How Preservice Teachers Respond to Representations of Practice: A Comparison of Animations and Video[1]

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Abstract

We compared effects of video and animated representations of teaching practice among teacher candidates. Sixty-one participants completed a questionnaire rating the representation in terms of its genuineness and its effectiveness enabling users to project to it their own experiences, to reflect, to conceive of alternative actions, and to notice aspects of subject matter and pedagogy. While participants significantly rated video as more genuine than animations, no significant differences were found in any of the other measures. The study thus raises no learning concerns about developing representations of practice with nondescript cartoon characters and using these in professional education.

Introduction

The problem of how to create, inside professional preparation programs, opportunities for novices to contend with the demands of practice while making use of relevant academic knowledge has been a mainstay in professional education. In teacher education the problem dates back to Dewey (1904), who questioned the educative potential of traditional separation between university courses focused on academic knowledge and complete immersion in school placements. Dewey advocated for a laboratory approach, where novice teachers would have opportunities to practice in a setting that included some of the complexities of real practice (e.g., actual students with learning difficulties) but where rich resources (e.g., especially prepared mentors) could support the novice's reflective use of theory and research. The Laboratory schools that developed after Dewey's proposal and the Professional Development Schools that emerged in the 80s are examples of designed settings where, among other things, future teachers can practice teaching with actual students (Goodlad, 1999; Winitzky, Stoddard, & O'Keefe, 1992). While the laboratory schools have been in decline since the 60's, designed settings for teacher candidates to practice have continued to emerge (e.g., Chazan, Callis, & Lehmann, 2008). In contemporary calls for research schools that can bridge the gap between educational research and practice (e.g., Hinton & Fischer, 2008), there continues to be an effort to use those settings for the professional training of novice practitioners, much in the way university hospitals serve as training grounds for young physicians.

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[1] Paper presented at the 2013 Annual Meeting of the American Educational Research Association, San Francisco.

[2] The work reported in this paper was done with the support of NSF grants ESI-0353285 and DRL-0918425 to Patricio Herbst. Opinions expressed here are the sole responsibility of the authors and do not necessarily reflect the views of the Foundation.

The era of accountability after the NCLB legislation has required teachers to demonstrate that they are not only knowledgeable but also effective. The need to ground effectiveness on a professional knowledge base has made ever more important the need to design settings where novices can develop and use that knowledge base. Appropriately, Lampert (2011) has called for the learning of teaching to be *in*, *from*, and *for* practice: Professional learning of teaching needs to be situated in activities that approximate that work, draw its curriculum from the work of teaching, and aim at competent performance doing that work. To implement such practice-oriented professional training is difficult, not the least because the interests of actual students must be protected. Thus teacher candidates may need to have some preparation for practice before encountering actual students in designed settings like professional development schools. This suggests an important design question: How can practice-based, professional learning opportunities be designed for novices at an early time, when it may not be wise to have them practice with actual clients?

In the professional preparation of teachers there have been two main approaches to usher teacher candidates into the practice of teaching. One of those categories includes engaging teacher candidates in the analysis of cases of teaching in the form of written descriptions of lessons or students' work or in the form of video, audio, or photographic records of practice (e.g., Lampert & Ball, 1998; Stein, Smith, Henningsen, and Silver, 2000). The other category includes engaging teacher candidates in the design and production of lessons and rehearsal of strategies and techniques having peers or mentors play the role of students (e.g., Allen & Eve, 1968; Lampert & Graziani, 2009). More recently, teacher educators have also used activities of scripting lesson dialogues (Crespo, Oslund, and Parks, 2011; Ghousseini, 2008; Zazkis, Sinclair, and Liliejdahl, 2013). Against that backdrop, the increased ease of production, navigation, and annotation of digital graphics content has brought a new medium for the consideration of teacher educators: Animations and digital comics created with cartoon characters.

