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Understanding the relationship between teachers' use of online demonstration videos and fidelity of implementation in *MyTeachingPartner-Math/Science*

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HIGHLIGHTS

- Positive relationship between demonstration video viewing and curricular fidelity.
- Potential benefit of demonstration videos not maximized due to varied and low use.
- Most teachers chose demonstration videos to watch based on self-identified need.
- Teachers identified video characteristics as useful for fidelity of implementation.

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1. Introduction

Evidence-based curricular programs are the current gold standard in early childhood education, linked to improved student outcomes and holding potential to reduce the achievement gap (Pianta, Barnett, Burchinal, & Thornburg, 2009). In order to effect widespread change in student learning, high-quality curricula need to be implemented at scale with high fidelity of implementation (FOI; Coburn, 2003; Clements, Sarama, Wolfe, & Spitler, 2015). Curricular FOI is the degree to which curricula are carried out as intended by developers (Berkel, Mauricio, Schoenfelder, & Sandler, 2011; Durlak & DuPre, 2008). One critical element of FOI we examine in this study is teachers' adherence to the core curricular components including materials, routines, and strategies. Unfortunately, FOI for early childhood curricula often varies by teacher, creating appreciably different experiences and ultimately, outcomes, for children (Lieber et al., 2009; Zaslow, Tout, Halle, Whittaker, & Lavelle, 2010). Thus, supporting FOI is necessary to achieve the potential benefits of high-quality curricula.

Professional development (PD) formats that support curricular FOI, such as workshops and coaching (Clements & Sarama, 2008; Starkey, Klein, & Wakeley, 2004), require substantial financial and human resources (Knight, 2014; TNTP, 2015). In sustainable curricular scale-up, districts, as opposed to curricula developers, must provide manageable PD supports for FOI that are less resource intensive (Coburn, 2003). FOI supports that allow for independent, teacher-driven PD engagement (Clements et al., 2015) could supplement more resource intensive and cost prohibitive PD and increase feasibility for school districts.

Internet-based resources allow for the provision of "just in time" supports (Romiszowski, 1997), or resources that can be used in the moment, while planning to teach a lesson (Dede, Jass Ketelhut, Whitehouse, Breit, & McCloskey, 2009; Gill, 2011). Teachers perceive pacing, flexibility, and convenient access as benefits of online PD (McNamara, 2010). However, provision of more resources does not necessarily mean more teacher use, especially in cases where teachers have agency over which resources they use and how often they use them (Kinzie, Whittaker, McGuire, Lee, & Kilday, 2015; Powell, Diamond, & Koehler, 2010). While researchers are beginning to examine characteristics of coaching that support FOI (Paxton, Wanless, & Rimm-Kauffman, 2013), little is known about the relationship between online supports (e.g.,

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demonstration video exemplars) and teachers' FOI. Isolating and examining teachers' use of online PD resources, their relationship with teachers' FOI, and teachers' perceived usefulness of those online supports can inform the design of future online curricular support systems.

In this study, we examine the use of online curricular demonstration videos, video exemplars of high-quality and high-fidelity implementation of specific teaching practices (Pianta, Mashburn, Downer, Hamre, & Justice, 2008). We seek to explore the relationship between early childhood teachers' use of online demonstration videos and their FOI of the *MyTeachingPartner-Math/Science (MTP-M/S)* early childhood mathematics and science curricula. Observing other teachers' instruction through videos is a common technique for teacher training (Borko, Jacobs, Eiteljorg, & Pittman, 2008; Star & Strickland, 2008). However, in studies published to-date, researchers have not yet examined if viewing video exemplars is positively associated with teachers' own FOI.

In order to better understand teachers' use of online PD resources, we qualitatively examine teachers' perceptions of the usefulness of online demonstration videos in supporting their FOI. Using a sequential mixed methods explanatory design, we draw on the strengths of numeric data to establish a significant positive relationship between demonstration video viewing and FOI. Then, we draw on the strengths of narrative data, employing elements of grounded theory (Charmaz & Belgrave, 2012; Strauss & Corbin, 1998), to further understand why teachers choose to use the videos or not.

1.1. Defining and measuring fidelity of implementation

Berkel et al.'s (2011) model of program implementation includes fidelity, quality of implementation, adaptation, and participant responsiveness. In this study, we focus on curricular fidelity of implementation (FOI), or the extent to which teachers adhere to the lesson design and carry out the actual components or steps in an activity as presented in the curriculum (e.g., Piasta, Justice, McGinty, Mashburn, & Slocum, 2015). For example, as illustrated in Fig. 1, each *MTP-M/S* activity includes an "*Investigate*" section comprised of a series of steps to guide students' inquiry (Kinzie et al., 2015). One indicator of adherence to an *MTP-M/S* activity is the completion of each investigation step. While we recognize that FOI can be considered more broadly as a multifaceted construct including but not limited to measures of dosage, quality, adaptation, and responsiveness (Berkel et al., 2011; Durlak & DuPre, 2008; O'Donnell, 2008), we use this narrower, adherence-focused definition of FOI based on instructional design of the demonstration videos to specifically show activities carried out as intended. Our confirmatory questions and hypotheses are based on our belief that the videos will have a primary influence on adherence to the curricular design.

FOI is of key importance in interpreting if outcomes are a true reflection of an intervention's effect. In others words, they can help, "distinguish between intervention failure and implementation failure" (Abry, Hulleman, & Rimm-Kaufman, 2015, p. 321). If an intervention is delivered with low fidelity, positive effects are not necessarily attributable to the intervention, and negative or null effects are not necessarily evidence of an unsuccessful intervention (Wang, Nojan, Strom, & Walberg, 1984; Durlak & DuPre, 2008). Investigations of preschool science (Gropen, Clark-Chiarelli, Ehrlich, & Thieu, 2011), literacy (Davidson, Fields, & Yang, 2009), and mathematics (Kinzie et al., 2015) curricula have found higher FOI to be positively associated with gains in students' skills. Findings such as these lend support for the importance of designing curricular support packages to specifically target teachers' FOI and examining FOI as a moderator of curricular effects.

1.2. Fidelity of implementation for sustainable curricular scale up

Sustainable curricular scale up – the degree to which curricula can be implemented over time in diverse contexts with continued fidelity to the curricular design (Coburn, 2003; Dede, 2006) – is of growing concern in the field of educational research (Century & Cassata, 2014). Ultimately, school districts need to sustain curricula with fewer financial and human resources than may have been available in the initial implementation (Fishman, Marx, Blumenfeld, & Soloway, 2004). Lack of resources might contribute to low levels of program sustenance, as in the case of *First Step,* a program supporting students' replacement of problem behaviors with positive behaviors both at school and home (Sumi et al., 2012). Despite positive academic and behavioral outcomes, only one of five sites maintained use of the program after a scale-up trial.

Recent studies and discussions of curricular sustainability emphasize the continued importance of FOI (Clements et al., 2015; Fishman, Penuel, Hegedus, & Roschelle, 2011; Layzer, 2013) beyond initial establishment of positive curricular effects. Sustained FOI is moderated by teachers' initial degree of implementation fidelity (Clements et al., 2015; Lieber et al., 2010). Teachers showing high FOI at the start of a study are better able to maintain implementation fidelity over time (Clements et al., 2015; Wenz-Gross & Upshur, 2012) and are more likely to continue to use curricula beyond an implementation trial (Lieber et al., 2010). Effective, independently accessible, and less resource-intensive supports hold promise both for initially increasing and sustaining high curricular FOI, maximizing the impacts of evidence-based curricula on student outcomes by establishing and maintaining treatment strength.

