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3-D Computer Animation vs. Live-Action Video: Differences in Viewers' Response to Instructional Vignettes

Dennie Smith, Tim McLaughlin, and Irving Brown
Texas A & M

Abstract

This study explored computer animation vignettes as a replacement for live-action video scenarios of classroom behavior situations previously used as an instructional resource in teacher education courses in classroom management strategies. The focus of the research was to determine if the embedded behavioral information perceived in a live-action video version of classroom management situations was the same as a 3-D computer animation version of the same content. Preservice teachers (N = 55) were randomly assigned to watch the video or an animated vignette and to complete a questionnaire. The results indicated there were no differences between the groups in identifying the critical behaviors. These findings have significant implications for the development of instructional resources and expanding learning environments to support all levels of teaching and learning. Rapidly advancing animation technology may offer multiple advantages or viable alternatives to staged actors and static content of live-action video in creating dynamic professional learning experiences.

As conceptions of development, learning, and teaching have moved toward more constructivist approaches to instruction, teachers have begun placing more emphasis on direct experience, interactions between teachers and students and between students and students for creating understanding (Kauchak & Eggen, 1998). At the same time, developing technology has led to video research to demonstrate the links between the pedagogical thinking and actual practice of teachers (Hennessy & Deany, 2009). For example, selected video episodes focusing on the learner have been used extensively over the past few years for helping teachers understand the teaching of mathematics (Santagata & Guarino, 2011; Towers, 2007) and science and English (Rosaen et al., 2010; Roth et al., 2011). One of the important outcomes of using video with learners is that it supports participants in reflecting upon their actions and understandings and assists in the retention and transference of pedagogical concepts into practice (Haw & Hadfield, 2011).

Concurrent with this theoretical shift in instructional practice and use of video, technology has grown in sophistication, proliferated in schools, and multiplied the benefits it offers to both teachers and learners. The graphics capabilities of computers, connectivity to web-delivered content, and ready access to video mediums, including animated content to augment instruction and interactive educational video games, have provided considerable potential for application in multiple teaching environments and in unlimited course contexts. The simulation capacity of synthetic imagery to depict locations, places, people, and activities offers learners opportunities to conduct inquiry and experimentation that would be too time consuming, costly, risky, or otherwise restrictive for them to undertake in authentic settings and with actual learners and teachers (Good & Brophy, 1997).

The continuing advances in the technology of animation provide curriculum designers more latitude in designing visual materials. For example, the complexity of securing human subject approval for research purposes can be fast tracked through the use of animated characters instead of students in realistic school environments. In addition, the economics of live-action video/film production can be cost prohibitive, and when the currency of visual material in terms of depicting styles of dress and situational problems becomes outdated, the content of live-action video is locked, while animation models, environments, and actions can be updated and reused.

Existing research shows the utility of using video vignettes as an instructional tool in teacher education courses in classroom management strategies, but more work is needed in the research concerning the use of newer technologies such as 3-D computer animation vignettes in a virtual classroom environment (Bailey, Tettegah, & Bradley, 2006; Moreno & Ortegano-Layne, 2007; Tettegah, 2005). According to Haw and Hadfield (2011), the interconnections of video products allow for more sophisticated use and increased awareness of likely responses of potential audiences.

In our specific case, one of the authors had previously developed and effectively used live-action video vignettes as instructional resources in teacher education courses on classroom management strategies (Smith, 1987). Over time, the videos had become dated in terms of teachers' and students' dress as well as other aspects of the classroom environments. Costs, as well as logistics for remaking the videos, were prohibitive.

We were intrigued by the prospects of converting the live action videos into episodic and extensible interactive animations for education and training. However, we were unsure if the subtle interactions embedded within the actors' performances, which provide informative cues to the teacher trainees, would be perceived in a similar manner once the characters and environment were presented as visually abstracted computer animations. Thus, the purpose of this study was to determine if we could rerepresent the live-action video material as computer animation without losing its effectiveness.