In the context of ThEMaT, a funded NSF proposal to the Teachers' Professional Continuum program, Herbst and Chazan (2003) proposed the development of cartoon-animated videos to represent scenarios in the teaching of high school algebra and geometry. These scholars have used the scenarios as triggers for conversations about practice among experienced practitioners (Herbst, Nachlieli, and Chazan, 2011), but they have also been used with novices (Moore Russo & Viglietti, 2011). Among its byproducts, ThEMaT produced an authoring tool, Depict[3] (Herbst & Chieu, 2011) with which users can create scenarios in the form of image sequences and which has shown to make a difference in future teachers anticipation of classroom lessons (Chen, 2012; Herbst, Chazan, Chen, Chieu, & Weiss, 2011). In parallel with that development, Tettegah (2005) also proposed the use of animated vignettes realized with cartoon characters for the development of understanding of psychological and social issues in learning. Bailey, Tettegah, and Bradley (2006), developed an authoring tool (Clover) which was used with teacher candidates to develop scenarios reflecting moral problem solving in teaching (Tettegah, Bailey, and Taylor, 2007). Also, in parallel with the ThEMaT and Clover projects, Moreno (2009; Moreno & Ortegano-Layne, 2008) developed an animated video case that she used to study novice teachers' learning of educational psychology concepts. Beneath these three projects was the thought is that if teacher candidates could relate to cartoon-based representations of practice, authoring software and professional learning opportunities could be designed for them

[3] Depict is a web-based tool available in the LessonSketch environment (www.lessonsketch.org).

to practice teaching virtually. This paper describes an experimental study comparing video records and animated representations of instruction as the basis to mount pedagogies of practice at early stages of professional preparation.

Theoretical Framework

Grossman and colleagues (2009) investigated preparation for professional practice in education, counseling, and the ministry. They identified three concepts that describe how professional practices are taught. Pedagogies of practice rely on *representations of practice*, such as video records or written cases, that make practice amenable to observation. Pedagogies of practice rely on *decompositions of practice,* such as checklists or descriptions that articulate the components of a professional activity. Pedagogies of practice also rely on *approximations of practice,* such as a role-playing activities or simulations. If novices could learn from cartoon-based representations of practice, approximations of practice could also be designed for budding professionals to practice virtually (e.g., through simulations that use a cartoon-based interface, see Chieu & Herbst, 2011).

We've taken inspiration from other fields of professional practice (e.g., dance) where representation systems have been designed to enable the study of practices (Guest, 1989; see also Preston-Dunlop, 1969). Teaching, like other interpersonal professions and trades (e.g., business management, clinical medicine, interior design, home organizing, concierge services) requires professionals to handle resources and people, in space and time, through action and language. Such complex practices could be represented in written descriptions or recorded in video, photography, and assemblages of artifacts. But those options have their own difficulties.

Text cases have been used for decades in many professions. But they present important problems as representations of practice. In particular, they often denaturalize the phenomena, reducing practice to what language can represent and casting professional knowledge as explicit, which oftentimes is not (Brown & Duguid, 1991). However, practice often relies on a background that is unspoken but rather coped with in a practitioner's understanding of a practice (Dreyfus, 1980; Stern, 2000). The skill to perceive the need for and the context of professional actions and decisions calls for immersion in cases that are rendered with the many modalities of a practice. In the case of teaching these modalities include visual, auditory, gestural, kinesthetic, and temporal, all of which are involved in professional meaning making; cases that represent practice in more of those modalities are more likely to achieve what scholars have called presence: The illusion that a mediated experience is not mediated (Lombard & Ditton, 1997).

The use of videocases has often been recommended on account of its capacity to better reproduce the multimodality of practice (Tochon, 1999). Many professions rely on experiential learning opportunities realized through video or multimedia including video records of practice (e.g., Lampert & Ball, 1998). But the capacity to assemble video records of practice is limited to what can be collected and shared. Furthermore, video records can present practice as too complex or too particular to context to be learnable. It seems that while video includes many of the communication modalities of actual practice, experiences for novices to learn could rely on scaffolding those.

We ask the question, how could a system of representation for teaching practice be designed that could communicate practical knowledge and enable its study by novices? Toward that end we've been exploring the role of animations and comics that use cartoon characters to represent classroom scenarios. The undertaking of this enterprise requires us to ask whether cartoon-based representations of teaching provide comparable opportunities for learning as other resources, particularly video records and written cases which are the norm in our field. In one earlier comparison Moreno and Ortegano-Layne (2008) showed that video and animation better facilitated future teachers' learning of educational psychology than a written text condition or a control condition where instruction was provided without reference to any case. Our study builds on that early work by exploring how animations and videos compare when they are put to use in various tasks relevant for the study of teaching. The present study considers variations in how the animation could be rendered, using in particular two animation conditions, one that displays students and teacher very schematically and another one where more graphical elements are used to display physical individualities.

