



PowerPoint's power in the classroom: enhancing students' self-efficacy and attitudes

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Abstract

The current study examined the effects of non-interactive computer assisted instruction on students' performance, self-efficacy, motivation, and attitudes. Half the lectures presented to two Introduction to Psychology college classes were taught in a traditional lecture format and half were accompanied by PowerPoint multimedia. Lecture order was counterbalanced across classes. Whereas lecture style did not affect academic performance, students had more positive attitudes about the course and greater self-efficacy with PowerPoint. In the class that started with PowerPoint lectures, student motivation declined after PowerPoint stopped accompanying lectures. However, student motivation did not increase after PowerPoint was added in the other class.

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1. Introduction and literature review

There is a debate in the educational literature over whether non-interactive educational technology, such as accompanying lectures with PowerPoint presentations, is beneficial to students (Creed, 1997; Rocklin, 1997). The channel in which information is presented not only affects

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the way the information is perceived, but the channel itself provides information to the perceiver (McLuhan, 1964). This leads to two important questions. First, what message is transmitted when instructors accompany lectures with PowerPoint presentations? Second, what is the educational impact of lecturing with PowerPoint?

One of the main features of PowerPoint is that it provides structure to a presentation. This aids in the order and pacing of the lecture (Hlynka & Mason, 1998) and makes it easier for lecturers to present clear summaries (Lowry, 1999). This may affect how much students learn from the lectures as the organizational structure of instructional material is related to students' understanding (Miller & McCown, 1986) and their retention of the material (Garner, 1992). Further, perceptions of teacher organization are related to the amount students learn (Pittman, 1985) and to their general cognitive development (Pascarella, Edison, Nora, Hagedorn, & Braxton, 1996).

In addition, accompanying lectures with PowerPoint is a more efficient time management strategy than writing on a whiteboard or using transparencies (Daniels, 1999; Mantei, 2000). As less class time is spent writing or changing transparencies, each lecture may flow better.

The research regarding the impact of lecturing with PowerPoint's on academic performance has been mixed as some researchers have found that it enhances students' academic performance (Kask, 2000, female students; Lowry, 1999; Mantei, 2000; Szabo & Hastings, 2000, Exp. 2) whereas others have found no effect (Daniels, 1999; Kask, 2000, male students; Rankin & Hoas, 2001; Szabo & Hastings, 2000, Exps. 1 & 3). The differing patterns of findings may be due to the methodologies employed. Three of the studies that found positive effects for PowerPoint confounded lecture format and order of presentation (Kask, 2000; Lowry, 1999; Mantei, 2000). These researchers compared recent cohorts of students taught with PowerPoint to cohorts taught via traditional lectures in previous semesters. As PowerPoint always accompanied newer lectures, any improvements in the lectures not due to the multimedia format would be attributed to it. Furthermore, cohort effects may account for the better performance by the more recent students.¹

A different concern is raised by Szabo and Hastings' (2000, Exp. 2) methodology. They presented three lectures to students: one with overheads, one with a PowerPoint presentation, and one with PowerPoint and lecture notes. They found that students performed worse on an exam concerning the material presented via overheads. Because the content of the lectures were different, it is unclear whether the students' performance was due to the lecture format or how hard it was to understand the material in each lecture.

Alternative explanations also exist for Mantei's (2000) results. He compared students who were taught with PowerPoint presentations and had access to lecture notes in advance to students who were taught in a traditional format and lacked access to lecture notes. Thus, the effect on academic performance could have been due to PowerPoint, the notes, or the combination of the two. This confound also may have affected Kask's (2000) study. Although Kask did not discuss whether students who received PowerPoint lectures were provided with lecture notes, she claimed this was a beneficial aspect of computer-aided presentations.

Szabo and Hastings (2000, Exp. 3) dealt with these issues by presenting students with both one traditional and one PowerPoint multimedia lecture with the lecture format order counterbalanced

¹ Three of the studies that found no impact of PowerPoint on performance also employed between group designs (Daniels, 1999; Rankin & Hoas, 2001; Szabo & Hastings, 2000, Exp. 1) and two of those confounded lecture format and order of presentation (Daniels, 1999; Szabo & Hastings, 2000, Exp. 1).

across participants. Under these conditions, they found lecture format did not affect students' performance. They proposed that it is necessary to replicate this finding over the course of a semester.