The broader goal of the research was to determine empirically if the embedded behavioral information as perceived by viewers of a video featuring human actors portraying situational scenes in real environments was the same as or different from a synthetic version of the same content featuring visually stylized computer animation of characters, actions, and environments. Specifically, the study was guided by the following research question: What behaviors, if any, do viewers perceive differently in an animated vignette as compared to a live-action video with the same subject matter?

Theoretical Framework and Review of Relevant Literature

The theoretical framework for this study was grounded in Bandura's (1986) social cognitive theory of learning. He points out in his discussion that modeling is the most common mode of learning new behaviors. "The learning may take varied forms, including new behavior patterns, judgmental standards, cognitive competencies, and generative rules for creating behaviors" (p. 49).

Moreno and Ortegano-Layne (2007) supported this view by noting that people learn from directly observing (real) people as well as by indirectly observing people in real or fictitious situations like motion pictures, television, plays, and books. Previous research has indicated that preservice teachers have chosen classroom scenarios as their preferred method of instruction over more traditional teacher education methods.

According to experiential models of learning, when students are presented with a classroom scenario demonstrating how the learned principles can be applied to the teaching practice, relevant aspects of the scenario are selected by matching the encoded principles with observed/described classroom behaviors and the example is integrated with students' past experiential knowledge. (Moreno & Ortegano-Layne, 2007, p. 452)

In addition, students are more likely to apply theoretical knowledge in future situations when they are presented with authentic classroom situations in narrative, video, or animation (Bransford & Schwartz, 1999). Goldman, Pea, Barron, and Derry (2007) presented theoretical frameworks for conducting video research with the major emphasis on collecting and selecting video data for research that would extend "our way of knowing about and sharing learning, teaching, and educational processes" (p. ix). Advancing technologies enable educators to capture more of the complexity in classrooms with the challenge of fairly presenting the underlying representations (Miller & Zbou, 2007). However, researchers must ensure that the representations are accurate by relying on expert opinion or coding of specific behaviors (Goldman et al., 2007).

The research study described in this paper focused on the blending of current teaching and learning theory with technology advances in the form of computer animation vignettes to make lessons more effective and significant in students' learning activities (Bailey et al., 2006; Schank, 1997). Given previous success in the use of the videos for teaching classroom management theory and strategies and the quest for developing more effective and efficient ways to teach preservice teachers, this information was important for determining continued and future development of this type of resource for teaching and learning.

Our hypothesis was that animated vignettes in a virtual classroom environment could be used as effectively as live-action video vignettes, without any significant loss of visual behavioral content, as an instructional tool in teacher education courses in classroom management strategies. Due to the capacity to reuse assets (models, environments, movements), artistically manipulate imagery, and vary the forms of interactivity, computer animation provides more flexibility than live-action video in terms of variation of the situations depicted, characterizations used, and use in the classroom (interactive and noninteractive media).

Significant challenges have emerged in recent times as a concern for developers and producers of visual media in school settings. The production of live action vignettes using people, especially children in classroom situations, can involve extensive approvals at the district, school, teacher, parent, and student levels. Recruiting and training actors, along with technical and policy issues of video photography in live classrooms offer additional challenges for video production. In addition, the budget for short live-action videos can range from $25,000 for a short film to $1.6 million per episode for longer works. The variation is highly dependent upon content and professional experience of the crew (Levinson, 2007; Rea & Irving, 2010).

Budgets for 3-D computer animation can range from $5,000 to over $1.5 million per minute (Cantor, Valencia, Kroyer, Ford, & Clark, 2004; Box office history for Disney-Pixar movies, 2011). A relative comparison between the development costs of animation versus video vignettes typically will show a higher initial cost for the use of animation, but a lower overall cost if a large number and variety of uses are planned. The price point at which an animated format becomes more cost-effective than a video format is difficult to determine without specific content information.

