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Video use in teacher education: a survey of teacher-educators' practices across disciplines

Poonam Arya[1] · **Tanya Christ**[2] · **Ming Ming Chiu**[3]

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Abstract Video methods utilize tenets of high quality teacher education and support education students' learning and application of learning to teaching practices. However, how frequently video is used in teacher education, and in what ways is unknown. Therefore, this study used survey data to identify the extent to which 94 teacher-educators used video in their teacher education courses along with the specific uses of video. Further, multilevel multivariate analyses identified what factors impacted these uses. Findings included that many teacher-educators underused video in their teacher education courses, and typically used only one type of video in each course. Any type of video use was significantly related to teacher-educator, course, and discipline-area factors, and interactions amongst these. Specific types of video use were significantly related to institutional-demographic, teacher-educator, support, course, discipline-area factors, and interactions amongst these. Implications for increasing video use and breadth of types of video uses in teacher education are discussed.

Keywords Video methods · Survey · Teacher education · Instructional technology

✉ Poonam Arya
parya@wayne.edu

Tanya Christ
christ@oakland.edu

Ming Ming Chiu
mingmingchiu@gmail.com

[1] Wayne State University, 279 Education Building, Detroit, MI 48202, USA

[2] Oakland University, Rochester, MI, USA

[3] Purdue University, West Lafayette, IN, USA

Introduction

Video methods (video discussion, video case-studies, videos embedded in multimedia, and video self-reflections) utilize tenets of high quality professional development (such as, modeling, scaffolding, co-construction, situated learning). They are also related to desired teacher outcomes like learning and application of learning to teaching practices (Arya et al. 2015; Christ et al. 2012, 2014; Harford and MacRuairc 2008; Tripp and Rich 2012; van Es and Sherin 2010). Despite these strong benefits, how frequently video is used in teacher education, and in what ways, is unknown Further, while there is ample research concerning factors related to technology use in education (Birch and Burnett 2009; Fresen 2010; Jan et al. 2012), there is no information specifically about what factors mediate the use of video methods in teacher education. Therefore, this study aimed to identify the extent to which video is used in teacher education and what factors are related to its use. We focus on a survey of teacher educators in our home state, as a starting point for exploring these issues more broadly.

Conceptual framework

To show the foundation for our research, we developed a conceptual framework based on theoretical and empirical literature that models how the video methods that we explore in our survey are connected to tenets of high quality professional

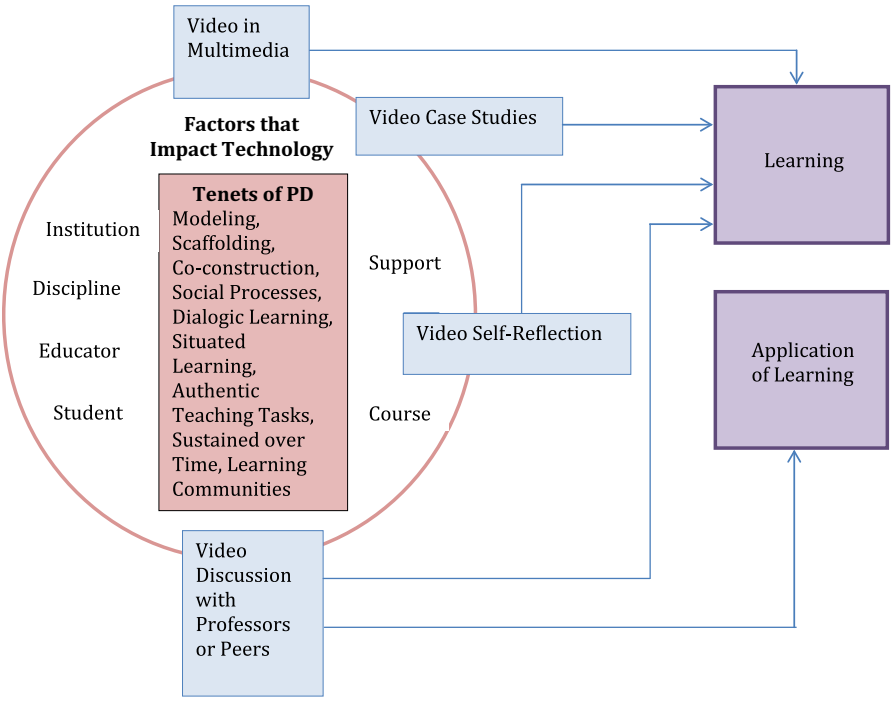

Fig. 1 Conceptual framework

development, potentially mediated by factors that impact technology use, and ultimately related to teacher outcomes (see Fig. 1). These relations provide a rationale for why it is critical to study the use of video in teacher education and the factors that impact its use.

Tenets of high quality professional development (PD) that are culled from the research literature are utilized in the video methods that we study in our survey research. For example, PD tenets such as *professional learning community* (Richmond and Manokore 2011; Roth et al. 2011; Vescio et al. 2008), *scaffolding* (Palinscar 1998; Vygotsky 1978), and *co-construction* of practices and knowledge (Faidley et al. 2000; Lave 2004) are utilized in video discussion methods. Likewise, the PD tenet *focus on teachers' everyday practices* (Borko et al. 2008) is utilized by video case study and video discussion methods. Additionally, *modeling* (Vygotsky 1978) is utilized in all video methods except video self-reflections. Furthermore, the use of *physical artifacts* that mediate the learning process (Cole and Wertsch 1996) and *situated learning* with an analytic focus and interaction with others (Greeno 2003) are utilized by all four video methods. Finally, there is the potential for *sustaining these practices over time* (Wei et al. 2009); but research does not address to what extent this occur in teacher-education practices. The central positioning of these tenets on the left side of Fig. 1 shows that these form the core foundation of our research.

Factors that potentially mediate the application of these central PD tenets toward use of video methods include institution, discipline, educator, student, support, and course factors. These were culled from the broader research on factors that impact technology use in education. It is the aim of our study to understand which of these factors mediates video use in teacher education. This potential mediating role is represented in Fig. 1 by positioning these factors between the tenets of PD and the video methods.

The arrows going from the video methods on the left side of the figure to the teacher outcomes on the right side of the figure show how different video methods are related to different teacher outcomes. For example, while application of learning only aligns with video discussion methods (Christ et al. 2014), learning (defined as acquiring new ideas about teaching practices) aligns with all video methods (Arya et al. 2013, 2015; Baecher et al. 2012; Calandra et al. 2014; Christ et al. 2012, 2014; Fadde and Sullivan 2013).

Our model identifies two important principles for teacher educators' use of video methods. First, given that different PD tenets are utilized in different video methods, and different video methods are related to different teacher outcomes, all video methods should be used in combination to broaden the tenets of high quality PD and teacher outcomes that are addressed. Second, since research related to high quality professional development suggests practices should be sustained over time (Wei et al. 2009), teacher educators should use video methods across their courses. Further, since factors can impact technology use, we should consider how these factors impact video use to inform planning to reduce barriers and increase use. What specific factors should be included in this model will be identified through our research findings.

Literature review

To inform our study, and particularly our survey questions, (1) we present relevant research about each of the four video methods presented in our theoretical framework, and (2) we review the broader research literature about factors related to educators' technology use (since we did not find any studies specifically about factors related to the use of video in teacher education).

Video methods in teacher education

Video case-studies

There are many ways to engage in case studies. Pertaining to our research, we define *video case studies* as including teachers viewing an exemplar video of a pedagogical practice and discussing it with their teacher educator and peers. Video case-studies allow education students to discuss teaching practices using multiple perspectives and grapple with decision-making in complex and ill-defined domains (Moyle 2008; Spiro et al. 1988). Unlike written case-studies, they allow education students to share an experience "by capturing voices, body language, and interactions" (Koc et al. 2009, p. 1159). Through discussion of the shared experience, education students not only learn to identify and reframe problems in the classroom, but also support one another in transforming inert knowledge into knowledge-in-use (Denzin and Lincoln 2005; Ngeow and Yoon-San 2003). Thus, video case-studies help to bridge the theory-to-practice gap (Arya et al. 2013; Christ et al. 2014; Llinares and Valls 2009; Star and Strickland 2008).

Video-based self-reflections

While there are many approaches to self-reflection, we define video-based self-reflections as the viewing of one's own teaching video to reflect on what went well, not so well, and potential changes for future teaching. Video-based self-reflections foster mindful learning (Eröz-Tuga 2013; Rosaen et al. 2008). Similar to video case-studies, video-based self-reflections allow education students to link theory to practice by helping them make connections between broad teaching and learning concepts and events in the video. The audio and visual information and the ability to view video recursively support education students' analysis of teaching and learning situations (van Es and Sherin 2002). Education students are able to focus on instruction and children, rather than just themselves, to refine their pedagogical thinking and knowledge (Arya et al. 2013, 2015; Christ et al. 2012, 2014; Rosaen et al. 2008; van Es and Sherin 2010). Guided prompts and peer discussions, along with video-based self-reflections, further deepen understandings about teaching events (Fadde et al. 2009; Masats and Dooly 2011; van Es and Sherin 2002).

Video discussions with peers

Video discussions with peers typically include three parts: (1) a teacher presents a video segment from of her instruction and identifies the topic or question to be discussed, (2) her colleagues view this clip, and (3) the teacher and her colleagues discuss the topic or issue identified by the teacher. In some cases teacher educators participate in or help to facilitate these discussions as well. These video discussions with peers provide opportunities to develop critical reflective discussion skills and multiple perspectives about the event. This results in reconsidering, shifting, and deepening their previous beliefs and knowledge about pedagogy, as well as developing understandings about the complexities of teaching events (Baecher et al. 2012; Calandra et al. 2014; Harford and MacRuairc 2008; Sanny and Teale 2008; Tripp and Rich 2012). Additionally, these discussions serve as a way for education students to gain situated feedback about their teaching practices from others, learn to question and provide quality feedback to others, and become more aware of their personal teaching needs and strengths (Arya et al. 2013, 2015; Christ et al. 2012, 2014; Eröz-Tuga 2013; Yaffe 2010). This results in transforming their knowledge about pedagogical practices by both "get[ing] ideas from others" (Bakkenes et al. 2010, p. 539) and generating ideas for uptake in their subsequent pedagogy (Arya et al. 2015; Christ et al. 2012, 2014; Harford and MacRuairc 2008; Shanahan and Tochelli 2014; Tripp and Rich 2012; van Es and Sherin 2010). Education students from across several disciplines (special education, religious education, and English Language Learner education) reported making changes in their pedagogy based on what they had learned through their video discussions with peers (Tripp and Rich 2012).

