U.S. Department of Education, 2016). The question is no longer whether technology should be used in schools, but how it can be used to enhance learning. Despite the increases in technology available to teachers and students, it is not being fully integrated into classrooms for learner-centered, high-level uses (An & Reigeluth, 2011; Hsu, 2016; Palak & Walls, 2009).

It has been evidenced that teachers’ beliefs about technology predict their technology use in the classroom (Ottenbreit-Leftwich et al., 2010). When teachers perceive technology to have value in the teaching and learning process, they are more likely to use it (Hsu, 2016; Mama & Hennessy, 2013; Miranda & Russell, 2012; Sadaf & Johnson, 2017; Taimalu & Luik, 2019). Furthermore, researchers have found a connection between constructivist teaching beliefs and technology use (Hermans et al., 2008; Hsu, 2016; Kim et al., 2013; Tondeur et al., 2017). Teachers who possessed more learner-centered beliefs about teaching were found to have more seamless integration of technology into lessons (Kim et al., 2013). There is some research to support teachers’ espoused beliefs aligning with their classroom practices (Deng et al., 2014; Hsu, 2016; Kim et al., 2013). In addition, teachers’ beliefs about technology use in the classroom may also be one of the strongest barriers to integration. For example, teachers’ beliefs may affect their ability to overcome other barriers due to the relative weight they place on each barrier (Blackwell et al., 2013; Ertmer, 1999; Ertmer et al., 2012; Miranda & Russell, 2012; Walker & Shepard, 2011).

Therefore, exploring the beliefs that underlie classroom practices can bring about the change necessary to enhance student learning through transformative, technology-rich lessons. However, teacher beliefs are complex. Particularly, teachers’ beliefs about technology use may not be constant but vary by time and conditions (Tang et al., 2020, 2021; Xie et al., 2021). Existing research has mainly focused on performing one-shot data collection to describe teachers’ beliefs but overlooked the variation across time (Tang & Bao, 2021). It is necessary to develop a longitudinal understanding of teachers’ beliefs about technology so as to devise sustainable strategies to support teachers’ use of technology in their classrooms. In addition, teachers’ enacted beliefs tend to divert from their espoused beliefs in the practices of technology integration (Ertmer et al., 2012). Understanding the alignment between teachers’ beliefs and practices is also needed to effectively support teachers’ technology integration.

The purpose of this action research study was to describe teachers’ beliefs about technology integration over a period of nine months and investigate the alignment between teachers’ beliefs and their classroom practices of technology integration. Research has indicated the need to understand teachers’ beliefs as a necessary step in integrating technology effectively (e.g., Ertmer & Ottenbreit-Leftwich, 2010, 2013; Tondeur et al., 2017). This study sought to establish a longitudinal account of teachers’ beliefs about technology integration by which we hope to set up the
first step in designing effective professional development and providing the skills necessary to integrate technology for student-centered learning (An & Reigeluth, 2011; Ertmer et al., 2012; Ottenbreit-Leftwich et al., 2010).

2 Literature review

2.1 Technology integration

An and Reigeluth (2011) defined technology integration as “the use of technology for instructional purposes” (p. 55). Effective technology integration helps teachers meet learning goals that they would not be able to accomplish otherwise (Cifuentes et al., 2011). Despite the substantial increase in access to technology within schools, an increase in use and more substantive uses have not followed. Teachers continue to use technology in ways that support their professional needs, but they are not using technology as an instructional tool for learning (Ertmer & Ottenbreit-Leftwich, 2010). For example, Karsenti (2016) found teachers used interactive whiteboards for presenting material to the class, displaying websites, and in place of blackboards.

In addition to traditional uses of technology, most teachers employ a teacher-centered pedagogical approach (Dawson, 2012; Palak & Walls, 2009). In such an approach, teachers impart knowledge to students who passively receive information. For illustrative purposes, Dawson (2012) found that teachers used technology 43% of the time for direct instruction, and 38% of the time for collaborative learning. Similarly, Polly and Rock (2016) noted that teachers used technology 65% of the time while students only used it 35% of the time. Moreover, when teachers are using technology, the tasks tend to tap low-level thinking skills, such as remembering, more than high-level skills, such as evaluating (Dawson, 2012; Ruggiero & Mong, 2015). For example, a study of teacher candidates’ lesson plans integrating technology revealed most technology uses focused on basic skills (Polly & Rock, 2016). Using technology for low-level tasks, such as drill and practice activities, provides students with repetition. However, high-level tasks utilizing technology could provide opportunities for students to engage and actively learn through communication and collaboration with others.

2.2 Teachers’ beliefs about technology

What teachers believe about teaching and learning impacts their behavior in the classroom. Pajares (1992) defined teachers’ beliefs as “[teachers’] attitudes about education—about schooling, teaching, learning, and students” (p. 316). Identifying teachers’ beliefs and what drives the enactment of beliefs is necessary to understand the choices teachers make within their classrooms. Research into technology integration has identified teachers’ personal beliefs as a factor affecting integration (Ertmer et al., 2006; Vannatta & Fordham, 2004). Several studies have identified teachers’ beliefs about the benefits of technology for student learning as one of the strongest predictors of use (McCulloch et al., 2018; Miranda & Russell, 2012; Petko, 2012).
Vannatta and Fordham (2004) argue that teachers’ philosophy and willingness to change are significant factors affecting integration. Technology teachers identified as exemplary technology users rated internal beliefs and commitment to student learning as the most influential factors guiding their technology use (Ertmer et al., 2006). Teachers’ self-efficacy with technology has been found to be another significant predictor of technology use (Gu et al., 2013; Holden & Rada, 2011; Vareberg & Platt, 2018). Additionally, the perceived usefulness and importance of technology for teaching was recognized as one of the most significant factors affecting teachers’ decisions to adopt technology (Miranda & Russell, 2012; Vareberg & Platt, 2018).

However, teachers’ beliefs are broad and cover a variety of different beliefs (Taimalu & Luik, 2019), such as pedagogical beliefs and value beliefs. Research suggests these beliefs are interrelated and serve as the main predictors of technology integration (Hsu, 2016).

