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Representations of Practice Used in Mathematics Methods Courses

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This preliminary study explored how many representations of standard videos, animations/comics, and 360 videos are being used in mathematics methods courses to teach future teachers. Drawing on knowledge from prior studies on standard videos, this study aimed to address the gaps in literature to encompass other representations that are being utilized and obtained. Analyses show that standard videos are the primary medium being used to teach future teachers in math methods, followed by animations/comics, and then 360 videos. Findings suggest that teacher educators are more likely to use a medium that they are more familiar with than a medium with greater perceived usefulness. Further, findings indicate that teacher educators perceived usefulness and frequency of use as not related to their level of familiarity with all representation types, suggesting more factors are at play.

Videos are considered an important tool for teacher education methods courses for facilitating professional learning (Grossman et al., 2009) and increasing contextual "pedagogical understandings" (Christ et al., 2017, p. 32). Across content areas, scholars have found that teacher educators use standard videos about three to six times per semester per methods course (Arya et al., 2016; Christ et al., 2017). Standard video comes in multiple formats, including from cameras worn by teachers in the classroom (Sherin et al., 2008), cameras that move and track the teacher or specific students (McCoy et al., 2018), and cameras placed at different points in the classroom (van Es et al., 2015).

Use of standard video in these and similar contexts has been found to be useful (Gaudin & Chaliès, 2015; Grossman et al., 2009). However, standard videos are not the only visual medium used to represent pedagogical practice.

In addition to standard videos, teacher educators have incorporated comic-based representations and animations (Herbst et al., 2011; Moreno & Ortegano-Layne, 2008) and, more recently, 360 videos. 360 video is a form of virtual reality (VR) in which special cameras record omnidirectionally. This capability allows teachers watching the video to look in any direction, and 360 video has been found to have specific advantages to capturing a more immersive representation of classroom environments than standard video (Roche & Gal-Petitfaux, 2017; Zolfaghari et al., 2020).

Since prior surveys of teacher educators have focused exclusively on standard videos, a gap in knowledge exists regarding the prevalence of representations of practice. Further, the sample of these prior surveys are limited for specific content foci; particularly regarding mathematics education (less than 1% of total sample: Arya et al., 2016; Christ et al., 2017). We considered both limitations significant, given the pioneering work by many mathematics teacher educators in studying and incorporating a wide range of media to represent pedagogical practice: comic-based representations (Herbst et al., 2011), wearable cameras (Sherin et al., 2008), 360 video (Buchbinder et al., 2021; Ferdig & Kosko, 2020; Weston & Amador, 2021; Zolfaghari et al., 2020), and so forth. Given this history of novel media use within mathematics teacher education research, we sought to understand how prevalent such media were amongst mathematics teacher educators who taught future teachers.

Literature Review

Varying mediums are used and explored based on teacher education educators' preferences within their methods courses. These tools lend a hand in allowing preservice teachers (PSTs) to observe effective classroom practices (Amador et al., 2016; Berliner et al., 1988), techniques (Grossman et al., 2009), and specific topics related to course discussions (van Es & Sherin, 2002). Following Grossman et al. (2009), these tools for preparing novice teachers (i.e., PSTs) are referred to as *representations of practice,* which include, but are not limited to, incorporating videos and student work.

Representations of practice facilitate PSTs' professional education by engaging them in professional noticing to attend, interpret, and respond to pedagogical events in the classroom (Amador et al., 2016; Berliner et al., 1988; van Es & Sherin, 2002). Use of representations of practice can be extended through decompositions and approximations of practice. A *decomposition of practice* allows PSTs to break down (or decompose) elements of a representation to focus on specific components or concepts (Grossman et al., 2009). Decompositions of practice include variations of video coding (Brunvard & Fishman, 2007), discussion of particular moments (Herbst & Milewski, 2018; van Es & Sherin, 2002), and other means of examining more fine-grained details.

An *approximation of practice,* as described by Grossman et al. (2009), involves an educator providing opportunities to practice and enact their professional learning. Such enactments can be portrayed through the creation of a lesson via videos or animation/comics (Herbst & Milewski, 2018), lesson rehearsals (Grossman, 2009), and so forth.

In the study described here, we focused particularly on representations of practice, as they are often used as a starting point for both decomposition and approximation of practice (e.g., Brunvard & Fishman, 2007; Grossman et al., 2009; van Es & Sherin, 2002). We focused on three media-based mediums as representations of practice (standard videos, animations/comics, and 360 videos), as they have been found to be highly beneficial in mathematics methods course for varying reasons. These media often incorporate multiple forms of sensory information (visual, auditory), thus distinguishing them from other representations of practice (i.e., written vignettes, lesson plans, and examples of student work). In the next few paragraphs, we summarize literature on how these mediums have been used by scholars, with a particular focus on their recommendations for teacher educators.