We note that while our group has been at the forefront of the use of comics and animations in the representation of professional practice, interest has been mounting inside and outside of education. An early attempt to represent education practice using comics is found in Balacheff (1988) where Balacheff used comics as an alternative way of displaying, for practicing teachers, different conceptions of mathematical proof. The efforts by Tettegah in education foundations and by Moreno in educational psychology paralleled ours in mathematics education. More recently, the development of Simschool has demonstrated how cartoon characters can be used to design the user interface of an intelligent simulator of student personalities (Christensen, Knezek, Tyler-Wood, and Gibson, 2011). Similarly, the TeachLive system designed by Dieker, Hynes, Hughes, and Smith (2008) uses a cartoon interface to mediate the interactions between a teacher candidate practicing teaching and interactors representing students of different personalities.

Outside of teacher education, comics, animations, and hybrids have been used in other sorts of training. Of recent salience in the news (McDonald, 2013) are the efforts by Jeremy Short and his colleagues who wrote management textbooks in comics form (Ketchen, Short, Combs, and Terrell, 2011; Short, Bauer, Ketchen, and Simon, 2011) and used them to teach university courses in business management (Short and Reeves, 2009). Likewise, in England KnowHowNonProfit, a part of the National Council of Voluntary Organizations (NCVO) has developed the Millcaster Tales, a narrative series realized through image sequences with voice over, dedicated to represent the know how of managing non profit organizations (see http://knowhownonprofit.org/millcaster; Holtham & Rich, 2012). Also, Pink & Ten-Pas (2008) have used the comics format to teach career development in the business sector. Upson & Hall (2013) provide an account of a variety of ways in which comics have been used in education writ large. The differences among the interest of users of comics and animation in education in the medium are possibly more salient than their similarities, but they suggest an evolving interest in the communicational virtues of the medium, as opposed to the critiques of the medium as debased literature pitched around the mid-twentieth century (see Jacobs, 2007).

Empirical studies on the benefits of the medium have varied in the outcome variables used. According to McDonald (2013) the recent study by Short used as outcome variable the extent of students' absorption of information and indicates that the study found comparable

absorption and better verbatim recall among users of the comic book version than among users of the text-only version. Other writings identify engagement and motivation as desired outcomes.

In teacher education, outcome variables can vary depending on the design of the cases. It is of course possible to look into mediate effects such as acquisition of information, yet it is also important to understand the characteristics of the engagement between users and media. In fact, much of the use of video in teacher education has sought to engage teacher candidates in detailed observation of classroom interaction focusing either on interpreting what students do and say or in analyzing and tinkering with the actions and decisions of the videotaped teachers. The content conveyed by videocases has sometimes been exemplary (Wang & Hartley, 2003) while in other cases chosen on the basis of completely different reasons: For example, Sherin and van Es (2005), used videos recorded in classrooms taught by the participants of their video club, while Nachlieli and Herbst (2009) used a video clip that included a deviation from a norm in instruction. We surmise that regardless of the goals that lead to the choice of one or another piece of video, the medium needs to support various intellectual and practical activities with it that would eventually help achieve those goals. The manner in which viewers might engage with the video could be described along several characteristics. In this study we asked participants questions that gauged how they were processing the information in the video or animations shown, we scored them on those questions, and sought to compare whether participants' scores on those questions depended on whether they had watched a video or an animation.

Method

This comparison is situated in the context of pre-service secondary mathematics teacher education. A two-hour interview protocol was designed and administered to participants who saw a case of instruction rendered either by its video record or by one of two animated translations of the recorded lesson. The protocol was arranged in six sections: genuineness, projectiveness, mathematics, noticing, reflectiveness, and alternativity, described in Table 1.

Table 1: Types and goals of questions in interview protocol

Section	*Goal of questions*
Genuineness	Comparing participants' perception of the genuineness of the representation, attending to how individuals and practices were perceived
Projectiveness	Detecting whether participants could imagine themselves taking part in a similar scenario either as the teacher or as a student
Mathematics	Assessing how much of the mathematics involved in the lesson participants could notice
Noticing	Assessing how much of the teaching and student work participants could notice, an issue that has been important for mathematics teacher educators who use video in their work (Sherin, Jacobs, and Philipp, 2010)
Reflectiveness	Aimed at finding out whether the representation elicits thinking about different aspects of the work of teaching (e.g., engaging students, clarifying what students mean)
Alternativity	Aimed at determining the extent to which a participant is able to entertain courses of action alternative to what they observed and the consequences of

	those actions

The interview was administered to participants in three conditions. In the video condition, participants had access to a 6 min unedited video clip of a high school geometry lesson. The only modification made to the raw video was the use of an effect that blurred the faces of the students and the teacher in order to preserve anonymity. The second and third conditions used animations that depicted the same episode captured in the video. To develop each animation we transcribed the video and recorded an audio track of the dialogue, laying an animated videotrack on it . One of these animated representations uses a nondescript character set with little graphical support for characters' individuality (the "ThExpians B", Figure 1) while the second used a more complex character set (the "ThExpians P", Figure 2) with greater character individuality.