### 2.2.1 Pedagogical beliefs

Teachers’ pedagogical beliefs relate to what teachers believe about the nature of teaching and learning (Tondeur et al., 2017). They are often classified in the literature as being either teacher-centered or student-centered (Deng et al., 2014). Teacher-centered beliefs are typically associated with behaviorism and may be called traditional pedagogical beliefs, whereas student-centered beliefs are associated with constructivism (Deng et al., 2014). Student-centered activities allow learners to construct knowledge actively rather than passively receiving knowledge from the teacher.

What teachers believe about the nature of knowledge influences their pedagogical beliefs (Deng et al., 2014; Kim et al., 2013). Teachers who feel knowledge comes from authority tend to use more of a teacher-centered approach to instruction (Deng et al., 2014). These traditional beliefs negatively impact technology use (Hermans et al., 2008; Taimalu & Luik, 2019; Tondeur et al., 2017). Teacher-centered instruction involving technology has been associated with low-level cognitive tasks, such as practice activities (Polly & Rock, 2016). Researchers have noted teachers with constructivist beliefs use technology more for teaching and learning (Hermans et al., 2008; Tondeur et al., 2017) and use it for constructivist purposes (Deng et al., 2014). Additionally, teachers who use technology for student-centered instruction have shown more seamless integration (Kim et al., 2013). A constructivist teaching style also impacts the intensity with which teachers use technology in the classroom (Petko, 2012). This suggests that teachers who hold pedagogical beliefs favoring student-centered instruction are able to create meaningful, authentic tasks for students through the use of technology.

However, teachers’ pedagogical beliefs are not mutually exclusive. Teachers may hold both student-centered and teacher-centered beliefs (Tondeur et al., 2017; Walker & Shepard, 2011). Tondeur et al. (2017) found that pedagogical beliefs and technology use exist in a bi-directional relationship, suggesting teachers’ beliefs can influence teachers’ use of technology and vice versa. These findings imply positive uses of technology can shape teachers’ beliefs about how technology can be used for learning.
2.2.2 Value beliefs

Teachers’ value beliefs relate to “the belief about the value of technology for their teaching practice” (Vongkulluksn et al., 2018, p. 71). The value teachers believe that technology has in helping achieve their instructional goals can impact their integration decisions (Hew & Brush, 2007; Ottenbreit-Leftwich et al., 2010). Researchers have found value beliefs positively affected teachers’ technology knowledge and their integration (Sadaf & Johnson, 2017; Taimalu & Luik, 2019). Furthermore, positive beliefs about the value of technology for teaching and learning predicted how much teachers and students used technology (Miranda & Russell, 2012; Mueller et al., 2008). Value beliefs also predicted the quality and quantity of technology integration (Vongkulluksn et al., 2018).

Beliefs teachers hold about the value of technology can impact technology use in other ways as well. Value beliefs can affect teachers’ use of technology for professional needs as well as student needs. For example, Ottenbreit-Leftwich et al. (2010) found that teachers valued technology as a means to increase their efficiency and effectiveness, but they also valued technology to engage students, enhance reading comprehension, and teach technology skills. Additionally, teachers’ value beliefs may affect how they perceive external barriers to integration. For example, teachers who value technology may perceive limited access to technology resources differently than teachers who value technology less because they work around the constraints (Vongkulluksn et al., 2018).

2.3 Alignment of beliefs and practices

Teachers’ beliefs play a significant role in the behaviors they enact in the classroom. However, research into the alignment of teachers’ beliefs and practices has drawn inconsistent results, with some researchers finding alignment between beliefs and practices while others do not (Ertmer, 2005; Fives & Buehl, 2012).

Studies examining teachers’ beliefs have found that teachers with constructivist beliefs exhibited alignment in their classroom practices (Deng et al., 2014; Ertmer et al., 2012; Hsu, 2016). Deng et al. (2014) determined teachers’ epistemic beliefs and pedagogical beliefs existed in a nested relationship, and their instructional uses of technology were in alignment with their beliefs. Ertmer et al. (2012) examined 12 award-winning teachers recognized for their technology integration and found through interviews and observations that their enacted practices aligned with their stated beliefs. For example, one teacher stated technology should be used for student-centered, authentic applications, and her observed classroom practices included using iMovie software and digital storytelling (Ertmer et al., 2012). Additionally, Hsu (2016) determined a significant majority (75%) of the teachers in her study held constructivist beliefs, and their beliefs were in alignment with their classroom practices. Alignment was evidenced through multiple high-level learning activities in teachers’ lessons (Hsu, 2016).

Researchers studying alignment of teachers’ beliefs and practices have found teachers do not always enact their espoused beliefs in the classroom (Chen, 2008;
Liu, 2011; Mama & Hennessy, 2013; Polly & Hannafin, 2011; Shifflet & Weilbacher, 2015). A case study of two teachers found their stated beliefs about technology use in the classroom were positive and aligned with constructivist uses of technology, yet some of their classroom practices did not match their stated beliefs (Shifflet & Weilbacher, 2015). A larger qualitative study found even when teachers held positive beliefs about technology use in education and recognized its value for teaching and learning, teachers’ practices did not reflect these beliefs (Mama & Hennessy, 2013). In addition, cultural emphasis on academic achievement may drive teachers to utilize teacher-centered methods (Chen, 2008; Liu, 2011). Another factor affecting alignment of beliefs and practices may be teachers’ lack of fully understanding how to implement constructivist strategies (Chen, 2008). Polly and Hannafin (2011) observed teachers with constructivist beliefs who felt they were using student-centered strategies in their classrooms, although they were not. However, when these teachers participated in professional development focused on student-centered instruction, the alignment between their beliefs and practices increased (Polly & Hannafin, 2011). While the research is inconclusive concerning whether teachers’ beliefs align with their practices, there is a need to understand what teachers believe about teaching and learning in order to determine why these discrepancies in alignment are occurring.