1.3. Online support for teachers' fidelity of implementation

Curriculum developers are shifting both formal, in-person PD formats (e.g., workshops, coaching), and independently accessible, teacher-selected PD resources (e.g., demonstration videos), online with promising results (Downer, Kraft-Sayre, & Pianta, 2009; Hamre, Pianta, Mashburn, & Downer, 2012; Powell, Diamond, Burchinal, & Koehler, 2010). Online PD increases flexibility and decreases travel costs while maintaining or extending geographic reach (Dede et al., 2009). Although evidence suggests the viability of online curricular guidance as an alternative to in-person support in terms of the impact on student learning gains (e.g., Powell, Diamond, Burchinal et al., 2010), curricular implementation interventions finding consistently high FOI often provide costly formal PD formats such as workshop series and intensive instructional coaching (Clements & Sarama, 2008; Knight, 2014; Starkey et al., 2004; TNTP, 2015). Online curricular resources, Internet-based supports providing instructional guidance and models, are a scalable and affordable alternative to promote successful curricular implementation leading to positive gains in student outcomes (Downer et al., 2011; Hamre et al., 2010).

The provision of online curricular resources also allows for increased teacher agency in self-selecting independently accessible supports, but there are mixed findings as to their relative value. Pianta et al. (2008) found teachers receiving both coaching and access to website resources that included video exemplars of high quality interactions had significantly greater improvement in classroom interactions than teachers with access to the website only, controlling for teacher and classroom characteristics. However, for those teachers with access to the website alone, higher usage rates, measured by page views, were associated with greater gains in classroom interaction quality. It seems there was value in the website resources independent of coaching, but they were most effective when used in a blended model. Contrary to Pianta et al.'s

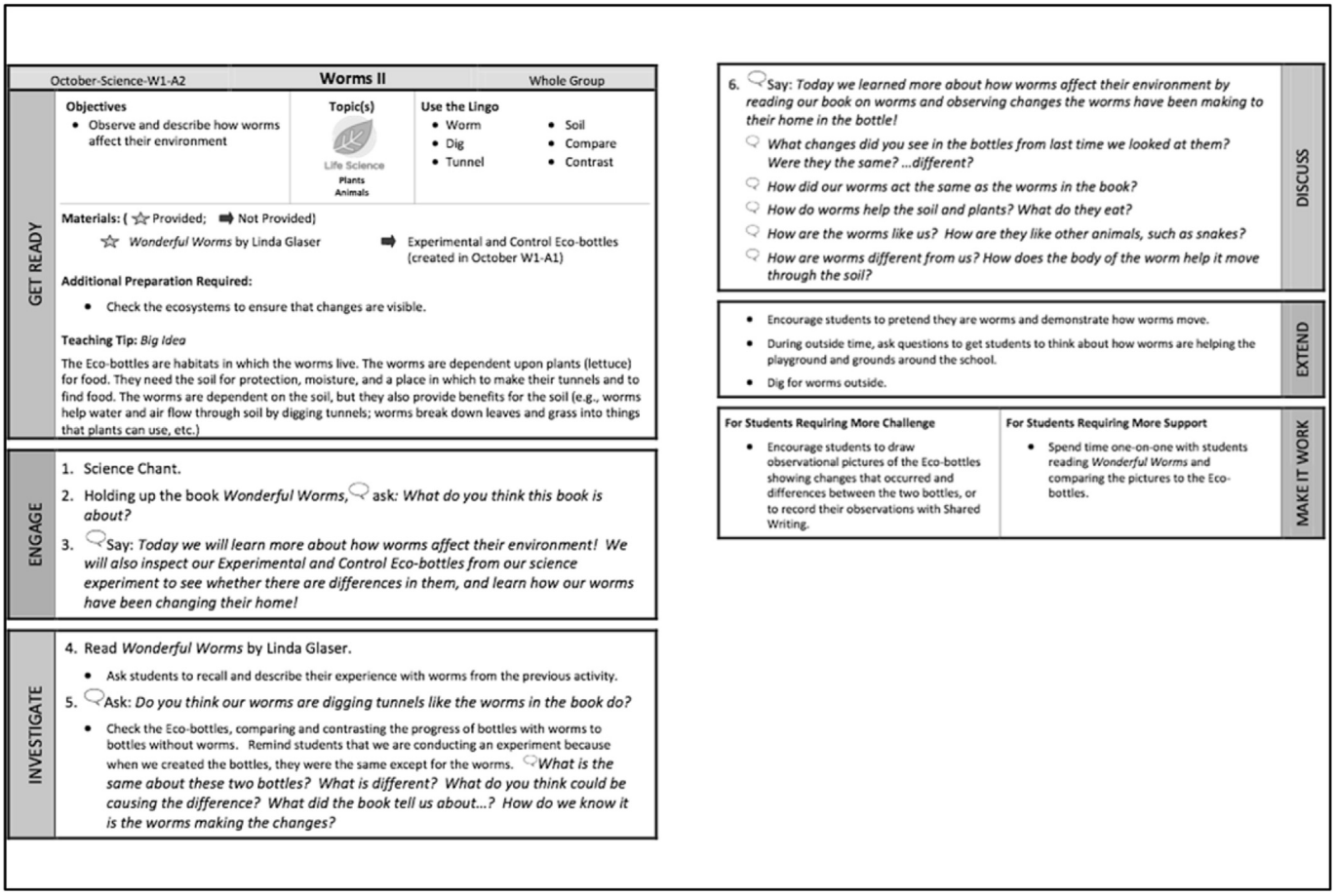

Fig. 1. *MTP-M/S* activity plan. All activity plans were provided in print format and available on the website, organized by curricular sequence.

(2008) findings, Hamre et al. (2012) did not find significantly different gains in students' social competence skills between teachers who received coaching in addition to website resource access and those who receive website resources only. The authors did find a similarly positive relationship between time teachers spent on a website and students' social competence skills. While the additive value of coaching to website resources is unclear, the positive relationship between website usage rates and both teacher practices and student outcomes supports the value of online resources as a promising curricular support.

In order to reap the identified benefits of online curricular resources, teachers must engage with them. However, teachers vary significantly in their use of provided resources. Downer, Kraft-Sayre, et al. (2009) investigated website usage patterns of pre-kindergarten (pre-k) teachers engaged in an intervention targeting teacher-child interactions and found that teachers, on average, accessed the PD website (lessons plans, lesson materials, and video exemplars) for approximately 4–5 h over the school year. But, the variance in teachers' minutes of website use per week was high (Year 1 $M = 11.2$ min, $SD = 16.1$; Year 2 $M = 9.0$, $SD = 13.1$), and teachers who received coaching in addition to online resources spent significantly more time using the website. There is similar range in use when teachers receive explicit direction toward resources (Hemmeter, Snyder, Kinder, & Artman, 2011; Powell, Diamond, & Koehler, 2010). Powell, Diamond, and Koehler (2010) found that teachers ranged from 0 to 74 visits to video exemplar pages and independently accessed only 20% of recommended video exemplars despite links embedded in the coach's written feedback.

