PERGAMON

Computers & Education 41 (2003) 77–86

COMPUTERS & EDUCATION

www.elsevier.com/locate/compedu

Effectiveness of PowerPoint presentations in lectures

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Received 14 August 2002; accepted 28 January 2003

Abstract

We investigated whether students liked and learned more from PowerPoint presentations than from overhead transparencies. Students were exposed to lectures supported by transparencies and two different types of PowerPoint presentations. At the end of the semester, students preferred PowerPoint presentations but this preference was not found on ratings taken immediately after the lectures. Students performed worse on quizzes when PowerPoint presentations included non-text items such as pictures and sound effects. A second study further examined these findings. In this study participants were shown PowerPoint slides that contained only text, contained text and a relevant picture, and contained text with a picture that was not relevant. Students performed worse on recall and recognition tasks and had greater dislike for slides with pictures that were not relevant. We conclude that PowerPoint can be beneficial, but material that is not pertinent to the presentation can be harmful to students' learning.

Keywords: Improving classroom teaching; Pedagogical issues; Teaching/learning strategies

1. Introduction and literature review

Although there has been much discussion over different methods to teach college students, lectures are not likely to stop being used. To emphasize particular points, many lectures use written material presented on a chalkboard, whiteboard, or by transparencies on an overhead projector. In the last 10 years, another method of presenting visual information with lectures has gained prominence: projecting information directly from a computer onto a screen (e.g., PowerPoint presentations). In fact, many colleges and universities have rooms or mobile carts equipped with

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0360-1315/03/$ - see front matter
doi:10.1016/S0360-1315(03)00027-7

technology necessary for any instructor to display information in this manner. Furthermore, some administrations are pushing for instructors to use this technology (e.g., Carlson, 2002).

Researchers have examined how helpful these types of presentations are. Overall, research indicates that students prefer PowerPoint type presentations to presentations from transparencies (Cassady, 1998; Perry & Perry, 1998; Susskind & Gurien, 1999; West, 1997). Unfortunately, information on whether computer presentations improve student performance is much less clear. Several studies point to the idea that graphics improve student recall (ChanLin, 1998, 2000; Lowry, 1999; Szaba & Hastings, 2002, Exp. 2). However, many courses that adopted multimedia presentations have not shown a corresponding increase in student performance (Stoloff, 1995; Susskind & Gurien, 1999; Szaba & Hastings, 2000, Exp. 1 and 3; West, 1997). In fact one study demonstrated a decrease in student performance when the instructor switched from transparencies to PowerPoint (Bartlett, Cheng, & Strough, 2000).

One factor that these studies did not investigate was the complexity of the multimedia presentations. For example, PowerPoint presentations can be as simple as having only text on a colored screen. Presentations can also be complex with tables, pictures, graphs, sound effects, visual effects, video clips, etc. The effectiveness of PowerPoint and other multimedia presentations may depend on the complexity of the presentation. In fact, several researchers have demonstrated that material such as irrelevant sounds (Moreno & Mayer, 2000), interesting but extraneous text (Schraw, 1998), and irrelevant pictures (Mayer, 2001, p. 113) can reduce comprehension.

It is also wise to consider advantages and disadvantages to the teacher when investigating the effectiveness of a new teaching method. In addition to the time needed to become familiar with creating computerized multimedia presentations, the effort needed to create and maintain multimedia presentations once the instructor is familiar with the software is important to examine.

2. Study 1

2.1. Rationale and hypothesis

In this study, we wanted to test whether using PowerPoint lectures (i.e., lectures that are supported by PowerPoint) would be liked more and would lead to better grades than using lectures supported by overhead transparencies. Furthermore, we wanted to assess how much effort instructors would need to create PowerPoint presentations compared to transparencies. Since there were several different ways that PowerPoint could be used, we also wanted to compare different types of PowerPoint presentations.

Given that the first author only taught one section of any course, we decided to have all students see all presentation forms. This within participants design has the advantage of students viewing all types of presentations; however, the disadvantage is that different types of presentations would be confounded with lecture content. To alleviate this problem, students saw each type of presentation in several lectures randomly throughout the semester. Furthermore, multiple exposures may decrease some biases that the students have. For example, PowerPoint presentations might only be liked because they were new. With multiple exposures this potential confound was reduced.

