Teaching of Psychology, 35: 121–125, 2008

ISSN: 0098-6283 print / 1532-8023 online
DOI: 10.1080/00986280802004578

Routledge
Taylor & Francis Group

TECHNOLOGY AND TEACHING

Educational Technologies: Impact on Learning and Frustration

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Educators are increasingly using educational technologies at the postsecondary level although little research has investigated the effects of such technologies on learning. Our research explored the effects of traditional lecture, slide-show-supplemented lecture, and virtual learning environment (VLE) on learning and frustration among college students. Participants in slide-show-supplemented lecture and VLE conditions demonstrated more learning than participants in the traditional lecture conditions. However, participants in the VLE conditions reported significantly higher levels of frustration relative to those in the traditional lecture and slide-show-supplemented conditions. Our findings may be particularly relevant in light of the increasing numbers of online college degree programs that use VLE platforms. We discuss additional implications and future research.

Investigations of educational technologies, such as Microsoft PowerPoint slide show presentations, have produced mixed results. For example, Amare's (2006) research revealed that college students enrolled in a traditionally instructed class earned higher test scores relative to students enrolled in a slide-show-supplemented class. Other studies (DeBord, Aruguete, & Muhlig, 2004; Szabo & Hastings, 2000) found that classes with slide-show-supplemented lectures did not produce academic gains relative to traditional instruction. In terms of students' perceptions, a number of studies have found that college students report that they enjoy slide-show-supplemented lectures (Bartsch & Cobern, 2003; Szabo & Hastings, 2000) and believe they benefit from slide show presentations in the classroom (Susskind, 2005).

We found similarly mixed results regarding the educational efficacy of virtual learning environments (VLE), such as Blackboard (2007; http://www.blackboard.com/us/index.Bb/) among college students. Brown and Liedholm (2002) found that students enrolled in a VLE answered more test questions incorrectly compared to students in a traditional class. Our investigation revealed studies that support (Maki, Maki, Patterson, & Whitaker, 2000) and challenge (Maki & Maki, 2000; Smeaton & Keogh, 1999) the educational efficacy of VLEs among college students.

We found only a handful of studies that investigated students' affective response to VLEs. Maki et al. (2000) found that students enrolled in a VLE reported more confusion, diminished interest, and reduced levels of satisfaction. Similarly, Hansen and Gladfelter (1996) found that some of their students reported feeling overwhelmed with the academic requirements associated with a VLE platform relative to traditional instruction.

Our primary goal was to explore three commonly used methods of instruction: traditional lecture (TL), slide-show-supplemented lecture (SSL), and VLE to determine which produced the greatest amount of learning among college students. Due to conflict in the literature regarding the educational effectiveness of SSLs (Amare, 2006; DeBord et al., 2004; Szabo & Hastings, 2000) and VLEs (Brown & Liedholm, 2002; Maki et al., 2000; Maki & Maki, 2000; Smeaton & Keogh, 1999) relative to TL, our research was exploratory in nature. Our review of the literature did not reveal any research comparing the pedagogical effects of VLEs to SSLs. Therefore, we were also interested in examining

the educational efficacy of VLEs relative to SSLs. To examine previous findings of negative affect associated with VLEs (Hansen & Gladfelter, 1996; Maki et al., 2000), we explored students' self-reported perceptions of frustration in response to educational tasks set in TL, SSL, or VLE format. We predicted that frustration would be low in the low-technology or TL condition, moderate in the SSL condition, and high in the high-technology or VLE condition.

Method

Participants

Our participants were 154 (78 women, 76 men) undergraduate students at a large, Midwestern university who were enrolled in the Psychology Department's participant pool to fulfill 2 hr of required research participation associated with a psychology class. We provided students with credit in their psychology class in return for their participation. The majority (90.26%) of our participants were between 18 and 24 years old.

Procedure

We controlled carefully for instructor, classroom, academic content, and lecture length among the experimental lectures, such that the conditions differed only with respect to mode of presentation. We randomly videotaped two of the four TL sessions and two of the four SSL sessions. A research assistant evaluated the videotapes to determine if differences in teaching style existed between conditions. The MANOVA we conducted to examine teaching style (i.e., duration of lecture, use of humor, use of explanatory stories, number of student questions asked, and instructor's physical movements) did not reveal significant differences between the TL and SSL conditions, Wilks's $\Lambda = 0.64$, $F(1, 4) = 0.28$, $p = .80$, $\eta^2 = .04$.

Groups of participants, ranging in size from 5 to 15, completed informed consent, an academic pretest, and a demographic questionnaire before the instructor randomly assigned them to one of the three experimental lecture conditions. The instructor presented the academic content (concepts of psychological conformity and obedience) to participants in a 40-min lecture. We used an introductory psychology textbook (Kassin, 1998) lecture outline on conformity and obedience to control for the content of information presented. For example, we asked the question "Is conformity good or bad?" in each lecture. The instructor varied the question only with regard to the method of presentation: verbally in the TL condition, verbally and written in the SSL condition, and written in the VLE condition. Following the lecture, participants had a 5-min review period and a 10-min break before completing the academic posttest and a self-report measure of frustration. The instructor provided participants with a debriefing at the conclusion of each experimental lecture. The university's institutional review board approved all aspects of our study.