Range in teachers' use of online curricular supports may be due, in part, to demographic characteristics. In a study of pre-k teacher coaching and web support PD, Downer, Locasale-Crouch, Hamre, and Pianta (2009) identified that older teachers and those with higher self-efficacy spent more time on the website resource pages. Alternatively, teachers' with more pre-k experience spent less time on the website resource pages.

By supplementing formal, externally driven PD experiences with resources intended for independent use, teachers have the opportunity for continuous learning focused on their individual needs (Jones & Dexter, 2014), an identified component of curricular sustainability (Clements et al., 2015). Additionally, the frequency of cost-intensive formal PD can be reduced to improve sustainable feasibility. However, if resources and attention are to be devoted to increasing teachers' positive perceptions and use of online resources for independent professional learning, their value in terms of associated positive changes in teacher practice needs to be closely examined.

1.4. Early childhood educators' need for fidelity of implementation support

Research suggests that early childhood educators need support in effectively implementing evidence-based best practices. Research conducted in U.S. pre-k settings shows that although most programs report having a curriculum, as much as 44% of the classroom day is spent in non-instructional activities (Early et al., 2010; La Paro et al., 2009). Additionally, large scale studies

suggest the quality of instructional support is low (Hamre, 2014). This may be due, in part, to variation in the efficacy of PD supports for teacher's curricular implementation (Lieber et al., 2009).

Online demonstration videos can be an effective component of a PD system (Pianta et al., 2008). They allow for a convenient and accessible display of high-quality, authentic practice (Pianta et al., 2009). Teachers can access them anytime, providing professional support when teachers need it (Perry & Talley, 2001). Early childhood teachers take advantage of this logistical affordance, evidenced by the varied timing of their resource access across the day and their use of videos throughout an intervention period (Powell, Diamond, & Koehler, 2010). However, teachers do not consistently take advantage of provided resources at high levels (Downer, Kraft-Sayre et al., 2009; Powell & Diamond, 2013).

Despite varied levels of use, early childhood teachers' perceptions of online supports are generally positive (Powell, Diamond, & Koehler, 2010; Whitaker, Kinzie, Kraft-Sayre, Mashburn, & Pianta, 2007). Teachers in Head Start classrooms, a nationally-funded program to promote the school readiness of children from low-income families, engaged in Powell, Diamond, and Koehler's (2010) coaching for vocabulary and phonemic awareness instruction consistently rated video exemplars high in terms of video usefulness. Additionally, early childhood teachers with access to website resources that included demonstration videos and teaching techniques perceived greater utility of an intervention website than teachers only receiving access to digital versions of curricular plans (Whitaker et al., 2007). As the ultimate goal of curricular support is to improve student outcomes through changes in teachers' classroom practices, a more nuanced understanding of *why* teachers' feel curricular demonstration videos are or are not useful could inform the design of future video resources to maximize teacher use.

1.5. MyTeachingPartner—Math/Science

Mathematics and science receive little instructional time in U.S. pre-k classrooms (Early et al., 2010; La Paro et al., 2009) and are areas in which teachers receive less training and PD support (Parks & Wager, 2015). However, early mathematics and science skills are foundational not only for students' future mathematics and science learning but also their learning in other domains (Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010). We designed the *MTP-M/S* curricula and professional support system to improve children's early mathematics and science skills by increasing the quality of interactions and instruction that support children's learning in these areas (Kinzie et al., 2014; Whittaker, Kinzie, Williford, & DeCoster, 2016).

The *MTP-M/S* curricula include 132 activities implemented across a school year (Kinzie et al., 2015). We designed the activities to foster student inquiry and provide contextualized learning of mathematics and science concepts, drawing connections between the students' world and targeted concepts. The curricula include "within activity" supports such as learning and development theory-based best practice teaching tips for each activity and adaptations for differentiated learning. (See Kinzie et al, 2015. for a complete description of the curricula development process and alignment with preschool mathematics and science research-based best practice.) Within-activity supports are accompanied by a blended formal, in-person and independent, asynchronous PD support system featuring video demonstrations.

1.5.1. MTP-M/S teacher support system

The *MTP-M/S* teacher support system consists of five in-person PD workshops across the school year and access to a dedicated website. We designed the workshops to increase teachers' content knowledge about children's mathematics and science learning and help teachers to plan for and reflect on activity implementation. The support system aligns with research-based best practice PD recommendations (Desimone & Garet, 2015) suggesting support should be sustained throughout the year (workshop spread and ongoing Internet resource access), focused on content (children's mathematics and science learning), and include active learning opportunities (teacher reflection). Further, the focus on mathematics and science is coherent with a national U.S. effort to improve students' mathematics and science skills (National Science and Technology Council Committee on STEM Education, 2013).

The *MTP-M/S* website includes: (1) video demonstrations of all curricular activities, (2) digital versions of activity plans, and (3) year-long activity trajectory displays by subject, identifying the domain of each mathematics and science activity and illustrating the flow of activities by domain across the year. When a teacher navigated to an activity, he or she first landed on the associated demonstration video page, as shown in Fig. 2. A teaching tip, identical to one on the activity plan, accompanied the demonstration video. The complete instructions for facilitating the activity were available on a second tab ("Activity Details").

Demonstration videos are the only resource unique to the website, as teachers also received activity plans and trajectories in print format. Demonstration videos range in length from 1 min, 29 s to 6 min, 7 s ($M = 3$ min, 55 s) and feature high fidelity implementations of all activity components that incorporate high-quality teacher-child interactions. We intended *MTP-M/S* activities to be 10–20 min long, so the demonstration videos show or describe key moments in the activity rather than a complete, unedited implementation. As teachers and students engage in each of the key phases of the activity (*Engage, Investigate, and Discuss),* text overlay identifies the phase and specific step in the activity plan, as shown in Fig. 1 with "*Investigate: check the Eco bottles."* We used video from the pilot implementation of *MTP-M/S* to create the demonstration videos, showing actual teachers implementing the curricula.

Desimone and Garet (2015) identify the use of catalogued video resources used in real-time as teachers plan their lessons as "an area ripe for further research" (2015, p. 258). In this study, we are specifically interested in the time teachers spent viewing the online demonstration videos and if this is related to their FOI. Further, we want to understand teachers' perceptions of the demonstration videos in terms of their usefulness for curricular implementation guidance.

2. Research questions

We used both quantitative and qualitative methods to investigate three research questions:

1. How often did teachers use the online curricular demonstration videos?
2. What was the relationship of the amount of time teachers spent viewing online curricular demonstration videos of *MTP-M/S* activities with their fidelity of curricular implementation?
3. Within a sample of teachers purposefully selected to represent a cross-section of high and low demonstration video use and high and low fidelity of implementation, what were their perceptions of the usefulness of the *MTP-M/S* demonstration videos for curricular implementation guidance?

