Pedagogical Techniques: Student Performance and Preferences

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ABSTRACT. The comparative effectiveness of three pedagogical techniques (use of a chalkboard, use of an overhead projector, and use of computer-projected software) was examined. The study involved students in three financial accounting principles classes at one university. Each student was exposed to each method for one third of the semester, and all completed daily quizzes plus midterm and final exams. The results of the study provide no evidence of overall differences in student learning among the three methods. Learning, however, was found to be related to students' preferences for pedagogical method—that is, exam grades were higher when students' preferred methods were used in the classroom.

Does the use of classroom computer projectors and presentation software engender a better education for college students than older pedagogical techniques involving chalkboards or overhead projectors do? Is there adequate justification for the financial and time costs associated with the purchase of classroom computer equipment, its installation, maintenance, and instructor training? Apparently, the administrations at many colleges and universities have answered these questions affirmatively, as electronic classrooms are proliferating, enabling instructors at many institutions to use presentation software in classrooms.

In the last 2 decades, the development of presentation software has meant that instructors may create software files in their offices and then display those files in classrooms, using computer projectors. Such software files result in presentations that may include text, graphs, sound segments, video segments, spreadsheets imported from other programs, images, photographs, animation, links to other computer files, and links to the Internet. When presentation software was first introduced, its capabilities were limited primarily to text and simple graphs, but this type of software has been further developed such that its qualities now rival those of more complex multimedia software.

Although computer-assisted teaching using presentation software has become a possibility only in recent years, expectations are high. Software applications have revolutionized some industries, and many in academia are convinced of benefits for instruction (Clark, 1983). Solomon (1994, p. 83) explained that classroom pedagogical computing has the potential to change the foundations of education and contended that the use of such technology is the third revolution in higher education in recent years, the first two being use of television and the microcomputer.

One of the primary alleged advantages of presentation software is that, when compared with traditional chalkboard presentations, such software better captures and maintains the interest of students and, consequently, results in enhanced student understanding and education. Jensen and Sandlin (1992, p. 49) suggested that because the current generation of students has grown up with television, videos, and electronic games, computer-projected materials in the classroom have great appeal. Shneiderman, Alavi, Norman, and Borkowski (1995, p. 20) contended that electronic classroom technologies have resulted in "fresh paint" for instructors' lectures because the technology fosters novel teaching. Similarly, Kozma (1991, p. 199) asserted that current pedagogical technologies present the prospect that the various advantages of the individual media can be brought together in a single instructional environment and strategically used to facilitate learning.

Regardless of the supposed benefits of electronic classrooms, however, many college professors do not use available in-class computer technology. One reason for faculty members' not utilizing electronic classroom capabilities is their lack of familiarity with the possible applications and options presented by the technology. Specifically, instructors may not understand how presentation software may help them in the particular courses they teach or how it could

enable them to fulfill their pedagogical objectives (Bryant & Hunton, 2000).

A second and related reason for underuse of in-class computer technology is skepticism regarding the effectiveness of this type of pedagogy. Some instructors are reluctant to make a significant effort to change their in-class pedagogy from a known, familiar method to a technology with unsubstantiated benefits (Shneiderman et al., 1995). Clark (1983, p. 445) argued that although alternative pedagogical media may influence the cost or extent of distributing instruction, such alternatives do not influence learning under any condition. Student achievement, Clark reckoned, is affected only by content.

A third explanation for faculty underutilization of in-class computer hardware and software is the perception that the effective use of such technology requires much time, effort, and creativity. Sammons (1994, p. 92), for example, estimated that software development for one course could require as much as 200 hours of faculty time. As a result of the requisite time commitment, some instructors complain that they do not have the time or incentive to make the transition from chalkboard presentations to those using presentation software. If faculty members do dedicate their available time resources to in-class technology, Solomon (1994, p. 83) warned, their institution may not appreciate their efforts or may even penalize them for devoting too much time to an activity that does not enhance their research records.

Many publishers are now responding to these concerns by developing presentation software associated with specific textbooks and distributing this software to instructors who adopt the texts. Although these software packages may have shortcomings, they may also render benefits for both publishers and instructors. By providing presentation software to professors, publishers may enhance the sales of their texts if the software is considered helpful. Instructors may also benefit because publisher-prepared software allows them to use in-class technology while avoiding the time commitment required to develop the software presentations. With some knowledge of the software programs that publishers use to create the presentation software files, instructors can tailor the computer-projected presentations to individual preferences—for example, to emphasize or expand discussion of certain concepts (Jensen & Sandlin, 1992). The option to revise the software package may be critical, as many instructors might object to an inflexible software package that delivers "canned" publisher-prepared presentations that cannot be easily amended (Sammons, 1994).