Traditional lecture. In the TL condition ($n = 47$), the instructor presented participants with an interactive oral lecture on conformity and obedience. The instructor used a dry-erase board to create visual aids, such as definitions, numeric notations (e.g., percentages), and diagrams relevant to the lecture. The instructor provided participants with paper and a pencil to take notes if they did not bring their own. The instructor also answered participants' questions regarding the presented material and encouraged conversation.

Slide-show-supplemented lecture. In the SSL condition ($n = 56$), the instructor presented participants with an interactive oral lecture and a slide show presentation on conformity and obedience. The instructor presented visual content, such as definitions, numeric notations (e.g., percentages), and diagrams, as well as relevant photographs, media, and graphics within the slide show presentation. The instructor followed the same pattern of student interaction outlined in the TL condition.

Virtual learning environment. In the VLE condition ($n = 51$), students had access to a Blackboard 5 (2007; http://www.blackboard.com/us/index.Bb/) Web site. Although we did not provide the VLE participants with any face-to-face instruction, we did provide them with a written introduction on the Web site. The introduction directed the participants to a slide show presentation similar to the one employed in the SSL condition, which we modified to contain information that the instructor had presented verbally in the TL and SSL conditions. Thus, we presented information in written format in the VLE slide show presentation that the instructor had presented verbally in the TL and SSL conditions. We included the same visual content in the VLE slide show presentation that we used in the SSL condition. The VLE participant's

only contact with the instructor was via the Web site Discussion Board. Participants posted questions on the Discussion Board, which the instructor answered in the order received.

Measures

Academic pretest and posttest. Each test was composed of 15 questions about conformity and obedience that we obtained from an introductory psychology textbook (Kassin, 1998) test item file. We chose the 30 multiple-choice questions based on their relevance to the academic content and their relative equivalency in difficulty, determined by Kassin (1998). We divided the questions into two groups of 15, which we randomly assigned to the experimental groups as either a pretest or posttest. We summed correct responses on the pretest and summed correct responses on the posttest, such that scores on either measure could range from 0 to 15.

Frustration. We assessed frustration using a subscale of the computerized version of the National Aeronautics and Space Administration–Task Load Index (NASA–TLX; Hart & Staveland, 1988). The NASA–TLX is a multidimensional rating procedure that provides an overall workload score by assessing the relative contribution of six sources of workload, including frustration. Hart and Staveland (1988) defined frustration as the participant's experience of feeling insecure, stressed, discouraged, and annoyed versus feeling secure, gratified, content, and relaxed while engaged in a task. The NASA–TLX asks participants to rate their experiences with bipolar descriptors representing either extreme on a continuum (*High–Low*, *Good–Poor*) ranging from 1 to 100.

Results

Baseline Equivalence of Samples

We compared the demographic features of our participants by condition to evaluate the baseline equivalency of our sample. We did not find significant differences in the distribution of men and women among the TL, SSL, and VLE conditions, $\chi^2(1, N = 154) = 0.26$, $p = .87$. Similarly, univariate ANOVAs that we conducted did not reveal significant differences among the experimental lectures conditions in terms of participants' mean age, $F(2, 151) = 2.21$, $p = .11$; mean year in school, $F(2, 151) = 2.42$, $p = .09$; or mean performance on the academic pretest, $F(2, 151) = 2.54$, $p = .08$.

Comparisons of TL, SSL, and VLE Conditions on Learning

We used linear regression to create an adjusted posttest variable that controlled for the covariate of participants' pretest knowledge (i.e., residual change; Cohen, Cohen, West, & Aiken, 2003). We examined mean differences among the three levels of the experimental lecture conditions on the adjusted posttest scores using univariate ANOVA. Our results revealed a moderate difference between experimental lecture condition and posttest scores when controlling for preexisting knowledge of conformity and obedience, $F(2, 151) = 3.68$, $MSE = 5.74$, $p = .03$, $\eta_p^2 = .04$ (small–medium effect; see Table 1 for descriptive statistics).

We conducted follow-up tests to evaluate pairwise differences among the experimental conditions and used the Fisher's Least Significant Difference (LSD) test procedure to control for Type I error across the three pairwise comparisons. We found significant differences in the adjusted means between the TL ($M = -.79$, $SE = .35$) and VLE ($M = .34$, $SE = .34$, $p < .05$) conditions as well as the TL and SSL ($M = .36$, $SE = .32$, $p < .01$) conditions, but no significant difference between the VLE and SSL conditions. In sum, we found that the VLE and the SSL formats facilitated greater learning than the TL condition.