We expected teachers to range in their use of the demonstration videos but did not have a specific hypothesis as to the amount of time they would spend watching videos. Based on prior work examining the relationship of the use of online teacher PD supports with growth in teachers' classroom practices (Pianta et al., 2008),

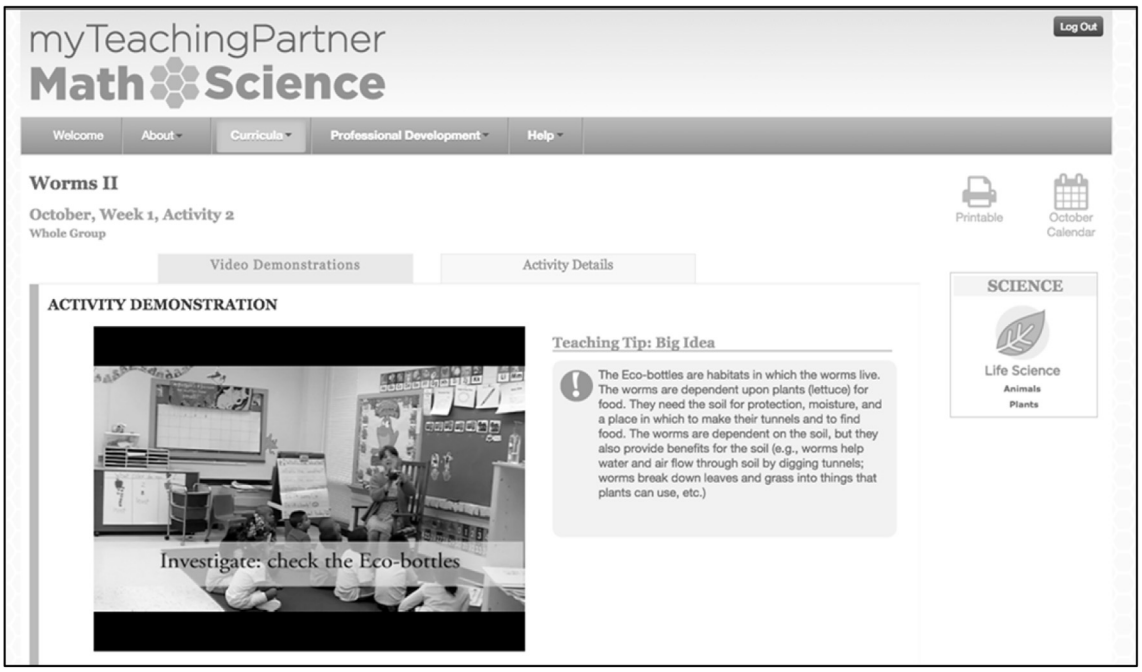

Fig. 2. *MTP-M/S* Demonstration video webpage for Worms II activity. Text overlay on the video highlights the "*Investigate*" step.

we hypothesized that time spent watching demonstration videos would be positively related to teachers' FOI. Finally, because early childhood teachers generally report positive perceptions of online curricular supports (Powell, Diamond, & Koehler, 2010; Whitaker et al., 2007), we hypothesized that the demonstration videos would be viewed as providing useful implementation guidance. However, we did not have any predictions about which specific components of the demonstration videos would be most useful.

3. Methodology and methods

3.1. MyTeachingPartner—Math/Science

The current study uses data from the first implementation year of the two-year randomized, controlled efficacy trial of *MTP-M/S* conducted using two cohorts at two sites. Site 1 classrooms ($n = 130$), participating between 2013 and 2015, were from a variety of public, private, and Head Start early childhood centers in a Midwestern metropolitan area. Site 2 classrooms ($n = 40$), participating between 2014 and 2016, were public pre-k classrooms in a southeastern mid-sized city school district. We recruited teachers by mailing flyers to preschool program directors and holding meetings with teachers, who needed computers to be eligible, to inform them about the study and ask for their consent to participate. For consenting teachers, we used block randomization, equally distributing classrooms across program types and locations, to assign teachers to the *MTP-M/S* treatment condition ($n = 87$) or Business-*as*-Usual condition ($n = 79$).

3.2. Present study sample

Focusing on support for teachers' curriculum implementation, we only included the 87 teachers assigned to the *MTP-M/S* treatment condition in this study's sample, as those teachers had access to both the *MTP-M/S* curricula and associated curricular supports. We further limited our sample to teachers who had (1) interacted with at least one of the online demonstration videos, and (2) had FOI data (see further information below in methods section). This led to a final sample of 34 teachers (Site 1: $n = 24$, Site 2: $n = 10$) (See Table 1).

We tested for demographic differences between included and excluded treatment teachers using independent samples *t*-tests (years of pre-k experience, age, years of education, technology habits) and a chi-square test of independence (ethnicity). There were no significant differences across demographic variables with the exception of teacher age. Excluded teachers were significantly younger than included teachers (t [76] $= 2.11$, $p = 0.04$).

At the end of their first study year, we used critical case purposeful sampling, sampling a small number of high-impact informant cases (Patton, 1990), to select four Site 2 teachers for follow-up interviews based on preliminary quantitative data analysis. Site 1 teachers could not be interviewed due to the time elapsed since their study participation. To purposefully select interviewed teachers, we used a scatterplot to display the correlation between the number of minutes teachers spent viewing demonstration videos and teachers' FOI. We selected four teachers based on their locations within the four quadrants of the scatterplot: Teacher A, high video viewing and high FOI; Teacher B, high video viewing and low FOI; Teacher C, low video viewing and high FOI; and Teacher D, low video viewing and low FOI (See below for measures and analysis). We placed the quadrant axes at 0.00 for standardized demonstration video viewing minutes and fidelity score such that

Table 1
Descriptive demographic statistics for included sample (N = 34).

Variables	*M*	*SD*	Range[a]
Age	41.00	11.26	22.00–61.00
Years of Experience in Pre-k	8.75	8.47	0.00–30.00
Years of Education	15.09	1.83	12.00–18.00
Ethnicity[b]	Freq.	%	
Black	5	14.7	
White	24	70.6	
Other	4	11.8	

[a] Range reflects range of reported values.
[b] 1 participant in the sample did not report ethnicity.

high video viewing and FOI are standardized scores above 0.00. Table 2 displays the selected teachers demographic baseline characteristics and outcome measures as compared to the means for the teachers in their respective quadrants. Teachers received fifty dollars for completing the interview.

3.3. Data collection procedures

Data for this study come from fall and spring teacher surveys, activity FOI codes based on videotapes, an automated weblog server, and semi-structured interviews. We mailed all teachers a paper copy of the fall survey, and they returned completed surveys in a pre-stamped envelope. We asked teachers to film their implementation of all *MTP-M/S* activities and submit these monthly by mail. To obtain an adequate sample of teachers' activity implementation practices across the year (September, October, November, February, March, April), across domains (mathematics vs. science), and across activity settings (whole vs. small group), we randomly selected two tapes for each teacher per month for coding. We coded an average of 8.24 tapes per teacher ($SD = 3.81$, *Mode* = 12), with a range of 2–12 tapes (the maximum possible). Teachers with less than 12 tapes either failed to submit some tapes or submitted tapes that were not codable. In order to have FOI outcome data, teachers needed to submit at least one codable video of their teaching practice. A codable video was at least 8 min, did not clearly cut off the activity, was loud enough to hear teacher and student utterances, and never had the teacher off camera for more than 60 s. Coding by trained research assistants, calibrating weekly with double-coded master videos to prevent coder drift, focused on documentation of implementation fidelity. We double coded 40% of the tapes, showing moderately strong inter-rater reliability ($\kappa = 0.78$; McHugh, 2012). We automatically collected teachers' viewing of demonstration videos in a weblog server. The first author conducted and recorded semi-structured interviews at the teachers' schools, asking about their use and perceptions of the demonstration videos. Two authors (E.A.B. and E.F.) coded all interviews.