Video discussions with teacher-educators

Video discussions with teacher-educators can take place individually or as a whole group (Arya et al. 2013; Molle 2013; Poekert 2011). Discussions provide an opportunity to highlight, clarify and provide feedback about practices to support deeper analysis and understanding of classroom instruction (Llinares and Valls 2009; van Es 2009). Also, they reduce isolation, increase mutual respect, create a shared language for practices, provide multiple voices and perspectives, and increase active engagement in learning (Ikpeze 2007; Juzwik et al. 2012; Parks 2009; van Es and Sherin 2010). Over time, education students are able to take on the facilitative role with their peers that the teacher-educator initially provided (Baecher et al. 2012; Fadde and Sullivan 2013).

Video embedded within multimedia contexts

Multimedia contexts are defined by their multiple sources of information (like, samples of education students' work, blogs, wikis, primary source documents) and modalities (text, sound, and video) that function together to help education students construct pedagogical knowledge (Lieberman and Pointer Mace 2010; Pointer-Mace 2009). Video embedded in multimedia contexts means that one of the sources of

information provided is video. These multimedia contexts allow for diversity in learning because students can choose to focus on different activities based on their individual learning styles, needs, and prior experiences (Ferdig et al. 2006). Many studies that examined the use of video discussions as part of multimedia learning environments online, such as Reading Classroom Explorer (RCE) or Socio-Technical Environment for Learning and Learning-Activity Research (STELLAR), found that these help education students contextualize what they are learning and lead to new understandings about pedagogy (Sanny and Teale 2008; Ferdig et al. 2006; Yadav et al. 2009).

Factors related to educators' technology use

Our literature review identified six factors related to educators' use of technology, each reviewed below.

Institutional demographic factors

This factor includes the type of university at which technology is being used. The few studies that have examined this factor found significant differences between technology use related to distinctions between research universities, polytechnic universities, and community colleges (Jenkins et al. 2011; Meyer and Xu 2009). The implications of these differences are that they identify which educational settings most need to focus on improving their technology use. Thus, we included questions on our survey regarding institutional demographic variables, such as public or private; urban, suburban, or rural; and highest degree offered.

Support factors

Two supports are related to technology use in education: (1) supports for designing courses that integrate technology use (Ahmadpour and Mirdamadi 2010; Birch and Burnett 2009; Kampov-Polevoi 2010; Louw et al. 2009), including funding and time (Jenkins et al. 2011), and (2) development of a culture that supports, promotes, or pushes technology use, particularly by providing a model of successful implementation by a colleague (Jan et al. 2012; Jenkins et al. 2011; Kampov-Polevoi 2010). Likewise, three factors hinder technology use: (1) unclear institutional policies and procedures (Birch and Burnett 2009), (2) financial, technical, or regulatory issues (Ahmadpour and Mirdamadi 2010; Tshabalala et al. 2014), and (3) lack of adequate support for integration (Tshabalala et al. 2014). Based on this research, we included questions in our survey about what supports were related to teacher-educators' use of video and whether others in their discipline-area were using video (such as, about their discipline's culture for using video).

Educator factors

The following affect the use of technology in teaching: (1) younger educators are more likely to use technology than older ones (Meyer and Xu 2009), (2) educators

who have a doctorate are more likely to use technology than those with a lesser degree (Meyer and Xu 2009), and (3) educators who teach a lesser course load are more likely to use technology than those who teach a higher course load (Birch and Burnett 2009; Kenney and Newcombe 2011). Based on this research, we included questions on the survey about how many years teacher-educators had been teaching, their highest degree, and how many courses they had taught in the past year. Additionally, we asked whether they were employed full time (versus part time), and were on tenure track (versus non-tenure track) to explore whether these variables as well.

Student factors

Students' being self-directed learners and having good critical thinking, problem solving, communication, and time management skills are factors related to educators' technology use (Fresen 2010). Lack of student preparation to use technology can hinder its integration (Ahmadpour and Mirdamadi 2010; Kenney and Newcombe 2011; Tshabalala et al. 2014). Based on this research, we included survey questions that asked teacher-educators about their perceptions of their education students' learning abilities and experience using technology. Further, given that students learn more when they are interested in a topic (Wigfield and Cambria 2010), we also asked teacher-educators about their perceptions of their students' interest in the subject matter they taught.

Discipline-area factors

Studies in this area have had mixed findings. While one study found that educators in the health sciences integrate technology less than those in other disciplines (Meyer and Xu 2009), another study found the opposite (Jenkins et al. 2011). In any case, discipline-area may affect teacher-educators' integration of video use in teaching, so we investigate it in our study.

Course factors

These have not been examined much in previous research, though one study showed that course delivery format affected educators' technology use (Kampov-Polevoi 2010). Different course delivery formats (face-to-face, hybrid, online) call for different pedagogical strategies to engage and immerse students in the learning experience (Hawkes and Coldeway 2002). For example, online courses are usually tied to some sort of a web-based course management system (such as, Moodle, Blackboard) that supports both learning and administrative tasks. Tools available in these systems naturally enable educators to integrate online elements such as video streaming and narrated PowerPoint lectures into the course content, things that might not be as feasible or easy to do when delivering a course in a traditional face-to-face format. Kampov-Polevoi (2010), who interviewed faculty members across various universities about their perceptions related to course conversion from a traditional format to an online delivery format, found that the most common

modification was the inclusion of interactive learning resources available on the open web and more videos, especially YouTube videos. Further, educators felt that online delivery format allowed them to not only use both asynchronous and interactive synchronous online forums for discussion, but also additional technology tools such as blogs or Second Life to support their teaching. Therefore, in our survey, we asked teacher-educators to indicate the course delivery format (such as, online, face-to-face, hybrid) to examine how this might be related to video use in their courses. Additionally, since the complexity of prior knowledge and desired knowledge differ across undergraduate and graduate course levels, we asked teacher-educators who took our survey to identify the level for each of their courses so that we could explore whether these were related to video use.

Research questions

Our research aimed to answer the following questions:

1. To what extent is video used in teacher education courses?
2. What institutional demographic, support, educator, education student, discipline-area, and course factors are related to any use of video in teacher education courses?
3. What institutional demographic, support, educator, education student, discipline-area, and course factors are related to specific types of video use in teacher-education courses?

Methods

Participants

To identify study participants, we searched the Web for all four-year institutions in our state. Only six institutions were excluded because they did not have colleges of education, and two were excluded because faculty e-mails were not available. Then we identified all content area education professors (such as, literacy, math, science, special education, and early childhood) at each school, irrespective of their rank or title, resulting in "a more or less complete list of individuals in the population to be studied" (Fowler 2014, p. 15). We focused on just our state due to how labor intensive it was to search for all education professors across the state at both public and private institutions; however, this approach allowed us to be fairly certain that almost all teacher educators in the state were at least invited to participate in the survey, improving our odds at a representative sample.

Our search resulted in identifying 230 professors at public four-year institutions and 106 professors at private or independent four-year institutions for a total of 336 potential participants in our state. Of these, 94 professors participated (78 % from public institutions, 22 % from private/independent institutions, 28 % male, and 72 % female).

Data collection

We chose online survey methods (versus in-person interviews or postal mail surveys) to (1) reduce "social desirability bias," (2) allow us to use "complex question skip patterns that are difficult in a paper-and-pencil version," and (3) reduce costs (as compared to mailings) for sending and resending the survey (Fowler 2014, p. 95, 70).

The survey design was framed by our purposes (to understand the current state of teacher-educators' use of video in various content area teacher-education courses, and what factors are related to its use), its variables were identified through our research review, and the questions were written, "to create measures of the variables" (Fowler 2014, p. 101). The survey contained 68 questions.

Questions were categorized by factors and ordered for logical flow. Filter or contingency questions were used to determine if a respondent was qualified to answer the questions to avoid survey error based on responses from unqualified participants and to reduce participants' total response time by not asking questions that did not pertain to them (Fowler 2014, p. 9). Mostly closed questions were used that requested objective facts, avoided "the 'don't know' option" and provided categories "along a single continuum" for ordinal data because ranking is more valid than agree/disagree format questions to avoid "errors associated with answers" (Fowler 2014, pp. 11, 83, 88). We did ask two open questions to capture possible responses beyond our preset choices about video use. The survey can be accessed through the link https://docs.google.com/document/d/11faW4yR77NxxhYzvm-Nn7YV0hyNaw8O6faS4fhodX_M/edit?usp=sharing.

To increase the reliability of our survey, we had a small group of professors who are teacher-educators, but not in our state, complete a "pre-survey evaluation" that included discussing their interpretations of the questions with us, and a "field pretest" to ensure that the survey made sense to the participants and technology worked properly (Fowler 2014, p. 102, 105). Based on these, we revised the survey to address "inadequate" or "incomplete" wording of questions and "poorly defined terms" to reduce "unwanted variation in answers across respondents" (Fowler 2014, pp. 77, 81, 82, 85).

The survey was emailed via Survey Monkey to all potential participants, and in line with typical online survey practice, resent to non-respondents once monthly across three months. The survey took approximately 15 min to complete. Responses were collected without identifiers and downloaded for analysis.

Data coding

For the first open question, about teacher-educators "other" uses of video, we used emergent coding and constant comparative method (Corbin and Strauss 2008) to identify the following categories that reflected responses: (1) using video to focus on children, (2) using video to show subject area content, (3) using video to show how to teach, (4) using videos on the Internet, and (5) using video for remote teaching. We applied these codes to each respondent's open response for each course to identify their extent of use.

For the second open-ended question, concerning how frequently teacher-educators used video, we converted responses into a total number of times video was used per course—for example, if a respondent reported using video "a few times per course" we coded the response "3" times per course; if the respondent reported using video "every other week" then we coded this "8" times (based on a typical 16-week course). When a range was reported (for example, "2–3 times per semester") we calculated the average ("2.5"). When responses were vague, such as "occasionally" or "infrequently," we excluded this data because it was impossible to code accurately (this was less than 1 % of the dataset).