Even if all publishers develop extensive presentation software in support of all their texts, however, the issue of effectiveness remains. Is learning enhanced if a professor's classroom discussion uses computer-projected information instead of such "low-tech" devices as chalkboards and overhead projectors?

Related Research

Although research on pedagogical media has been conducted since the early 20th century (Clark, 1983), few studies in recent years have focused on computer-assisted classroom teaching. An additional challenge in drawing conclusions about these prior studies is the evolving nature and quality of the hardware and software that are used in classroom instruction. As Jensen and Sandlin (1992, pp. 39–40) indicated, the results of past empirical studies of computer-assisted learning may be somewhat misleading because of the pace of technological change in teaching equipment and software. Certainly, however, valuable insights may be gained by reviewing this research.

In a 1983 review of education media comparison studies, Clark concluded that most of this research clearly indicates that media do not influence learning under any conditions:

> Five decades of research suggest that there are no learning benefits to be gained from employing different media in instruction, regardless of their obviously attractive features or advertised superiority. All existing surveys of this research indicate that confounding has contributed to the studies attributing learning benefits to one medium over another and that the great majority of these comparison studies clearly indicate no significant differences. (p. 450)

Regarding student preferences, Clark (1983, p. 455) also concluded, from his review of education research, that students often inadvertently prefer media that result in less learning for them.

Kozma (1991) similarly reviewed research and literature regarding the effects of media and pedagogy but drew very different conclusions:

> The research reviewed in this article suggests that capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the ways learners represent and process information and may result in more or different learning when one medium is compared to another for certain learners and tasks. (p. 179)

There are other studies involving college business students that suggest that computer-assisted teaching does have an effect on student learning. As reported in a 1990 study, Ott, Mann, and Moores conducted a 3-week experiment involving beginning accounting students. In that study, personality types were determined and comparisons were made between a student group that was exposed to lectures and a student group that received computer-assisted instruction. The authors concluded that, for both treatment groups, personality types explained some of the variation in exam scores. They also concluded that some student types tend to perform better when lectured, whereas other types perform better under computer-assisted learning.

Jensen and Sandlin (1992, pp. 56–57) compared a 1991 accounting theory class that used computer-assisted teaching to a 1989 class that did not. The authors found that students in the computer-assisted class scored higher on exams and produced better research papers.

In a 1994 study, Alavi (1994) discovered that graduate business students who were taught in an electronic classroom environment earned significantly higher final exam grades than did those taught with traditional instructional methods. Additionally, those students exposed to the computer-supported pedagogical approach had higher perceived skill development, higher self-reported learning, and higher evaluation of the classroom experience than other students did.

Butler and Mautz (1996) conducted a laboratory experiment in which one group of business students was exposed to a 30-minute multimedia presentation regarding a systems theory concept and a second group attended a presentation of the same duration that was supported by traditional visual aids. Butler and Mautz's findings indicated an apparent interaction between individuals' preferred means of representing information and the effects of multimedia. Multimedia pedagogy improved recall for individuals who prefer to represent information through nonverbal means but hindered recall for highly verbal individuals. The authors also concluded that although students' preferred representation schemes play an important role in the effectiveness of multimedia, they do not appear to affect learning across all learners.

Experiment Design

In an effort to understand better the effectiveness of three different pedagogical techniques, we designed an experiment that involved students in three classes of introductory financial accounting principles at one private university in the southeastern United States. All three classes were conducted in the same classroom and were taught by the same instructor. This instructor had taught the financial accounting principles course at the university several times. The same textbook, schedule, and syllabus were used for all three classes. Each class met on Mondays, Wednesdays, and Fridays for sessions of 50 minutes. Each class had 26 students.

During the semester, three pedagogical techniques were used in each class, although the timing of their usage varied from class to class (see Table 1). The pedagogical techniques involved class discussions facilitated by (a) a chalkboard and chalk, (b) an overhead projector and black-and-white typed overheads, or (c) computer-projected presentation software with multicolor text and graphic images. The classroom used for this project was equipped with all three of these devices, and the instructor was familiar with them, having used them in prior courses. Presentations under each method had identical information content, and neither printed nor electronic discussion notes were made available to the students.