3.4. Measures

3.4.1. Teacher and classroom characteristics

The fall teacher survey collected demographic information including teachers' age, ethnicity, years of experience teaching pre-k, and years of education. Teachers also completed a technology habits scale consisting of three items asking teachers how frequently (from 1 "*never*" to 5 "*almost daily*") they "*used technology to teach in their classroom*," "*provided students opportunities to learn with technology*," and "*used the Internet to assist in their lesson planning*." We averaged the three items' scores for a possible score between 1.0 and 5.0. Teachers had a moderately high mean score of 3.83 ($SD = 1.02$, Range = 1.67–5.00). Parents completed a survey collecting information on annual household income, aggregated to a classroom mean. For included teachers' classrooms, the average mean classroom annual income was $51,149.33 ($SD = $25,356.13).

3.4.2. Fidelity of implementation

The *MTP-M/S Fidelity Measure* primarily assesses teachers' adherence to the *MTP-M/S* curricular design (Kinzie, Whittaker, Kilday, & Williford, 2012). Ten items measure teachers' adherence to the lesson plan, such as "*All main components in the activity are completed*" (Numbered items in the activity plan, See Fig. 1). The ten adherence items evaluated adherence to group size (whole vs. small), materials use, warm-up chant use, the engage prompt, the main (numbered items) and supporting components (bulleted items), teacher and student use of mathematic and scientific language, use of discuss questions, children's engagement in tasks. Four items assess teachers' quality of activity implementation, such as *"Teacher extends/elaborates on students' comments or questions."* The four quality items evaluated the accuracy of teacher mathematic or scientific explanations, the extent to which teacher's elicited children's observations and explanations, the extent to which children shared those observations and explanations, and the extent to which teachers extended on student comments and questions. Coders watched each video twice, primarily focusing first on adherence items and second on quality items. In this study, we found the measure to have acceptable internal consistency ($\alpha = 0.70$; Nunnally & Bernstein, 1994). The measure included four dichotomous items and ten 4-point Likert scale items. For all analyses, we standardized scores at the item level and averaged, equally weighting each item regardless of item level scaling ($M = 0.22$, $SD = 4.58$, Range = −10.01–7.17).

3.4.3. Online demonstration video use

We tracked teachers' use of web-based resources through a server that automatically recorded specific information about the

Table 2
Demographics and scores for site 2 selected teachers and interview selection quadrant means.

Selected Teacher Demo Viewing and FOI Quadrant	Age *M* (SD)	Years of Pre-K Exp. *M* (SD)	Tech Habits *M* (SD)	Demo Viewing Minutes *M* (SD)	FOI Score[a] *M* (SD)	Spring Survey Demo Video Perceptions[b]		
						Add to Practice	Worth Time	Easy to Use
Teacher A High Demo Viewing & High FOI ($n = 8$)	54 45.5 (10.6)	8 7.1 (9.7)	4.0 4.4 (0.5)	254.30 186.4 (127.0)	7.2 4.6 (1.7)	5 4.7 (0.5)	5 4.7 (0.5)	5 4.9 (0.5)
Teacher B High Demo Viewing & Low FOI ($n = 3$)	53 50.7 (7.8)	15 13.3 (10.1)	5.0 4.4 (0.5)	110.38 83.18 (25.6)	2.7 −5.7 (3.8)	5 4.0 (1.4)	5 4.0 (1.4)	5 4.0 (1.4)
Teacher C Low Demo Viewing & High FOI ($n = 11$)	35 35.9 (6.4)	13 8.6 (7.2)	4.3 3.5 (1.0)	0.75 7.20 (15.1)	3.7 3.0 (1.8)	3 3.7 (0.8)	3 3.6 (1.1)	3 4.1 (0.7)
Teacher D Low Demo Viewing & Low FOI ($n = 12$)	29 39.8 (17.7)	1 8.1 (9.7)	5.0 3.6 (1.2)	0.73 10.21 (9.5)	−4.4 −3.7 (2.8)	-[c] 3.8 (1.6)	– 3.5 (1.5)	– 4.4 (0.9)

[a] Fidelity scores are standardized.
[b] Not all teachers completed the spring survey such that each quadrant has a different *n* for these means: High Demo Viewing & High FOI $n = 7$; High Demo Viewing & Low FOI $n = 2$; Low Demo Viewing & High FOI $n = 10$; Low Demo Viewing & Low FOI $n = 8$.
[c] The selected teacher for Low Demo Viewing & Low FOI did not complete the spring survey.

length of time that teachers spent watching demonstration videos. Server data included the video actions of play, pause, seek (forward and backward), end video, leave page, and close window, all with associated time stamps. These allowed us to calculate the number of minutes each teacher spent watching demonstration videos across the year, removing any time the video was paused and accounting for seek actions (removing when seeking forward and adding when seeking backward and rewatching). If a teacher watched a video more than once, all minutes spent viewing were included in his or her total time, as we felt the teacher was meeting his or her self-perceived need by watching the video again.

3.4.4. Perceptions of the demonstration video usefulness

We used a semi-structured interview protocol to ascertain teachers' perceptions of the demonstration videos' usefulness. The protocol began with a broad question about teachers' planning practices, *"Can you tell me about how you prepared to teach MTP-M/S activities*?" Then, we explained our interest in learning more about their use of online curricular supports, specifically the demonstration videos. Questions targeted teachers' patterns of use for videos (e.g., *If you watched demonstration videos, when did you typically watch them? Why did you decide to watch a demonstration video?*) and their perceived value of videos (e.g., *Can you tell me about what you expected to learn from the demonstration videos? Were demonstration videos useful to your practice? If so, how or which part?*). We also used three quantitative items from the spring survey to triangulate teachers' general perceptions of the demonstration videos: "*The MTP-M/S Demonstration Videos (1) added value to my practice, (2) were worth the time I spent on them, and (3) were easy to use."* Possible responses ranged from 1, "*Strongly disagree,*" to 5, "*Strongly agree."*

3.5. Analyses

To address research question one, we examined teachers' use of the online demonstration videos in terms of minutes spent viewing demonstration videos. To address research question two, we investigated the relationship of teachers' use of the demonstration videos with their FOI using multiple regression with teacher as the unit of analysis. Covariates in the model included site, classroom mean family income, and teacher characteristics (years of experience teaching, years of education, age, ethnicity, and technology habits).

Two teachers did not have data for at least one covariate, so we used full information maximum likelihood estimation in *Mplus version 7.0* to account for missing data. We included teachers' age and technology habits in the model based on previous findings from *MTP-M/S* data that both teachers' age and technology habits (e.g., frequency of using the Internet in planning) were associated with their use of website supports (Furnari, Whittaker, Kinzie, & Barton, Unpublished manuscript). We also included teachers' years of experience based on Downer, Locasale-Crouch et al.'s (2009) findings that teachers with more years of experience spent less time and older teachers spent more time using website resources.

To address research question three, we used elements of grounded theory (Charmaz & Belgrave, 2012; Strauss & Corbin, 1998) to analyze the interviews, moving from open coding to axial coding (Strauss, 1987). While we drew from grounded theory analytic techniques, we do not present a full formed theory and believe further data collection is necessary to do so. The first author read through all interview transcripts to identify any emergent themes. Initial open coding did not restrict themes to those related to demonstration videos in order to allow all patterns to surface, inclusive of those that may at first seem irrelevant. We reorganized the initial set of themes into categories related to video demonstration use and perceived usefulness, removing several subcategories we determined to be unrelated to the use of demonstration videos (e.g., descriptions of other classroom curricula). The first author then reread the interviews, applying the refined categories and subcategories through axial coding. Another author on the paper applied the same axial categories and subcategories to establish reliability of code application and identify any additional themes missed in the first coding cycles. Finally, we met to discuss any discrepant code applications and came to full consensus (Forman & Damschroder, 2008) on both the categorical codes and the application of those codes.