2.2. Method

2.2.1. Participants

Thirty-nine students (35 women and four men) in a Social Psychology class at the University of Texas of the Permian Basin agreed to be participants for this study. This class met three times a week for 50 min. The semester was approximately 15 weeks long.

2.2.2. Classroom environment

The classroom had 55 chairs for students arranged in auditorium style seating. There was a large presentation area for the instructor. A projection screen was located on the left side of the presentation area at an angle to the students. The nearest person was slightly less than 10 feet from the screen and the farthest person was slightly more than 30 feet from the screen.

Transparencies were projected with a 3M model 9100 overhead projector. Individual letters of the presentation were approximately 1–2 inches in height and width depending on the specific letter. The full transparency slide was larger than the projection screen. While using the transparencies, the lights at the front of the room were turned off.

PowerPoint presentations were run on a 6100/60W Power Mac and projected through a Sharp QA-1500 overhead adapter sitting on a Dukone Model 4000 overhead projector. In order for the material to be legible, all lights had to be out in the room and the contrast setting on the projector was on the highest level. It is the instructor's belief that many of the newer projection devices are significantly brighter than the equipment used here. Each letter was approximately 2–3 inches in height and width. The instructor received no complaints about the legibility or the lighting in the room.

2.2.3. Types of presentations

A set of new presentations (including new transparencies) was created for this course. These presentations were based on transparencies previously made. There were three types of presentations that supported the lectures: transparencies, basic PowerPoint, and expanded PowerPoint. Basic PowerPoint presentations only included text information. Expanded PowerPoint presentations included not only text but also pictures, sounds when new text was presented, and text appearing in different ways. (Each expanded PowerPoint unit had, on average, seven pictures, graphs, or tables.) Although the pictures did relate to the lecture, the sound effects and how the text appeared generally did not. Prior to the study the instructor had experience in creating basic but not expanded presentations.

2.2.4. Procedure

The instructor (i.e., the first author) planned to teach 12 units in this study. Each unit lasted a week and consisted of two 50 min lectures. The third class period each week was for quizzes and group activities. The same presentation style was used for the entire unit. Presentation styles were randomly arranged such that each style was used four times during the semester and the same style was not used two weeks in a row. After one class in a particular unit, the instructor was unhappy with the way the unit was progressing and therefore decided to do something very different during the second lecture. This unit was not included in the analysis, which left 11 units. On an introductory unit preceding the 11 units, students were exposed to a PowerPoint pre-

sentation so that they would have some familiarity with this type of presentation before they were asked to judge it. After each class students rated the presentation. Also, at the end of the semester, we asked students their overall opinions of the class.

2.2.5. Measurements

We gathered a variety of measures to assess the effectiveness of the presentations. For each of the 11 units we recorded some features of the presentation, which included the number of points that were made and the amount of time it took to prepare the presentation. To assess comprehension, students took a 10 multiple choice question quiz for each unit. The average number of correctly answered questions was recorded.

After each lecture students rated how much they learned in this class using a 1–9 scale, with 1 indicating nothing at all, 5 indicating some information, and a 9 indicating a large amount of information. Students also rated how much they enjoyed the class using a 1–9 scale with 1 indicating did not enjoy at all, 5 indicating neutral, and 9 indicating greatly enjoyed. All of these ratings were made anonymously. Students dropped their surveys in a box when they exited the classroom.

At the end of the semester students rated retrospectively how much they enjoyed and how much they learned from the lectures with transparencies, basic PowerPoint, and expanded PowerPoint. These ratings were made on the same scale as the ratings from the individual lectures. Students were also asked some specific questions about PowerPoint such as whether the presentation style made a difference and whether certain factors increased or decreased the effectiveness of the PowerPoint presentations. These questions were made on a nine-point scale in which 1 indicated Strongly Disagree, 5 indicated Neutral and 9 indicated Strongly Agree.