At first glance, the findings look clearer for the effects of PowerPoint on students' attitudes concerning the course. Positive attitudes are observed when lectures are accompanied by PowerPoint presentations (Atkins-Sayre, Hopkins, Mohundro, & Sayre, 1998; Daniels, 1999; Frey & Birnbaum, 2002; Harknett & Cobane, 1997; Kask, 2000; Lowry, 1999; Mantei, 2000; Nowaczyk, Santos, & Patton, 1998; Szabo & Hastings, 2000). PowerPoint presentations are perceived as more interesting than traditional lectures (Atkins-Sayre et al., 1998; Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000). Furthermore, accompanying lectures with PowerPoint presentations enhances students' academic self-efficacy. Students felt it was easier to understand the course material (Atkins-Sayre et al., 1998; Kask, 2000; Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000) and to take notes (Frey & Birnbaum, 2002; Kask, 2000) when PowerPoint was used. The students' enhanced self-efficacy may have been driven by their perception that the PowerPoint lectures were better structured (Szabo & Hastings, 2000) and emphasized key points better (Frey & Birnbaum, 2002; Szabo & Hastings, 2000) than traditional lectures.

However, many of these studies (Daniels, 1999; Harknett & Cobane, 1997; Kask, 2000; Lowry, 1999) only asked questions about PowerPoint lectures and did not include a comparison group of alternative lectures. This approach is problematic as it is unclear whether students preferred PowerPoint lectures to traditional lectures. Further, as the instructors were asking about attitudes toward their own use of PowerPoint, demand characteristics could have enhanced evaluations of PowerPoint.

This was dealt with by other researchers (Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000) who asked their students to compare the current class to courses that employed traditional lectures. Although this eliminates the lack of a comparison group, the issue of demand characteristics still exists. Furthermore, there are two problems with the comparison group. First, the comparison group of traditional classes was different for each student. Second, the traditional classes covered different course material than the PowerPoint course. Thus, questions assessing 'how easy it is to understand the material' or 'how interesting the course is' depend on which courses students' use as their comparison group.

2. Rationale and hypotheses

To account for some of these methodological issues, the current study employed a mixed participants design in which two cohorts of Introductory to Psychology students received half of their lectures in a traditional format and half accompanied by PowerPoint multimedia presentations. The lecture format order was counterbalanced across cohorts. This design allows for a better assessment of students' academic performance than the between participants design typically employed. First, it eliminates the confound between lecture type and presentation order observed in previous studies (Kask, 2000; Lowry, 1999; Mantei, 2000). Second, it reduces concerns about cohort effects because within cohorts comparisons can be made.

The methodology also is beneficial for examining students' attitudes and self-efficacy beliefs. Previous research either lacked a comparison of PowerPoint lectures to traditional lectures (Daniels, 1999; Harknett & Cobane, 1997; Kask, 2000; Lowry, 1999) or students compared the instructor's

PowerPoint lectures to traditional lectures in other courses (Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000). These methodologies do not allow for assessment of whether PowerPoint lectures are preferred to traditional lectures. When there is no comparison lectures or when the comparison is to other instructors' lectures, there may be strong demand characteristics to provide positive evaluations of the PowerPoint lectures.

In the current design, each student received both traditional and PowerPoint lectures by the same instructor. Therefore, it is possible to examine whether students prefer PowerPoint or traditional lecture formats. Furthermore, students were asked whether they had a preference for one of the teaching methodologies and not an overall evaluation of the course. This reduced demand characteristics to provide a positive response for PowerPoint lectures as it was not clear what the instructor's preference was.

The current research assessed the effects of accompanying lectures with PowerPoint presentations on students' test performance, self-efficacy, attitudes about the course and course-related motivation. Four hypotheses were made based on the premise that lecturing with PowerPoint would create the perception of structure and organization. The first hypothesis was that students would have more positive attitudes about the course when lectures were accompanied by PowerPoint presentations. Students were expected to perceive that the lectures were more organized and that the professor did a better job with PowerPoint presentations. Further, they were expected to prefer those lectures to traditional lectures.