Based upon the appeal of entertainment oriented animated videos, films, television shows, video games, and web-content, the absence of live characters and real places does not appear to be a deterrent to engagement across the age spectrum of learners (Greenfield et al., 1994; Jenkins & Hinrichs, 2003). Winner (1985) argued that representational style alters what we learn from objects; that, in relation to realistic representation, symbolic representations make viewers attend to the "syntactic repleteness" of the object. The object is engorged with relational meaning rather than a simple container of object-specific information.

In uses of computer graphics imagery variations in visual fidelity (including form, texture, color, and animated behavior) have been shown to be factors influencing task performance and the level of engagement (Cho et al., 2003; Fishcher, Bartz, & Strasser, 2005; Pellacini & Ferwada, 2002; Shim & Kim 2003; Vinayagamoorthy, Brogni, Gillies, Slater, & Steed, 2004; Youngblut, 2007). Finally, the capacity to alter visual fidelity in synthetic imagery provides the authors of educational content the potential opportunity to adjust content to either enhance or minimize degrees of ambiguity according to the desired learning level goals (McLaughlin, Smith, & Brown, 2010).

Method and Data Sources

Development of the Animated Vignette

The live-action video series, *Decision Points,* was created for the purpose of presenting short problem-solving situations to teachers as a training video for learning effective techniques for classroom management. The videos, featuring secondary students, were selected for this study and were originally produced in 1987. The characters were middle or high school students who volunteered to role-play scripted classroom scenarios that were provided by the video developers.

One of the video vignettes, "Cooperative Test" (Smith, 1987), was selected for development of a computer animated version illustrating the same content and behavior of the students in the live-action video. A team composed of three professors and a graduate student combined their basic methodologies to define the environment, appearance, and behaviors of animated characters in a virtual classroom. A graduate student used 2-D graphics editing software and Adobe's Photoshop to develop the visual style of the students and classroom environment evocative of caricatures found in animated television series and games popular in youth culture (see Figures 1 and 2). The design and key-frame animated performance was realized using Autodesk's Maya 3-D modeling and animation software. The term *3-D* used in the context of this study indicates the depiction of objects in three-dimensional Cartesian space and does not indicate use of stereographic techniques.

The timing of actions, spatial relationships of characters and the environment, and the composition of elements within the image frame presented a visually abstracted depiction of students, classroom, and actions from the live-action video vignette. Both the live action video and the animation version were 1 min and 26 s long. Approximately 500 hr of design, animation, and research were required to produce the animated version of the video used in this study.

Figure 1. *A still image from the classroom video film vignette.*

Figure 2. *A still image from the classroom animation featuring characters and environment in stylized visual form and material.*

Participants

The study's participants were preservice education students (N = 55) enrolled in an upper level education course at a large, southwestern public university. Participants were randomly assigned to a group that viewed the animation vignettes (n = 27), or a group that viewed the video vignettes (n= 28). Twenty-three of the participants in the animation group were female, and 25 of the participants in the video group were female. Approximately 83% of the preservice students (n = 45) were middle school teachers, 13% (n = 7) of the students were early childhood/elementary school teachers, and the remaining students (n = 3) were secondary school teachers. The majority (93%, n=51) of the preservice teachers were 21-24 years of age, 3 students were 25 years of age or older, and 1 student was younger than 20.

Instrument

The researcher-developed instrument used in this study (see appendix) was designed to examine the perceptions of video characters' behaviors by preservice teachers with regard to their viewed vignette. In developing the current instrument, the researchers identified 15 behaviors or actions portrayed in the *Decision Points* video to establish face validity. Eight graduate students (3 masters and 5 doctoral) with teaching experience from 3 to 15 years viewed the video and agreed 100% on eight of the items included in this study to substantiate face validity. The instrument collected data related to the specific actions of the participants observed in the vignette, whether real or imagined.