2.3. Results

2.3.1. After class surveys

Given the dependence of lectures within a topic unit, the unit of analysis for the surveys taken after class was the topic unit. Table 1 displays the ratings that compare the lectures supported by transparencies, basic PowerPoint, and expanded PowerPoint. In comparing the three groups, we constructed a set of contrast codes in a one-way between ANOVA (Judd & McClelland, 1989). The first comparison examined the difference between the transparency lecture method and the two PowerPoint methods. The second comparison examined the difference between the two PowerPoint lecture styles.

Table 1
Means (and standard deviations) of ratings made after classes as a function of lecture type

Measure	Transparency	Basic PowerPoint	Expanded PowerPoint
Liking (1–9)	7.24 (0.34)	7.43 (0.17)	7.55 (0.23)
Learning (1–9)	7.38 (0.08)	7.59 (0.10)	7.63 (0.14)
Quiz (0–10)	8.36 (0.48)	8.41 (0.53)	7.49 (0.30)
Time to prep in hr	1.83 (0.39)	1.50 (0.61)	2.83 (0.38)
Points made	26.5 (3.11)	28.5 (8.81)	31.0 (4.00)

Although there is a trend indicating that students preferred PowerPoint presentations, there was no significant difference between the three groups on how much students stated they liked the lectures, $P > 0.10$, for both contrasts. We did find a difference between the transparency lecture style and the PowerPoint lecture styles on how much students perceived they learned from the presentation, $F(1,10) = 12.3$, $P = 0.008$. Students believed that they learned more from the PowerPoint presentations. (No difference in perceived learning was found between the two different PowerPoint presentations, $P > 0.10$.) This finding provides some evidence that PowerPoint presentations may be useful.

Examination of the quiz grades revealed a different conclusion. Students did approximately 10% worse on the quizzes that came from the expanded PowerPoint lectures. This difference resulted in a nonsignificant difference between the transparencies and the PowerPoint presentations, $F(1,10) = 2.03$, $P > 0.10$, and a significant difference between the two PowerPoint presentations, $F(1,10) = 6.68$, $P = 0.03$. This finding indicates a disadvantage in using the expanded PowerPoint lecture slides.

We found another disadvantage to the expanded PowerPoint condition when examining the time to prepare the lectures. Over 50% more time was required to prepare these lectures. This pattern again resulted in a nonsignificant difference between the transparency and PowerPoint presentation conditions, $F(1,10) = 1.20$, $P > 0.10$, and a significant difference between the two PowerPoint conditions, $F(1,10) = 12.98$, $P = 0.007$.

There was no evidence that more content was covered with any particular lecture style. The number of points discussed during a topic did not significantly differ for either of the contrasts, both P's > 0.10.

2.3.2. End of semester surveys

We then examined the surveys taken at the end of the semester. Students were asked how much they liked and how much they learned from the three types of presentations. Since we could link individual responses, we analyzed these data with a repeated measures ANOVA. Given the three groups, we constructed the same set of contrast codes as in the previous analysis.

Overall these results were similar to the results obtained through the surveys gathered after each individual lecture. When asked at the end of the semester the transparency lecture ($M = 6.35$, S.D. = 2.15) was liked significantly less than the average of the basic PowerPoint lecture ($M = 7.97$, S.D. = 0.98) and the expanded PowerPoint lecture ($M = 8.00$, S.D. = 1.39), $F(1, 30) = 4.18$, $P = 0.05$. Also at the end of the semester, students stated they learned less from the transparency lecture ($M = 7.45$, S.D. = 1.89) than the average of the basic PowerPoint lecture ($M = 8.06$, S.D. = 1.09) and the expanded PowerPoint lecture ($M = 7.97$, S.D. = 1.08), $F(1,30) = 20.1$, $P < 0.001$. There were no significant differences between the two PowerPoint lecture styles on either measure, both P's > 0.10.

We then analyzed two questions indicating how much a difference the lecture style matters. On the nine-point strongly disagree/strongly agree scale, students, on average, slightly agreed that the lecture style did affect learning ($M = 6.32$) although there was a relatively high amount of variability in the responses (S.D. = 2.57). Students also agreed that lecture style affected enjoyment ($M = 7.23$, S.D. = 1.98).

