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DEVELOPMENT ARTICLE

Do classroom exemplars promote the application of principles in teacher education? A comparison of videos, animations, and narratives

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Abstract Students learned about teaching principles with a multimedia program that either did not include a classroom exemplar illustrating how to apply the learned principles to the teaching practice (control group) or included a classroom exemplar in video, animation, or text format. Across two experiments, video and animation groups reported more favorable attitudes towards learning and were better able to apply the learned principles than the control group. Text and control groups did not differ in their learning or attitudes towards learning, suggesting that format is an important factor in determining the effectiveness of classroom exemplars as pedagogical tools for teacher education. Results encourage the use of visual classroom exemplars to promote the application of theory into practice.

Keywords Exemplars · Modeling · Video · Animation · Application · Learning · Motivation

Introduction

How can we help student teachers to effectively apply teaching principles to classroom experiences? One promising technique is that of using classroom exemplars during instruction: the presentation of a classroom scenario that

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illustrates how to apply the learned concepts into the teaching practice (Laframboise & Griffith, 1997). The goal of this research was to empirically test the effectiveness of classroom exemplars by examining whether their presentation in video, animation, or text format would affect students' perceptions about learning and motivation and their ability to apply the learned principles to new classroom situations. In particular, we were interested in answering the following three research questions: Does the presentation of a classroom exemplar affect students' application of teaching principles to novel classroom scenarios? Does the presentation of a classroom exemplar affect students' attitudes towards learning? Does the format of a classroom exemplar affect students' attitudes towards learning?

To answer these questions, in two experiments, we compared the learning outcomes and perceptions of teacher education students who were asked to learn about teaching principles with a multimedia instructional program that either did not include a classroom exemplar illustrating how to apply the principles learned to practice (control group) or included a classroom case exemplar in video, animation, or text format. We used the following measures of learning: a conceptual test, where we asked students to demonstrate their understanding of the theoretical principles learned in the program, and an applications test, where we asked students to apply the principles learned to their own teaching. In addition, we examined students' attitudes towards learning by asking them to rate their learning experience with a program rating questionnaire.

Classroom scenarios: instructional uses and formats

There have been many different uses of classroom scenarios in teacher education in the past (Koehler, 2002). One common use follows the business instructional model and consists of presenting classroom scenarios as cases or dilemmas to promote future teachers' problem solving and critical thinking skills (Wilkerson & Gijselaers, 1996). Although this approach is increasingly popular among leading teachers and educational researchers (Williams, 1992; Williams & Hmelo, 1998), the focus of the present study is on the presentation of classroom scenarios for a different instructional function, namely, to illustrate how knowledge about teaching and learning can be applied to real classroom situations (Barnett, 1991; Barnett & Tyson, 1999; Van den Berg, Jansen, & Blijleven, 2004). This function is especially important under the light of last decade's dialogue about reforming education to facilitate students' transition from school to the work environment (Sears & Hersh, 1999), with much attention given to the need for replacing inert knowledge (Whitehead, 1929) with learning from contextualized, meaningful settings (Putnam & Borko, 2000).

Support for the idea that classroom exemplars may help prospective teachers bridge theory and practice is evident in current educational practices. For instance, many textbooks for teacher education include detailed

descriptions of classroom interactions between teacher and students exemplifying applications of the principles taught (Borich & Tombari, 1997; Eggen & Kauchak, 2004; Fetsco & McClure, 2005; Ormrod, 2004; Woolfolk, 2004). In addition to these narratives, there are many efforts in the development and use of classroom videos to convey more of the complexity of classroom events (Beck, King, & Marshall, 2002; Lampert, Heaton, & Ball, 1994). A good illustration of the use of classroom exemplars in video format is the Stanford Teacher Education Program, which offers online real-life classroom videos demonstrating good teaching practices for English language learners as part of the required California Cross-Cultural Language and Academic Development (CLAD) certification program (Bikle, Billings, & Hakuta, 2003).