Table 1. Descriptive Statistics for TL, SSL, and VLE Conditions

	Academic Pretest		Academic Posttest		Frustration Score	
Condition	M	SD	M	*SD*	M	*SD*
TL	7.21	2.21	10.81	2.95	23.62	20.91
SSL	6.39	2.41	11.64	2.29	21.31	23.76
VLE	6.29	1.96	11.59	2.48	38.38	33.17

Note. TL = traditional lecture; SSL = slide-show-supplemented lecture; VLE = virtual learning environment. Pretest and posttest scores represent mean correct responses on each 15-point measure. Frustration scores represent participants' self-reported mean frustration on a 1- (*low*/*good*) to 100- (*high*/*bad*) point scale reflecting their experiences attempting to learn the academic concepts.

Comparisons of TL, SSL, and VLE Conditions on Frustration

We examined mean differences in frustration[1] among the three experimental lecture conditions using a one-way ANOVA. We found a significant difference in frustration, $F(2, 108) = 4.65$, $p = .01$, $\eta_p^2 = .08$ (medium effect). As such, we conducted follow-up tests to evaluate pairwise differences among the means and used Fisher's LSD test to control for Type I error across the three pairwise comparisons. Our tests revealed a significant effect for the VLE condition ($M = 38.38$, $SE = 4.26$) relative to the TL condition ($M = 23.62$, $SE = 5.00$), Cohen's $d = .52$ (medium effect), and the SE condition ($M = 21.31$, $SE = 4.15$), Cohen's $d = .60$ (medium effect). We did not find significant differences in frustration between the TL and SSL conditions. In sum, we found that participants reported experiencing greater frustration in the VLE condition relative to the other conditions.

Discussion

We were interested in examining the efficacy of various educational technologies. We found that SSLs and VLEs produced greater learning among college students relative to the TL format. Our findings are contrary to previous research, which did not find significant gains associated with SSLs (Szabo & Hastings, 2000) and VLEs (Brown & Liedholm, 2002) compared to traditional lecturing. We believe that the increased academic achievement in the SSL and VLE conditions may reflect a number of phenomena. One possible explanation is that the SSL and VLE formats created an active learning environment, which produced greater academic gains (Benjamin, 1991; Fox & Hackerman, 2003) than the more passive learning environment found in the TL condition. Weiner's (1990) perspective on arousal and learning suggests that emotionally stimulating instructional materials enhance learning motivation and subsequent learning outcomes. Thus, the success of the SSL and VLE formats may be due to the participants' preference for technologically enhanced and visually stimulating educational formats.

We believe that these explanations may also shed light on the absence of significant achievement differences between the SSL and VLE conditions. Our participants, the majority of whom were young adults, may be accustomed to having information presented to them in a visually stimulating manner as a function of having grown up with a variety of visual tools (e.g., television, video games, computers). Both SSL and VLE conditions incorporated aspects of visual multimedia, including colors, graphics, and pictures, which may have produced active and arousing learning environments. Further research is required to better elucidate the influence of these factors on technologically enhanced learning environments.

Participants in our study reported greater frustration (i.e., insecurity, stress, discouragement) with the VLE method of instruction compared to the TL and SSL conditions. One explanation for the higher levels of reported frustration in the VLE format may be the absence of direction and guidance provided by an instructor. Historically, the role of the teacher has been to explicitly and implicitly direct students, controlling the amount of information and presenting it in way that is manageable and relevant to students. The VLE participants were not provided with explicit and regular professorial guidance, which may have increased the level of difficulty associated with the academic task and reported experiences of frustration (Amsel, 1992).

We would like to acknowledge the limitations to our study. Our use of only one research assistant in the videotape coding process resulted in an absence of reliability data regarding our instructor's teaching style. Additionally, the one-lecture paradigm we employed limits extrapolation to quarter- or semester-long courses. Bartsch and Cobern (2003) found a nonsignificant difference between overhead transparencies and expanded slide shows that incorporated extraneous graphics and a significant difference between expanded and basic slide shows on students' quiz performance over the course of a semester. These findings, in conjunction with the research reported here, suggest that further exploration of the cumulative influence of educational technologies in a more authentic setting would be prudent to fully understand the advantages and disadvantages of these educational tools. Future studies investigating students' self-reported emotional responses to educational technologies are likely also warranted. Future research may also focus on the role of assistance in VLEs. An active instructor directing discussion boards and providing students with regular feedback and assistance is likely to create a

[1]Total number of participants for analyses examining frustration ($n = 110$) is lower due to participant error (e.g., did not provide an identification code, provided an incorrect or incomplete code) in the completion of the NASA–TLX.

different learning experience than a VLE without such guidance.

Without an understanding of Web-based instruction and learning, there is the danger that courses employing educational technologies will become prematurely driven by technology rather than pedagogy. Although our results support the use of educational technologies, participants in our study also reported greater frustration with the highest technology (i.e., VLE) condition relative to other methods of instruction. Professorial guidance and feedback may help to alleviate such frustration. Our findings may be particularly relevant in light of the increasing numbers of online college degree programs that use VLE platforms exclusively.

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Notes

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2. The National Institute for Alcohol Abuse and Alcoholism provided partial support for the preparation of this article through grant T32AA007455.
3. We thank James E. Freeman and three anonymous reviewers for their helpful feedback during the editorial process. We also thank Mary E. Larimer, Mindi Yuspeh, and Philip Hove, for their many contributions to this project.
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