Finally, we analyzed questions concerning whether certain parts of the PowerPoint presentations were effective. Students were close to neutral as to whether notes should come in from dif-

ferent ways ($M = 5.65$, S.D. = 1.58), whether the presentations were better with sound effects ($M = 5.87$, S.D. = 2.47), and whether items should be used only if they were directly relevant ($M = 5.94$, S.D. = 2.37). However, students did agree that pictures should be included ($M = 7.29$, S.D. = 1.55).

2.4. Discussion

There are three main findings from this study. First, there is disagreement whether students preferred PowerPoint presentations to presentations given with transparencies. Retrospective ratings indicated students preferred PowerPoint presentations; however, end-of-class ratings did not show any difference. It is unclear which measure is more valid. End of class ratings were immediate; however, since that analysis only included 11 classes, the analysis has low power. The end of semester ratings indicated a difference, but students may only be accurate in remembering how they felt at the time of the lecture.

The second main finding was that students believed that they learned more from both types of PowerPoint lectures than the lectures that used transparencies. There was agreement in both the end-of-class and retrospective ratings on this measure. Third, some results indicate weaknesses with the expanded PowerPoint presentations. Specifically, expanded PowerPoint presentations take longer to create and, more distressingly, corresponded with lower average quiz scores.

The first disadvantage in expanded PowerPoint presentations was not a surprise. From the instructor's experience, the majority of extra time was spent searching for relevant pictures on the World Wide Web or through Clip Art files. This extra time allowed the instructor to place approximately seven pictures, graphs, or tables into the presentation. Given that lectures will often be reused, the extra time spent gathering materials would likely be considered reasonable to many faculty members.

However, if the addition of non-text information into the lecture decreases comprehension, then the extra time should not be used. Therefore, it is important to determine whether non-text information does or does not help. The quizzes indicated that there was a significant drop in mastery of the material. However, there were several differences between the basic and expanded PowerPoint presentations. In the expanded PowerPoint presentations, both items that were relevant to the context were presented (e.g., most of the pictures), and items that were not relevant to the context were presented (e.g., most of the sound effects). One possibility is that irrelevant items detracted from the learning and it was the irrelevant items that caused the decrease in performance. Other literature supports this hypothesis (Mayer, 2001; Moreno & Mayer, 2000; Reiber, 1996).

3. Study 2

3.1. Rationale and hypothesis

In this second study we attempted to examine whether the relevancy of items affected learning in PowerPoint presentations. To keep the study relatively simple, we decided to examine the effect of only visual cues. Specifically, we decided to compare whether relevant or irrelevant pictures would facilitate or impair learning.

3.2. Method

3.2.1. Participants

Twenty-seven participants (20 female and seven male; median age = 29) who were students at the University of Texas of the Permian Basin completed this study. Some participants received extra credit for completing the study. Other students were volunteers.

3.2.2. Procedure

Participants viewed 30 fact-based slides through a PowerPoint presentation. Each slide had one fact listed on it (e.g., "The Chinese invented sauerkraut"). These facts were chosen because they would likely be easily understandable but not known. The facts came from a variety of different knowledge areas. Facts were not related to each other.

As the slide was presented, the researcher read the text aloud. Participants rated how much they liked each on a seven-point Likert scale ranging from "1" which indicated "Strongly like" to "7" which indicated "Strongly dislike". The researcher gave the participants 20 s to view each slide and mark their preference rating. After viewing the presentation, participants were instructed to write down as many facts as they could remember. Finally, participants were given a multiple-choice test that consisted of 30 questions, one question per slide.

3.2.3. Independent variable manipulation

Of the 30 slides, 10 slides had only text, 10 slides had text on the lefthand side and a related picture on the right, and 10 slides had text on the lefthand side and an unrelated picture on the right. An example of text with a related graphic was a picture of a thermometer next to the statement "Minus 459.67 degree Fahrenheit is considered absolute zero." An example of text with an unrelated graphic was a picture of a snowman with the text "The first book published was Johann Guttenberg's Bible".