Despite the widespread use of classroom scenarios in teacher education, it is only since the mid-1990s that researchers in the field began to empirically test what and how do students learn from being presented with classroom scenarios, with a considerable amount of recent work being centered around classroom case reasoning (Zeichner, 1999). The goal of this study was to extend on this growing body of research by investigating whether and under which format conditions do classroom exemplars promote students' learning and perceptions about learning. Furthermore, at present, computer-based technologies that include three dimensional graphics and digital sound synthesis have given rise to increasingly realistic artifacts that blur the distinction between reality and its representation (Ellis, 1995; Moroney & Moroney, 1999). These emergent technologies have the potential to be applied to develop classroom animations. Thus, an important contribution of this research is to break new ground in the educational technology field by examining the effects of animated classroom exemplars on prospective teachers' learning and attitudes.

Theoretical framework and predictions

The theoretical roots for using examples in education can be found in the works of Schank (1982, 1997) on dynamic memory and further back in theories of concept formation and experiential learning (Smith & Medin, 1981; Tulving, 1977). Experimental results from cognitive psychology support the idea that there is a set of processes that are specific to learning from past experiences (Aamodt & Plaza, 1994; Anderson, 1983; Kolodner, 1993; Schank, 1982). For example, Schank (1982, 1997) developed and tested a theory of learning based on retaining of experience in a dynamic, evolving long-term memory structure which holds both a memory for past experiences and a memory for general domain knowledge, similar to the classic distinction between episodic and semantic memory systems (Tulving, 1977). In this model, a reminding of earlier experiences plays a central role in problem solving and learning. Several studies have lent support to this theory by showing that when people are presented with a new scenario where they need to apply their domain knowledge, they rely on their general knowledge of the problem domain but are also able to retrieve examples of similar past

experiences and reuse them in the new problem situation (Anderson, 1983; Ross, 1987), especially when the problem solver is an expert in the domain (Kolodner, 1993).

There is also considerable evidence that familiar examples can serve as models that can be used in new situations (Dunbar, 1995). Relevant to this study is the impact of models on academic skills, where students may learn procedural knowledge by observing how their teachers perform on different tasks (Braaksma, Rijlaars-dam, & van den Bergh, 2002). Although many of the models from whom we learn are live models—real people that we observe doing something, advocates of a social cognitive theory of learning have shown that we are also influenced by models that are displayed by real or fictional characters in books, plays, movies, or television (Bandura, 1986). Therefore, the pedagogy of presenting classroom exemplars for teacher education is also supported by a central concept in social cognitive theory of learning: symbolic modeling. Next, we present the research questions to be answered in this study and their respective predictions.

Research question 1: Does the presentation of a classroom exemplar affect students' learning?

As pre-service teachers learn about teaching principles, they organize and integrate the new information with their prior domain knowledge. In addition, according to experiential models of learning (Schank, 1997), 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. By being presented with both the theoretical principles and an example of the application of such principles, students are more likely to apply the principles to new classroom scenarios because of the pre-existing connections between their theoretical knowledge and a similar classroom situation (Bransford & Schwartz, 1999). Likewise, according to social cognitive theory of learning, when student teachers are presented with a classroom narrative, video, or animation modeling how an expert teacher applies principles of teaching to her classroom, they will be more likely to imitate the displayed behaviors in the future. In sum, based on this theoretical framework, we predicted that students who learn about teaching principles with the presentation of a classroom exemplar would outperform those who learn about the same topic without the presentation of a classroom exemplar on applying the learned principles to new classroom situations.

Research question 2: Does the presentation of a classroom exemplar affect students' attitudes towards learning?

Although the presented theoretical framework does not include assumptions regarding affect and motivation, the idea that learning with classroom

exemplars may promote positive attitudes from prospective teachers is consistent with several theories of motivation and learning (Moreno, 2005; Pintrich, 2003; Renninger, Hidi, & Krapp, 1992). In this regard, we hypothesized that presenting a classroom exemplar during instruction would make prospective teachers' perceive the learning experience as being more meaningful and valuable to their professional goals (Wigfield & Eccles, 2000). This hypothesis is consistent with past research showing that pre-service teachers prefer to learn from classroom scenarios than from other traditional teaching methods (Barnett & Tyson, 1999; Henry, Castek, Roberts, Coiro, & Leu, 2004) and that students report favorable perceptions when learning with classroom examples (Gentner, Loewenstein, & Thompson, 2003; Lundeberg, Levin, & Harrington, 1999). Therefore, our second prediction was that students who are presented with a classroom exemplar would report more favorable perceptions about learning and motivation than those who learn without a classroom exemplar.