If students view the PowerPoint lectures as more organized, they may find it easier to note those lectures' key points, take notes, and learn the material. This leads to the second hypothesis, that students would have stronger course-relevant self-efficacy beliefs when PowerPoint multimedia presentations were employed.

Third, as students are expected to view the material discussed in PowerPoint lectures as easier to understand, they are predicted to perform better on the exam that covered material from PowerPoint lectures than on the exam that covered material from traditional lectures.

Finally, if students believe they are more capable of learning material taught via PowerPoint, then they should be more motivated to attend the PowerPoint multimedia lectures than the traditional lectures. Thus, the final hypothesis was that students' course-related motivation would be greater when lectures were accompanied by PowerPoint multimedia presentations.

3. Method

3.1. Participants

Participants were general psychology students attending a small, liberal arts college in Virginia. All participants were enrolled in one of two Introduction to Psychology sections. The classes met three times a week for 50 min each session. Sections were scheduled back to back during afternoon hours. The first section was composed of 33 students (14 males and 19 females) and the second section was composed of 18 students (10 males and eight females). As the students chose which section they attended, the participants were not randomly assigned to conditions. Therefore, any differences observed between the groups may reflect pre-existing differences in academic ability, preparation or motivation.

3.2. Procedure

For the first five weeks of the semester, section one was taught via a traditional lecture method where the instructor provided course-related information to students while writing notes on a whiteboard. The same instructor provided the same lectures and notes to section two. However, the notes were presented by PowerPoint presentation software (version 4.0 for the Macintosh). The presentations were displayed on a screen by a SharpVision XG-E660U projector. Most of the PowerPoint presentations' content was text; however, a few slides contained graphics to display psychological concepts. When graphics were displayed on PowerPoint, section one viewed the graphics on an overhead. In both sections, the instructor lectured from the same detailed notes. Questions and discussion of content by students was encouraged in both sections.

After the first five weeks, students had their first exam. Students were asked to complete a survey that assessed their classroom motivation after they finished the exam.

Lecture format was switched after the first exam, so that section one experienced lectures with PowerPoint presentation software and section two experienced the traditional lecture approach. After another five weeks (week 10 of the semester) the students took another exam, similar in format to their first exam. Students were again asked to complete the student motivation survey. In addition, they were asked to answer 15 items that reflected their attitudes toward the course and their self-efficacy, as well as to provide open-ended comments about lectures with and without PowerPoint.

To preserve students' anonymity on the various measures while tracking their responses, students were asked to identify themselves only by providing the name of their favorite elementary school teacher. Students were informed that these names would be stored for future use but that they would not be associated with their actual names.

3.3. Measures

3.3.1. Achievement

The students' percentage of items answered correctly on the examinations administered during weeks five and ten was assessed. The first exam contained 45 multiple choice and eight short answer questions and the second exam contained 42 multiple choice and eight short answer questions. Each question was worth one point.

3.3.2. Course-related motivation

Students completed a 14 item version of Christophel's (1990) Student Motivation Scale. The scale included the 12 items used by Christophel as well as one additional item from Beatty, Behnke, and Froelich (1980) and one from Richmond (1990). The scale consisted of 14 semantic differential items designed to assess students' enthusiasm for specific courses. Each item was measured on a 7-point scale. Students were asked to circle the number that best represented their feelings about the course. Examples of items included challenged/unchallenged, inspired/uninspired, and looking forward to it/dreading it. Reliability for the scale was measured at each survey implementation.

Cronbach's alpha yielded a score of .88 for the measure after exam one and .87 for the measure after exam two.