Therefore, this research addressed the following research questions (RQ):

1. What are teachers’ beliefs about the role of technology in teaching and learning?
2. How do teachers’ observed classroom practices align with their stated beliefs about technology?

3 Method

A convergent mixed methods design (Creswell & Plano Clark, 2018) was applied in this action research project (Mertler, 2017) to understand the beliefs that teachers held toward technology for learning and how their beliefs were reflected in their practices of integrating technology. Central to mixed methods research is the belief that combining quantitative and qualitative data will provide a more complete understanding of the research problem (Creswell, 2014). Ultimately, findings from two sources of data collection were converged to develop a comprehensive understanding of teachers’ beliefs about technology and the alignment between teachers’ beliefs and their practices of integrating technology (Creswell & Plano Clark, 2018).

3.1 Setting

This study took place at a small, private school in the southeastern United States. The first author served as Curriculum and Instruction Technology Coordinator at this institution. All students attending the school were diagnosed with the learning
disability dyslexia. The school offers reading remediation for students with dyslexia through an intensive phonics-based method, the Orton-Gillingham Approach. This approach emphasizes multisensory methods of instruction, and teachers are trained to use these multisensory instructional methods for remediation of dyslexia. The school maintains a population of 250 students enrolled in kindergarten through sixth grade. Classes are capped at 10 students in order to provide specialized reading instruction. Every classroom is assigned two teachers who work together in a co-teaching relationship and share teaching responsibilities throughout the day. In addition to 50 classroom teachers, the school employs five teachers who cover curriculum on digital and print media, art, music, and physical education. Therefore, the total number of faculty members at the school is 55. Teachers had ample access to technology. In addition to every classroom being equipped with a Smart Interactive Display, all teachers were issued an Apple MacBook Pro laptop computer. Students had access to Apple iPads or Macbook in a one student to one device ratio. Despite the abundance of technology available, teachers’ comfort levels and ability to use these resources for student-centered learning varied.

3.2 Participants

3.2.1 Survey participants

The sample for the quantitative phase included all 55 faculty members, including 51 female teachers and four male teachers. Teachers ranged in age from 23 to 74 years old. Twenty-three teachers had earned a bachelor’s degree, 31 had earned a master’s degree, and one had obtained a specialist degree. Levels of experience varied among teachers with 51% having less than five years of experience at the school and 29% having more than 10 years of experience at the school.

The survey was distributed as a Google Form, only allowing one submission per teacher. The form collected email addresses to identify participants in the qualitative phase of the study. A total of 29 teachers responded to the survey but one did not consent to participate in the study. Therefore, the response rate for the survey was 51%.

3.2.2 Interview and observation participants

Participants were selected for follow-up interviews and observations using a purposeful sampling method (Merriam, 1998) based on their level of technology integration reflected in survey responses in sections about technology integration. Quartiles for their scores were calculated and two teachers were chosen for each level of technology integrators (e.g., experienced, intermediate, and novice, see Table 1).

3.3 Data collection

Before data collection began, an Institutional Review Board (IRB) approval was granted. Quantitative data was collected through a survey. Survey data was used to inform the selection of participants for the qualitative phase (Creswell, 2014).
Qualitative data was collected through interviews and classroom observations on the selected participants (Creswell, 2014). In the end, findings from qualitative data were combined with the quantitative survey data to answer the research questions (Creswell & Plano Clark, 2018) (Table 2).

3.3.1 Survey

A survey instrument was adapted from the Survey of Technology Integration and Related Factors (STIR) (Pittman & Gaines, 2015) and the Technology Skills, Beliefs, and Barriers scale (Brush et al., 2008). Our survey included 49 items divided into five sections. The first section collected demographic information and qualifications, such as teachers’ age, years of teaching experience, and highest degree. Participants were asked to rate each statement on using a Likert-type scale ranging from (1) Strongly Disagree to (5) Strongly Agree. Statements addressed 1) access to technology and the availability of technical support at the school, 2) beliefs about technology in teaching and learning, 3) students’ use of technology in their classrooms, and 4) teachers’ use of technology. Internal consistency was tested using Cronbach’s alpha coefficients. All sections show acceptable or higher internal consistency (α > 0.70, Gliem & Gliem, 2003) (Table 3).

3.3.2 Interviews

Three rounds of semi-structured interviews were conducted with the six selected participants in order to develop detailed understanding of teachers’ beliefs regarding the role of technology in teaching and how those beliefs aligned with practices (Creswell, 2014). By interviewing participants three times, we established

| Table 1 | Six participants selected for the interview and observation |
| --- | --- |
| Pseudonym | Group | Quartile | Subjects |
| Amelia | Experienced | 1 | Phonics, math, social studies |
| Rachel | Experienced | 1 | Math, writing, social studies, science |
| Charlotte | Intermediate | 2 | Phonics, math, writing, social studies |
| Emma | Intermediate | 3 | Phonics, math, writing, social studies, science |
| Olivia | Novice | 4 | Phonics, math, social studies |
| Sophia | Novice | 4 | Phonics, math, writing, social studies, science |

| Table 2 | Research questions and data sources |
| --- | --- |
| Research Questions | Data Sources |
| RQ1: What are teachers’ beliefs about the role of technology in teaching and learning? | Survey |
| RQ2: How do teachers’ observed classroom practices align with their stated beliefs about technology? | Interviews |

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a longitudinal trajectory to identify changes in their beliefs and practices of technology integration. Through maximum variation sampling (Bloomberg & Volpe, 2016), diverse perspectives of technology integration were gleaned from interviews. Interviews were conducted via video conferencing software and recorded based on participants’ consent. Each interview was transcribed for analysis.

The first interview with participants lasted approximately 40 min and took place before any classroom observations. This interview followed a semi-structured format to pose the same questions to participants, but also ask clarifying questions as needed (Creswell, 2014). Two to eight interview questions were generated for each research question along with probing questions to elicit further elaboration or clarification from participants. Before initial interviews began, the interview protocol was pilot tested with two teachers in order to refine and finalize questions prior to data collection. Based on their feedback, revisions were made to clarify the distinction between technology for teaching and technology for learning.