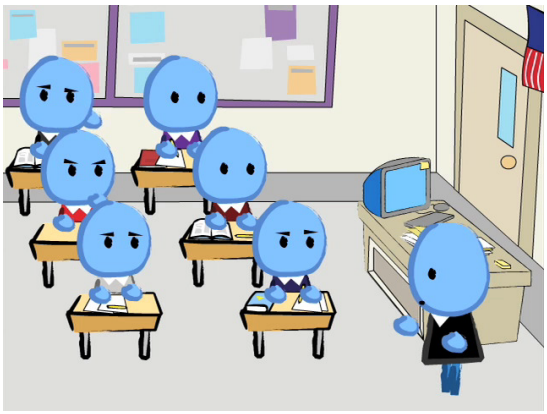

Figure 1: ThExpians B

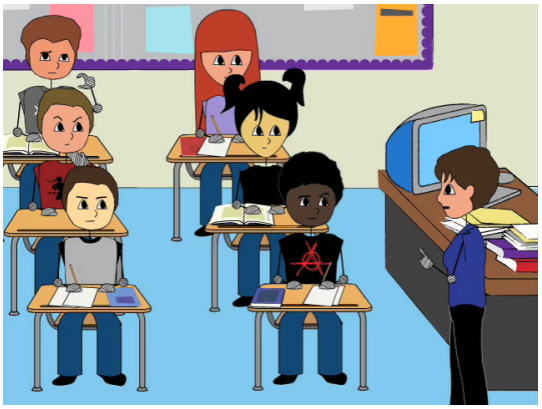

Figure 2: ThExpians P

Data Sources

We solicited volunteers through email sent to students in secondary mathematics teacher preparation programs and not yet at the student teaching stage. The sample included 61 teacher candidates from 13 universities located in 4 states in the American Midwest and 3 states in the East. There were 27 males and 34 females. Interviewees were randomly assigned to one of the three conditions.

Analysis

Measures

Genuineness

An important theme in the literature on presence and telepresence is the extent to which representations of humans are perceived to be humans. Mori's (1970) hypothesis of an uncanny valley asserts that the more that those representations resemble human features the more that viewers will expect them to act like humans (Feil-Seifer, Skinner, & Mataric, 2009; Pollick, 2009). For those and financial reasons our group decided to create animations of classroom

scenarios with a character set that represented humans without many physical details (see Figure 1), though we also developed a character set with more physical details (see Figure 2). We were interested in knowing how these choices of representation ranked next to video record as the norm. To measure this, we asked participants to rate the characters and their actions in terms of their perceived genuineness. The eleven questions included in the protocol were grouped into two constructs: Genuineness of the representation of the characters and setting (Individuality Genuineness) and genuineness of the representation of the actions (Action Genuineness). Table 2 reports alpha levels for Action Genuineness and Individuality Genuineness in addition to the measures of Projectiveness, Reflectiveness, and Alternativity discussed below. Both noticing and mathematics were measured through checklists that asked if given elements were present or absent (e.g., "trapezoid" in the mathematics list, "defines a geometric object" in the teacher actions list).

Table 2: Internal reliability of measures

Dimension	*Internal reliability*
Genuiness	
Action Genuineness	Cronbach's Alpha = .644
Individuality Genuineness	Cronbach's Alpha = .693
Projectiveness	Cronbach's Alpha = .551
Reflectiveness	Cronbach's Alpha = .831
Alternativity	Cronbach's Alpha = .702

Genuineness of representation: Individuality and Action

We looked at the two aspects of genuineness noted above separately: Individuality Genuineness (IG), and Action Genuineness (AG). Mean ratings for IG (Table 3) shows that participants who watched the video saw it as more genuine than participants who viewed either of the animated representations. These differences were significant at the 0.05 level. Participants who saw the animation using more humanlike characters (ThExpians P, Figure 2) rated it as more genuine than participants who viewed the other animation (ThExpians B, Figure 1), but this difference was not significant.