4. Results

4.1. Teachers' use of demonstration videos

Descriptive analysis of the online server data revealed that teachers watched demonstration videos during their first year of implementation for approximately 1 h across the school year (M = 57.14 min, SD = 96.46 min), with a range of 0.0 min–445.88 min. The distribution of demonstration video viewing minutes was positively skewed, such that the majority of teachers fell between 0.0 min and 153.6 min (2.6 h), one standard deviation above the mean. The teacher with 0.0 viewing minutes interacted with the demonstration video player (e.g., used seek to move through a video) but never actually played a video. The teacher with 445.88 viewing minutes watched almost 7.5 h of videos across the school year, 4.03 standard deviations above the mean. Fig. 3 illustrates teachers' viewing minutes by month across the school year.

4.2. Relationship between fidelity of implementation and demonstration video viewing

A multiple regression analysis identified a significant positive relationship between the minutes a teacher spent viewing demonstration videos and his or her mean fidelity score, after controlling for all covariates (See Table 3). For every one standard deviation increase in demonstration video viewing minutes (96.46 min), teachers FOI scores increased by 0.64 standard deviations (2.93 points). This is approximately one and a half hours of additional professional learning time for more than a half standard deviation increase in implementation adherence. With an approximate average of 4 min per video, this is analogous to watching approximately 24 demonstration videos out of the library of 132 videos. The R^2 for the overall model was 0.43, indicating that the entire collection of predictors was able to explain 43% of the variance in the mean fidelity scores.

Two of the covariates were also significant predictors of teacher's average fidelity: teachers' age and their technology habits, controlling for the other covariates and demonstration video viewing minutes. For every one standard deviation increase in teachers' age (11.26 years), their average FOI decreased by 0.52 standard deviations (2.38 points). For every one standard deviation increase in teachers' technology habits score (1.02), their average FOI decreased by 0.33 standard deviations (1.51 points).

4.3. Perceptions of demonstration videos for activity implementation

We identified three categorical themes in teachers' responses to interview questions about their use of demonstration videos to support activity implementation: (1) video use drivers, (2) video use deterrents, and (3) video usefulness characteristics. The first

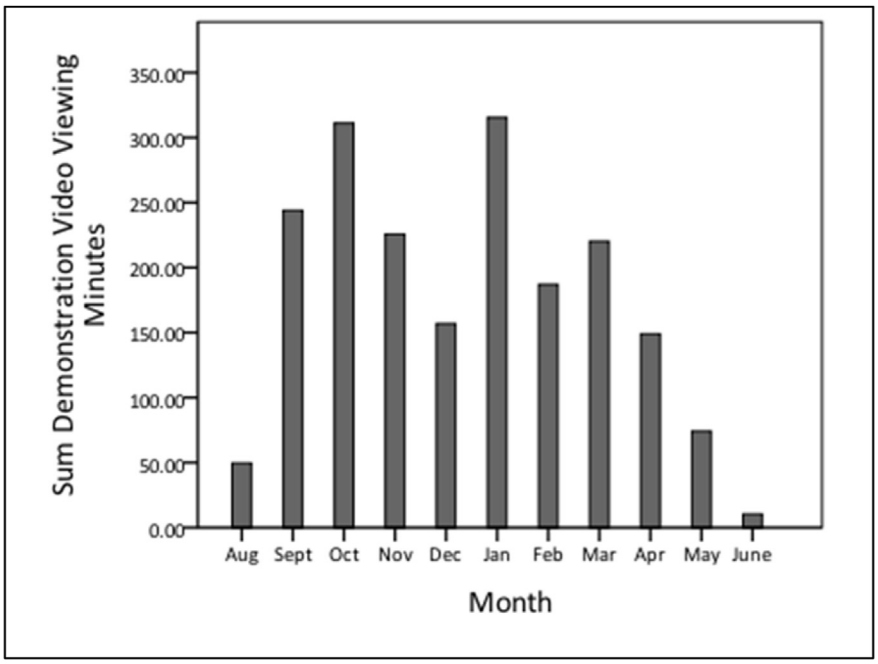

Fig. 3. Teachers' demonstration video viewing across the school year. The bar graph illustrates the sum of demonstration video viewing minutes for all teachers by month. Both August and June are included because Site 1 schools begin in August and Site 2 schools finish in June.

two categories, video use drivers and video use deterrents, capture why teachers voluntarily accessed and viewed demonstration videos. The third category, video usefulness characteristics, captures teachers' perceptions of how the videos they chose to watch supported their implementation.

4.3.1. Video use drivers and deterrents

Teachers seemed to be driven to select and use demonstrations videos for two reasons: *targeted video selection* and *routine preparation* (Table 4). Three of the four teachers, all except Teacher D (low video viewing, low FOI), described *targeted video selection*, choosing to watch a specific video based on previewing the written activity plan. Sometimes, this was motivated because teachers found a direction confusing and sought clarity for the printed activity plan (See Fig. 1). For example, Teacher C (low video viewing, high FOI) describes, "… There was a couple that I had to go back and reread … if I wasn't clear, then I would go to a video for support." Her description suggests that in order to teach particular lessons with high fidelity she needed the additional video support, but that was not the case for all activities, likely reducing her total video viewing time. *Targeted video selection* was also driven by teacher lack of familiarity with activity content. Teacher B (high video viewing, low FOI) describes how she chose to watch a video of a lesson on counting with a ten-frame, "I hadn't taught counting before. So, that was all new, and I just didn't understand that." She further explained that by watching the video, she learned an instructional strategy for a content objective, counting, she had not yet taught and continued to use that strategy throughout the curriculum.

The second motivation for video selection was *routine preparation*, systematic viewing of the demonstration videos as part of the planning process. Only one teacher, Teacher A (high video viewing, high FOI), described this viewing pattern, believing she watched almost every video for the lessons she taught in her first year of teaching the *MTP-M/S* curriculum. Teacher A also described repeated viewings and sharing the videos with her teaching assistant. Combined, all of the demonstration videos total approximately 515 min (about 8.5 h), and Teacher A watched approximately 7.5 h of video across the school year.

Interviewed teachers described two primary video use deterrents: a *lack of time* and *difficulty relating to depicted classrooms* (Table 4). Only Teacher D (low video viewing, low FOI) described a *lack of time* as the reason she did not choose to watch videos, despite seeing potential value in the videos. "I'd like more time in my day, because I think they probably would help me at least understand … I think watching the video I would probably become more comfortable with the lesson itself." Teacher C and Teacher D, both teachers with low video viewing, described the second deterrent, *difficulty relating to depicted classrooms*. Teacher D (low video viewing, low FOI) primarily described the number of students as unrealistic. "It's hard because I have 18 kids where it looks like half of them only have like 12 kids in their class, and that makes a huge difference," and Teacher C (low video viewing, high FOI) described the demographics of students in the videos as unlike her

Table 3
Standardized multiple regression predicting teachers' mean fidelity score.