Data analysis

First we modeled teacher-educators' frequency of *any video use* with a two-level nested model of courses within teacher-educators (Goldstein 1995). A variance components model tested for significant differences at each level.

$$Any\_video_{ij} = \beta_{00} + \ e_{ij} + \ f_{0j} \tag{1}$$

Any_video_{ij} for course i by teacher educator j has grand mean intercept β_{00} with unexplained components (*residuals*) at the course- and teacher educator-levels ($\mathbf{e}_{ij}$, $\mathbf{f}_{0j}$). First, we entered the institutional demographic variables: highest degree offered is masters, doctoral degree offered, private institution (vs. public institution), urban and suburban (vs. rural) (**Institution**).

$$\begin{aligned} Any\_video_{ij} = \beta_{00} + \ e_{ij} + \ f_{0j} + \beta_{0s}\mathbf{Institution}_{0j} + \beta_{0t}\mathbf{TeacherEducator}_{0j} \\ + \beta_{0u}\mathbf{Student}_{0j} + \beta_{0v}\mathbf{Support}_{0j} + \beta_{wj}\mathbf{Course}_{ij} \\ + \beta_{xj}\mathbf{Discipline}_{ij} + \beta_{zj}\mathbf{Interaction}_{ij} \end{aligned} \tag{2}$$

We tested whether sets of predictors were significant with a nested hypothesis test (χ^2 log (likelihood, Kennedy 2008). Non-significant variables were removed. Then, we applied this procedure to teacher-educator variables: gender, highest degree, years teaching at the college level, square of years teaching at the college level (to test for non-linear effects), tenured and tenure track (vs. not on tenure track), full-time position (vs. part-time), number of courses taught, squared number of courses taught (to test for non-linear effects), perceptions that others in their discipline teach with video (**Teacher Educator**). Next, we applied this procedure to teacher-educators' ratings of their students' learning abilities, interest in the subject matter, and experiences with technology (**Student**). Then, we applied this procedure to support variables: administrators, technology support staff, university incentives for using technology, university requirements for using technology, access to technology, professional development for using technology, and experience using technology (**Support**). Next, we applied this procedure to courses: graduate (vs. undergraduate), practicum, service-learning, online and hybrid (vs. traditional) (**Course**). Afterwards, we applied this procedure to discipline-areas: literacy, mathematics, science, social studies, special education, art education, curriculum, early childhood, and English Language Learner (**Discipline**). Lastly, we tested the interactions among the significant variables (**Interaction**).

Table 1 Summary statistics per course (N = 463)

Variable	Mean times used per course	SD	Min	Max
Outcome variables				
Frequency of any video use	5.790	7.652	0	40
Frequency of video-based self-reflections	0.892	3.049	0	16
Frequency of videos discussions with peers	0.801	3.064	0	16
Frequency of videos discussions with teacher-educators	0.596	2.497	0	16
Frequency of video integrated within multimedia contexts	1.352	3.745	0	16
Frequency of video case studies	3.138	6.618	0	40
Frequency of video used to focus on course content	0.486	3.359	0	40
Frequency of video used to focus on children	0.050	0.554	0	10
Frequency of videos used to focus on how to teach	0.220	1.346	0	16
Frequency of videos used from the Internet	0.348	2.414	0	40
Frequency of videos used for remote teaching	0.069	1.050	0	16
Institutional demographic variables				
Highest degree: Masters	0.488		0	1
Doctoral degree offered	0.419		0	1
Private institution (vs. public)	0.242		0	1
Urban (vs. rural)	0.315		0	1
Suburban (vs. rural)	0.382		0	1
Teacher educator variables				
Female	0.739		0	1
Faculty highest degree is PhD	0.890		0	1
Years teaching at the college/university level	13.529	8.209	1	35
Tenure (vs. not tenure track)	0.503		0	1
Tenure track–not yet tenured (vs. not tenure track)	0.305		0	1
Full-time position	0.916		0	1
Number of courses taught	5.985	1.931	1	8
Other teacher-educators in my discipline-area use video in their courses across the nation	3.145	0.738	2	5
Other teacher-educators in my discipline-area use video in their courses at my university	3.114	0.869	1	5
Education student variables				
My students have high learning ability	4.343	0.765	1	5
My students are interested in the subject matter	4.378	0.734	1	5
My students have experience using technology	4.089	0.741	1	5
Support variables				
Support from administrators	0.132		0	1
Support from technology support staff	0.415		0	1
Support from university incentives for using technology	0.114		0	1
Support from university requirements for using technology	0.060		0	1
Support from access to technology	0.672		0	1
Experience using technology	0.635		0	1

Table 1 continued

Variable	Mean times used per course	SD	Min	Max
Support from professional development on using technology	0.218		0	1
Course variables				
Graduate course	0.590		0	1
Practicum course	0.151		0	1
Service-learning course	0.006		0	1
Online course	0.233		0	1
Hybrid course (online and face-to-face meetings)	0.028		0	1
Discipline-area variables				
Literacy	0.168		0	1
Math	0.052		0	1
Science	0.076		0	1
Social studies	0.099		0	1
Special education	0.134		0	1
Art education	0.123		0	1
Curriculum studies	0.121		0	1
Early childhood	0.102		0	1
English language learners/bilingual bicultural education	0.084		0	1

Second, we modeled teacher-educators' frequencies of *specific types of video use* (video-based self-reflection, discussion of videos with peers, discussions of videos with teacher-educators, video integrated within multimedia contexts, video case-studies, videos used to focus on course content, videos used to focus on children, videos used to focus on how to teach, videos used from the Internet, and videos used for remote teaching) with multilevel, multivariate models (Goldstein 1995).

$$\mathbf{Video\_Type}_{ijy} = \beta_{00y} + \mathrm{e}_{ijy} + \mathrm{f}_{0jy} \tag{3}$$

The video type y for each course i by teacher educator j has grand mean intercept β_{00y} and course- and teacher educator-level residuals ($\mathbf{e}_{ijy}$, $\mathbf{f}_{0jy}$). We entered the same variables using the same procedures as above.

$$\begin{aligned}\mathbf{Video\_Type}_{ijy} = \beta_{00y} + \ & \mathrm{e}_{ijy} + \mathrm{f}_{0jy} + \beta_{0sy}\mathbf{Institution}_{0jy} + \beta_{0ty}\mathbf{TeacherEducator}_{0jy} \\ & + \beta_{0uy}\mathbf{Student}_{0jy} + \beta_{0vy}\mathbf{Support}_{0jy} + \beta_{wjy}\mathbf{Course}_{ijy} \\ & + \beta_{xjy}\mathbf{Discipline}_{ijy} + \beta_{zjy}\mathbf{Interaction}_{ijy}\end{aligned} \tag{4}$$

We used an alpha level of .05. To control for the false discovery rate, we used the two-stage linear step-up procedure, which outperformed 13 other methods in computer simulations (Benjamini et al. 2006). For a 0.4 effect size at $p = .05$, statistical power at the teacher educator-level = 0.86; Konstantopoulos 2008). We analyzed residuals for influential outliers.

Results

The results are organized to answer our three research questions. Summary statistics and frequency counts were used to answer the first question, and statistical models were used to answer the second and third research questions. Results stemming from the statistical models describe first entry into the regression, controlling for all previously included variables. Non-significant results are not discussed.

Teacher-educators' use of video in teacher education

To represent a nuanced view of teacher-educators' use of video methods in teacher education, we present our data both as summary statistics that show average use of video per course (see Table 1) and frequency counts of video use from the raw survey data (see Figs. 2, 3, 4).

First, the summary statistics show that the 94 teacher-educators who responded to our survey reported using video nearly six times (m = 5.79) in each course, on average (see Table 1). To better understand teacher-educators' video use, we examined the frequency counts from our raw data. These show that video use per course was bimodal—48 % of teacher-educators used video just 1–4 times, and 34 % used it 13 or more times (see Fig. 2). Thus, 66 % of teacher-educators are using video less than weekly, which is likely inadequate given that professional development research shows that practices must be sustained across time (Wei et al. 2009). This shows a need for increased use of video in teacher education.

Second, the summary statistics show that teacher-educators' average use of each type of video per course varied. The most frequent uses of video were case-studies,

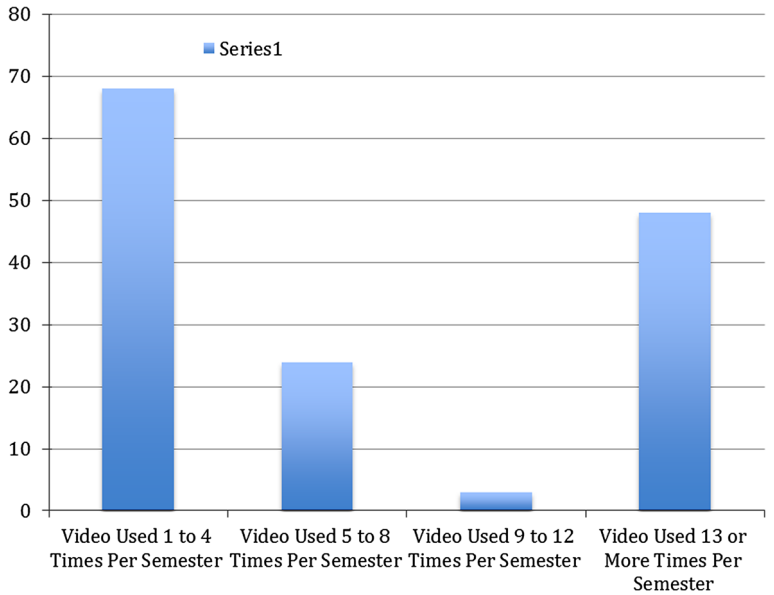

Fig. 2 Distribution of frequency of any video use across courses (N = 143)

which were used three times per course on average (m = 3.138), followed by multimedia that was used about once per course (m = 1.352), then videos for self-reflection (m = 0.89) and discussions of videos with peers (m = 0.80) that were each used less than once per course (see Table 1). Thus, most common uses of video in the research literature (multimedia, self-reflection, and discussions with peers) were rarely used in teacher-education courses. Further, the low use of video discussions is problematic given that this method is the only one that research has shown is connected to teachers' application of their learning to practice. Additionally, frequency counts from the raw data further show that teacher-educators often used three to four types of video method across their courses (see Fig. 3), but typically only used one type of video in each of their courses (see Fig. 4). This suggests that while teacher-educators are capable of using multiple video methods, but likely do not realize the importance of using these multiple methods in combination as is highlighted by our conceptual model.