Table 3: ANOVA on IG across representations

					95% Confidence Interval	
(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Video	Thexpians P	2.70000*	.76554	.005	.7490	4.6510
	Thexpians B	4.45000*	.55949	.000	3.0440	5.8560
Thexpians P	Video	-2.70000*	.76554	.005	-4.6510	-.7490

	Thexpians B	1.75000	.83690	.127	-.3549	3.8549
Thexpians B	Video	-4.45000*	.55949	.000	-5.8560	-3.0440
	Thexpians P	-1.75000	.83690	.127	-3.8549	.3549

*. The mean difference is significant at the 0.05 level.

Table 4 reports on the comparison of mean AG ratings. Based on earlier evidence from focus groups of experienced teachers (Herbst & Kosko, 2012) where we had seen comparable reactions to the actions of animated characters as to those of video participants, we had hoped to find less of a difference. The analysis still yielded higher AG ratings for participants in the video condition than in any of the animation conditions. Participants rated the genuineness of actions higher when those actions were represented in video than when they were represented with animated cartoons, no matter what character set was used. Those differences were significant. Similar to the case of Individuality Genuineness, the comparison between perceptions of genuineness of actions by ThExpians B and ThExpians P yielded no significant differences. The results of the genuineness analysis could cast doubt as to whether preservice teachers perceive animations as genuine representations of practice in comparison to video. The lack of significant differences in the genuineness of the characters in the two animations suggests show that our decision to represent classroom interaction with ThExpians B may have been acceptable.

Table 4: ANOVA on AG across representations

					95% Confidence Interval	
(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Video	Thexpians P	2.80000*	.76691	.003	.8561	4.7439
	Thexpians B	2.32619*	.55399	.000	.9430	3.7094
Thexpians P	Video	-2.80000*	.76691	.003	-4.7439	-.8561
	Thexpians B	-.47381	.79971	.913	-2.4883	1.5407
Thexpians B	Video	-2.32619*	.55399	.000	-3.7094	-.9430
	Thexpians P	.47381	.79971	.913	-1.5407	2.4883

*. The mean difference is significant at the 0.05 level.

In spite of the differences in genuineness, the data on the other variables shows that participants were still able to notice, project, reflect, and judge the teaching in the episodes.

Projectiveness

Four items measured projectiveness, dealing with how typical the participant rated the episode in relation to their student experiences and experiences observing classrooms. The reliability (α=0.551) is low. Participants' projectiveness scores showed no significant difference across the conditions. We take this to mean that there is no evidence to assert that the animated versions of the story are any more difficult to relate to than the video version (see Table 5). This observation is particularly encouraging in light of the genuineness ratings.

Table 5: ANOVA on Projectiveness across representations

					95% Confidence Interval	
(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Video	Thexpians P	.58421	.75282	.827	-1.2991	2.4675
	Thexpians B	.54135	.85522	.897	-1.5961	2.6788
Thexpians P	Video	-.58421	.75282	.827	-2.4675	1.2991
	Thexpians B	-.04286	.83378	1.000	-2.1270	2.0413
Thexpians B	Video	-.54135	.85522	.897	-2.6788	1.5961
	Thexpians P	.04286	.83378	1.000	-2.0413	2.1270

Noticing and Mathematics

Responses to the noticing and mathematics were scored on the percentage of correct observations made and percentage of incorrect observations made. We compared four different sets of means (see Tables 6 and 7).

Table 6: ANOVA of Mathematics

						95% Confidence Interval	
	(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
ANOVA of Noticing Non-present Mathematics across representations	Video	Thexpians P	-.40000	.30907	.496	-1.1764	.3764
		Thexpians B	-.34524	.26184	.478	-.9986	.3081
	Thexpians P	Video	.40000	.30907	.496	-.3764	1.1764
		Thexpians B	.05476	.31976	.998	-.7459	.8554
	Thexpians B	Video	.34524	.26184	.478	-.3081	.9986
		Thexpians P	-.05476	.31976	.998	-.8554	.7459
ANOVA of Noticing Mathematics present across representations	Video	Thexpians P	-1.75000*	.68892	.046	-3.4761	-.0239
		Thexpians B	-1.71905*	.60697	.025	-3.2624	-.1757
	Thexpians P	Video	1.75000*	.68892	.046	.0239	3.4761
		Thexpians B	.03095	.49403	1.000	-1.2133	1.2752
	Thexpians B	Video	1.71905*	.60697	.025	.1757	3.2624
		Thexpians P	-.03095	.49403	1.000	-1.2752	1.2133

As shown in Table 6, participants who viewed either animation noticed significantly more of the mathematical content than those who watched the video. While one possible explanation is that in simplifying the representation, the animations enable the viewer to attend to important aspects being represented, we recognize that the simplification happened both in the graphics and the audio and that it is possible that quality differences in the soundtrack might account for all of the differences. Table 7 shows that there were no significant differences when it comes to the noticing of teacher actions or the accuracy of this noticing.