Research question 3: Does the presentation format of a classroom exemplar affect students' learning and attitudes towards learning?

This research question was motivated by current teacher education practice, which includes classroom narratives and videos as instructional aids. In line with past video research, we hypothesized that presenting classroom video exemplars would convey a higher sense of authenticity and realism that may result in denser memory traces than those resulting from reading a corresponding classroom narrative (Valmont, 1995; Wetzel, Radtke, & Stern, 1994). Additionally, because authentic problems presented in realistic contexts have been shown to be motivating for students (Stepien & Gallagher, 1993), and positive attitudinal effects have been found when pre-service teachers learn with classroom videos during computer networking instruction (Fitzgerald & Semrau, 1998; Lacey & Merseth, 1993; Van den Berg, et al., 2004), we predicted that the video exemplar would promote higher learning and more favorable perceptions about learning than the narrative exemplar. Finally, our predictions regarding the animation treatment were unclear. On one hand, the animations used in the present study were identical to the corresponding videos in many aspects (i.e., they included identical auditory information and provided three dimensional graphic representations of all classroom participants and artifacts). However, animations do not have the same degree of realism than videos.

To elucidate the role of the presentation format further, we asked an instructional design external expert to provide us with a brief evaluation of how each one of the three exemplar formats used in our study represented the information to-be-learned and to predict the learning outcomes from each treatment. According to this expert, unlike the visual exemplars, the text narrative format has the advantage of allowing students to move at their own pace and review what they have just read. On the other hand, text narratives are limited because they do not allow students to visually experience the

actual appearance of the teacher, students, and artifacts or the dynamic aspects of a real classroom, such as how a teacher moves about the class and the timing and pauses given during questioning. An additional disadvantage of text narratives is that they do not seem to hold as much attention as the visual classroom exemplars. In comparing videos and animations, the expert observed that they both presented identical audio information, mostly the same visual information yet, the animation included less background motion than the video. This difference was noted to be a potential advantage or disadvantage, depending on whether the instructional objective is to have prospective teachers focus on the interaction between teacher and students (in which case de-emphasizing the background may be an advantage) or to present prospective teachers with a more authentic classroom example (in which case de-emphasizing the background may be a disadvantage). As can be seen from the expert's evaluation, each of the three presentation formats may present advantages and disadvantages in relation to the others. A contribution of this study is to shed light to our third research question by empirically investigating the role of classroom exemplar presentation format on prospective teachers' learning and perceptions about learning.

Experiment 1

Method

Participants and design

The participants were 80 student teachers (63 females and 17 males) from three educational psychology introductory courses from a southwestern university who were given credit towards their course grade for their participation. The mean age of the participants was 26.75 (SD = 8.96). The reported ethnicities were: 45 White Americans, 24 Hispanic Americans, 6 Native Americans, 3 African Americans, and 2 Asian Americans. There were 20 participants each in the video, animation, text, and control groups.

Materials and apparatus

For each participant, the paper-and-pencil materials consisted of a consent form and a debriefing form, each typed on 8.5 by 11 inch sheets of paper. The computerized materials consisted of a multimedia instructional program that included the following steps: (a) the program solicited information concerning the participant's name, gender, age, and ethnicity; (b) the program introduced the theoretical topic—the information processing model and how to make information meaningful to students—with a presentation consisting of text and graphics included in the textbook adopted by the participating classrooms (Eggen & Kauchak, 2004); (c) to measure the participant's knowledge of the topic, it presented a ten item multiple choice test from the instructor's test

bank corresponding to the textbook (internal reliability of .74); (d) groups video, animation, and text were presented with a classroom exemplar illustrating how a teacher applied the principles learned in her classroom in the respective format, and the control group was given the same amount of time than the video, animation, and text groups to review the principles learned; (e) students were asked to complete the program rating questionnaire at their own pace; (f) students were given five minutes to answer each one of the questions included in the applications test. All students' responses were recorded by the computer program. The multimedia programs were developed using Flash MX™ (Macromedia, 2002), SoundForge (Macromedia, 2001), and 3D Studio Max (Autodesk, 2003). The program for all groups was approximately 65 min, of which 20 min were spent on steps (a) and (b), 10 min on step (c), 15 min on step (d), 10 min on step (e), and 10 min on step (f). The apparatus consisted of 4 PC desktop computer systems, which each included a 14-inch monitor and Sony headphones.