3.3.3. Attitudes toward the course and self-efficacy

Students completed an additional survey regarding their perceptions of the course. Seven items assessed students' attitudes about the course. Students were asked about the condition (PowerPoint or traditional lectures) in which they believed: (a) the lectures were more organized, (b) the lectures were less interesting, (c) the professor did a better job, (d) they felt worse missing class, (e) they enjoyed the lectures more, (f) they preferred the lectures more, and (g) whether they were more motivated to attend class. Eight questions examined their self-efficacy and behavior in the course. Students were asked about the condition (PowerPoint or traditional lectures) in which they believed (a) the lectures were harder to understand, (b) they took more notes, (c) it was harder to take notes, (d) their notes were more organized, (e) it was harder to understand their notes, (f) their notes were more useful for studying, (g) they spent more time studying, and (h) whether they were more confident for their exams. Responses were on a 7-point scale, where 1 indicated a strong preference for PowerPoint lectures, and 7 indicated a strong preference for traditional lectures (without PowerPoint). Participants' responses were reverse coded for the following items: the lectures were less interesting, the lectures were harder to understand, it was harder to take notes, and it was harder to understand their notes.

3.3.4. Open-ended comments

Participants were also asked to provide open-ended comments about the two lecture formats.

4. Results

4.1. Attitudes

The students' responses to the attitudes questions were analyzed using one sample *t* tests. Student responses lower than 4 reflected a preference for PowerPoint lectures, whereas scores greater than 4 indicated a preference for traditional lectures. A response of 4 indicated that the students did not display a preference for lectures with or without PowerPoint. Participants' responses were tested to see whether they significantly differed from the midpoint of 4. Students displayed a clear preference for lectures accompanied by PowerPoint on six of the seven attitude questions (Table 1). As expected, they believed that the lectures were more organized and the professor did a better job when lectures included PowerPoint presentations. Further, they reported that the lectures were more interesting and enjoyable with PowerPoint and that they were more motivated to attend those classes. However, lecture style did not affect how students felt about missing class. Thus, hypothesis 1 was strongly supported as students displayed more positive attitudes for PowerPoint lectures on six of the seven attitude questions.

Table 1
Means, standard deviations, and *t* test scores of the student responses for the attitude and self-efficacy questions

Item	<i>M</i>	<i>SD</i>	<i>n</i>	<i>t</i>
The lectures were more organized	1.90	1.02	50	−14.62 ^d
The lectures were more (less) interesting ^a	3.37	1.47	50	−3.05 ^c
I felt bad missing class more	4.28	1.53	49	1.30
The professor did a better job	2.80	1.34	50	−6.37 ^d
I enjoyed the lectures more	3.22	1.65	50	−3.39 ^d
I was more motivated to attend class	3.49	1.44	50	−2.52 ^b
I preferred the lectures more	2.61	1.73	50	−5.74 ^d
The lectures were easier (harder) to understand ^a	2.53	1.06	50	−9.86 ^d
I took more notes	2.58	1.87	39	−4.83 ^d
It was easier (harder) taking notes ^a	2.47	1.60	39	−6.02 ^d
My notes were more organized	1.70	0.91	39	−15.96 ^d
My notes were easier (harder) to understand ^a	2.43	1.28	39	−7.79 ^d
I spent more time studying for exams	3.90	1.41	38	−0.45
My notes were more useful for exams	2.50	1.36	39	−6.98 ^d
I was more confident for the exams	2.95	1.46	39	−4.53 ^d

Note. Means lower than 4 reflected a preference for PowerPoint.

^a These items were reverse-coded. The original wording is in the parentheses.

^b $p < .05$.

^c $p < .005$.

^d $p < .001$.

4.2. Self-efficacy

Similar analyses to those employed for the attitude questions were used to examine the results of the self-efficacy questions.² The students viewed themselves as more effective with PowerPoint presentations. They believed that it was easier to understand the lecture and to take notes when PowerPoint accompanied lecture. They also claimed that they took more notes and that their notes were more organized, easier to understand, and useful for exams with PowerPoint (Table 1). Further, they were more confident for the exam that covered PowerPoint lectures. However, students reported that they studied equally as long for the exams that covered traditional and PowerPoint lectures. Hypothesis 2 was strongly supported as students believed they were more effective when PowerPoint accompanied lectures on seven of the eight self-efficacy and behavior questions.