Table 7: ANOVA of Noticing

			Mean Difference			95% Confidence Interval	
	(I) Treatment	(J) Treatment	(I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
ANOVA of Noticing Non-present Teaching Actions across representations	Video	Thexpians P	.05000	.29357	.998	-.6840	.7840
		Thexpians B	-.24048	.29351	.803	-.9738	.4928
	Thexpians P	Video	-.05000	.29357	.998	-.7840	.6840
		Thexpians B	-.29048	.26944	.638	-.9626	.3817
	Thexpians B	Video	.24048	.29351	.803	-.4928	.9738
		Thexpians P	.29048	.26944	.638	-.3817	.9626
ANOVA of Noticing Teaching Actions across representations	Video	Thexpians P	.90000	.58106	.341	-.5515	2.3515
		Thexpians B	.67381	.54371	.530	-.6832	2.0308
	Thexpians P	Video	-.90000	.58106	.341	-2.3515	.5515
		Thexpians B	-.22619	.56087	.970	-1.6269	1.1746
	Thexpians B	Video	-.67381	.54371	.530	-2.0308	.6832
		Thexpians P	.22619	.56087	.970	-1.1746	1.6269

*. The mean difference is significant at the 0.05 level.

Reflectiveness

We gauged reflectiveness by asking participants to rate on a 5-point Likert scale how much the episode made them think of different aspects of teaching. The high internal reliability of this construct (see Table 2) justified the summing of item results in order to produce a single score for reflectiveness. Using this score we found no significant difference for reflectiveness based on the type of representation viewed (see Table 8). Thus there is no evidence that the animated representations are any less effective at promoting thought about teaching than the video. In addition to these Likert-scale items, we also collected open-ended responses that both lend support to these findings and provide information about the way in which participants were thinking about teaching as they viewed the episode.

Table 8: ANOVA on Reflectiveness across representations

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Video	Thexpians P	-2.67632	2.17269	.538	-8.1450	2.7923
	Thexpians B	-.07393	2.45487	1.000	-6.2083	6.0604
Thexpians P	Video	2.67632	2.17269	.538	-2.7923	8.1450
	Thexpians B	2.60238	2.09844	.531	-2.6497	7.8545
Thexpians B	Video	.07393	2.45487	1.000	-6.0604	6.2083
	Thexpians P	-2.60238	2.09844	.531	-7.8545	2.6497

Alternativity

Alternativity questions had acceptable internal reliability (see Table 2). The ANOVA on the participants' aggregate scores with respect to the type of representations found no evidence that participants viewing the animations were any less likely to find alternative courses of action likely (see Table 9). This suggests that animations are at least as useful for encouraging thinking about alternative courses of action as videos. We collected open-ended responses that provide some insight into the way that the participants talk about these alternative scenarios, which are reported in the full paper.

Table 9: ANOVA on Alternativity across representations

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Video	Thexpians P	-.49837	.68837	.855	-2.2402	1.2435
	Thexpians B	-.35948	.65315	.929	-2.0227	1.3038
Thexpians P	Video	.49837	.68837	.855	-1.2435	2.2402
	Thexpians B	.13889	.53018	.991	-1.1944	1.4722
Thexpians B	Video	.35948	.65315	.929	-1.3038	2.0227
	Thexpians P	-.13889	.53018	.991	-1.4722	1.1944

Conclusion

Considering that professional education could benefit from the use of designed, as opposed to gathered, representations of practice, this study compared the effectiveness of animations of teaching and video records as used by teacher candidates. While participants see video as more genuine, there are no other statistically significant differences in favor of video. On the one hand this is not surprising on the face of extant arguments that media type does not make a difference (Clark, 1994). On the other hand these results are cautiously encouraging the development of designed representations for use in professional education. This result is of practical significance inasmuch as it indicates that in the absence of video records, animations can be comparably effective. Furthermore, the lack of differences between the two kinds of animations speaks to the viability of designing animations with relatively low expense in the realization of individual characters—characters with less individuality (such as ThExpians B) can elicit from preservice teachers comparable work as video or animations with characters with more individuality.

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