The final survey contained 11 descriptions of likely actions portrayed by the actors given the scenario. For example, the participants were asked if they witnessed a "male student looking at female student's paper" during the vignette. Three of the 11 actions were distractors, that is, the actions did not actually exist and were included to help verify the validity of the experimental results. The participants were required to check a box next to each action indicating that they observed the action in the vignette or to leave it blank if they did not see it.

Procedure

The study was conducted in a classroom management course (55 students) in a university with a large teacher preparation program. Preservice teachers were randomly assigned to watch a live-action video or animated vignette. The selected vignette depicting a student cheating on an exam was shown to each group and followed up with a checklist to identify the behaviors viewed in the video or animated versions. The procedures were standardized for the two groups by using the following method:

1. Participants were seated.
2. The information sheet for informed consent was read and collected.
3. The live-action video or animated version of the vignette was played and students were instructed to observe behaviors; both the live-action video and the computer animation were displayed at 30 frames per second; subjects viewed the respective stimuli from equivalent viewing angles.
4. The survey was distributed for completion.
5. Five minutes (from the point of last student receiving survey) were allowed for the completion of the surveys.
6. The surveys were collected and the students were thanked for their participation.

Data Analysis

To prepare the data for analysis, a simple coding scheme was employed to convert the participant responses in the form of check marks on the survey into numeric data stored in an Excel spreadsheet. With exception of question 3 (Likert data) and the demographic questions regarding the participants' age and area of academic study, all of the data were converted into binary responses. SPSS (v. 16) was used for all data analysis. Descriptive statistics were collected on all of the data to extract frequency data for the responses as well as to verify the continuity of the data set. Crosstab statistics were performed on the data to calculate the Pearson's chi-square as well as generating the Crosstab Cells. Fisher's Exact test values were also calculated to confirm the Pearson's chi-square Analysis.

Results

For each of the 11 items under consideration in this study, the participants in both groups were asked, "What did you see?" The participants either marked the box for each item if they observed the action in the vignette or left the box unchecked signifying they did not see the action. The null hypothesis (H_0) for each statistical test was "there is no difference in the proportion of participants who observed a particular action while watching the animation than the proportion who observed the same action while watching the video." The conclusions, which were supported by the chi-square analysis, were based on an alpha level of 0.05 for all statistical tests.

Table 1 shows the chi-square and Fisher's Exact test statistics. In 9 of the 11 questions (about 82%), the participants viewing the animated vignette reported seeing the same actions as the participants viewing the live-action video. Data analysis results from only two questions (1 and 9) had a Pearson's chi-square significance value less than 0.05.

In hypothesis testing, if data analysis revealed a significance value less than the alpha level, then the null hypotheses must be rejected in favor of the alternative hypothesis (H_a). In this study the alternative hypothesis (H_a) for each statistical test was "there is a difference in the proportion of participants who observed a particular action while watching the animation than the proportion who observed the same action while watching the video." Having such a small significance value on these two questions required the rejection of the hypothesis that there was no difference between what the two study groups viewed, meaning that the two groups of participants did view the vignette and video differently for these two questions only.

Consistent with the large Pearson's chi-square value and small significance value, the cross tabulation for question 1 (see Table 2) shows a disparate relationship between the actual versus the expected counts for both the video and the animation viewers. The same is true, but to a lesser degree, for Question 9. The number of participants who responded positively for the action, "Male student quickly glances back and forth," was more evenly distributed than in Question 1. Seventeen participants from the video group responded positively, compared to an expected count of 20.9. Twenty-four participants from the animation group participants responded they saw the same action versus an expected count of 20.1.

Students viewing the animation vignette were three times more likely to notice students' whispering than students who viewed the video; conversely, students viewing the video were about four times more likely to notice eye movements.