Factors related to any video use in teacher education

Based on the statistical model, three factors were significantly related to any video use in teacher-education courses: teacher-educator, course, and discipline. Further, we present interaction effects among these, and discuss variance.

Teacher-educator factors

Teacher-educators' years of university teaching and tenure-track status were linked to their video use (see Table 2, model 1). Teacher-educators whose years of teaching at the university level exceeded the mean by one year averaged 0.3 more video uses per course. This means that if a teacher-educator has taught 6 more years

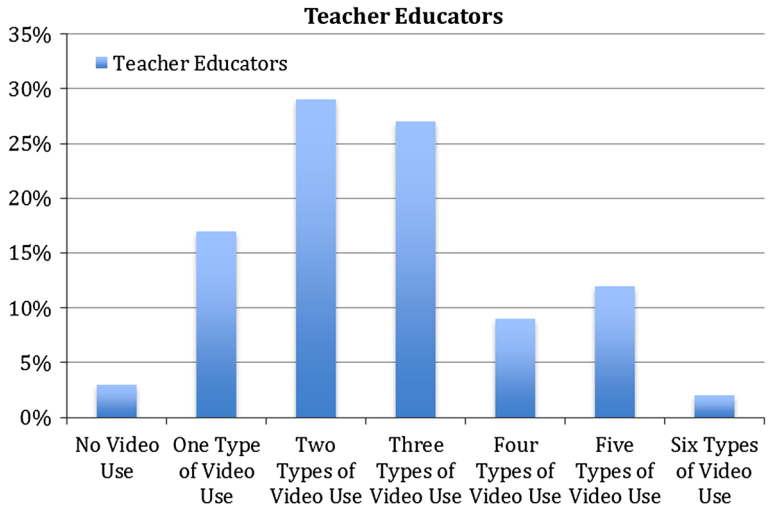

Fig. 3 Number of types of video use (such as, multimedia, case study, and others) per teacher educator

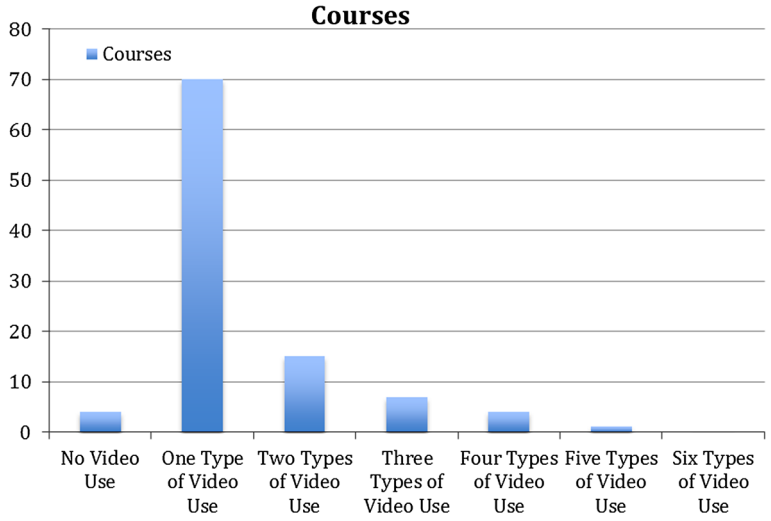

Fig. 4 Number of types of video uses per course

than the average, she uses 1.8 more videos per year than her less seasoned colleagues; and, if a teacher-educator has taught 12 more years than the average, she uses 3.6 more videos per semester.

Moreover, tenure track teacher-educators averaged three more video uses per course. So, compounded, a tenured teacher-educator who has been teaching 12 years longer than average uses 6.6 more videos than other teacher-educators. Given the importance of video use across time, this can potentially have a huge impact on teachers' learning because it provides almost weekly video use.

Altogether, teacher educator variables accounted for 10 % of the differences in video use. Thus, educator factors are an important mediator between tenets of professional development (PD) and use of video methods.

Course factors

Graduate and online courses were also significantly linked to teacher-educators' video use. When teaching graduate courses, teacher-educators averaged two more video uses per course (see Table 2, model 2). When teaching online courses, teacher-educators averaged three more video uses per course (see Table 2, model 3). Given that the average use of videos per course is six, using two to three more videos in these contexts is an impressive 33–50 % increase. Course variables accounted for an extra 0.5 % of the variance in any video use. Thus, course factors are also important mediators between tenets of professional development (PD) and use of video methods.

Table 2 Summary of regression coefficients of 5 multivariate models predicting frequency of use of any video technology (with standard errors in parentheses)

Explanatory variable	Regressions predicting frequency of any video use				
	Model 1	Model 2	Model 3	Model 4	Model 5
Years teaching at the college/ university level	0.321	0.325	0.314	0.272	0.124
	(0.075)***	(0.076)***	(0.072)***	(0.068)***	(0.072)
Tenure track	3.438	3.062	3.135	3.468	4.110
	(1.345)*	(1.364)*	(1.299)*	(1.216)**	(1.544)**
Graduate course		−2.242	−2.934	−2.468	−5.021
		(0.622)***	(0.636)***	(0.627)***	(0.786)***
Online course			3.328	3.535	2.733
			(0.799)***	(0.780)***	(0.760)***
Discipline: literacy				4.029	−0.194
				(0.848)***	(1.156)
Discipline: special education				2.154	2.273
				(0.807)**	(0.767)**
Years teaching at the college/ university level * tenure track					0.671
					(0.174)***
Years teaching at the college/ university level * online course					0.244
					(0.090)**
Tenure track * graduate course					4.314
					(1.204)***
Graduate course * discipline: literacy					6.621
					(1.405)***

Variance at each level	Explained variance at each level				
	Model 1	Model 2	Model 3	Model 4	Model 5
Teacher educator (46 %)	0.202	0.168	0.264	0.380	0.493
Course (54 %)	0.003	0.042	0.062	0.094	0.178
Total variance explained	0.095	0.100	0.155	0.225	0.322

Discipline factors

Teaching courses in the disciplines of literacy or special education were significantly associated with teacher-educators' video use. When teaching literacy courses or special education courses, teacher-educators averaged two or four more video uses per course, respectively (see Table 2, model 4). This means that instead of using six videos per course (on average), teacher-educators in these disciplines are using two to four more videos per course (eight to ten videos total), which reflect a 33–66 % increase. Discipline-area accounted for an extra 7 % of the variance in any video use. Thus, discipline is an important mediating factor for applying tenets of PD through the use of video methods.

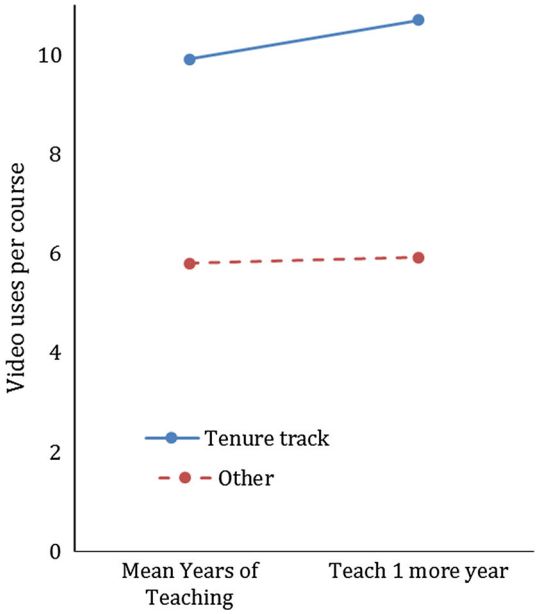

Fig. 5 Interaction between years of teaching and tenure track status related to video use

Interaction effects

There were four significant interaction effects. The effects of teaching one more year than average is stronger for tenure track faculty or online courses (+0.7 or +0.2 more video uses per course; Table 2, model 5; see Figs. 5, 6). The effects of teaching a graduate course are stronger for tenure track faculty or teaching literacy courses (+4 or +7 more video uses per course) (See Figs. 7, 8). So, under certain conditions such as, faculty being tenured and the course being online, there are significant increases in video use. Thus, not only do specific factors mediate the application of PD tents via video use, but also how these factors occur in combination is important. Variance in any video use was slightly larger across courses by the same teacher-educator (54 %) rather than across teacher-educators (46 %). This is likely because video use depended on the type of course (for example, online, face-to-face, or practicum) and discipline-area (like, literacy, early childhood, science and others).

Factors related to types of video use in teacher education

Based on the statistical model, five factors were significantly related to types of video use in teacher-education courses: institution, teacher-educator, support, course, and discipline. Further, we present interaction effects among these.