Research on the use of standard videos in teacher education has delved into the multiple benefits and varying applications. To begin, scholars suggest that incorporating the use of a standard video with PSTs allows for self-reflection of a students' own instructional practice to improve on their teaching style (Arya & Christ, 2013; Gaudin & Chaliès, 2015; Sherin et al., 2008). Similarly, standard videos can be used so PSTs can to watch their peers or other instructors' lessons, providing insight on various strengths of a lesson or weaknesses that encourage reflection toward improving one's own pedagogy (Arya & Christ, 2013). Thus, allowing for PSTs to watch standard videos gives them the chance to connect learning theories discussed in class with classroom practices (Bliss & Reynolds, 2004; Grossman et al., 2009).

Earlier in this paper, we described 360 video as distinct from standard video in that it records omnidirectionally. As such, it allows the viewer, not the videographer, to choose which direction to focus when viewing a recorded classroom scenario (Roche & Gal-Petitfaux, 2017; Walshe & Driver, 2019). This feature of 360 video is considered by many scholars as a primary benefit for teaching PSTs.

First, by capturing an omnidirectional (as opposed to unidirectional) view of the classroom, PSTs report a higher sense of immersion in the recorded classrooms (Cross et al., 2018; Ferdig & Kosko, 2020), compared to the use of standard classroom videos (see also Feurstein, 2019). This feature allows PSTs to notice more student actions, since they have the freedom of viewing the classroom at varying angles (see also Roche & Gal-Petitfaux, 2017). Similar to standard video, 360 video has been used to create vignettes for PSTs to engage (Walshe & Driver, 2019), as well as engaging PSTs in viewing their own or their peers' classroom teaching (Balzaretti et al., 2019). However, 360 video is a relatively new medium in teacher education, with the first known published study of its use coming from Roche and Gal-Petitfaux (2017).

Use of animations and comics have emerged in teacher education over the past two decades (Earnest & Amador, 2019; Herbst et al., 2011; Moreno & Mayer, 1999; Moreno & Ortegano-Layne, 2008). With the rise of animation platforms such as GoAnimate and LessonSketch, teacher educators have been able to create classroom scenarios by scripting events that had happened in the past or were plausible to have happened. Thus, animations/comics differ from standard and 360 videos in that they need not have happened to be depicted and conveyed.

Various benefits have been associated with this feature of the medium. For example, Herbst et al. (2011) observed that PSTs who created their own comics representing instruction engage "in a self-correcting process" (p. 15) that allows them to reflect on their pedagogical decisions more in-the-moment. Animations/comics provide PSTs a chance to imagine lessons and anticipate how students might think through concepts based on their prior knowledge (see also Amador et al., 2021).

The ability to imagine lessons contributes to research of utilizing animation/comics in lesson planning, *planimation*, which allows PSTs to approximate "specifics of mathematical teaching, along with student responses" (Earnest & Amador, 2019, p. 57). Further, animations/comics provide a means for teachers to share excerpts of their practice without concern for student privacy that comes with recording on standard or 360 video (Herbst & Milewski, 2018).

Whether focusing on comic-based depictions of actual classroom practice or hypothetical scenarios that may not emerge easily in the classroom (Herbst et al., 2011), animations/comics have also been found to facilitate PSTs' professional noticing (Amador et al., 2016; Casey & Amidon, 2020). Thus, the creation and viewing of animations/comics can facilitate PSTs' reflection on their lessons or the lessons of others (Earnest & Amador, 2019; Moore-Russo & Wilsey, 2014).

Research has shown that these three mediums have been used in teacher education for similar purposes. Standard video, 360 video, and animations/comics have all been used to increase the skill of teacher noticing (Barnhart & van Es, 2015; Brunvand & Fishman, 2007; Herbst et al., 2016; Walkoe & Levin, 2018;), reflection of self and others (Blomberg et al., 2014; Chieu & Herbst, 2016; Earnest & Amador, 2019; Feurstien, 2019; Walshe & Driver, 2019), and as decomposition of approximation for discussion of particular moments vital to education (Herbst et al., 2011; Roche & Rolland, 2020).

Friesen and Kuntze (2018) investigated multiple mediums and found that PSTs "engage comparably well with representations of practice in the formats text, comic and video with regard to the perceived motivation, immersion and resonance" (p. 127). Research has focused on how these mediums are being used to teach future teachers but not discussing how often they are being utilized. The benefits of these mediums have been documented; however, documentation does not equate to prevalence of adoption of representation.