4.3. Achievement

To examine the effects on achievement and on motivation, 2×2 mixed ANOVAs were conducted with time during the semester (before first or second exam) as the

² Eleven of the students did not complete the back of the survey where seven of the eight self-efficacy questions were.

within-participants variable and lecture style order (section 1: No PowerPoint/PowerPoint, section 2: PowerPoint/No PowerPoint) as the between-participants variable. This analysis was conducted because it allows the assessment of performance and motivation for similar lecture content.

Hypothesis 3 proposed that students' grades would be higher when PowerPoint presentations accompanied lectures. Therefore, students in section 1, who initially had traditional lectures, were predicted to perform better at Time 2 than at Time 1. The opposite pattern was expected for students in section 2, who initially had PowerPoint lectures. However, the results of the analysis revealed that the interaction effect was not significant, $F(1,49) = .09$, ns, $\eta^2 = .00$. Furthermore, there were no significant differences for time, $F(1,49) = .02$, ns, $\eta^2 = .00$, or class section, $F(1,49) = 1.52$, $p > ns$, $\eta^2 = .03$. Students in both sections did as well on exam 1 (section 1: $M = 83.8\%$, $SD = 13.0\%$, section 2: $M = 81.0\%$, $SD = 10.7\%$) as on exam 2 (section 1: $M = 84.6\%$, $SD = 9.5\%$, section 2: $M = 80.6\%$, $SD = 12.9\%$). Thus, hypothesis 3 was not supported.

4.4. Student motivation

The interaction between time during the semester and lecture style order, $F(1,47) = 5.56$, $p < .05$, $\eta^2 = .11$, was significant. Simple effects analyses of time during the semester within each class section were conducted to investigate the pattern of the interaction. Students in section 1 were just as motivated when they received traditional lectures at Time 1 ($M = 5.0$, $SD = .79$) as when they received PowerPoint presentations at Time 2 ($M = 4.9$, $SD = .82$), $t(31) = 1.65$, ns. However, students in section 2 were more motivated at Time 1, when they received PowerPoint lectures ($M = 5.1$, $SD = .75$), than at Time 2, when they received traditional lectures ($M = 4.6$, $SD = .81$), $t(16) = 3.94$, $p < .001$.

The main effect for time during the semester, $F(1,47) = 18.16$, $p < .001$, $\eta^2 = .28$ also was significant. Students reported greater motivation during the first five weeks ($M = 5.1$) than during the second five weeks ($M = 4.8$). Hypothesis 4 was partially supported as the predicted pattern was only observed for one section.

4.5. Students' free responses

Thirty-eight students provided written impressions of lectures with and without PowerPoint. Most comments reflected positively either on the organization of PowerPoint lectures or on the students' greater perceptions of self-efficacy with PowerPoint. See Table 2 for a list of the written comments and their frequency. The most common comments were that: PowerPoint improved their note taking (29% of students who provided a response), PowerPoint lectures were more organized (26%), PowerPoint helped emphasize the lectures' main points (24%), and it was easier to understand PowerPoint lectures (18%). Whereas most students viewed the organizational aspects of PowerPoint positively, a few students viewed this characteristic as creating less spontaneous (5%) and personable (3%) lectures.

Table 2

Written responses from students concerning accompanying lectures with PowerPoint

Comment	Number of responses	Percentage of returns
Improved note taking/notes more organized	11	29%
Lecture was more organized	10	26%
PowerPoint helped emphasize main points	9	24%
PowerPoint made it easier to understand the lecture	7	18%
General positive comment concerning PowerPoint	5	13%
PowerPoint made it easier to follow lecture	3	8%
PowerPoint was better for preparing for the tests	2	5%
PowerPoint serves as outline	2	5%
Can add to PowerPoint outline	2	5%
Took less notes with PowerPoint	2	5%
Less spontaneity, tangents with PowerPoint	2	5%
Less interesting/personable with PowerPoint	1	3%
Zonk out with PowerPoint	1	3%

5. Discussion

5.1. Impact on students' achievement

The most interesting results of this study pertain to the difference between the students' subjective and objective performance. The results imply that accompanying lectures with PowerPoint presentations does not significantly affect student achievement. Although the PowerPoint lectures were perceived as more organized and easier to understand, they did not enhance the students' performance on exams. It should be noted that as the professor was lecturing to each section from identical notes and attempting to provide similar content, the typical organizational benefits of accompanying lectures with PowerPoint presentations might have been minimized.