The second interview with participants took place after the initial classroom observations and lasted approximately 30 min. The follow-up questions asked were unique to each participant and related to the specific technology tools they chose to use in the lessons observed.

The third interview with participants took place after each of them was observed a second time. The interviews lasted approximately 30 min and followed a semi-structured format. The interview protocol contained the same questions included in the second interview. Follow-up questions were individualized for each participant based on the technology tools they used in the second lessons observed.

### 3.3.3 Observations

For this study, classroom observations served to identify how teachers were using technology and whether their stated technology beliefs matched their classroom practices (Mack et al., 2005). Observations also served as reference points to inform questions regarding actions and behaviors observed during the second and third interviews (Merriam & Tisdell, 2016). Two rounds of observations were conducted by the primary investigator who assumed the role of observer as participant. The first round took place after the initial interview with participants via video-conferencing software due to the school utilizing distance learning. The second round took place in-person. Each observation lasted the length of the class (30–60 min).

| Survey Section                                      | Cronbach’s alpha |
|-----------------------------------------------------|------------------|
| Technology Access and Support (Items 7–13)          | 0.86             |
| Importance of Technology in Teaching and Learning (Items 14–32) | 0.91             |
| Technology Use by Students (Items 33–40)            | 0.75             |
| Technology Use by Teachers (Items 41–49)            | 0.84             |
All observations followed a semi-structured format to assess the same aspects of technology use in each teacher’s classroom while also flexibly note other events and interactions observed (Mertler, 2017). A semi-structured observation protocol was created in consultation of the Looking for Technology Integration Instrument (LoFTI), Teaching Dimensions Observation Protocol (TDOP), and ISTE Classroom Observation Tool (ICOT). Finally, six sections were included: settings, groups, teacher activity, student engagement, technology activities, and technology tools used.

3.4 Data analysis

3.4.1 Quantitative

Descriptive statistics were obtained for each section to understand teachers’ and students’ uses of technology throughout the school and teachers’ beliefs about the role of technology in instruction.

3.4.2 Qualitative

Thematic analysis (Braun & Clarke, 2006) was applied by reviewing interview transcripts and observation notes to assign codes. Specifically, two cycles of coding were completed during quantitative data analysis. We organized the data in Delve by participant and coded all data points for one participant before moving on to the next participant.

The first cycle involved coding the most essential data (Creswell, 2014). This cycle consisted of three rounds of coding utilizing four different methods: in vivo, descriptive, process, and values coding (Saldaña, 2015).

We employed in vivo coding for the interviews and descriptive coding for the observations to develop each individual story as a whole. This also established an account of participants’ experiences with and perceptions of technology integration at a specific point so as to identify changes over time. In vivo coding was appropriate for our goal of having participants describe their technology integration experiences and beliefs using their own words (Saldaña, 2015). Descriptive coding was used to analyze observations since it provides a focused filter for analyzing data and builds a foundation for future rounds of coding (Miles et al., 2020). We assigned codes to meaningful units of text and placed in vivo codes in quotation marks to separate them from descriptive codes.

Process coding was performed to explicitly tell the story of how participants were using technology as indicated by their actions (e.g., gerunds) and how their use changed over time (Bogdan & Biklen, 1998). This method uses gerunds as codes to “imply action intertwined with the dynamics of time” (Saldaña, 2015, p. 111). The use of gerunds also captured the actions that occurred during observations. In total, 312 process codes were assigned to the data.

Values coding was a particularly appropriate method for this study because it captures participants’ “values, attitudes, and beliefs, representing his or her perspectives and worldview” (Saldaña, 2015, p. 131). This method helped understand
the aspects of teaching that participants valued, their attitudes toward technology, their beliefs about the role of technology in teaching and learning, and how these changed during the study. As such, codes were labeled with a B, V, or A to represent participants’ beliefs, values, and attitudes (see Fig. 1). This round generated 597 values codes.

After coding one participant in each round, we conducted peer debriefing with a scholar expertized in technology integration. The scholar reviewed the codes, questioned what codes meant, offered feedback, and provided guidance.

To transition to the second cycle of coding, we exported all coded transcripts in Delve as Microsoft Excel files. We reviewed all the codes generated in the first cycle and began visualizing the data by considering how codes answered research questions (Bogdan & Biklen, 1998). We highlighted codes that seemed related in order to give structure to the data.

The second cycle served to reorganize and reanalyze the data in order to generate categories and eventually themes (Saldaña, 2015). We performed two rounds of pattern coding, which involves arranging similarly coded data into categories that attribute meaning (Saldaña, 2015). We created a pattern code for the related codes with a narrative sentence of how we arrived at the code and what it meant. After coding all participants’ data points, we copied all the pattern codes into a new spreadsheet, devoting a separate sheet to each participant. We printed each page of this spreadsheet and cut them out in order to arrange the codes for participants (see Fig. 2). We also made notes detailing a description of participants’ beliefs and practices of technology integration. This step helped us deepen our understanding of individual patterns for each participant. During this process, we would step away and come back to see if we agreed with the codes and categories. Working in this manner was helpful as we changed categories a few times and divided some categories into smaller categories. Meanwhile, we also took notes in our researchers’ journals as themes began to emerge.

The final step was to generate themes using pattern coding (Saldaña, 2015). We stepped away from the analysis for a few days to keep a clear mind when eliciting the themes. Then, we revisited the categories as well as the journal notes we

![Fig. 1 Values coding in Delve](image)
had recorded. Once a theme became apparent, we wrote it down on an index card and placed it above the categories and codes (see Fig. 3). We met to discuss the emerging themes and re-examine the themes to make any necessary edits.

Our qualitative data analysis resulted in four themes and seven categories. To verify the accuracy of these themes, we conducted member checking by providing participants an opportunity to review and verify whether the findings accurately depict their experiences and perspectives (Merriam & Tisdell, 2016). All six participants responded expressing agreement with the themes without suggestions.
for changes. Qualitative findings are presented below using rich, thick descriptions from participants (Creswell, 2014).