Current Research of Frequency of Use

Research on standard video, 360 video, and animations/comics demonstrates that each medium has been used to educate future teachers. However, the extent to which such researched mediums have been applied to mathematics pedagogy courses is relatively unknown. Relatively few studies surveyed the prevalence of representations of practice amongst teacher educators, generally, with remaining scholarship including only surveys of research (not general use) of particular representations of practice.

Surveys of literature on standard video usage indicate that they are generally used as vignettes (of an "unknown teacher"), to review pedagogy of oneself, or professionally evaluate the teaching of a peer (Gaudin & Chaliès, 2015; Hamel & Viau-Guay, 2019; Major & Watson, 2018). Examining the grade-level differentiation of such scholarship, Major and Watson (2018) found that 34.1% were at the secondary level (ages 11-18), while 25.6% were at the primary/elementary level (ages 5-11). In terms of content, 30.5% of such studies focused on mathematics while 11.0% focused on literacy.

Contrasting such reviews of literature are survey results of teacher educators' use of such representations of practice. Arya et al. (2013) found that literacy educators used videos in their teacher education coursework more than three times as frequently as did mathematics educators. This finding is the inverse relationship of scholarship observed by Major and Watson (2018) and pressed Arya et al. (2013) to note, "We are not sure why teacher-educators in other disciplines are using it less (like science and math), particularly given that much of the research on its effectiveness has been conducted in those disciplines" (p. 296).

Arya et al. (2013) found that, on average, PSTs use six standard videos throughout a semester within their methods courses (fewer for mathematics pedagogy courses). They also reported that teacher educators are more likely to use videos in their methods courses if they were provided "support from administrators, access to technology, and experiences using technolog[y]" (p. 287).

A later study by Christ et al. (2017) with a larger sample size reported a lower value of three standard videos over a semester. A compilation of research from Guadin and Chaliès (2015) on the use of video for professional development led to their recommendation that when viewing a video, PSTs (and in-service teachers) need their experience to be scaffolded for the video to be effective. This recommendation stresses the need for understanding how standard videos are being used in a methods classroom.

Scholarship on use of comic/animations focuses predominately on platforms such as LessonSketch and GoAnimate. Although such platforms are useful for varying reasons (Herbst et al., 2011), they require a rather large learning curve (Amador et al., 2021). Adoption of 360 videos in teacher education has a similar challenge regarding a potential learning curve for recording and editing such videos (Feurstein, 2018). However,

the technology is relatively new in teacher education. Reviewing research on 360 video in education, Snelson and Hsu (2020) identified only nine articles at the time (this number has significantly increased since, as is noticeable in our reference list).

The novelty of 360 video is not a trivial matter, and although animations/comics have emerged in teacher education since the early 2000s, those media might be considered relatively "novel" as well. Specifically, common U.S. mathematics methods textbooks, such as *Elementary and Middle School Mathematics* (Van de Walle et al., 2018) and *Guiding Children's Learning of Mathematics* (Johnson et al., 2018), include standard videos related to mathematics pedagogy with their textbooks. However, earlier versions of these texts do not include such resources (Johnson et al., 2008; Van de Walle et al., 2018). Notably, many of the videos included in such texts indicate they were recorded in the 1990s or just after 2000. Although not a systematic review of such resources, such trends suggest that availability of representations of practice may be available but less noticeable (i.e., harder to find).

We conjectured that the more access an educator has to varying mediums increases the likelihood they might incorporate such media into their courses. The needed background knowledge and "attitudes towards technology in terms of their perceptions of its relative advantage over current methods, compatibility with current practice, usefulness and ease" (Birch & Burnett, 2009, p. 122) may be a major deterrent in including varying mediums. The addition of necessary familiarity of varying platforms (Amador et al., 2021; Feurstein, 2019) may also contribute to the lack of use. Thus, we conjectured that the time commitment needed to become familiar with these mediums may hinder the prevalence of use, despite the benefits that they may have. To evaluate whether such conjectures hold merit, we conducted a pilot study to examine the following research questions:

1. How prevalent is the use of standard video, 360 video, and animations/comics among mathematics teacher educators?
2. What resources do mathematics teacher educators use to find the mediums they use in their methods courses (i.e., textbook, internet, or self-created)?
3. How are mathematics teacher educators using these mediums in their methods courses?
4. Does the level of familiarity of each medium relate to a mathematics teacher educators' perceived usefulness of that tool?

Methodology

Participants

Participants included 23 mathematics teacher educators in a single midwestern U.S. state, who responded regarding their use representations of practice in their mathematics method course or courses (standard video, 360 video, and comics/animations). Participants were recruited through e-mail by contacting the school director for each college or

university that had a teacher educator program in the midwestern U.S. state of focus.