	β	SE β	p
Demonstration Viewing Minutes	**0.64**	**0.15**	**<0.001**
Covariates			
Site	−0.09	0.28	0.749
Teacher Years of Experience	0.23	0.17	0.169
Teacher Years of Education	0.19	0.19	0.301
Teacher Age	**−0.52**	**0.18**	**0.004**
Teacher Ethnicity[a]			
Black	−0.22	0.17	0.199
Other	−0.18	0.14	0.189
Teacher Technology Habits	**−0.33**	**0.13**	**0.013**
Mean Classroom Annual Income	−0.41	0.24	0.083
R^2 (SE R^2)	0.43 (0.13)		0.001

Note. Bold text indicates statistical significance of the coefficient.
[a] Coefficients are categories of Black and Other tested against White as the reference category.

Table 4
Interviewed teachers' perceptions of demonstration video drivers and deterrents.

Video Drivers	Teachers Mentioning	Examples
1. Targeted Video Selection	HV, HF HV, LF LV, HF	*"If I felt that there was a lesson that I needed more support on, then I would watch the videos."* – LV, HF
2. Routine Preparation	HV, HF	*"Usually twice, sometimes three times, especially if I need my assistant to see what I saw, because my assistant might not be in the planning stage of the lesson."* – HV, HF
Video Deterrents	**Teachers Mentioning**	**Examples**
1. Lack of Time	LV, LF	*"I'd like more time in my day, because I think they probably would help me at least understand … I think watching the video I would probably become more comfortable with the lesson itself."* – LV, LF
2. Difficulty Relating to Depicted Classrooms	LV, HF LV, LF	*"… the population of children is a little different. So, it's kind hard to determine … how much they'll understand and how they'll react to a lesson."* – LV, HF

own, "… our population [of students] is similar among teachers throughout Briarwood.[1] So, I think it would be better to watch … maybe videos of our colleagues teaching the lesson." However, Teacher B (high video viewing, low FOI) noted the difference in the student behavior featured on the videos but did not seem to be deterred by this, suggesting some teachers may still relate to videos despite situational differences.

4.3.2. Video usefulness

We identified eight themes as characteristics of video usefulness from interviews with Teacher A, Teacher B, and Teacher C (See Table 5). Teacher D (low video viewing, low FOI) only spoke hypothetically about what she thought might be useful, as she could not remember independently watching demonstration videos. The emphasis on positive video aspects aligns with the generally positive perception expressed by teachers on the spring survey items (Table 3). Teachers A and B with high video viewing rated the videos as 5 for their impact on teaching practice, being worth the time to watch them, and ease of use. Teacher C, low video viewing and high FOI, rated the videos as 3 for all items, logically less than the high video users. Teacher D, low video viewing and low FOI, did not complete the survey.

The three most frequently mentioned usefulness themes were *enactment of written activity plans, adaptation of the activity,* and *expected student behavior. Enactment of written activity plans* encompasses references to the visual or aural representation of the activity as being beneficial to supplement the written description. Teacher A and Teacher B, both with high video viewing, explicitly described themselves as being visual learners,[2] seeking an image to accompany the text prompts and directions. *Adaptation of the activity* refers to instances when a teacher watched a video and made a purposeful choice to change the activity based on what she saw. This included changing the group size format (small vs. whole), modifying the materials or arrangement of materials, rearranging the order of activities, and adjusting the content based on student abilities. Interviewed teachers described making preemptive changes to the activity based on their physical classroom layout, specific students, or group behavior dynamics (e.g., difficulty sitting for discussion). *Expected student behavior* refers to instances when teachers were unsure of how their students would react to an aspect of a lesson, such as live worms in a science activity, or specific questions. Interviewed teachers described anticipating their own students' possible reactions based on those of the students in the video.

The next two most frequently mentioned usefulness themes were *organization and use of materials* and *benchmark expectation of implementation.* Interviewed teachers described how they were unsure as to how the materials should be prepared or arranged for the lesson. By watching the video, they were able to see one or more examples (many videos feature multiple teachers) that were high fidelity materials arrangements. Teacher B (high video viewing, low FOI) described how she did not know how a 10-frame was used for counting, "so then when I watched her, then of course it made sense the rest of the year." Teacher A and Teacher B, both high video viewers, sought information about what was expected of them by the researchers in implementing the lesson. They saw the demonstration videos as a benchmark of what researchers were looking for in lesson implementation.

The final three usefulness themes, *highlighting challenging features, questioning model, and timing and pacing of the activities,* were each only mentioned by one teacher. Teacher A (high video viewing, high FOI) appreciated when the videos included a voice-over highlighting an important procedural or conceptual feature of the lesson, such as the necessity of counting one object at a time. Teacher C (low video viewing, high FOI) repeatedly discussed her discomfort with the questioning aspect of the activities and sought information about the question-driven discussion with students and their reactions. *Timing and pacing of the activities* is an example of how videos could be adjusted in the future to be more useful. Teacher A (high video viewing, high FOI) repeatedly mentioned a desire to get a sense of timing and pacing from the videos, an expectation she had for the videos that was not met due to their brevity.

5. Discussion

Fidelity of implementation is critical for establishing and maintaining efficacy of a curriculum (Durlak & DuPre, 2008), but there is little research on specific strategies to support FOI. Seeking to fill this gap, we examined the relationship between the time teachers spent viewing demonstration videos and their FOI. Confirming our hypothesis that time spent watching demonstration videos would be positively related to teachers' FOI, we found a strong positive relationship between the two. Although this is not a causal relationship, the possibility that viewing demonstration videos, independently accessible and low-cost sustainable resources, could increase teacher FOI is promising given the need to sustainably move curricula to scale and maintain high-fidelity implementation over time (Clements et al., 2015; Coburn, 2003).

[1] District name changed to maintain anonymity.

[2] Although recent literature (Rohrer & Pashler, 2012) has not found sufficient evidence to support the notion that individuals learn best through one channel, this is the *perception* of the teachers.

Table 5
Interviewed teachers' perceptions of demonstration video usefulness characteristics.

Video usefulness themes	Teachers Mentioning	Examples
1. Enactment of Written Activity	HV, HF HV, LF LV, HF	*"Seeing it, being a visual learner, I think. Seeing it and when you're teaching it, thinking, 'Oh yea, she did this.'"* – HV, LF
2. Adaptation of Activity	HV, HF HV, LF LV, HF	*"… how long I think it's going to take me to do that lesson and I try to look at a way to incorporate some of those questions at the end throughout the lesson."* – HV, LF
3. Expected Student Behavior	HV, HF HV, LF LV, HF	*"… to maybe get a better understanding of how to teach the lesson and how to ask questions and to see actually how the kids react to it."* – LV, HF
4. Organization and Use of Materials	HV, HF HV, LF	*"I did the one where it's the number matching, and I'm like, 'How did they line the numbers up? Was it important to have the numbers go from 0 to 6 or is it okay to put 0 to 4 and then drop it down?' That sort of thing."* – HV, HF
5. Benchmark Expectation of Implementation	HV, HF HV, LF	*"I think it's easier … 'cause it was so new last year, just watching somebody else do it and … seeing what's expected or what you're looking for."* – HV, LF
6. Highlighting Challenging Features	HV, HF	*"… from time to time when … somebody speaks [on a voiceover] as to what needs to be done because maybe the person didn't bring up that … part of the lesson. I think that is very valuable … it was something like, umm, 'Make sure you are counting the orange squares and indicate how important it is to start at the bottom and go up'* –HV, HF
7. Questioning Model	LV, HF	*"how to ask questions and to see actually how the kids react to it … maybe if there's something that needed to be changed up a little bit."* – LV, HF
8. Timing and Pacing of the Activities	HV, HF[a]	*"… we were just, I was looking for all kind of answers to the timing of the lessons."*

[a] Teacher described as what she would have liked to get from demonstration videos but did not actually get.