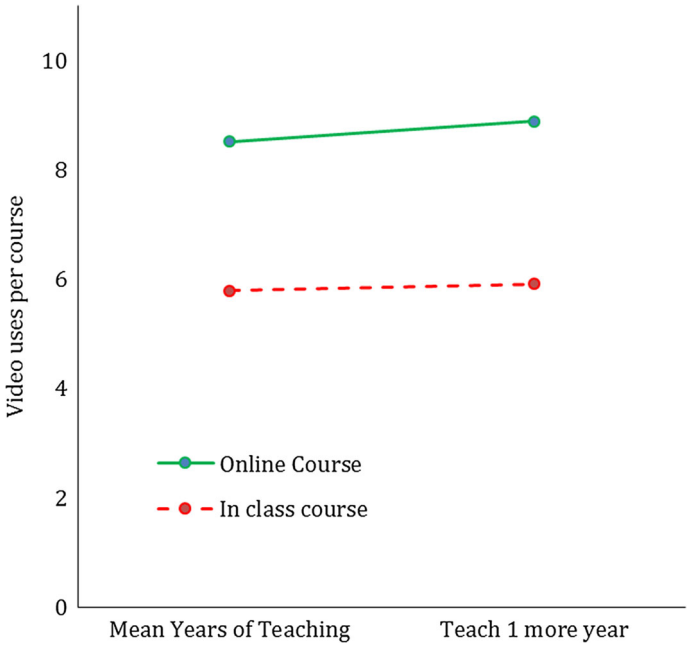

Fig. 6 Interaction between years of teaching and course delivery format related to video use

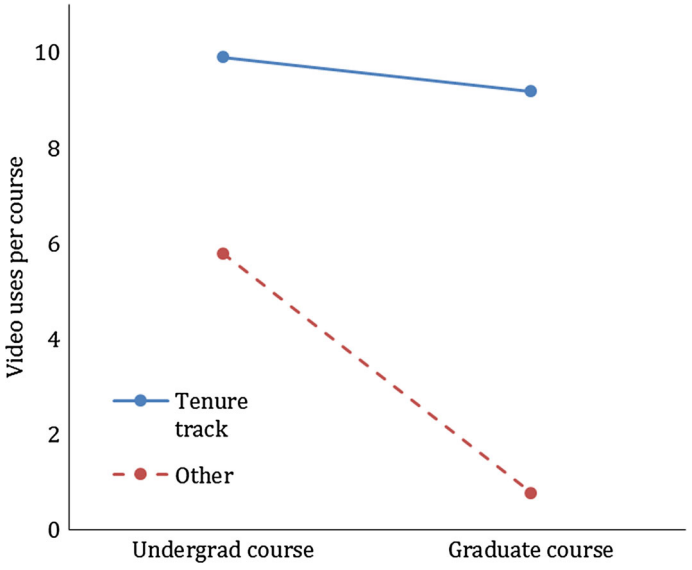

Fig. 7 Interaction between graduate courses and tenure track related to video use

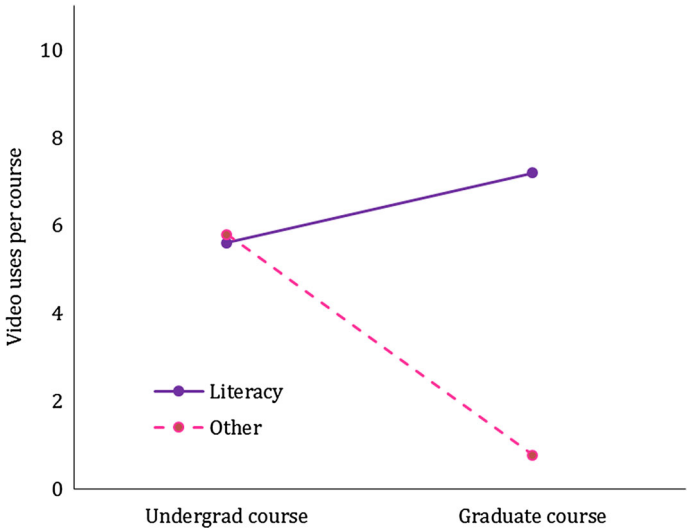

Fig. 8 Interaction between graduate courses and literacy courses related to video use

Institutional demographic factors

Institutional demographic factors were linked to teacher-educators' types of video use (see Table 3, model 1). In universities in which a masters was the highest degree offered, teacher-educators averaged 0.5 fewer video discussions with peers per course than those who worked in universities whose highest degrees were undergraduate or Ph.D. Teacher-educators who worked in private institutions averaged 0.3 more videos used for remote teaching per course than those who worked in public institutions. Our data do not explain these differences. Institution variables accounted for 2 % of the variance in teacher-educators' use of video discussions with peers and 1 % of the variance in teacher-educators' use of videos for remote teaching. Thus, institutional factors play an important mediating role between tenets of Professional development (PD) and video use.

Teacher-educator factors

Teacher-educators' years of university teaching, tenure track status, and number courses taught were significantly linked to types of video use (see Table 3, model 2). Teacher-educators who taught one year more than average at university had 0.1 more uses of video integrated within multimedia contexts and 0.3 more video case-studies per course on average. This suggests that teaching experience enhances video use, and that this is cumulative over time. For example a teacher-educator who has taught ten years longer than average will use video case-studies an additional three times and multimedia one additional time, on average per course.

Compared to other teacher-educators, those on tenure track averaged four more video case-studies per course—this results in 10 uses per course, or almost weekly

Table 3 Summary of regression coefficients of 7 multivariate models predicting teacher-educators' types of video use (with standard errors in parentheses)

Explanatory variable	Multivariate regressions predicting frequencies of types video uses						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Video-based self-reflection							
Number of non-doctoral courses taught		−0.308	−0.326	−0.333	−0.309	−0.250	−0.243
		(0.101)**	(0.097)**	(0.098)**	(0.099)**	(0.097)*	(0.094)*
Support from administrators			1.590	1.602	1.155	1.201	1.395
			(0.543)**	(0.539)**	(0.561)*	(0.546)*	(0.531)**
Practicum course					1.049	0.785	0.305
					(0.317)**	(0.314)*	(0.350)
Discipline: literacy						2.285	1.888
						(0.365)***	(0.393)***
Practicum course * discipline: literacy							1.810
							(0.640)**
Video discussion with peers							
Graduate degree highest offered	−0.488	−0.658	−0.586	−0.584	−0.584	−0.573	−0.108
	(0.220)*	(0.240)**	(0.236)*	(0.236)*	(0.241)*	(0.241)*	(0.244)
Number of non-doctoral courses taught		−0.214	−0.242	−0.251	−0.230	−0.170	−0.151
		(0.109)*	(0.104)*	(0.104)*	(0.105)*	(0.103)	(0.094)
Support from administrators			1.883	1.895	1.494	1.536	2.258
			(0.517)***	(0.515)***	(0.539)**	(0.520)**	(0.533)***
Practicum course					0.862	0.616	−0.076
					(0.286)**	(0.283)*	(0.304)
Discipline: literacy						2.234	2.263
						(0.372)***	(0.414)***

Table 3 continued

Explanatory variable	Multivariate regressions predicting frequencies of types video uses						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Graduate degree highest offered * support from administrators							−1.352
							(0.620)*
Graduate degree highest offered * discipline: literacy							−1.912
							(0.461)***
Practicum course * discipline: literacy							2.701
							(0.554)***
Video discussion with teacher educator							
Number of non-doctoral courses taught		−0.193	−0.207	−0.214	−0.206	−0.172	0.005
		(0.074)**	(0.072)**	(0.072)**	(0.070)**	(0.072)*	(0.103)
Support for access to technology			0.522	0.539	0.608	0.552	0.404
			(0.241)*	(0.242)*	(0.243)*	(0.246)*	(0.248)
Hybrid course					1.867	1.979	1.958
					(0.476)***	(0.481)***	(0.472)***
Discipline: Literacy						1.003	1.042
						(0.318)**	(0.316)**
Number of non-doctoral courses taught * Support for access to technology							−0.274
							(0.114)*
Video integrated within multimedia context							
Years teaching at the college/university level		0.118	0.113	0.124	0.121	0.102	0.111
		(0.030)***	(0.030)***	(0.031)***	(0.030)***	(0.031)**	(0.030)***
Support: experience using technology			1.126	0.987	1.045	0.959	0.440
			(0.514)*	(0.525)	(0.520)*	(0.524)	(0.532)

Table 3 continued

Explanatory variable	Multivariate regressions predicting frequencies of types video uses						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Graduate course				−1.056	−1.290	−1.186	−1.185
				(0.310)**	(0.321)***	(0.320)***	(0.318)***
Online course					1.006	1.037	−0.585
					(0.401)*	(0.397)**	(0.596)
Discipline: Literacy						1.684	1.557
						(0.429)***	(0.427)***
Support: experience using technology * online course							2.684
							(0.751)***
Video case studies							
Years teaching at the college/university level		0.299	0.298	0.302	0.295	0.255	0.070
		(0.058)***	(0.057)***	(0.058)***	(0.055)***	(0.052)***	(0.048)
Tenure track		4.056	3.994	3.858	3.986	4.054	4.073
		(1.031)***	(1.026)***	(1.033)	(0.988)***	(0.923)***	(1.010)***
Graduate course				−1.322	−1.765	−1.544	−1.149
				(0.534)*	(0.549)**	(0.546)**	(0.531)*
Online course					2.369	2.658	−1.128
					(0.678)***	(0.665)***	(0.741)
Subject: literacy						3.694	2.167
						(0.748)***	(0.747)**
Subject: special education						1.618	3.738
						(0.687)*	(0.987)***
Years teaching at the college/university level * tenure track							0.465
							(0.113)***

Table 3 continued

Explanatory variable	Multivariate regressions predicting frequencies of types video uses						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Years teaching at the college/university level * online course							0.287
							(0.075)***
Tenure track * online course							7.133
							(1.391)***
Graduate course * discipline: special education							−3.066
							(1.247)*
Online course * discipline: literacy							7.960
							(1.418)***
Video used to focus on course content							
Graduate course				−0.893	−0.879	−0.905	−0.938
				(0.319)**	(0.319)**	(0.320)**	(0.317)**
Video used to focus on children							
Graduate course				−0.115	−0.115	−0.119	−0.068
				(0.053)*	(0.053)*	(0.053)*	(0.056)
Discipline: early childhood						0.221	0.509
						(0.085)**	(0.138)***
Graduate course * discipline: early childhood							−0.457
							(0.173)**
Video used to focus on how to teach							
Hybrid course					1.657	1.635	1.685
					(0.351)***	(0.349)***	(0.350)***

Table 3 continued

Explanatory variable	Multivariate regressions predicting frequencies of types video uses						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Video used from the internet							
Number of non-doctoral courses taught[2]		0.008	0.008	0.010	0.009	0.009	0.010
		(0.004)*	(0.004)*	(0.004)*	(0.004)*	(0.004)*	(0.004)**
Support: experience using technology			0.418	0.400	0.395	0.400	0.431
			(0.147)**	(0.146)**	(0.151)**	(0.149)**	(0.148)**
Graduate course				−0.602	−0.551	−0.555	−0.550
				(0.203)**	(0.204)**	(0.204)**	(0.203)**
Service-learning course					3.867	3.777	3.517
					(1.126)**	(1.125)**	(1.137)**
Number of non-doctoral courses taught[2] * Service-learning course							−0.140
							(0.053)**
Video used for remote teaching							
Private institution	0.277	0.284	0.283	0.281	0.290	0.287	0.292
	(0.113)*	(0.113)*	(0.113)*	(0.113)*	(0.113)*	(0.112)*	(0.112)**