4 Results

4.1 Quantitative results

Descriptive statistics were obtained for each section of the survey.

4.1.1 Technology access and support

The mean scores for all items within this section fell between (3) Adequate and (4) Good. Overall, teachers felt there was acceptable access to technology and support for technology at the school, and the mean score for statements in this section ($M=4.24$, $SD=0.82$) aligned with Good.

4.1.2 Importance of technology in teaching and learning

The mean score ($M=4.00$, $SD=0.80$) revealed most teachers agreed with the statements regarding the importance of technology for teaching and learning. This section addressed both teachers’ beliefs about the importance of technology for teaching (items 14–22) and for student learning (items 23–32). Mean scores revealed teachers placed slightly higher importance in the use of technology for teaching ($M=4.07$, $SD=0.79$) than learning ($M=3.94$, $SD=0.80$). Means for responses to each item ranged between (3) Neutral and (4) Agree.

4.1.3 Technology use by students

The overall mean score for this section was 2.70 with a standard deviation of 1.26, indicating considerable variations in students’ technology use for class-related activities. The most frequently used technology by students was drill and practice/learning games ($M=2.96$, $SD=1.17$). The majority of teachers ($n=19$) stated students used these at least once per week. Word processing ($M=2.93$, $SD=1.46$) and presentation tools ($M=2.93$, $SD=1.30$) were also used almost weekly by students. However, there was significant disparity among responses.

4.1.4 Technology use by teachers

The mean score for this section fell between (3) Once per week and (4) Several times per week ($M=3.26$, $SD=1.49$), revealing teachers use some of the technology tools frequently. Results revealed Communication with Parents/Students ($M=4.32$, $SD=1.24$) was the most frequently used and Website Creation or Maintenance ($M=2.14$, $SD=1.33$) was the least used. The use of Organization/tracking software showed the most disparity ($M=3.18$, $SD=1.70$).
Teachers were also asked to describe their level of technology integration as (1) Nonexistent, (2) Limited, (3) Average, (4) Above Average, or (5) Excellent. The mean for this item ($M = 3.39$, $SD = 0.74$) revealed most teachers felt their level of technology integration was (3) Average.

4.2 Qualitative findings

Four themes were generated from the qualitative interviews and classroom observations. Table 4 presents each theme along with the categories, example pattern codes, and first-cycle codes associated with it.

4.2.1 Theme 1: Teachers’ beliefs about the role of technology are influenced by their level of technology integration

This theme describes how teachers’ beliefs about the role of technology varied by their level of technology integration. The two experienced integrators viewed technology as an essential tool for their instruction because it engaged students, thus increasing their learning. However, two novice integrators and two intermediate integrators viewed technology as a tool to support, or supplement, their instruction. This discrepancy in how teachers view the role of technology has been recognized in the literature. Ertmer and Ottenbreit-Leftwich (2010) noted, “it is time to shift our mindsets away from the notion that technology provides a supplemental teaching tool and assume, as with other professions, that technology is essential to successful performance outcomes (i.e., student learning)” (p. 256). This theme consisted of the categories (a) technology as a supplement and (b) technology to engage students.

The category Technology as a Supplement describes how novice and intermediate integrators viewed technology as supplemental to their instruction but not an essential component. Some of the ways they used technology to supplement instruction were to provide a visual, evaluate students, and reinforce concepts. These uses align with teacher-centered methods of instruction. There were also discrepancies between novice and intermediate integrators in how they viewed technology as a supplement.

Olivia and Sophia, who were novice integrators, held teacher-centered pedagogical beliefs as Olivia described “I am definitely coming from teacher-centered.” Olivia and Sophia displayed limited technology use during their initial observations and stated in interviews that they did not use technology frequently. Despite their limited use, both teachers expressed beliefs that technology use was expected, if not required. Their perception that technology use is required, however, has not motivated them to use it more.

Sophia: I feel like [technology]’s becoming less of an option....before you were like ‘oh, that’s a nice tool, but I’m still gonna do that this way and not use the technology.’

Olivia: I think that [the lesson] represents me using [technology] as an added experience, not so much a main avenue.
| Themes                                                                 | Categories                                      | Pattern Codes                                      | Codes                                                                 |
|----------------------------------------------------------------------|------------------------------------------------|---------------------------------------------------|----------------------------------------------------------------------|
| Teachers’ beliefs about the role of technology are influenced by their level of technology integration | Technology as a supplement                      | Technology supports teaching                       | Supporting Instruction with Technology, Assisting the Teacher, “technology is useful to put on top” |
|                                                                     | Technology to engage students                   | Technology supports learning                       | Supporting Instruction with Technology, Assisting the Teacher, “technology is useful to put on top” |
| Teachers believe technology use should be balanced with multisensory methods | Teachers’ perceptions of multisensory methods   | Hands-on methods are important                    | Incorporating Multisensory Activities, “integrate the sensory motor aspect” |
|                                                                     | Balancing technology and multisensory methods   | Using technology for multisensory component       | Finding Balance in Technology Use, “technology versus other hands on methods” |
| Teachers are motivated to use tools that are easy for them and their students | Ease of use                                     | Ease of use                                       | Selecting Technology That’s Easy to Use, “easiest for me to grade,” |
| Teachers’ beliefs are dynamic                                         | Recognizing the benefits of technology          | Motivated by ease of use                          | Connection with Distance Learner, “faster that typing a sheet” |
|                                                                     | Concern of overreliance on technology           | Shifting attitude toward technology                | “these kids have been on the screen too much,” |
|                                                                     |                                                 | Personal productivity                              | Balancing Technology Use                                              |
Intermediate integrators Emma and Charlotte mentioned technology as a supplement to their instruction and used technology to support their instruction during observations. Unlike the novice integrators, they recognized technology could support student learning and provided more learning opportunities for their students that involved technology. Emma said, “[technology] just assists the teacher in letting them work with the content in other ways than just a teacher standing in the front of the room presenting material.” One way she enacted this belief in her classroom was by having students play a learning game on the website Kahoot.