Methods courses these teacher educators taught ranged within and across grade band, including early childhood (ages 3-9; n = 9), middle level (ages 9-14; n = 12), secondary (ages 14-18; n = 7), or multigrade band mathematics methods (n = 2). Participants included 21 faculty members and two graduate teaching assistants, with an average of 23.4 years total experience teaching at any level (preK-13; range = 6 to 47 years).

Measures

Participants were given a brief (15-minute) survey via the online platform Qualtrics. Participants provided demographic information, such as prior years of experience teaching PSTs, institution, and self-identified gender and ethnicity. Participants were then asked about their use of representations of practice in their mathematics methods courses. As noted in the literature review, we were uncertain how familiar participants would be with 360 video or animations/comics as representations of teaching practice. Therefore, a brief 1-minute video was imbedded in the survey prior to questions about representations of practice that illustrated what standard video, 360 video, and animations/comics looked like as representations of practice.

Participants were asked to state approximately how many of each medium they used, on average, per each mathematics methods course they taught between fall 2018 and spring 2020. Additionally, they were asked follow-up questions regarding how many of each medium used representations: cases that feature a whole mathematics course, cases of small group discussions, PSTs recording of their own pedagogy, or simulations of teaching. Last, participants were asked to report on a 5-point Likert scale their level of familiarity (0 = *not at all familiar* to 4 = *extremely familiar*) and their perceived usefulness (0 = *not at all useful* to 4 = *extremely useful*) of each medium (standard video, 360 video, and animations/comics). Finally, participants were asked to select where they found the representations of practice they used (provided free via the internet, provided by the course textbook, or self-created).

Analysis and Results

Analysis of the data included documenting and reporting descriptive statistics to note the prevalence each medium was reported to be used per methods course. The analysis also included the frequency of use per each grade band and type of medium. Thus, descriptive statistics were used to answer the first three research questions.

Further, Spearman Rho was used to examine the relationship between teacher educators' use of, familiarity with, and perceived usefulness regarding each medium (Research Question 4). The Spearman rank order coefficient is a "measure of association between two variables" (Siegel & Castellan, 1988, p. 235) and is appropriate for examining ordinal and continuous data, particularly with smaller sample sizes (n = 23) such as that in the current study. Thus, Spearman correlation was chosen over

Pearson since it is the more appropriate choice when dealing with ordinal data.

Reported Use

Descriptive statistics suggested that standard videos were the most common representation of practice used in mathematics methods courses in the midwestern state sampled, with the average number of eight videos (M = 8.13, SD = 8.97) used per methods course. By contrast, on average, only one video (M = 1.00, SD = 2.30) 360 and two animations/comics (M = 1.74, SD = 3.15) were reported as used per methods course.

Table 1 further illustrates the breakdown of the media source by the way they were obtained (i.e., premade or self-created) compared to the total amount of teacher educators using it. Interestingly, 60.9% of the mathematics teacher educators who use standard videos reported creating their own videos. By contrast, 42.9% reported that they created their own animation/comic, and only a quarter of participants who used 360 video created their own.

Table 1
Media Source Weighted by the Number Who Reported Using

Media Type	Standard Videos	Animation/ Comics	360 Videos	Total
Medium obtained from web or textbook)	22 (95.7%)	5 (71.4%)	3 (75%)	23 (100%)
Medium self-created	14 (60.9%)	3 (42.9%)	1 (25%)	17 (79.4%)
Total	23	7	4	23

Table 2 displays how standard videos were used to illustrate content for each indicated grade band for 19 participants (four participants did not report this data). Most standard videos used were reported as whole class scenarios, followed by cases of individuals or small groups. The prevalence of such usage appears to decrease as methods courses focused on higher grade bands. Use of PSTs' own recordings and simulations were reported as infrequent.

Table 2
Content of Standard Mathematics Videos

Age	Whole Class	Cases of Individuals or Small Groups	PSTs Recording Own Pedagogy	Simulations for PSTs
Early Childhood *n* = 13	*M* = 4.15 *SD* = 4.14 Range = 0–15	*M* = 3.31 *SD* = 2.81 Range = 0– 0	*M* = 0.38 *SD* = 0.87 Range = 0–3	*M* = 0.31 *SD* = 0.85 Range = 0–3
Middle Level *n* = 16	*M* = 3.37 *SD* = 3.65 Range = 1–15	*M* = 2.44 *SD* = 2.66 Range = 0–8	*M* = 0.69 *SD* = 1.01 Range = 0–3	*M* = 0.63 *SD* = 1.20 Range = 0–3
Secondary *n* = 9	*M* = 3.11 *SD* = 2.42 Range = 0–8	*M* = 1.44 *SD* = 2.01 Range = 0–5	*M* = 0.67 *SD* = 1.32 Range = 0–3	*M* = 0.89 *SD* = 1.54 Range = 0–4
Middle Level & Secondary *n* = 2	n/a	*M* = 1.50 *SD* = 2.12 Range = 0–3	n/a	n/a

Table 3 conveys the reported use of animations/comics in mathematics methods courses. As with standard videos, animations/comics were primarily reported as depicting whole mathematics classrooms and individual or small groups. For 360 videos, only three participants reported having used the medium, but such videos primarily included whole class scenarios. These participants varied in their grade band from early childhood (n = 1), middle childhood (n = 1), and secondary (n = 1).