The classroom exemplar used for the video group was a 15 min video that was part of the instructor's supplemental materials (Ormrod, 2003a). It consisted of a lesson on climate, geography, and economics in a junior high social studies class. The animation used for the animation group was developed by a professional computer animator who was instructed to replicate the information contained in the video. The final product consisted of an animation that had an identical duration to the video, played the same audio files contained in the video, and which represented the same classroom artifacts and interactions among teacher and students with three dimensional computer graphics. The narrative used for the text group was developed by two instructors who were experienced in the use, development, and evaluation of classroom narratives and based on guidelines available in the qualitative research on teaching with classroom cases (Shulman, 1992). The final product consisted of a text narrative that described the classroom scenario (i.e., classroom artifacts, student and teacher characteristics), the dialogue between teacher and students, and the non-verbal behaviors depicted in the video.

The multiple choice test used in step (c) was scored by the computer program based on the scoring key provided by the corresponding instructor test bank (Eggen & Kauchak, 2004). The program rating questionnaire used in step (e) consisted of the following six questions, each requiring students to select an answer from a 7-point Likert scale: ''How interesting was the multimedia program you just used?'' (with 1 as *boring* and 7 as *very interesting*); ''How entertaining was the multimedia program you just used?'' (with 1 as *tiresome* and 7 as *very entertaining*); ''How motivated were you to learn about this educational psychology topic with this program?'' (with 1 as *not motivated* and 7 as *very motivated*); ''If you had a chance to use this program to learn about a new educational psychology topic, how eager would you be to do so?'' (with 1 as *not eager* and 7 as *very eager*); ''How helpful was the program you interacted with to learn about this educational psychology topic?'' (with 1 as *not helpful* and 7 as *very helpful*); and '' How much did the program help you understand the relation between the educational psychology theory and

classroom instruction?'' (with 1 as *not helpful* and 7 as very *helpful*). The internal reliability of the questionnaire was .89. Using principal axis estimation, a factor analysis yielded evidence for the valid aggregation of the six items into a total learning and motivation perception score, which was computed by adding the scores from the six items and dividing by six.

The applications test used in step (f) consisted of the following two questions: ''Pick a topic of your interest (i.e., math, science, art education, etc.). Based on the information-processing model, what are some things that you, as a teacher can do to make instruction effective? Please be specific in your suggestions'' and ''Imagine that you need to plan a lesson in a topic of your choice, what are some methods that you can use to make the new information meaningful for students? Please be specific in your suggestions''

The grading rubric for the applications test was developed by two instructors. The final rubric, after several cycles of evaluation and revision, included a set of acceptable and unacceptable answers for each one of the two application questions. Examples of acceptable answers for question 1 included specific applications of the concepts of working memory, long-term memory, and the cognitive processes of attention, rehearsal, encoding, and retrieval to participants' teaching area. Examples of acceptable answers for question 2 included specific applications of the concepts of elaboration, organization, and activity to participants' teaching area. Within the set of acceptable answers, we identified two types of responses: model applications (MA) and novel applications (NA). MA included responses where students' transferred the applications modeled by the exemplar to their own teaching area; NA included responses where students applied the principles learned in ways that were not modeled by the exemplar.

In addition to the acceptable answers, we coded the following two categories of student responses: extraneous applications (EA) and generic applications (GA). EA included responses where students described concrete applications of principles not relevant to the lesson, such as when students applied motivation theories rather than the information processing theory to answer question 1. GA included responses where students reworded the principles presented in the theoretical module of the lesson but failed to offer a specific application to their teaching area. From these data, we computed a MA, NA, EA, GA, and overall score of acceptable answers for each participant by counting the number of MA, NA, EA, GA, and the sum of MA and NA produced in the applications test, respectively. Two independent scorers, not aware of the treatment condition of each participant, determined the scores. Inter-rater reliability between the scorers was 81%. Differences in scoring were solved by agreement.