Additionally, their pedagogical beliefs were not squarely teacher-centered. Emma described her beliefs as “in the middle” while Charlotte said her beliefs were teacher-centered but “moving towards student-centered.”

Emma: It’s an aid to what I’m trying to teach or make them aware of…I think it’s there to support the lesson that we’re doing and to give another way for students to interact and show what they know and be creative and really just be a supplement to the content and the lesson.

Charlotte: Because of technology, different types of books are accessible to [students] that are read to them that they might not have picked up and been able to understand or to read or comprehend because they weren’t able to read them.

The category Technology to Engage Students is defined as teachers using technology to engage students. Two intermediate integrators and two experienced integrators expressed beliefs about technology engaging students. Teachers used technology to engage students by making learning relevant to their lives and giving them multiple opportunities to interact with the content. These uses align with student-centered instruction (An & Reigeluth, 2011; Hermans et al., 2008).

Charlotte and Emma, who were intermediate integrators, used technology to engage students, but they expressed different reasons for doing so. Emma stated she uses technology “to pique their interest and keep [students] excited.” She saw technology as an opportunity to engage students by making them interested in the content and sustaining their attention. This was witnessed during her first observation when she had students shift between synchronous direct instruction and self-paced independent practice in Seesaw and Kahoot. Charlotte also used technology to engage students by making the content relevant to their lives. She recognized that harnessing students’ interests through technology could keep them engaged.

Charlotte: Students become more engaged when you teach them based on what they like or what they enjoy learning and based on their interest, and I think technology can help with that interest.

Like the intermediate integrators, experienced integrators used technology to create excitement and interest for students. Amelia noted using technology “gives [students] one more opportunity to do something that is not what they’re used to and it wakes up their brain.” Experienced integrators used several different methods to engage students through technology. Rachel believed that making
content relevant to students increased their engagement. She noted, “if they’re more engaged and they’re taking charge of their learning, then it’s going to be a lot more relevant for them and they’re going to be more excited about it.” During the first observation, Rachel tapped into students’ interests for her math lesson on adding decimals. She showed students the Target website and told them they could each pretend to buy a game. She scrolled through the different games available on the website and students picked one they liked. Rachel then recorded the price of each game the students selected into an addition problem for the class to solve. Rachel made the math problem relevant to students by giving them choice in selecting a game and providing a real-world context where they would be adding decimals.

One difference between the experienced and intermediate integrators was the belief by experienced integrators that technology was essential to their practice. Amelia and Rachel held the most student-centered beliefs of all participants.

Rachel: It’s both because some of our apps like Braining Camp, it engages them, but it’s also tied directly to our learning goals. So I think they go hand in hand.

Amelia: If I didn’t have a computer and all of [this hardware and software], I would have to completely change how I do planning and communicating and collaborating.

4.2.2 Theme 2: Teachers believe technology use should be balanced with multisensory methods

A core principle of the Orton-Gillingham Approach is the use of multisensory instructional methods. This theme encompasses teachers’ belief that any technology use integrated in the classroom must not replace multisensory instruction but be used in conjunction with it. This theme consists of the categories (a) teachers’ perceptions of multisensory methods and (b) balancing technology and multisensory methods.

Multisensory methods are defined as instructional methods that require students to use multiple modalities, such as seeing, hearing, and feeling. The importance of multisensory methods was a unanimous sentiment expressed by teachers with different levels of technology integration. Teachers also saw benefits to using technology for instruction, particularly experienced integrators who used their technology knowledge and content knowledge to make instructional decisions.

Olivia: I always try to put a lot of multisensory aspects into my lessons, meaning hearing, seeing, spelling, so that drives my lesson plan. They need to have a strong visual, after they have the strong visual, they need to hear it, but they also need to be doing something as a motor component where they write.

Emma: [technology] is just another way to tap into all of the different learning modalities that we use….When we’re talking about phonics or math, we can teach the content and then they can actually try to apply it by different manipulatives or tools that they’re using in whatever app or software that we’re offering to them.
Teachers expressed a desire to balance technology use with these methods. For example, Amelia thought about balancing technology with multisensory methods during each lesson as well as throughout the week. She stated about learning activities in her lessons, “I try to do a sandwich of pen paper, bulk of technologies, mostly Pear Deck, and then a game or an activity that’s hands-on.” She built her lessons by using multiple learning activities, and students shifted from pencil and paper activities to technology-based activities. This was witnessed during her second observation of a math lesson. Early in the lesson, students solved math problems using pencil and paper. Then, they used virtual manipulatives in the Braining Camp app to create t-tables and solve problems. After that, students completed an exit ticket in Classkick before starting a math game the teacher had created that was printed on cardstock. In addition to each lesson, Amelia thought about slowly increasing how much technology students used throughout the week. She stated, “we begin the week with pen to paper work and hands-on activities, but then as we continue on throughout the week, I’ll incorporate more technology.” She was strategic in deciding when to use technology and how much to use.

4.2.3 Theme 3: Teachers are motivated to use tools that are easy for them and their students

Previous research has found teachers’ decisions to use technology in their classrooms are influenced by the perceived ease of use of that technology (Vareberg & Platt, 2018). Similarly, all of the teachers in this study cited ease of use, either on their part or the students’ part, as a factor in deciding to use technology.

Rachel: I think that’s a pretty big factor because there’s just so many options out there like Seesaw and Pear Deck and Google Slides and Google Drive and all of that, and sometimes I pick one over the other just because it’s a little bit easier.

Amelia: I would mostly say I pick Pear Deck and then Classkick [because] those are the two easiest for me to make and grade and to send back corrections.

In addition to their own ease of use, participants considered how easy tools were for their students to use. Selecting tools by viewing how students would experience them was a priority for the participants.

Amelia: I try to use technology that requires very little steps and then kind of look at it from a student perspective and see if it’s something that's doable for a fourth grader.