Table 1
Behavior Observation Data Analysis-Chi-Square

Action	Pearson's Chi-Square Value	Pearson's Chi-Square Sig.	Fisher's Exact Test	Phi Sig.
1. Students whispering before test/assignment.	26.711	0.000*	0.000	0.000
2. Students taking test/assignment.	2.152	0.142	0.236	0.142
3. Students moving desks closer.	0.669	0.413	0.669	0.413
4. Male student dropping pencil.	0.503	0.478	0.705	0.478
5. Female student pointing at pencil.	1.002	0.317	0.611	0.317
6. Students whisper as male student picks up pencil.	0.005	0.943	0.600	0.943
7. Male student looks at female student's paper.	1.056	0.304	0.491	0.304
8. Female student moving her paper to edge of desk.	0.982	0.322	1.000	0.322
9. Male student quickly glances back and forth.	5.750	0.016*	0.029	0.016
10. Female student puts her head down and avoids eye contact.	0.029	0.864	1.000	0.864
11. Male student signals with hand that he is done looking at paper	2.515	0.113	0.143	0.113

*$p < .05$

In the 9 of 11 cases in which the statistics supported the authors' prediction that the participants viewing the live-action videos would see the same actions as the group viewing the computer generated animations, the test statistics and cross tabulation cell counts provided strong affirmation. The most striking of these is found in the responses to Question 10. A small Pearson's chi-square value coupled with a large significance value (0.029 and 0.864, respectively) demonstrate the statistical significance of the near perfect matches in the cross tabulation; an actual count of 17 versus an expected count of 17.3 for the video group and an actual count of 17 versus an expected count of 16.7 for the animation group, which corresponds to a 50% proportion each for the dominant response ("yes") in Question 10.

A similar outcome was found in the response to Question 8. The dominant response was determined by comparing the "% within Vignette" values between the dichotomous dependent variables "yes" and "no." Thus, the test statistics and cross tabulation cells indicated that there were no significant differences in overall perception of events and character behaviors between the two visual mediums.

Table 2
Behavior Observation Data Analysis-Cross Tabulation

Action	Vignette	Count	No	Yes
1. Students whispering before test/assignment.	Video	Actual	8.0	20.0
		Expected	17.3	10.7
	Actual	Actual	26.0	1.0
		Expected	16.7	10.3
2. Students taking test/ assignment.	Video	Actual	0.0	28.0
		Expected	1.0	27.0
	Actual	Actual	2.0	25.0
		Expected	1.0	26.0
3. Students moving desks closer.	Video	Actual	24.0	4.0
		Expected	24.9	3.1
	Actual	Actual	25.0	2.0
		Expected	24.1	2.9
4. Male student dropping pencil.	Video	Actual	5.0	23.0
		Expected	4.1	23.90
	Actual	Actual	3.0	24.0
		Expected	3.9	23.1
5. Female student pointing at pencil.	Video	Actual	25.0	3.0
		Expected	26.0	2.0
	Actual	Actual	26.0	1.0
		Expected	25.0	2.0
6. Students whisper as male student picks up pencil.	Video	Actual	22.0	6.0
		Expected	21.9	6.1
	Actual	Actual	21.0	6.0
		Expected	21.2	5.9
7. Male student looks at female student’s paper.	Video	Actual	0.0	28.0
		Expected	0.5	27.5
	Actual	Actual	1.0	26.0
		Expected	0.5	26.5
8. Female student moving her paper to edge of desk.	Video	Actual	1.0	27.0
		Expected	0.5	27.5
	Actual	Actual	0.0	27.0
		Expected	0.5	26.5
9. Male student quickly glances back and forth.	Video	Actual	11.0	17.0
		Expected	7.1	20.9
	Actual	Actual	3.0	24.0
		Expected	6.9	20.1
10. Female student puts her head down and avoids eye contact.	Video	Actual	11.0	17.0
		Expected	10.7	17.3
	Actual	Actual	10.0	17.0
		Expected	10.3	16.7
11. Male student signals with hand that he is done looking at paper.	Video	Actual	26.0	2.0
		Expected	23.9	4.1
	Actual	Actual	21.0	6.0
		Expected	23.1	3.9

Discussion

The general framework of this study was based on the premise that if participants viewed similar behaviors from animated vignettes as they did from live-action video vignettes, then this instructional content could be transformed into animation without sacrificing its benefits to students as an interactive means of depicting complex situations for problem solving. In 9 of the 11 questions, there was no significant difference between actions reported by participants viewing the animated vignettes and the participants viewing the live-action video vignettes.