Table 3
Content of Mathematics Animations/Comics

Age	Whole Class	Cases of Individuals or Small Groups	PSTs Animating Own Pedagogy	Simulations for PSTs
Early Childhood *n* = 13	*M* = 0.54 *SD* = 1.39 Range = 0–5	*M* = 0.54 *SD* = 1.33 Range = 0–4	*M* = 0.08 *SD* = 0.28 Range = 0–1	n/a
Middle Level *n* = 15	*M* = 0.79 *SD* = 0.40 Range = 0–1	*M* = 0.31 *SD* = 1.01 Range = 0–4	*M* = 0.19 *SD* = 0.79 Range = 0–3	n/a
Secondary *n* = 9	*M* = 0.67 *SD* =1.32 Range = 0–4	*M* = 0.44 *SD* = 1.01 Range = 0–3	*M* = 0.44 *SD* = 1.01 Range = 0–3	*M* = 0.33 *SD* = 1.00 Range = 0–3
Middle Level & Secondary *n* = 2	n/a	n/a	n/a	n/a

Reported Familiarity and Usefulness

Mathematics teacher educators reported high familiarity with standard videos (*M* = 3.52, *SD* = 0.59). The level of familiarity for both animations/comics (*M* = 1.65, *SD* = 1.23) and 360 video (*M* = 1.61, *SD* = 1.16) suggests that mathematics teacher educators were aware of but only slightly familiar with these mediums. Contrasting these results, participants rated the perceived usefulness of standard videos and 360 videos to be moderately useful, with an average of 3.17 (*SD* = 0.89) and 3.04 (*SD* = 0.97), respectively. Recall that scores ranged between 0 (*not at all useful*) to 4 (*extremely useful*) for each representation. The perceived usefulness of animations/comics averaged as somewhat useful (*M* = 2.52, *SD* = 0.81). Regardless of level of familiarity, mathematics teacher educators reported each of these mediums to be useful in educating future teachers.

Spearman Rho

Analysis of Spearman rho included all 23 participants. Familiarity and perceived usefulness were reported for each medium by all the participants. The relationship between mathematics teacher educators' reported familiarity of 360 video and its perceived usefulness was found to be statistically significant ($\rho = .598$, $p < .001$). The Spearman rho coefficient, however, was not statistically significant for the relationship between reported familiarity and perceived usefulness of standard videos ($\rho = .274$, $p = .274$) or animations/comics ($\rho = .269$, $p = 0.239$).

Additionally, findings show that a teacher educators' level of familiarity may influence how often (i.e., frequency) they use some mediums. Analysis from Spearman rho shows a statistically significant relationship between familiarity of standard videos and reported frequency of use ($\rho = .433$, $p = .039$) and familiarity of 360 videos and frequency of use ($\rho = .561$, $p = .005$). Surprisingly, the spearman rho coefficient was not statistically significant for familiarity of animations/comics and reported frequency of use ($\rho = .343$, $p = .109$). This lack of a relationship suggests that, despite some mathematics teacher educators' level of familiarity ($M = 1.65$, $SD = 1.23$), they still choose to not use this representation ($M = 1.74$, $SD = 3.15$).

Discussion

Results suggest that standard videos are the most common type of representation amongst mathematics teacher educators in the sampled U.S. state, followed by animations/comics and 360 videos. Our data indicate that mathematics teacher educators' level of familiarity is associated with the frequency they use 360 video and standard videos, but such relationships are not statistically significant regarding animation/comics. Further, the level of familiarity of 360 videos is strongly associated with perceived usefulness of 360 video but not the other two representations. These findings may suggest that other contributing variables influence why a teacher educator would or would not use other mediums.

Although findings suggest a participant's familiarity may be related to the degree 360 videos and standard videos are used in their mathematics methods courses, these results are from a single U.S. state, and further research is needed. Our findings suggest that mathematics teacher educators may be more inclined to use premade material (via internet or textbook) than to create their own. This result may stem from difficulties with learning to create certain mediums, such as those discussed by Feurstein (2019), but could also be due to availability of resources for teacher educators in learning to use various media (i.e., animations/comics and 360 video). Our findings indicate that other factors are at play that we did not assess, such as the time needed to learn different mediums and time spent creating them. This phenomenon warrants future study.