Emma: If it’s too hard and we’re spending a lot of time teaching them how to use an app as opposed to we’re using this app to support our content that we’re trying to teach, then I’m not going to use it.
4.2.4 Theme 4: Teachers’ beliefs are dynamic

Teachers’ beliefs toward technology changed over the course of this study. Three teachers recognized new uses for technology within their classrooms while two teachers grew concerned over how much technology was being used. A previous longitudinal study found that teacher’s beliefs are not linear and changed over time, which in turn affected their practices (Levin & Wadmany, 2006). The technology-rich distance learning environment was a catalyst driving this change. This theme consists of the categories (a) recognizing the benefits of technology and (b) concern of overreliance on technology.

The category Recognizing the Benefits of Technology describes a change in teachers’ beliefs toward identifying beneficial uses for technology over the course of this study. Three teachers increasingly recognized technology played an essential role in instruction. For example, Sophia stated, “I would say it’d be supplementary” when asked in her initial interview about the role of technology in the classroom, but in her second interview, she responded to the same question saying, “It’s crucial. I think it can make or break a lesson or make and break a school year.” Sophia realized that without technology, she would not be able to continue teaching her students for the remainder of the school year. The role of technology in her classroom changed from being a supplementary tool to one that was essential for instruction.

In addition, teachers realized technology could be used in ways they had not used it before. For example, Emma, an intermediate integrator, found ways to use technology to replace her classroom activities in the distance learning setting. One activity teachers commonly used to help students learn to spell difficult words was called technique. Emma found she was still able to have students do technique during class by using Seesaw. She stated, “I’ll send them off to Seesaw, and they’ll do technique on Seesaw as opposed to in their book.” Emma also expressed enthusiasm regarding efficiency when using an online lesson plan book. During our third interview, she shared that she was using technology to streamline the distribution of work to students and using less paper.

Emma: I’m even using an online plan book this year that I didn’t use before because I just find it easier....instead of having to write my lessons down or make copies for [my co-teacher when I’m out] I [can] just share it with her virtually.

Two teachers also discovered technology increased their personal productivity. For instance, when asked what factors she considered when choosing a technology tool, Olivia responded, “I am really looking towards efficiency.” She recognized and appreciated the efficiency of Seesaw in creating activities. She stated enthusiastically, “What is great about Seesaw is that edit and copy feature. Within minutes you have a new activity. It’s faster than typing a sheet.” Olivia found these features in Seesaw a quick and effortless way to create new activities for her students based on ones she had created previously, thus, increasing her personal productivity.

Two experienced integrators, who were enthusiastic about technology during their initial interviews, expressed growing concerns about technology use. Rachel
had initially expressed the belief that technology was appropriate for any setting and content, yet after the return to in-person learning she grew concerned about how much technology was being used in her classroom. Striking a balance between using technology and using other methods was important to her. She expressed concern over how much screen time students were getting at several points in her third interview and acknowledged her changing beliefs toward technology. When asked how the lesson we observed during her second observation aligned with her pedagogical beliefs, she stated, “I think that has kind of changed because I’m all about technology, but there have been sometimes where I’m like, okay, these kids have been on the screen too much and it’s too much for them.” This change in beliefs was evident in her observation. During the lesson, most of the instruction was teacher-centered and students were observed using technology only during the second half of class. She elaborated on the struggle she felt between wanting to use technology but being concerned about how much she was using. Amelia also made statements about how prioritizing technology affected her classroom and her beliefs.

Rachel: [I’m] just kind of finding the balance between too much technology and technology for the benefit of education. I’m kind of still trying to find that balance and finding some days we’re just going to do paper and pencil, cause we’re not going to get the iPad out today because we’ve been looking at a screen all day.

Amelia: Before distance learning, incorporating technology was something exciting for me. I really enjoy adding it in because it didn’t need to be added in. So being able to incorporate these new things was so awesome and cool for the kids and they weren’t used to it and things like that. But now, because it’s needed every day, it kind of has lost its novelty for the kids, and for me a little bit.

5 Discussion

The purpose of this study was to, in a longitudinal perspective, describe teachers’ beliefs and practices relating to technology integration at a school for students with dyslexia. To answer the research questions, quantitative and qualitative research findings were integrated. The findings add to the existing literature on technology integration. The discussion of findings is organized by the two research questions of the study.

5.1 What are teachers’ beliefs about the role of technology in teaching and learning?

5.1.1 Teachers’ beliefs about technology and their practices of technology integration

Teachers’ beliefs about the role of technology affect their integration. Research suggests that teachers with student-centered beliefs are more likely to integrate technology and teacher-centered beliefs can negatively impact integration (Hermans et al., 2008).
Teacher responses to the survey revealed more teacher-centered beliefs and practices among faculty than student-centered ones. These findings suggest that teachers at the school used technology more for teacher-centered instruction and teachers perceived that student use involved low-level thinking skills, which aligns with previous research findings (Dawson, 2012; Palak & Walls, 2009; Polly & Rock, 2016).

Qualitative inquiry of interview and observation data revealed teachers’ beliefs differed by their levels of integration. Experienced integrators demonstrated more student-centered aspects in their lessons, such as providing students with choice and connecting content to real-world scenarios. They made statements regarding technology being essential to their practice during interviews. Furthermore, experienced integrators demonstrated robust technology use during their observations. These findings support previous research that teachers with more student-centered beliefs demonstrate more seamless integration of technology (Kim et al., 2013) and positive value beliefs toward technology (Hsu, 2016; Taimalu & Luik, 2019). Novice integrators, by contrast, displayed teacher-centered characteristics during lessons, such as drill and practice activities and direct instruction. Observations and interviews revealed they frequently used technology to provide a visual for students, which often involved using presentation software. Novice integrators expressed beliefs that technology was a supplemental piece of their instruction and could be used to support their lessons. They viewed technology as an extra component that could be added into their instruction but was not necessary. These findings concur with previous research indicating traditional teacher-centered beliefs negatively impact technology use (Hermans et al., 2008).