These 30 slides were mixed together. To avoid a confound with specific slides being easier or more difficult to remember, three sets of 30 slides were created. The presentation type (text only, related picture, unrelated picture) was counterbalanced such that 1/3rd of the participants saw a specific fact in the text only condition, 1/3rd of the participants saw that fact in the related picture condition, and the remaining participants saw that fact in the unrelated picture condition.

3.3. Results

Table 2 compares the three presentation conditions on how much students enjoyed and how much students remembered the facts. A series of two-sample dependent t-tests indicated that, on average, participants liked the text only slides and the slides with related graphics more than the slides with unrelated graphics, both P's < 0.01. (Although there is an increase in the chance of a type I error by using these t-tests compared to a one-way within ANOVA, we believe that these statistics more clearly illustrate the differences between the three groups.) There was no difference between the text only slides and the slides with related graphics, $P > 0.10$. This pattern was repeated for the two learning measures. Participants recalled and recognized more facts from the text only and related graphics conditions than from the slides with unrelated graphics, all P's < 0.05. Again, there was no difference between the text only slides and slides with related graphics, both P's > 0.10.

Table 2
Comparison of PowerPoint slides with text only, related graphics, and unrelated graphics

Measure	Type of slide			*t*-values		
	Text only	Related pictures	Unrelated pictures	Text only vs. related	Text only vs. unrelated	Related vs. unrelated
Liking	3.32	3.39	4.13	−0.47	−3.51**	−2.95**
Recall	2.00	1.93	1.33	0.21	2.36*	2.02*
Recognition	9.41	9.52	8.97	−0.65	2.58*	2.37*

All significance tests done with two-sample dependent *t*-tests. Liking measure was with 1–7 scale with higher numbers indicating greater dislike. Recall and recognition was out of 10 facts.

*$P < 0.05$; ** $P < .01$.

3.4. Discussion

The results indicate that unrelated graphics in a presentation have a negative effect on the enjoyment and the learning of the material. One possible explanation for this finding is that the participant may have been made uneasy when viewing the slides. The researcher noticed that when text was presented with a graphic that did not match the statement, participants seemed confused. Reiber (1996) supports this idea. He found that pictures that were unrelated to the text became more of a distraction and produced more interference than related pictures.

The results also indicate that having related pictures were neither beneficial nor harmful to the enjoyment or learning of the material. The lack of any difference could be influenced by several different factors. First, the participants seemed to find the facts interesting and therefore they paid attention to the information. We believe the picture was not necessary to motivate the participant to be interested in the material. Second, the participants likely were able to understand the fact without the help of a picture. Therefore, the graphic may not have been necessary to increase learning in this case. However, when the material is more complicated or the students do not know much about the information, the graphics may be beneficial. For example, one study indicated that although a text with an image compared to a condition with only text did not do better on a recall task, the text with image did do better on a problem solving task (Large, Beheshti, Breuleux, & Renaud, 1996).

These results also support Mayer's cognitive theory of multimedia learning (2001, p. 53). In this model people, when learning, will place relevant words into auditory working memory and relevant images into visual working memory. People then organize information separately in auditory and visual memory and finally integrate these representations with prior knowledge. In our study the relevant picture did not help because it did not add information over a different channel. The text was already being processed in the visual channel. We may have seen some effect of relevant pictures if the facts were only orally presented. However, the irrelevant pictures could have created problems with participants integrating the visual information. Therefore, Mayer's model predicts the observed decrease in learning in this condition.

4. General discussion and conclusion

Discovering more information concerning what types of presentations help what types of students would be useful to teachers. There are several directions that this research could follow. For example, it would be useful to explore whether individual characteristics predict improved learning in certain situations. For example, Large et al. (1996) found that 6th grade students who had high spatial ability did better when presented with text and images compared to just text. However, students with low spatial ability demonstrated no difference between the two groups.