In order to maximize on the potential that demonstration video viewing affords in supporting FOI, teachers need to view the videos. Teachers interviewed in this study described two patterns of demonstration video use: as a systematic component of their planning or as a targeted supplementary support, used when necessary. We predicted teachers would range significantly in the time they spent watching demonstration videos. Again, confirming our hypothesis, data from this study suggest teachers vary significantly in their degree of use; their average viewing time was about 1 h but ranged substantially from zero to approximately 7.5 h. This usage pattern is similar to the inconsistent use of web resources found in earlier studies of curricular support websites (Downer, Kraft-Sayre et al., 2009; Hemmeter et al., 2011; Powell, Diamond, & Koehler, 2010), despite generally positive perceptions of website resources (Powell, Diamond, & Koehler, 2010; Whitaker et al., 2007). The significant range in teachers' use of demonstration videos impacts the potential for widespread effect, a concern when planning future support systems.

The periodic use of demonstration videos throughout the year meets one of the key characteristics of high-quality PD, duration over time (Desimone & Garet, 2015), by spreading out the hypothetically equivalent workshop hours over the course of a year. However, not all teachers watched video each month. One strategy for increasing the consistent use of resources such as demonstration videos would be to track and recognize the additional professional learning time teachers invest, as is done with digital badging systems (Diamond & Gonzalez, 2014). It seems teachers may need more support and guidance in using the online resources effectively, and a blended approach that combines fewer formal, leader-driven professional learning, with independent, teacher-driven, professional learning is likely appropriate. This aligns with research recommending a facilitator to scaffold teachers' video use (Arya, Christ, & Chiu, 2014). However, findings that teachers do not necessarily use videos chosen specifically for them (Hemmeter et al., 2011; Powell et al., 2010) suggest it may be more valuable to train teachers by modeling the use and benefits of independently accessible resources. This is also a less time and financial resource-intensive strategy than individually selected videos for each teacher.

Teachers in this study identified drivers and deterrents to demonstration video use, as well as eight characteristics of usefulness for implementation guidance. While we believed teachers would generally perceive the demonstration videos positively, we did not hold any a priori hypotheses as to the elements of the videos they would identify as more or less useful. To increase teacher use of demonstration videos, future curricula developers might design videos based on identified usefulness characteristics, highlight these features during training, and support teachers' time allocation to include video viewing into planning. User-centered design of curricular support systems allows for feedback loops between teachers and developers in order to produce resources better aligned to user needs (Kinzie et al., 2006), suggesting the value of teacher-identified usefulness characteristics for the creation of future demonstration video exemplars. For example, Teacher C identified models of questioning with students as a feature of the videos, but she was actually a low video user. Extended questioning sequences were not featured in the demonstration videos to keep them short, but providing additional videos to explicitly model high fidelity questioning sequences might increase use. The second interviewed teacher with low video viewing, Teacher D, primarily identified time as her barrier to use. The video clips were designed to be brief, ranging in length from 1:29 to 6:07 with a mean length of 3:55, but teachers may need more support in how to structure their planning to incorporate these videos. They might be better able to see the value of demonstration videos before beginning a new curriculum if the elements of usefulness and planning strategies are incorporated into initial training. Of note, however, is the restriction of our interview sample to those teachers that had interacted with the video player. It is possible that complete nonusers would identify additional drivers, deterrents, or usefulness characteristics, an area for future investigation.

While demonstration video viewing had a positive relationship with teachers' FOI, two of the included covariates had a negative relationship with FOI: teachers' age and technology habits, a measure of technology use frequency. This suggests that older teachers could use more targeted FOI support. Older

teachers recognize the value of professional development for the school as a whole more than for themselves specifically (Hustler, Mcnamara, Jarvis, Londra, & Campbell, 2003), so highlighting personal usefulness of support resources, as described above, might prove helpful for these teachers. Internet-based resources, including but not limited to demonstration videos, may be an avenue by which to reach older teachers, as they engage more frequently with curricular websites than their younger counterparts (Downer, Locasale-Crouch et al's., 2009). Similarly, Internet-based resources might be an appropriate delivery medium by which to provide FOI support to teachers who already frequently engage with technology. It is possible that they use the Internet to find additional Internet-based resources that may be contradictory to the curriculum, reducing FOI, so replacing those resources with developer-provided online resources, well-supported in training, could improve FOI. Use of a technology-based digital badging system, as described above, might be a motivator for teachers already familiar with and using technology. Negative relationships between characteristics of teachers and FOI lend further support to the continued investigation of demonstration videos as FOI supports, in addition to the investigation of other Internet-based support resources.

5.1. Limitations and future directions

The current study speaks only to the relationship of demonstration video viewing and FOI during the first year of curriculum implementation. However, it is possible that the relationship changes as teachers become more familiar with the curriculum in subsequent implementation years or when the ownership of the curriculum shifts primarily to the school district leaders for sustainable scale-up. Given the ease of access and low cost of demonstration videos once they are created, it is feasible for teachers to continue to use them. Further investigation of the effect of demonstration video viewing should examine this relationship over time, exploring the possibility of a nonlinear relationship. Additionally, demonstration videos may serve as a "catch-up" strategy for new teachers who were not present at initial trainings, rather than simply handing them a written curriculum.

A limitation of this study is the small sample size of interviewed teachers. Therefore, we did not seek to make generalizable statements, purposefully selecting critical cases based on theoretical representation of the quantitative data (Marshall, 1996; Patton, 1990). Increasing the number of interviewed teachers to confirm and expand usefulness characteristics of the videos would increase the transferability of findings to a more generalizable sample of teachers. Due to the negative relationship between teachers' age and FOI, a purposeful sample of older teachers to identify potentially different characteristics of usefulness would also help inform targeted support for this subset of teachers for whom FOI is particularly low. Continuing to use sequential explanatory mixed methods in future work examining online FOI supports would build a rich body of literature to inform purposeful curriculum design decisions.

The majority of teachers interviewed spoke of the videos as informing their adaptation of the lesson. However, the *MTP-M/S Fidelity Measure* is limited in that it does not specifically assess whether and how lessons were adapted. Adaption of curricula to meet contextual needs is particularly important given the desire to scale-up curricula within the context of classrooms and students with diverse learning needs (Durlak & DuPre, 2008; Lendrum & Humphrey, 2012). Measuring adaptation as part of FOI can help to identify the types of adaptations that teachers are making, and where adaptation is and is not beneficial for students' learning (Blakely et al., 1987; Dusenbury et al., 2003).

6. Conclusions

The positive association between teachers' online curricular demonstration video viewing and their FOI suggests demonstration videos are a viable fidelity support resource worthy of further investigation. Although evidence-based curricular programs are linked to improved student outcomes (Pianta et al., 2009), these curricula need to be implemented with fidelity. Identifying types of effective curricular resources for teachers is one step toward increasing FOI. However, it is not only critical to create those resources but also to encourage and support teachers' use of independently-driven PD activities.

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