5.1.2 School culture influenced teachers’ beliefs

This study found the school culture impacted teachers’ beliefs about the role of technology for instruction of students with dyslexia, echoing prior research findings that teachers’ beliefs are influenced by external factors such as school characteristics (Hew & Brush, 2007; Tondeur et al., 2017). One aspect of the school culture that shaped teachers’ beliefs was the emphasis on multisensory methods of instruction. All teachers relayed the importance of multisensory methods in their interviews, and these instructional methods were observed in their classroom practices. This aligns with Hew and Brush’s (2007) finding that teachers resist adopting technology they perceive as contradicting the norms of the subject culture. Regardless of their varying views on how technology can be combined with multisensory methods, the use of multisensory methods is a deeply ingrained school norm.

5.1.3 Teacher beliefs evolved with time

Our longitudinal investigations found five teachers expressed changes in their beliefs about technology after the experience of distance learning, which supports previous research findings that teachers’ beliefs changed after participating in a technology-rich environment (Levin & Wadmany, 2006), such as distance learning (Barbour & Reeves, 2009). Levin and Wadmany (2006) found that the process of educational change involving technology was unique to each teacher. This study corroborates
those findings as each integrator experienced unique changes in their beliefs based on their own individual circumstances.

### 5.2 How do teachers’ observed classroom practices align with their stated beliefs about technology?

This research question sought to determine if teachers’ beliefs aligned with their classroom practices. Five teachers in this study did not describe their beliefs as fitting clearly into one category or the other, corroborating prior findings of a meta-analysis by Tondeur et al. (2017). Olivia took a strong stand labeling her beliefs teacher-centered, but all other teachers described their beliefs as being between student-centered and teacher-centered to some degree. These varying beliefs can be reflected in teachers’ classroom practices as they exhibited both traditional and constructivist classroom practices (Orlando, 2013; Shifflet & Weilbacher, 2015).

Four teachers with different levels of integration experience demonstrated alignment of their stated beliefs and classroom practices, supporting prior findings (Ertmer et al., 2012; Hsu, 2016). For example, Amelia, an experienced integrator, said her beliefs contained aspects of both student-centered and teacher-centered practices, and classroom observations revealed this to be true. Olivia, a novice integrator, recognized her beliefs as teacher-centered. She delivered direct instruction, presented information to students, and had them engage in independent learning. However, one intermediate integrator and one novice integrator displayed misalignment between their beliefs and practices. Emma and Sophia felt their beliefs were in between student-centered and teacher-centered, but their instruction was teacher-centered. For example, Emma’s observations were primarily didactic with students completing independent learning activities that promoted storing and remembering information. The finding is aligned with research that has shown teachers’ beliefs are not always in alignment with their practices (Chen, 2008; Liu, 2011; Mama & Hennessy, 2013; Polly & Hannafin, 2011; Shifflet & Weilbacher, 2015).

Previous research provides a few reasons why teachers’ beliefs are misaligned with their practices (Chen, 2008; Liu, 2011; Orlando, 2013). Two teachers in this study made statements expressing the belief that phonics required teacher-centered methods, echoing Orlando (2013) that some teachers felt the curriculum dictated teacher-centered instruction. Chen (2008) suggested teachers may not fully understand pedagogical beliefs in order to accurately describe their own. This could explain why Emma’s and Sophia’s stated beliefs did not align with their observed practices. During our first interview, Emma asked for clarification about what was meant by teacher-centered and student-centered when asked to describe her pedagogical beliefs. Sophia’s response to the question about her pedagogical beliefs was contradictory. She stated her beliefs were in the middle, but her description of teacher-centered beliefs was not relevant. For these teachers, not fully understanding pedagogical beliefs may have been the reason they stated their beliefs were in-between student-centered and teacher-centered.
5.3 Implications for practice

Finding from this research study provide several implications for the school. Professional development is recommended to address gaps and deficiencies in teachers’ technological knowledge. Professional development should not only build teachers’ technical skills, but also show them how technology can be used to enhance content and what pedagogical approaches best support technology use. In addition, due to the school norm of providing multisensory instruction, professional development that provides teachers ways to marry multisensory methods with technology is advised. Using phonics content relating to the Orton-Gillingham Approach will create meaningful, authentic learning experiences for teachers (Ertmer & Ottenbreit-Leftwich, 2010; Ertmer et al., 2015). Additionally, this training will build teachers’ technological content knowledge by showing teachers ways to use technology with their phonics content (Ertmer, 2005).

5.4 Limitations and future research

As with the majority of research studies, the current study is subject to limitations. First, this study collected responses from participants through a self-reported survey, which may reflect self-presentation bias and teachers may inaccurately report their own practices (Kopcha & Sullivan, 2007). Second, for qualitative inquiry, the researcher’s own subjectivities can present biases in how findings are interpreted (Roulston & Shelton, 2015). We kept a researcher’s journal to document our thoughts and to self-examine practices and assumptions (Roulston & Shelton, 2015). However, findings from this research should be viewed in light of this limitation. Finally, restrictions due to COVID-19 placed limitations on this study. Namely, initial observations had to be conducted through virtually that limited our observation of their actions.

Future research could examine technology integration with an emphasis on identifying pedagogical strategies for online learning that work well with the Orton-Gillingham Approach at schools for students with dyslexia. In addition, future research may identify teachers’ specific barriers in a longitudinal perspective so as to reduce or eliminate those barriers with minimal or considerable effort.

6 Conclusion

Technology has continued to advance over the last few decades, yet classrooms are not taking advantage of the increase in access by using technology in authentic, meaningful ways. Effective technology integration requires a pedagogical shift whereby teachers utilize technology as a cognitive tool. It is necessary to understand teachers’ beliefs to understand their intentions and actions within the classroom. Identifying teachers’ deep-seated beliefs about the role of technology in teaching and learning is a crucial step in affecting this change. The longitudinal nature of this
study revealed teachers’ beliefs about technology changed over time driven by their level of technology integration experience and also school culture. All teachers at the school were thrust into an online teaching environment without having any prior experience and with minimal training. Teachers learned new uses for technology for their students and themselves. They also recognized technology use must be purposeful and carefully planned so that reliance on technology is not too great.

Declarations

Conflict of interest There is no any potential conflict of interest in the work.

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