Variance at each level	Explained variance at each level						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Video-based self-reflection							
Teacher educator (34 %)	0.000	0.148	0.229	0.228	0.176	0.239	0.265
Course (66 %)	0.002	0.004	0.001	0.002	0.034	0.099	0.103
Total variance explained	0.000	0.053	0.080	0.080	0.083	0.147	0.159
Video discussion with peers							
Teacher educator (38 %)	0.053	0.137	0.251	0.251	0.201	0.277	0.415

Table 3 continued

Variance at each level	Explained variance at each level						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Course (62 %)	0.000	0.000	0.000	0.000	0.024	0.078	0.101
Total variance explained	0.019	0.050	0.091	0.091	0.090	0.153	0.220
Video discussion with teacher educator							
Teacher educator (18 %)	0.000	0.119	0.249	0.247	0.305	0.273	0.326
Course (82 %)	0.001	0.002	0.002	0.003	0.031	0.057	0.060
Total variance explained	0.000	0.024	0.047	0.048	0.082	0.097	0.109
Video integrated within multimedia context							
Teacher educator (42 %)	0.001	0.172	0.215	0.192	0.235	0.235	0.279
Course (58 %)	0.000	0.002	0.004	0.043	0.049	0.083	0.095
Total variance explained	0.000	0.073	0.093	0.105	0.127	0.147	0.173
Video case studies							
Teacher educator (36 %)	0.000	0.239	0.242	0.226	0.304	0.481	0.743
Course (64 %)	0.000	0.006	0.006	0.026	0.030	0.045	0.122
Total variance explained	0.000	0.090	0.091	0.098	0.129	0.203	0.347
Video used to focus on content							
Teacher educator (7 %)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Course (93 %)	0.000	0.001	0.001	0.022	0.022	0.022	0.023
Total variance explained	0.000	0.000	0.000	0.017	0.017	0.017	0.016
Video used to focus on children							
Teacher educator (5 %)	0.000	0.004	0.007	0.000	0.000	0.084	0.037
Course (95 %)	0.000	0.000	0.001	0.019	0.019	0.023	0.039
Total variance explained	0.000	0.001	0.001	0.009	0.009	0.026	0.039

Table 3 continued

Variance at each level	Explained variance at each level						
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Video used to focus on how to teach							
Teacher educator (15 %)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Course (85 %)	0.001	0.001	0.003	0.003	0.062	0.060	0.062
Total variance explained	0.000	0.000	0.001	0.000	0.033	0.033	0.033
Video used from the internet							
Teacher educator (5 %)	0.000	0.164	0.389	0.558	0.471	0.461	0.565
Course (95 %)	0.000	0.003	0.002	0.013	0.040	0.039	0.046
Total variance explained	0.000	0.009	0.018	0.035	0.058	0.056	0.067
Video used for remote teaching							
Teacher educator (0 %)	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Course (100 %)	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Total variance explained	0.014	0.014	0.014	0.014	0.014	0.014	0.014
All types of uses							
Teacher educator (25 %)	0.016	0.172	0.268	0.204	0.222	0.462	0.549
Course (75 %)	0.000	0.003	0.003	0.040	0.059	0.127	0.153
Total variance explained	0.004	0.046	0.071	0.082	0.100	0.212	0.254

Each regression model included a constant term

* $p < .05$; ** $p < .01$; *** $p < .001$

use of video. The case is clear for having experienced and tenure-track faculty teaching education courses.

Additionally, teacher-educators who taught one more course than average used fewer video-based self-reflections (−0.3), video discussions with peers (−0.2), or video discussions with teacher-educators (−0.2) per course on average. This may be related to how these video methods are implemented in courses. For example, if teacher educators grade self-reflections and participation in video discussions, then those faculty who teach more courses would have significantly more work in terms of grading assignments as compared to those faculty who teach fewer courses.

Meanwhile, teacher-educators' number of courses had a non-linear relationship with videos used from the Internet—those who taught one more course than average had 0.1 more videos used from the Internet per course while those who taught two more courses than average had 0.3 more videos used from the Internet per course. Again, we expect that this has to do with the time needed to implement this method (for example, videos on the Internet are already prepared and accessible to students, so the teacher educator has less preparation time to use these as compared to making videos or loading them onto a platform to share with students).

Altogether, teacher educator variables accounted for 5 % of additional variance in video-based self-reflection, 3 % in video discussions with peers, 2 % in video discussions with teacher-educators, 7 % in video integrated within multimedia contexts, 9 % in video case-studies, and 1 % in video from the Internet. Thus, educator factors serve as important mediators between tenets of PD and video use in teacher education.

Support factors

Support from administrators, access to technology, and experiences using technologies were significantly linked to types of video use. Teacher-educators who received support from administrators averaged use of two more video-based self-reflections and two more video discussions with peers per course (see Table 3, model 3). So, support from administration results in 67 % more video use. Meanwhile, teacher-educators with access to technology averaged 0.5 more video discussions with teacher-educators per course. Clearly, support and resources from administration are critical.

Moreover, teacher-educators who had experience using technology averaged one more use of video integrated within multimedia contexts and 0.4 more uses of video from the Internet per course. Considering that teacher-educators use video in multimedia about once per course (on average; see summary statistics), this means that experiences using technology doubles its use. Thus, building teacher-educators' experiences using technology is critical.

Altogether, support factors accounted for 3 % of additional variance in video-based self-reflection, 4 % in video discussions with peers, 3 % in video discussions with teacher-educators, 2 % in video integrated within multimedia contexts, and 1 % in video from the Internet. Thus, support factors also mediate the utilization of tenets of PD through use of video in teacher education.

Course factors

Course levels and delivery models were also significantly linked to types of video use. When teaching graduate courses (versus undergraduate courses), teacher-educators averaged one more use of video integrated in a multimedia context, one more use of video case-study, one more use of video to focus on course content, 0.1 more videos to focus on children, and 0.6 more videos used from the Internet per course (see Table 3, model 4). Thus, teaching graduate courses has an almost globally positive effect on video use. We conjecture that this may be related to the use of video to connect with professional practices being developed at this level; however, in our view, using video for this purpose is equally important in undergraduate courses that can connect to practices in their practicum experiences.

When teaching online courses (versus all other delivery formats), teacher-educators averaged one more use of video integrated into a multimedia context, and two more uses of video case-studies per course (see Table 3, model 5). Thus, teaching online almost doubles these two uses of video in online formats. When teaching hybrid courses, teacher-educators averaged two more video discussions with teacher-educators or two more videos used to focus on how to teach per course—these reflect at least a 200 % increase in use. When teaching practicum courses, teacher-educators averaged one more use of video-based self-reflection and one more use of video discussions with peers per course—this doubles the average use for these video methods. When teaching service-learning courses, teacher-educators averaged four more uses of videos from the Internet per course—over a 400 % increase from the average 0.34 uses overall.

Course variables accounted for 0.3 % of additional variance in video-based self-reflection, 3 % in video discussions with teacher-educators, 3 % in video integrated within multimedia contexts, 4 % in video case-studies, and 2 % in video with a focus on course content, 1 % in video with a focus on children, 3 % in videos that focus on how to teach, and 4 % in videos used from the Internet.

Discipline-area factors

Literacy, special education, and early childhood courses were linked to types of video use. When teaching literacy courses, teacher-educators averaged two more uses of video-based self-reflections, two more uses of video discussions with peers, one more use of video discussion with teacher-educators, two more uses of video integrated into multimedia contexts, and four more uses of video case-studies per course (see Table 3, model 6). It is important to note that most of these increases are over 100 %, and are for video methods used less than once per course on average, showing not only more use of video methods, but also more use of less-often used methods in literacy teacher education. When teaching special education courses, teacher-educators averaged two more uses of video case-studies per course. This almost doubles the average for case-study use. When teaching early childhood courses, teacher-educators averaged 0.2 more uses of video to focus on children per course. This is four times greater than the overall average use of video that focuses on children (0.05).

Discipline area variables accounted for 7 % of additional variance in video-based self-reflection, 6 % in video discussions with peers, 2 % in video discussions with teacher-educators, 2 % in video integrated within multimedia contexts, 7 % in video case-studies, and 2 % in video with a focus on children. This may suggest that certain disciplines have more experience in using certain methods, or that particular methods are more useful for different disciplines (for example, the focus on the child in early childhood).

Interaction effects

Factors interacted to affect teacher-educators' types of video use (see Table 3, model 7). In universities in which the highest degree offered is a masters, support from administrators, or teaching a literacy course had smaller effects on teacher-educators' use of video discussions with peers (−1 or −2 [fewer] times per course, respectively). Further, for practicum courses, teaching literacy had larger effects for the use of video discussions with peers (+3 more times per course; see Fig. 9). This is likely because teachers are discussing video of their practicum instruction in these courses, which highlights the benefits of connecting video methods with practica experiences.