Procedure

Participants were tested in groups of 1–4 per session. First, participants were given the consent forms and seated at an individual cubicle in front of a computer. Second, participants were randomly assigned to one of the four

conditions based on a roster produced by our computer system (which used an algorithm to randomly allocate the number of students to be included in the study evenly among the four conditions). Third, participants were told to put on headphones and click on the computer screen to begin the program. Once the program was finished, participants were thanked for their participation and debriefed.

Results

Table 1 shows the mean scores and standard deviations for the control, text, video, and animation groups on measures of pretest, applications test, MA, NA, EA, GA, and perceptions about learning and motivation. To examine how the presentation of a classroom example affects students' learning, we conducted two analyses. First, an analysis of covariance (ANCOVA) with treatment group as between-subjects factor, the overall applications test score as the dependent measure, and the pretest scores as a covariate. The results of a prior test of homogeneity of regression had indicated no interaction effect between the covariate and the dependent variable ($r = .12$), $F(3,75) = .283$, $P = .84$. The ANCOVA revealed a significant difference between treatments on the applications test, $F(3, 75) = 2.99$, MSE = 13.70, $P < .05$, $\eta^2 = .11$. Because cells sizes were equal, the more powerful Tukey approach was used as a follow up test. Results indicated that the animation group produced higher scores than the text and control groups and that the video group produced higher scores than the control group (Ms = 4.85, 4.75, 3.35, and 3.25; SDs = 2.50, 2.31, 1.63 and 2.05, for the animation, video, text, and control groups, respectively).

Second, to examine if the groups differed on the type of answers produced in the applications test, we conducted a multivariate analysis of variance with treatment group as between-subjects factor and students' MA, NA, EA, GA scores as dependent measures. The analysis revealed a significant difference

Table 1 Mean score on pretest, applications test, model applications, novel applications, extraneous applications, generic applications, and learning and motivation perceptions, and corresponding standard deviations for four groups—experiment 1

Group	*N*	Pretest		Applications test		Model applications		Novel applications		Extraneous applications		Generic applications		L & M perceptions	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Control	20	6.20	1.85	3.25	2.05	0.75	0.85	2.60	1.57	0.40	0.82	1.50	1.47	3.34	1.20
Text	20	6.50	1.54	3.35	1.63	1.50	1.23	1.75	1.68	0.65	0.74	0.45	0.69	3.89	1.17
Video	20	6.65	1.27	4.75	2.31	1.75	1.07	3.00	1.86	0.40	0.82	0.50	0.69	4.73	1.24
Animation	20	6.70	1.59	4.85	2.50	1.95	1.95	2.90	1.92	0.55	0.83	0.65	0.87	4.17	1.29

Note: Actual scores ranges were 0–10 for the pretest, 0–10 for the applications test, 0–5 for model applications, 0–7 for novel applications, 0–3 for extraneous applications, 0–4 for generic applications, and 1–7 for learning and motivation perceptions. L & M stands for learning and motivation

between treatments on the dependent measures, Wilks' $\lambda = 0.63$, $F(12,193) = 3.08$, $P = .001$, $\eta^2 = .14$. Corresponding analyses of variance were conducted on each dependent variable as follow-up tests using the Bonferroni method to adjust for Type I error. The results revealed that the groups did not differ in the NA scores or the EA scores. On the other hand, there were significant differences among groups on the MA scores, $F(3, 76) = 4.58$, MSE = 5.51, $P = .005$, $\eta^2 = .15$, and on the GA scores, $F(3, 76) = 4.98$, MSE = 4.82, $P = .003$, $\eta^2 = .16$. Animation, video, and text groups produced higher MA scores than the control group, which produced higher GA scores than the animation, video, and text groups.