This knowledge is important for curriculum and clinical simulation development, as the animation medium offers the advantages of longer visual currency (e.g., dress and hair fads), overcoming the need for securing permissions, actors, environments (increasingly difficult to obtain in real world settings), and potentially providing cost benefits in production as computer technology continues to advance.

This study demonstrated that animation is as effective as video vignettes in communicating key elements within a presentation intended for educational training in classroom management. In the face of the rapid advance and use of animation technology in education and training, such validation is necessary to assess the effects of the loss of nuances in communication when observing human behaviors. The study also confirmed Haw and Hadfield's (2011) work noting the interconnections of video products and the likely responses of potential audiences. There was no significant loss of intended content by viewers of animated vignettes, and the medium was equally effective as older technologies in communicating featured visual elements and behaviors that were deemed essential for promoting learning and improving teaching.

The policy implications infer that cost-effective video animations could enhance the training of teachers to deal with classroom management as well as other critical professional competencies. Teachers, for example, would be able to use animation technology to depict specific problems and to work collaboratively with other educators in finding solutions to complex teaching and learning situations. In addition, this animation research may have implications beyond teacher education in other fields seeking new technologies for developing and delivering training.

Limitations of this study included judgmental sampling of undergraduate students from two courses in classroom management theory and the resulting small size of the sample. In addition, the funds available for this research were limited to the development of only one animation vignette. A larger randomized sample and use of additional vignettes may produce similar results, but results of this study cannot be generalized to other animation vignettes or larger sample sizes.

We do not claim that animation is more effective than video. We would, however, suggest that in this case animation was just as effective as the original video. Future research could further explore learning differences, achievement, and transferability of learning related to the effectiveness of video and animation. The degree of complexity and the nature of the subject matter certainly could be factors in future research. More research is needed, also, regarding the degrees of complexity in creating authentic scenarios for communicating various behaviors that are essential in interactive and simulated problem situations.

Though our motivation for this study emerged from the desire to convert live-action video vignettes into interactive simulation/training video for future teachers, an issue that we did not explore is the impact of trainee/player agency over the angle of view of a scenario and how even simple game artificial intelligence might alter the vignettes. Thus, a potential broader impact of this research is the stimulation and expansion of the use of animation in learning materials through empirically derived confidence in the capacity of synthetic imagery to match live-action representations and character interactions.

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Author Note

Dennie Smith
Texas A & M
email: denniesmith@tamu.edu

Tim McLaughlin
Texas A & M
email: timm@viz.tamu.edu

Irving Brown
Texas A & M
email: iab4phd@tamu.edu

Appendix

Classroom Management Vignette Survey

Demographic Information:

☐ Male ☐ Female

Age: ☐ 17-18 ☐ 19-20 ☐ 21-22 ☐ 23-24 ☐ 25 +

Area of Concentration in education:

☐ Early Childhood ☐ Elementary

☐ Middle School ☐ High School

Please check behaviors that apply:

1. What did you see?

- ☐ Students whispering before test/assignment
- ☐ Students taking test/assignment
- ☐ Students moving desks closer
- ☐ Male student dropping pencil
- ☐ Female student pointing at pencil
- ☐ Students whisper as male student picks up pencil
- ☐ Male student looks at female student's paper
- ☐ Female student moving her paper to the edge of her desk
- ☐ Male student quickly glances back and forth
- ☐ Female student puts her head down and avoids eye contact
- ☐ Male student signals with his hand that he is done looking at paper