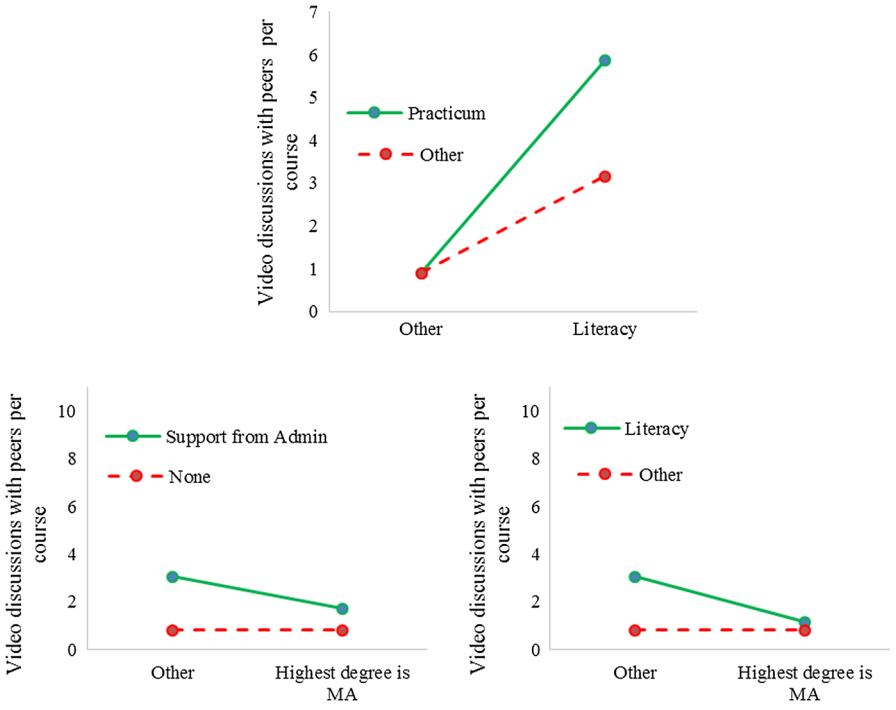

Fig. 9 Interactions between factors related to the use of video discussions with peers

For teacher-educators who taught more courses, access to technology had a smaller effect on use of video discussions with teacher-educators (−0.3 fewer times per course). See Fig. 10. For teacher-educators whose university teaching exceeded the mean by a year, being on tenure track, and teaching an online course had larger effects on use of video case-studies (+0.5, +0.3 more times per course, respectively). Additionally, online courses showed larger effects for use of video case-studies for literacy courses. Possibly these provided a way to model methods that could not be modeled in person.

Further, graduate courses showed weaker effects for using video case-studies in special education (−3 [fewer] times per course; see Fig. 11). We wonder if this might be related to privacy issue for the children who would be featured in the videos. For practicum courses, teaching literacy had larger effects on the use of video-based self-reflections (+2 or more times per course; see Fig. 12). This may be related to the strong tradition of engaging in reflective practices in literacy education. Online courses showed larger effects for experience using technology on use of video integrated within multimedia contexts (+3 more times per course; see Fig. 13). It seems plausible that this may be related to the need for greater technological skill to set up a multimedia environment.

For teacher-educators who taught more courses, teaching a service-learning course had a larger effect on use of videos from the Internet (+0.1 times more per course). Graduate courses showed weaker effects for using videos to focus on children in early childhood education (−0.5 [fewer] times per course; see Fig. 14). We wonder if this is related to a shift from focus on practices in general (like, focus on a video of a child) to videos of one's own practices (like, pedagogy with the child).

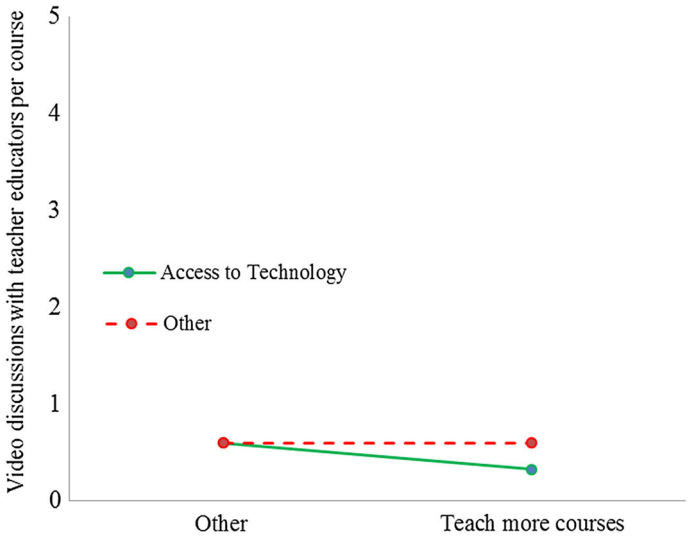

Fig. 10 Interactions between factors related to the use of video discussions with teacher-educators

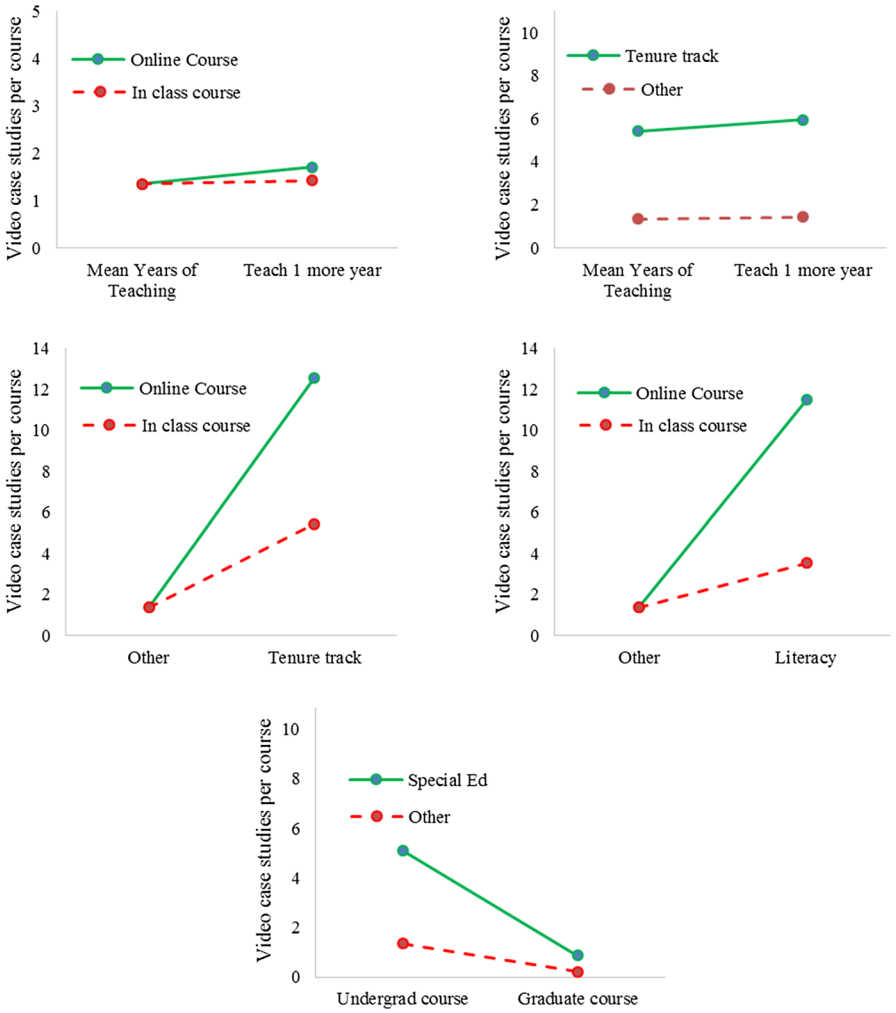

Fig. 11 Interactions between factors related to the use of video case studies

Discussion

This study identified the extent to which teacher-educators in our state are using video methods in their teacher-education courses, as well as what types of video they are using, and factors that impact these uses. These findings extend previous research about the use of technology in education and factors related to its use (Birch and Burnett 2009; Fresen 2010; Jan et al. 2012) by providing specific information about these issues for video use in teacher education. In this section, we evaluate the current state of video use in teacher education in our state against the principles identified in our conceptual framework, discuss how our results provide a

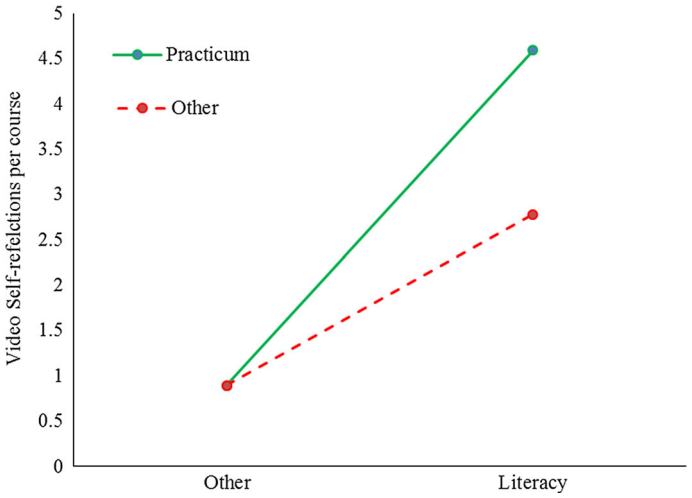

Fig. 12 Interactions between factors related to the use of video-based self-reflections

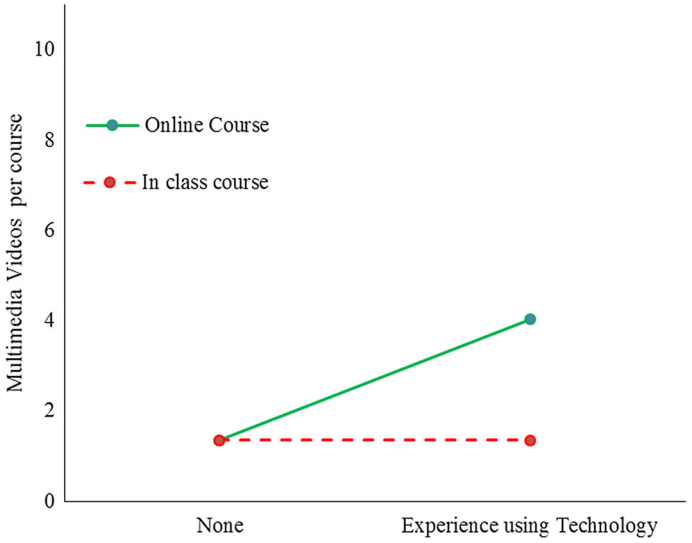

Fig. 13 Interactions between factors related to the use of video embedded within multimedia contexts

more nuanced view of the factors that impact video use in teacher education to build on our initial conceptual framework, provide implications for improving the use of video in teacher education, and discuss limitations of the study and future research directions.