In addition, to examine whether the presentation of a classroom exemplar affects students' perceptions about learning, we conducted an analysis of variance using the treatment group as between-subjects factor and students' perceptions about learning and motivation score as the dependent measure. The analysis revealed a significant attitudinal difference between treatments, $F(3, 76) = 4.03$, MSE = 269.13, $P < .05$, $\eta^2 = .14$. Post-hoc Tukey tests showed that the video group rated the learning experience more favorably than the text and control groups and the animation group rated the learning experience more favorably than the control group.

Experiment 2

The goal of Experiment 2 was to replicate our first study using a different topic and a different group of students.

Method

Participants and design

The participants were 80 student teachers (53 females and 27 males) from three educational psychology introductory courses that were given credit towards their course grade for their participation. The mean age of the participants was 26.14 (SD = 7.12). The reported ethnicities were: 47 White Americans, 29 Hispanic Americans, 1 Native American, 2 African Americans, and 1 Asian American. There were 20 participants each in the control, text, video, and animation groups.

Materials and apparatus

The paper-and-pencil materials were identical to those used in Experiment 1. The computerized materials consisted of a multimedia instructional program that was identical to the one used in Experiment 1 with the following modifications: Step (b) was modified to introduce the new theoretical topic—essential teaching skills and characteristics of constructivist classrooms; step (c) presented a ten item multiple choice test from the instructor's test bank

(internal reliability of .79) that measured the participant's knowledge of the new topic; for students in video, animation, and text groups, step (d) presented a classroom exemplar illustrating essential teaching skills and characteristics of constructivist classrooms in the respective format; and step (f) presented two applications questions about the new topic. The classroom exemplar used for the video group was a 14 min video that was included in the instructor's supplemental materials (Ormrod, 2003b). It consisted of a constructivist lesson on Bernoulli's principle in a middle school science class. The animation and text exemplars were developed using the same procedure described in Experiment 1 and the multimedia programs were developed with the same software and apparatus used in Experiment 1.

The internal reliability of the questionnaire presented in step (e) was .92. Using the same procedure than the one used in Experiment 1, we found again evidence for the valid aggregation of the six items into a total learning and motivation perception score. The applications test used in step (f) consisted of the following two questions: ''Pick a topic of your interest (i.e., math, science, art education, etc.). Based on the essential teaching skills you just learned about, what are some things that you, as a teacher can do to make instruction effective? Please be specific in your suggestions.'' and ''Imagine that you need to plan a constructivist lesson in a topic of your choice, what are some methods that you can use? Please be specific in your suggestions.''

The grading rubric for the applications test was developed using the same procedure described in Experiment 1. Examples of acceptable answers (MA and NA) for question 1 included specific applications of the following teaching skills to participants' teaching area: attitudes, use of time, organization, communication, focus, feedback, questioning, review, and closure. Examples of acceptable answers for question 2 included specific applications of the following principles to participants' teaching area: providing learners with a variety of examples and representations of content to accommodate differences in background knowledge, connecting content to the real world, promoting high levels of interaction with classroom discussions or cooperative learning activities, and using guided discovery methods. The scoring procedure was identical to the one described in Experiment 1. Inter-rater reliability between the scorers was 83%.

Procedure

The procedure was identical to the one used in Experiment 1.

Results

Table 2 shows the mean scores and standard deviations for the control, text, video, and animation groups on measures of pretest, applications test, MA, NA, EA, GA, and learning and motivation perceptions. Similar to Experiment 1, we first examined whether the presentation of a classroom exemplar affects students' learning by conducting an ANCOVA using treatment group

Table 2 Mean score on pretest, applications test, model applications, novel applications, extraneous applications, generic applications, and learning and motivation perceptions, and corresponding standard deviations for four groups—experiment 2

Group	*N*	Pretest		Applications test		Model applications		Novel applications		Extraneous applications		Generic Applications		L & M Perceptions	
		M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Control	20	6.50	1.50	4.55	2.14	1.80	1.10	2.75	1.52	0.95	0.76	1.40	1.35	3.48	1.01
Text	20	5.35	2.23	5.40	2.09	2.85	1.60	2.55	1.32	0.80	0.70	0.80	0.70	3.83	1.43
Video	20	6.15	1.69	6.40	2.37	2.80	1.51	3.60	1.57	0.70	0.57	0.70	0.73	4.58	1.41
Animation	20	6.70	1.72	6.85	2.25	3.35	1.50	3.50	1.67	0.85	0.59	0.60	0.68	4.88	1.13