These findings replicate and extend those of Szabo and Hastings (2000, Exp. 3), who employed a counterbalanced design. Students in their study received one lecture in a traditional format and one accompanied by PowerPoint. The results of the current study imply that lecture format not only does not affect academic performance when students have limited exposure to each teaching format but also when it is manipulated over the course of a semester. Thus, when students are taught via both traditional and multimedia lectures, their academic performance is not dependent on lecture format.

Although the participants believed that they were more capable students with PowerPoint, their performance on the exams was not affected by the presence or absence of multimedia presentations. This pattern of results replicated Szabo and Hastings (2000, Exp. 1) who found that students believed PowerPoint was useful for learning although it did not affect their grades. These findings raise the question of why PowerPoint enhances students' self-efficacy beliefs but not their performance. One possibility is that although PowerPoint's structure and organization led to the perception of improved note taking, this might have been a subjective rather than objective reality.

Second, lecture format did not seem to influence the students' studying behavior. This may reflect one of the limitations of PowerPoint. Creed (1997) argued that whereas PowerPoint structures

the content of lectures, it does not structure how students interact with the material outside of the classroom. Alternatively, responses to this question may reflect the impact of outside forces. For example, students may find the time they can spend studying for any single class to be limited, regardless of their enthusiasm or perceived knowledge on the subject matter.

However, these findings are in conflict with a number of other studies that show that accompanying lectures with PowerPoint presentations improved students' performance (Kask, 2000, female students; Lowry, 1999; Mantei, 2000; Szabo & Hastings, 2000, Exp. 2). As the current research is split between studies that find beneficial effects on performance and those that do not, it may be time to conduct more fine-grained analyses rather than only assessing whether the presence or absence of multimedia influences performance. Researchers should examine the effects of specific features of PowerPoint such as the availability of on-line notes or the use of graphics, animation, and videos in these presentations. Such studies may be able to assess the conditions under which PowerPoint enhances students' academic performance.

5.2. Impact on students' attitudes and self-efficacy

Both students' responses to the attitude questionnaire and their open ended comments reflected greater positive attitudes and self-efficacy beliefs when PowerPoint accompanied lectures. As expected, the students claimed that when PowerPoint was used, the lectures were more organized and their main points were emphasized more. This perception of organization impacted the students' self-efficacy beliefs. They believed it was easier to follow and understand the lectures accompanied by PowerPoint, which made it easier for them to take notes, and to organize, understand, and use those notes for test preparation. In addition, the students perceived the classes with PowerPoint as more interesting and entertaining.

The current findings show that the use of PowerPoint multimedia improves students' self-efficacy concerning note taking capabilities even when notes were not available in advance. This extends the previous findings that found accompanying lectures with PowerPoint while also providing PowerPoint handouts aided students' self-efficacy concerning note taking (Frey & Birnbaum, 2002; Kask, 2000³). As PowerPoint allows information to be easily presented in bulleted format, students may be more confident that they are recording the main points of the lecture. Future research should examine whether PowerPoint affects students' note taking not just their self-efficacy.

There were a few areas where PowerPoint did not have a positive influence. In addition to the aforementioned null results for the amount of time studying, students claimed they were more motivated to attend PowerPoint lectures, however, they did not feel worse missing them. As they believed it was easier to take useful notes from these lectures, they may have felt that other students' notes would be better with PowerPoint as well. Therefore, it may have been viewed as less detrimental to skip class and borrow someone else's notes when PowerPoint was used than when it was not. Thus, students' greater interest in attending PowerPoint lectures may have been balanced by the lesser negative ramification of missing those classes.

³ Kask (2000) implied that students received lecture notes but did not specify whether or not this occurred.