The findings presented in this paper are limited to one U.S. state, with a limited sample size ($n = 23$), and observed frequencies and correlations may change from one U.S. state (or nation) to another. However, these

findings point to some key implications for mathematics teacher education.

First, despite a large body of literature on the use of animations/comics in mathematics methods courses (e.g., Amador et al., 2016; Casey & Amidon, 2020; Herbst et al., 2011) and a growing body of literature for 360 video (Balzaretti et al., 2019; Ferdig & Kosko, 2020; Roche & Gal-Petitfaux, 2017), mathematics teacher educators in this state reported a general lack of familiarity with these mediums and lower usage in methods courses. Although conference presentations and publications are useful for informing teacher educators of such representations, they appear to be insufficient. Thus, the need is critical for teacher educators professional organizations, such as Society for Information Technology and Teacher Education (SITE) and the Association of Mathematics Teacher Education (AMTE), to provide professional development resources.

Moreover, given the prevalent use of course textbooks as sources of representations of practice, methods textbook publishers like Pearson, McGraw-Hill, and others should consider integrating such mediums into their available suite of resources provided to teacher educators. This need is amplified by the fact that such incorporation of standard videos is relatively recent (with the last few years). Teacher educators' reported perceived usefulness in this study points to potential interest in using such mediums, but the data also reflect a need for resources from teacher educators.

Another set of key findings from this study lay in comparison with various reviews of research on video use (Gaudin & Chaliès, 2015; Hamel & Viau-Guay, 2019; Major & Watson, 2018) and surveys of teacher educators' implemented use (Arya et al., 2013; Christ et al., 2017). For example, Major and Watson (2018) found that the studies on standard video use were more prevalent at the secondary level than the primary grades level. However, results presented here suggest videos were used more frequently in early childhood mathematics methods courses (primary grades outside of this U.S. state) than in secondary mathematics methods courses.

Additionally, findings from Arya et al. (2013) and Christ et al. (2017) that reported relatively infrequent use of standard videos do not correspond with mathematics teacher educators in our sample, as their reported usage was higher than the general average found by these prior studies Additionally, animations/comics were used at a higher rate amongst our sample than mathematics teacher educators in Christ et al.'s (2017) report. Notably, our total sample size was significantly smaller (23 versus 208); however, this focused targeting as a pilot provides useful findings regarding how various representations are used.

Our findings suggest that standard videos are the primary representation being used in mathematics method courses, with 360 video and animation/comics being far less prevalent. This situation may stem from mathematics teacher educators obtaining their resources primarily online or through a textbook publisher (i.e., premade), with fewer mathematics teacher educators opting to create their own, especially regarding 360 video and animations/comics. The primary goal for this pilot was to better understand what representations of practice are being used in

mathematics methods classes, how these resources are obtained, and what factors may influence usefulness. This pilot study offers a glimpse into what mathematics teachers educators use; however, further research is needed to gain more insight on why teacher educators use, or do not use, specific representations of practice.

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References

Amador, J., Estapa, A., Kosko, K., & Weston, T. (2021). Prospective teachers' noticing and mathematical decisions to respond: Using technology to approximate practice. *International Journal of Mathematical Education in Science and Technology, 52*(1), 3–22. https://doi.org/10.1080/0020739X.2019.1656828

Amador, J., Weston, T., Estapa, A., Kosko, K., & De Araujo, Z. (2016). Animations as a transformational approximation of practice for preservice teachers to communicate professional noticing. *Journal of Technology and Teacher Education, 24*(2), 127–151. https://www.learntechlib.org/p/171240/

Arya, P., & Christ, T. (2013). An exploration of how professors' facilitation is related to literacy teachers' meaning construction process during video-case discussions. *Journal of Reading Education, 39(1)*, 15-22.

Arya, P., Christ, T., & Chiu, M. M. (2016). Video use in teacher education: a survey of teacher-educators' practice across disciplines. *Journal of Computing in Higher Education*, 28, 261–300. https://doi.org/10.1007/s12528-016-9116-y

Balzaretti, N., Ciani, A., Cutting, C., O'Keeffe, L., & White, B. (2019). Unpacking the potential of 360 degree video to support pre-service teacher development. *Research on Education and Media, 11*(1), 63–69. https://doi.org/10.2478/rem-2019-0009

Barnhart, T., & van Es., E. (2015). Studying teacher noticing: Examining the relationship among pre-service science teachers' ability to attend, analyze and respond to student thinking. *Teaching and Teacher Education, 45,* 83-93.