Furthermore, the amount of knowledge a person already has could play a role in whether graphics are useful. Lee, Gillan, and Harrison (1996) have indicated that the amount of beginning knowledge may have an effect on whether multimedia or traditional lecture is better; however their findings indicate mixed results as to which type of presentation is better. Other studies (ChanLin, 1998) found no moderating effect of beginning level of knowledge. Finally, Mayer and Gallini (1990) found that students with low prior knowledge benefited on conceptual recall and problem solving, but not verbatim recall, when given graphics describing both the components and action taking place. Students with high prior knowledge only benefited from the graphics on problem solving.

In conclusion, we are not trying to state that instructors who are comfortable with non-lecture formats should change to PowerPoint presentations. Rather, we are providing some information about the advantages and disadvantages of using PowerPoint to individuals who currently use teaching styles related to PowerPoint. Again, we found although students stated they preferred PowerPoint to basic transparencies at the end of semester ratings this finding was not replicated with ratings taken immediately after class. Furthermore, we found that just using text and PowerPoint presentations does not take more time than creating transparencies. Finally, we found that although related graphics may be beneficial, unrelated graphics are not helpful for enjoyment or learning. Also, graphics are not necessary for simple declarative information, but may help with more difficult, complex, or abstract concepts presented through lecture. If graphics are desired then PowerPoint presentations have the flexibility to easily include them.

References

Bartlett, R. M., Cheng, S., & Strough, J. (2000, August). *Multimedia versus traditional course instruction in undergraduate introductory psychology*. Poster presented at Annual American Psychological Association, Washington, DC.

Carlson, S. (2002, March 29). Wired to the hilt. *The Chronicle of Higher Education*, A33–A35.

Cassady, J. C. (1998). Student and instructor perceptions of the efficacy of computer-aided lectures in undergraduate university courses. *Journal of Educational Computing Research*, *19*, 175–189.

ChanLin, L.-J. (1998). Animation to teach students of different knowledge levels. *Journal of Instructional Psychology*, *25*, 166–175.

ChanLin, L.-J. (2000). Attributes of animation for learning scientific knowledge. *Journal of Instructional Psychology*, *27*, 228–238.

Judd, C. M., & McClelland, G. H. (1989). *Data analysis: a model-comparison approach*. New York: Harcourt Brace Javanovich.

Large, A., Beheshti, J., Breuleux, & Renaud, A. (1996). Effect of animation in enhancing descriptive and procedural texts in a multimedia learning environment. *Journal of the American Society for Information Science*, *47*, 437–448.

Lee, A. Y., Gillan, D. J., & Harrison, C. L. (1996). Assessing the effectiveness of a multimedia-based lab for upper division psychology students. *Behavior Research Methods, Instruments, Computers*, *28*, 295–299.

Lowry, R. B. (1999). Electronic presentation of lectures—effect upon student performance. *University Chemistry Education*, *3*(1), 18–21.

Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.

Mayer, R. E., & Gallini, J. K. (1990). When is an illustration worth ten thousand words? *Journal of Educational Psychology*, *82*, 715–726.

Moreno, R., & Mayer, R. E. (2000). A coherence effect in multimedia learning: the case for minimizing irrelevant sounds in the design of multimedia instructional messages. *Journal of Educational Psychology*, *92*, 117–125.

Perry, T., & Perry, L. A. (1998). University students' attitudes towards multimedia presentations. *British Journal of Educational Technology*, *29*, 375–377.

Rieber, L. P. (1996). Animation as a distractor to learning. *International Journal of Instructional Media*, *23*, 53–57.

Schraw, G. (1998). Processing and recall differences among seductive details. *Journal of Educational Psychology*, *90*, 3–12.

Stoloff, M. (1995). Teaching physiological psychology in a multimedia classroom. *Teaching of Psychology*, *22*, 138–141.

Susskind, J., & Gurien, R. A. (1999, June). *Do computer-generated presentations influence psychology students' learning and motivation to succeed?* Poster session presented at the annual convention of the American Psychological Society, Denver, CO.

Szaba, A., & Hastings, N. (2000). Using IT in the undergraduate classroom: should we replace the blackboard with PowerPoint? *Computers & Education*, *35*, 175–187.

West, R. L. (1997). *Multimedia presentations in large classes: a field experiment*. Paper presented at the Annual Convention of the American Psychological Society, Washington, DC.