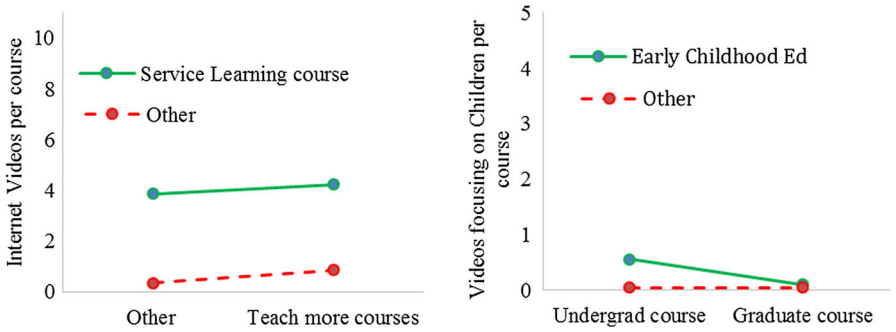

Fig. 14 Interactions between factors related to other types of video use

The current state of video use in teacher education

Our conceptual framework identified two key principles for video use in teacher education: (1) multiple video methods should be used, and (2) these should be sustained over time. In comparing our results to these criteria, we find that video use in teacher education could be improved both by having more teacher educators use video more frequently over time, and by having them use a combination of methods within each of their courses.

More video use across time is needed

Our finding that teacher-educators used video, on average, 6 times per semester may result in thinking that current video use is sufficient. However, this average is misleading, because while some use it one or more times per week, many use it less than 4 times per semester (recall that the distribution was bimodal). Therefore, while one might argue that if video is well integrated in the course six times per semester could be effective to support teachers' learning, but in actuality few teacher educators are doing so. Thus, the use of video is not being sustained over time by many teacher educators, as is suggested by professional development research (Wei et al. 2009). Given the important connection between video methods and teacher outcomes, we suggest that more teacher-educators should use video more frequently across the semester.

Integrating multiple video methods is needed

We found that typically only one type of video was used per course. This is also problematic given that our conceptual framework shows that multiple video methods are needed to meet a variety of high quality professional development tents and teacher outcomes. These findings highlight the need to find out why teacher-educators are not using video adequately and regularly in their courses. Further, they underscore the importance of providing professional development that highlights

the need to use multiple video methods across the semester in teacher-education courses.

A more nuanced view of the factors impacting video use

Understanding the factors related to video use in teacher education is important given the vast research supporting its use (Arya et al. 2015; Christ et al. 2012, 2014; Harford and MacRuairc 2008; Tripp and Rich 2012; van Es and Sherin 2010). While our conceptual framework identified factors that affect technology use in education, our research findings identified which of these specifically affected video use in teacher education and how. Thus, these findings build on and extend our initial conceptual framework.

Unlike the broader research on technology integration in education, we did not find that student factors were related to video use in teacher education. This might have been because teacher-educator report data was used in our study, or due to real differences between the factors that affect technology use in education versus video use in teacher education. Further research is needed to understand this finding.

Additionally, our findings show more nuanced relations between these factors and video use. Teacher-educator, course, and discipline factors affected whether teacher educators used any video at all, as well as the types of video they used in the courses. In addition to these, institution and support factors also affected specific types of use of video. Further, the findings highlight how factors do not always operate independently but work together to impact educators' video use in their courses. For example, a combination of institution, support, and discipline factors affected educators' types of video use; whereas course and teacher-educator factors together influenced not only whether educators use videos, but also what types of videos they used. These findings both contribute to our conceptual model and provide important implications for practice.

Implications for improving video use in teacher education

Based on our findings about the factors that impact video use in teacher education, we suggest that to improve video use in teacher education we need to (1) use more faculty who are tenured and have been teaching longer, and control how many courses they teach; (2) provide multiple kinds of supports for teacher-educators, including professional development (PD); and (3) provide opportunities for faculty to teach across course formats, and provide PD to help them do so.

Faculty and the courses they teach

According to our findings, who teacher-educators are and how many courses they teach matter. If we want to increase video use, then the field should use more tenure-track and experienced faculty to teach education courses. In particular, we found that more experienced and tenure track teacher-educators were not only more likely to use video overall, but they were also more likely to integrate specific uses of video, such as video integrated within multimedia contexts and video case-studies.

Additionally, teacher-educators should teach fewer than six courses per year to promote video use, particularly the use of video for self-reflection, discussion with peers, and discussion with teacher-educators. This finding aligns with previous research that showed a lower course load facilitated educators' use of technology (Birch and Burnett 2009; Kenney and Newcombe 2011). Alternatively, another solution may be to provide professional development to help teacher educators integrate these methods in ways that require less outside of class time, such as having students self-assess their participation, assess one another's participation, or not assess participation could potentially increase the use of these video methods by reducing the time demands of grading.

Supports including PD

Multiple supports for use of video also seem prudent to provide, including professional development, to increase video use in teacher education. These include support from administrators for implementing video-based self-reflections, access to technology to support video discussions with teacher-educators, and opportunities to expand teacher-educators' experiences with technology (since our findings show that teacher-educators' experience with technology is related to using video integrated within multimedia contexts and video from the Internet). Our findings align with the supports identified as important in previous research (Ahmadpour and Mirdamadi 2010; Birch and Burnett 2009; Jan et al. 2012; Jenkins et al. 2011; Kampov-Polevoi 2010; Louw et al. 2009; Tshabalala et al. 2014).

Opportunities to teach across course formats and PD

Since we found that video is used more frequently in graduate and online courses, and previous research showed that educators' use of video for online courses was related to their integration of video in other formats (for example, face-to-face courses; Kampov-Polevoi 2010), it may be worth exploring whether having teacher-educators teach across multiple formats and levels may increase their overall video use. This might also help carry specific uses of video in one format over to other course formats that same teacher-educator teaches. This is important because each type of video use supports different aspects of learning—like, video case-studies support development of theory-to-practice connections and decision-making in ill-defined domains (Moyle 2008; Spiro et al. 1988) and video-based self-reflections and video discussions with peers about one's own practices support understanding how to improving one's teaching (Arya et al. 2013, 2015; Christ et al. 2012, 2014; Eröz-Tuga 2013; Rosaen et al. 2008; van Es and Sherin 2010). Thus, providing professional development for teacher educators that explain and model how to use different types of video methods within a course may lead to both greater breadth and depth of learning by education students.

Limitations and future research suggestions

While our research extends previous research and provides implications for improving the use of video in teacher education, it has some limitations pertaining both to design and understanding the findings.

Four limitations related to design provide directions for future research. First, since "respondents differ in significant ways from non-respondents" (Fowler 2014, p. 45), we hypothesize that teacher-educators who were less likely to use video might also have been less likely to respond to our survey. If so, the results might represent an overestimation of the use of video in teacher education. Future research in this area might use other methods to avoid this problem. Second, we sampled teacher-educators in our state, so we do not know whether these results are representative of national or international populations of teacher-educators. Further research is necessary to explore these issues. Third, while we focused on individual instructors use of video in their courses, future research might also examine video use across teacher education programs. Fourth, while our survey data tell us about the extent and categories of video use in teacher education, they do not tell us about the quality of these uses, such as opportunities to collaborate with colleagues about video use or the extent to which video methods integrate well with other aspects of a course (for example, practicum experiences). These important issues should also be addressed through future research.

Additionally, two issues related to understanding our findings warrant further research. First, institutional demographic factors made a difference in use of video, but it is unclear why universities that offer a master's as the highest degree would have fewer uses of video than those universities that have undergraduate or Ph.D. as the highest degree. While this finding is in line with previous research that found differences in types of universities were related to differences in technology use (Jenkins et al. 2011; Meyer and Xu 2009), future research might explore reasons for these findings. Second, we found differences in the use of videos across various disciplines in teacher education, which aligns with previous research findings that discipline-area affects technology use (Jenkins et al. 2011; Meyer and Xu 2009), but 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 these disciplines (Borko et al. 2008; Llinares and Valls 2010; van Es and Sherin 2010; Zhang et al. 2011). Additionally, we are unsure why discipline-area was related to types of video use. For example, while literacy courses used a variety of types of video more frequently than other disciplines (video-based self-reflections, video discussions with peers, video discussion with teacher-educators, video integrated into multimedia contexts, and video case-studies), special education courses used video case-studies more frequently than all other disciplines except for literacy and early childhood education used more video to focus on children than all other disciplines. Future research, such as interviewing teacher-educators across disciplines, might explore these issues.

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Poonam Arya is an associate professor of Reading, Language, and Literature at Wayne State University where she teaches courses in literacy theory and research, reading assessment, and critical pedagogy. Her research interests include studying collaborative discussions of videos to support teachers' reflective practice and decision-making processes; eye movements, retellings and oral readings of children as they transact with multimodal texts. Her work has appeared in journals like Reading Research Quarterly, Language Arts, The Kappan, Journal of Technology and Teacher Education, and Journal of Teacher Education. She can be reached at 279 Education Building, Department of Reading, Language, and

Literature, College of Education, Wayne State University, Detroit, MI 48302, USA, or by email at parya@wayne.edu.

Tanya Christ is an Associate Professor of Reading and Language Arts at Oakland University. She teaches courses related to reading assessment and instruction practices for K-12. Her research focuses on teacher education, early childhood literacy processes, and issues of culture and equity. She has taught both inclusion and general education in Title 1 classrooms in Brooklyn, NY. Her work appears in journals such as Journal of Teacher Education, Journal of Literacy Research, Early Childhood Research Quarterly, and Journal of Research in Reading. She can be reached at 460F Pawley Hall, Department of Reading and Language Arts, School of Education and Human Services, Oakland University, Rochester, MI 48309, USA or by email at christ@oakland.edu.

Ming Ming Chiu is Charles R. Hicks Professor of Educational Psychology and Research Methodology at Purdue University. He invented two statistics methods: statistical discourse analysis (SDA) and multilevel diffusion analysis (MDA). SDA models online and face-to-face conversations, showing how students' social metacognitive skills enhance their micro-creativity. MDA shows how ideas spread through populations and detects corruption in the music industry. Dr. Chiu also showed how economic growth, inequalities and cultural values affect nearly 500,000 students learning in 65 countries. Supported by 26 grants totaling over $4.5 million, he disseminated his research through 164 publications (including 89 journal articles), 3 television broadcasts, 17 radio broadcasts, and 148 news articles in 21 countries and regions. He can be reached via email at mingmingchiu@gmail.com.