Berliner, D. C., Stein, P., Sabers, D. S., Clarridge, P. B., Cushing, K. S., & Pinnegar, S. (1988). Implications of research on pedagogical expertise and experience in mathematics teaching. In D.A. Grouws & T. J. Conney (Eds.), *Perspectives on research on effective mathematics teaching* (pp. 67–95). National Council of teachers of Mathematics.

Birch, D., & Burnett, B. (2009). Bringing academics on board: Encouraging institution-wide diffusion of elearning environments. *Australasian Journal of Educational Technology*, *25*(1), 117–134. https://doi.org/10.14742/ajet.1184

Bliss, T., & Reynolds, A. (2004). Quality visions and focused imagination. In J. Brophy (Ed.), *Using video in teacher education* (Vol. 10; pp. 29–51). Emerald Group Publishing Limited. https://doi.org/10.1016/S1479-3687(03)10002-8

Blomberg, G., Sherin, M. G., Renkl, A., Glogger, I., & Seidel, T. (2014). Understanding video as a tool for teacher education: Investigating instructional strategies to promote reflection. *Instructional Science, 42*(3), 443–463.

Brunvand, S., & Fishman, B. (2007). Investigating the impact of the availability of scaffolds on preservice teacher noticing and learning from video. *Journal of Educational Technology Systems*, *35*(2), 151–174.

Buchbinder, O., Brisard, S., Butler, R., & McCrone, S. (2021). Preservice secondary mathematics teachers' reflective noticing from 360-degree video recordings of their own teaching. *Journal of Technology and Teacher Education, 29*(3), 279-308.

Casey, S., & Amidon, J. (2020). Do you see what I see? Formative assessment of preservice teachers' noticing of students' mathematical thinking. *Mathematics Teacher Educator*, *8*(3), 88–104. https://doi.org/10.5951/MTE.2020.0009

Chieu, V. M., & Herbst, P. (2016). A study of the quality of interaction among participants in online animation-bases conversations about mathematics teaching. *Teaching and Teacher Education, 57,* 139–149.

Christ, T., Arya, P., & Chiu, M. M. (2017). Video use in teacher education: an international survey of practices. *Teaching and Teacher Education*, 63, 22–35. https://doi.org/10.1016/j.tate.2016.12.005

Cross, S., Wolfenden, F., & Adinolfi, L. (2018). *Transforming classroom observation and professional development with 360-degree video and mobile VR* [Paper presentation]. 8th annual Education Alliance Wymposium, Washington, DC, United States. http://oro.open.ac.uk/57771/1/Cross

Earnest, D., & Amador, J. M. (2019). Lesson planimation: Prospective elementary teachers' interactions with mathematics curricula. *Journal of Mathematics Teacher Education, 22*, 37–68.

Ferdig, R. E., & Kosko, K. W. (2020). Implementing 360 video to increase immersion, perceptual capacity, and noticing. *TechTrends, 64,* 849-859. https://doi.org/10.1007/s11528-020-00522-3

Feurstein, M. S. (2019). Exploring the use of 360-degree video for teacher-training reflection in higher education. In S. Schulz (Ed.), *Proceedings of DELFI Workshops 2019* (p. 153-160). Gesellschaft für Informatik e.V.z. https://dl.gi.de/handle/20.500.12116/27956

Friesen, M., & Kuntze, S. (2018). Competence assessment with representations of practice in text, comic and video format. In O. Buchbinder & S. Kuntze (Eds.*), Mathematics teachers engaging with representations of practice* (pp.113-130). Springer.

Gaudin, C., & Chaliès, S. (2015). Video viewing in teacher education and professional development: A literature review. *Educational Research Review, 16*, 41–67. https://doi.org/10.1016/j.edurev.2015.06.001

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. W. (2009), Teaching practice: A cross-professional perspective. *Teachers College Record*, *111*(9), 2055–2100. https://tedd.org/wp-content/uploads/2014/03/Grossman-et-al-Teaching-Practice-A-Cross-Professional-Perspective-copy.pdf

Hamel, C., & Viau-Guay, A. (2019). Using video to support teachers' reflective practice: A literature review. *Cogent Education*, *6*(1), 1673689. https://doi.org/10.1080/2331186X.2019.1673689

Herbst, P., Chazan, D., Chen, C. L., Chieu, V. M., & Weiss, M. (2011). Using comics-based representations of teaching, and technology, to bring practice to teacher education courses. *ZDM, 43*(1), 91–103. https://doi.org/10.1007/s11858-010-0290-5

Herbst, P., Chazan, D., Chieu, V. M., Milewski, A., Kosko, K., & Aaron, W. (2016). Technology-mediated mathematics teacher development: Research on digital pedagogies of practice. In M. L. Niess, S. Driskell, & K. Hollerands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 76–105). IGI Global. https://doi.org/10.4018/978-1-5225-0120-6.ch004

Herbst, P., & Milewski, A. (2018). What StoryCircles can do for mathematics teaching and teacher education. In R. Zazkis & P. Herbst (Eds.), *Scripting approaches in mathematics education: Mathematical dialogues in research and practice* (pp. 321–364). Springer. https://doi.org/10.1007/978-3-319-62692-5

Johnson, A., Tipps, S., & Kennedy, M. (2008). *Guiding children's learning of mathematics* (11th ed.). Cengage Learning.