A number of students reported that lectures with PowerPoint were less spontaneous and discussed fewer tangents. The perception of structure and organization in PowerPoint lectures may have led students to view these lectures as more pre-planned and less spontaneous, even if there were no differences in the amount of tangential information covered. Alternatively, because of the formal structure of PowerPoint presentations, students may have been less willing to interrupt the professor (Nowaczyk et al., 1998). In a similar fashion, although the professor attempted to provide identical content during the PowerPoint and traditional lectures, spontaneity may have been reduced in the PowerPoint lectures because the sequence of slides makes it hard to jump from point to point (Hlynka & Mason, 1998; Parks, 1999). Hence, PowerPoint's format may have reduced the number of tangents introduced by either the students or the professor. To examine this issue, researchers could attend lectures on the same material taught in both traditional and PowerPoint formats to examine the spontaneity of the class interactions.

Furthermore, as self-efficacy is theorized to influence students' choice of tasks, their persistence, and effort in addition to affecting academic achievement (Bandura, 1986; Shunk, 1995), future research should assess behavioral measures of students' effort and persistence such as their attendance, classroom participation, and how they study for exams in order to examine why students feel more competent with PowerPoint yet do not perform better with it.

The current results not only replicate previous findings of positive attitudes (Atkins-Sayre et al., 1998; Frey & Birnbaum, 2002; Harknett & Cobane, 1997; Kask, 2000; Lowry, 1999; Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000) and enhanced self-efficacy (Atkins-Sayre et al., 1998; Frey & Birnbaum, 2002; Kask, 2000; Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000) when PowerPoint accompanied lectures but also improve the validity of these claims. A number of these studies lacked a comparison group of alternative lectures (Daniels, 1999; Harknett & Cobane, 1997; Kask, 2000; Lowry, 1999) whereas in others, students compared the PowerPoint lectures to traditional lectures in other courses (Mantei, 2000; Nowaczyk et al., 1998; Szabo & Hastings, 2000). Further, there may be strong demand characteristics to provide positive evaluations of PowerPoint lectures in both of these designs. Although there may be demand characteristics to provide favorable evaluations for PowerPoint lectures in the current study, this effect should be smaller as the professor did not specify a preference for either lecture style.

5.3. Impact on students' motivation

Students that received traditional instruction first and then received lectures with PowerPoint did not experience a change in classroom motivation. However, students who were initially taught with PowerPoint and then received traditional lectures became less motivated during the traditional lecture format. These students may have perceived the professor's decision to stop using PowerPoint as reflecting a decrease in the effort he applied to preparing lectures. If the professor was not seen as interested in the class, it is not surprising that the students' motivation also declined. This suggests that if instructors regularly implement technology, they should not abandon it mid-semester. Regardless of whether the technology achieves the effect that the instructor desires, it affects the students significantly enough such that its absence may generate decreases in enthusiasm and even participation in the class. However, as there does not seem to be a problem with introducing technology midway through the semester, instructors can start using PowerPoint

presentations at any point in the course as long as they continue to use the technology for the duration of the course.

Students' attitudes, self-efficacy beliefs, and motivation were influenced by non-interactive computer technology. This interpretation is contingent on the study's limitations. Although many professors may use the traditional format described here, it is likely that many instructors use equipment such as overheads and additional handouts. Because this study compared only the traditional format to multimedia PowerPoint presentations, it is unclear whether the observed effects were due to the use of the computer medium or the organization and structure that is facilitated by PowerPoint. Future research should compare multimedia PowerPoint presentations to the same PowerPoint slides printed on overheads to determine whether the computer medium establishes differences in motivation and self-efficacy.

Furthermore, there are issues regarding the sample. First, group equivalence was not possible as the current study was field research. There are potential group differences in abilities, previous exposure to PowerPoint, motivation, etc. Second, as both sections had small class sizes, these results may not generalize for courses with greater numbers of students. There is reason to expect these findings may be weaker when there are large class sizes, as Kask (2000) observed that PowerPoint's effect on students' performance was reduced by 50% when it was used in an auditorium.

Results of this study provide reason to believe that non-interactive computer assisted instruction yields more subjective effects than objective ones. However, this remains an empirical question. Thus, additional research should attempt to understand the manner in which computer technology influences student outcomes. Such research will help to develop a more complex and integrated understanding of education theory and instructional strategies.

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