Note: Actual scores ranges were 0–10 for the pretest, 0–11 for the applications test, 0–7 for model applications, 0–7 for novel applications, 0–2 for extraneous applications, 0–5 for generic applications, and 1–7 for learning and motivation perceptions. L & M stands for learning and motivation

as between-subjects factor, the applications test score as the dependent measure, and the pretest scores as a covariate. Again, we found no violation of the assumption of homogeneity of regression, ($r = .10$), $F(3,75) = .20$, $P = .89$. The ANCOVA revealed a significant difference between treatments on the applications test, $F(3, 75) = 4.17$, MSE = 20.62, $P = .009$, $\eta^2 = .14$. Post-hoc Tukey tests indicated that animation and video groups produced higher scores than the control group (Ms = 6.85, 6.40, and 4.55; SDs = 2.25, 2.37 and 2.14, respectively).

Second, we examined if the groups differed on the type of answers produced in the applications test by conducting a multivariate analysis of variance with treatment group as between-subjects factor and students' MA, NA, EA, GA scores as dependent measures. The analysis revealed a significant difference between treatments on the dependent measures, Wilks' $\lambda = 0.65$, $F(12,193) = 2.84$, $P = .001$, $\eta^2 = .13$. Follow-up analyses of variance were conducted on each dependent variable using the Bonferroni method to adjust for Type I error. The results showed the same pattern found in our first experiment: groups did not differ in NA scores or EA scores but there were significant differences among groups on the MA scores, $F(3, 76) = 4.07$, MSE = 8.43, $P = .01$, $\eta^2 = .14$, and on the GA scores, $F(3, 76) = 3.12$, MSE = 2.58, $P = .03$, $\eta^2 = .11$. Animation, video, and text groups produced higher MA scores than the control group C, which produced higher GA scores than animation, video, and text groups.

Finally, we conducted an ANOVA, using the treatment group as between-subjects factor and students' learning and motivation perceptions score as the dependent measure. This analysis revealed a significant attitudinal difference between treatments, $F(3, 76) = 3.92$, MSE = 285.88, $P < .05$, $\eta^2 = .13$. Post-hoc Tukey tests showed that animation and video groups rated the learning experience more favorably than the control group and that the animation group rated the learning experience more favorably than the text group.

Discussion

Theoretical implications

Theoretically, the findings support an experiential theory of learning by showing that the presentation of visual classroom exemplars (videos and animations) helped students' apply theoretical principles to practice as compared to not presenting a classroom exemplar. Furthermore, our analysis of the type of answers given during the applications test provides strong support for social cognitive theory (Bandura, 1986). Across the two experiments we found that although groups did not differ on the amount of NA, animation, video, and text groups produced significantly more MA than those in the control group. Moreover, consistent with the consulted expert's opinion, who noted that the animation exemplar had minimized the representation of non-relevant behaviors included in the video exemplar, the animation group produced the larger mean number of MA across both experiments. In line with research examining the effects of models on academic skills (Braaksma, Rijlaars-dam, & van den Bergh, 2002), the participants who were presented with a model teacher illustrating how to apply the learned principles into her practice were more likely to transfer the modeled strategies to their own teaching areas than those not presented with the model.

Interestingly, the pattern of results for MA reverted for GA across experiments. Despite the explicit instruction in our applications test to ''Please be specific in your suggestions'', the control group gave significantly more answers rewording the theoretical principles learned than the rest of the groups. Because the treatment used with the control group consisted of instruction on the theoretical principles alone, this finding may not be surprising. However, it further supports the idea that presenting an explicit connection between theory and practice during instruction increases the likelihood of applying the principles when students are presented with a new classroom scenario (Bransford & Schwartz, 1999).