Johnson, A., Tipps, S., & Kennedy, M. (2018). *Guiding children's learning of mathematics* (13th ed.). Cengage Learning.

Major, L., & Watson, S. (2018). Using video to support in-service teacher professional development: The state of the field, limitations and possibilities. *Technology, Pedagogy and Education*, *27*(1), 49–68. https://doi.org/10.1080/1475939X.2017.1361469

McCoy, S., Lynam, A., & Kelly, M. (2018). A case for using Swivl for digital observation in an online or blended learning environment. *International Journal on Innovations in Online Education, 2*(2). https://doi.org/10.1615/IntJInnovOnlineEdu.2018028647

Moore-Russo, D. A., & Wilsey, J. N. (2014). Delving into the meaning of productive reflection: A study of future teachers' reflection on representations of teaching. *Teaching and Teacher Education, 37*, 76–90.

Moreno, R., & Mayer, R. E. (1999). Deriving instructional design principles from multimedia presentations with animations. In D. C. Martin (Ed.), *Proceedings IEEE International Conference on Multimedia Computing and Systems* (Vol. 1, pp. 720–725). IEEE. https://doi.org/10.1109/MMCS.1999.779288

Moreno, R., & Ortegano-Layne, L. (2008). Do classroom exemplars promote the application of principles in teacher education? A comparison of videos, animations, and narratives. *Educational Technology Research and Development*, *56*(4), 449–465. https://doi.org/10.1007/s11423-006-9027-0

Roche, L., & Gal-Petitfaux, N. (2017). Using 360° video in physical education teacher education. In P. Resta & S. Smith (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference* (pp. 3420–3425). Association for the Advancement of Computing in Education. https://www.learntechlib.org/primary/p/178219/

Roche, L., & Rolland, C. (2020). Scaffolding professional learning with 360 video for pre-service teachers. In D. Schmidt-Crawford (Ed.), *Proceedings of the Society for Information Technology & Teacher Education* (pp. 569-576). Association for the Advancement of Computing in Education.

Sherin, M. G., Russ, R. S., Sherin, B. L., & Colestock, A. (2008). Professional vision in action: An exploratory study. *Issues in Teacher Education, 17*(2), 27–46. https://files.eric.ed.gov/fulltext/EJ831297.pdf

Siegel, S., & Castellan Jr., N. J. (1988). *Nonparametric statistics for the behavioral sciences* (2nd ed.). McGraw-Hill Humanities/Social Sciences/Languages.

Snelson, C., & Hsu, Y. C. (2019). Educational 260-degree videos in virtual reality: A scoping review of the emerging research. *TechTrends, 64*, 404–412. https://doi.org/10.1007/s11528-019-00474-3

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M (2013). *Elementary and middle school mathematics: Teaching developmentally* (8th ed.). Pearson.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M (2018). *Elementary and middle school mathematics: Teaching developmentally* (10th ed.). Pearson.

van Es, E. A., & Sherin, M. G. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interactions. *Journal of Technology and Teacher, 10*(4), 571–596. https://www.learntechlib.org/primary/p/9171/.

van Es, E. A., Stockero, S. L., Sherin, M. G., Van Zoest, L. R., & Dyer, E. (2015). Making the most of teacher self-captured video. *Mathematics Teacher Educator*, *4*(1), 6–19. https://doi.org/10.5951/mathteaceduc.4.1.0006

Walkoe, J., & Levin, D. M. (2018). Using technology in representing practice to support preservice teachers' quality questioning: The roles of noticing in improving practice. *Journal of Technology and Teacher Education*, *26*(1), 127–147.

Walshe, N., & Driver, P. (2019). Developing reflective trainee teacher practice with 360-degree video. *Teaching and Teacher Education*, *78*(1), 97–105. https://doi.org/10.1016/j.tate.2018.11.009

Weston, T. L., & Amador, J. M. (2021). Investigating student teachers' noticing using 360 video of their own teaching. *Journal of Technology and Teacher Education, 29*(3), 309-338.

Zolfaghari, M., Austin, C. K., Kosko, K. W., & Ferdig, R. E. (2020). Creating asynchronous virtual field experiences with 360 video. *Journal of Technology and Teacher Education, 28*(2), 315-320. https://www.learntechlib.org/p/216115/