In addition, this research supports the idea that using visual classroom exemplars in teacher preparation courses promotes students' positive attitudes towards learning. In both studies, students presented with an exemplar in video or animation formats had more favorable learning and motivation perceptions than those who learned with no exemplar. This finding extends past research on the motivational effects of using visual aids during instruction (Barnett & Tyson, 1999; Henry et al., 2004) and is consistent with cognitive affective theories of learning according to which affective factors mediate learning by increasing or decreasing cognitive engagement (Moreno, 2005; Pintrich, 2003; Renninger et al., 1992).

Why did the benefits of presenting a classroom exemplar in video and animation formats did not extend to the text format? Any attempt to answer this question brings a potential criticism from the early media-comparison opponents (Clark, 1983). However, as Clark (1999) more recently stated, ''...certain elements of different media, such as animated motion or zooming,

might serve as sufficient conditions to facilitate the learning of students who lack the skill being modeled (p. 453).'' Consistent with the consulted expert's opinion, we believe that one of the reasons underlying the superiority of the video and animation media is that they both are better able to convey certain information as compared to text narratives. Specifically, the lack of temporal and visual information may have imposed a burden on students' meaning making process while reading the narrative. In this regard, it is important to note that classroom narratives assume students' ability to visualize the scenario. However, if students lack this skill, learning may be negatively affected due to the absence of visual cues and increased amount of effort required to visualize the described behaviors and connect them with the principles learned.

Finally, as the expert fairly predicted, presenting classroom visualizations may also promote learning by increasing students' motivation and, in turn, attention. This idea was supported in our research. Across the two experiments the text group produced lower scores on the learning and motivation perception measure, which included ratings about how interesting, entertaining, and motivating the instructional program was. A similar effect was found in a recent study (Moreno & Valdez, in press), in which prospective teachers who learned teaching principles with classroom video exemplars reported higher affective ratings than those who learned teaching principles with the same classroom exemplars in the text format.

To summarize, the fact that the control and text groups did not differ in their learning or perceptions about learning and motivation suggests that format is an important factor in determining the effectiveness of classroom exemplars as pedagogical tools for teacher education. However, more research is needed to fully understand the mechanisms underlying the better application of principles that the video and animation groups demonstrated in our study as compared to the text narrative condition.

Practical implications and limitations

On the practical side, the contribution of this study is to provide an empirical research base to guide the design of classroom exemplars as instructional tools. Most educational psychology textbooks present classroom exemplars in the form of case narratives within the text and only a few examples are provided in the form of videos or electronic video captions as multimedia supplemental materials (Eggen & Kauchak, 2004; Ormrod, 2004; Woolfolk, 2004). That is, despite the fact that videotape players are readily available in virtually every educational setting in the United States (Wetzel et al., 1994) and that computers and CD-ROMs are becoming more and more available to students and teachers, the exemplar formats that seem to be the most effective are the least used in the teaching practice. Thus, the most direct practical contribution of this research is to provide empirical data showing the superiority of visual exemplars over text narratives, suggesting the need to develop

more of this kind of thinking tools to promote application skills and positive learning and motivation perceptions.

A distinctive contribution of this research is to identify a promising tool for instruction and research: classroom animations. The advantages of using animations stems from the flexibility they offer in developing instructional materials and the ease with which investigators can use them to conduct experiments. Although educators and researchers can produce real classroom footage for teacher preparation, such creations entail the investment of much time and expense and do not warrant capturing a relevant learning situation. On the other hand, classroom animations can be designed to be aligned with the instructional objective of the lesson, to help students' meaning making process by focusing only on relevant teaching behaviors, and to represent different outcomes, contingent on students' input.

Finally, it is important to note that the implications of our study are limited because we chose to present a classroom scenario with a specific function (i.e., as an example of how to apply teaching principles), population (i.e., prospective teachers), and content domain (i.e., educational psychology), and only included learning and affective measures immediately after a short intervention. Would the effects we observed be the same had we used classroom scenarios for a different educational objective, population, or domain? Would the effects be larger if we were to include other pedagogies (i.e., classroom or small group discussions) or more examples during instruction? Would the effects we found remain in the long term and transfer to students' teaching practice? Additional research is needed to better understand under which conditions classroom exemplars promote application of theory into practice.

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