On any given class day, the instructor facilitated discussion on the same topics in each of the three classes but used a different technique in each. In one class, the concepts and problems were illustrated on the chalkboard. In another class, an overhead projector and transparencies that had been prepared by the instructor were used to depict the same concepts and problems. The instructor used presentation software to facilitate discussion of the same concepts and problems in the third class. This latter technique used an in-class computer projector to project text, graphs, and images from a software file that the instructor had prepared.

A midterm examination was administered after one third of the semester had passed, and the techniques were then rotated among the classes (see Table 1). After two thirds of the semester had passed, a second midterm examination was administered, testing students' application of the concepts discussed since the first exam, followed by a final rotation of the techniques. At each interval, the exams administered were the same for each class regardless of the presentation technique that had been used. Each class, consequently, was exposed to each pedagogical technique for one third of the course. At the end of the semester, a third exam was administered regarding the concepts discussed since the second midterm. Each exam counted for 25% of students' course grades and was composed of 40 multiple-choice questions and four problems.

Daily quizzes were administered in the last few minutes of each class, and the grades of these quizzes counted for 20% of the course grades. Each quiz was composed of four or five multiple-choice questions related to the topics discussed during the class meeting. Daily quizzes were the same for each class regardless of the presentation technique used for that class.

In the last week of the semester, students completed a questionnaire regarding their preferences among the pedagogical techniques. The students completed the questionnaire a few days prior to the administration of the last exam.

There were several reasons for this research design. Although the involvement of one instructor, one classroom, and one university limited the generalizability of the findings, the design also prevented confounding interactions related to multiple instructors, classrooms, and universities. The 3 × 3 arrangement depicted in Table 1 ensured that every student was exposed to each of the three treatments for the same duration and that all course topics were included in the project. Use of daily quizzes enabled measurement of immediate effects of treatments, and midterm exams measured the cumulative treatment effects of several class meetings. Furthermore, the quiz and exam grade weights associated with each of the three periods were equal, resulting in equivalent incentives for student performance among the treatments. This design facilitated comparisons among groups that received different treatments, as well as longitudinal comparisons—that is, differences in student performance when exposed to the three treatments.

TABLE 1. Project Design

Class	First third of semester	Second third of semester	Last third of semester
A	Chalk	Software	Overhead
B	Overhead	Chalk	Software
C	Software	Overhead	Chalk

Results and Analysis

Among the three classes, there were no significant differences related to quiz grades (p = .547, Kruskal-Wallis) or exam grades (p = .147, Kruskal-Wallis).

We examined whether students, as a group, performed differently after par-

ticipating in classroom discussions that utilized chalkboards, overhead projectors, or computer-projected software. As indicated in Table 2, students did not earn significantly different grades on daily quizzes (p = .337, Friedman) or exams (p = .917, Friedman) among the three treatments. Similarly, attendance did not differ significantly among the three treatments (p = .311, Friedman). In other words, the students did not collectively earn higher or lower grades when discussions were facilitated by presentation software or by the other methods. Nor did students attend class more or less often when class sessions utilized a chalkboard or by the other pedagogical techniques.

As mentioned previously, students completed a questionnaire near the end of the semester regarding their preferences for the pedagogical methods. This questionnaire was completed prior to the administration of the last exam; students, consequently, had knowledge only of their first two exam scores at the time the questionnaire was completed. After having participated in classroom discussions that used the three methods, 33% of the students indicated that they preferred discussions that used a chalkboard, 13% preferred discussions that used an overhead projector, and the remaining 54% indicated a preference for projected software. We considered quiz and exam grades in analyzing student preferences. The results of student exam performance, grouped by preferences, are reported in Table 3. With each of the three pedagogical methods, those students who experienced their preferred technique had higher exam scores than their classmates who were not exposed to their preferred method, and these differences were significant ($p \leq$ .093, Kruskal-Wallis). For example, students who preferred presentations with an overhead projector had exam scores that were higher than those of their classmates when the overhead was used.

Similarly, students who preferred presentations with a chalkboard or overhead projector earned higher exam scores when their preferred method was used than when it was not, and these differences were significant ($p \leq .015$, Friedman). Students who preferred chalkboard presentations, for example, performed better on exams when the chalkboard was used than when the overhead projector or projected software was used. The exam scores of students who preferred projected software, however, were not significantly different among the three different treatments—that is, the exam grades of software-preferring students were not significantly better or worse when discussions used a chalkboard, overhead projector, or presentation software (p = .228, Friedman).

Student daily quiz scores were also analyzed in conjunction with preferences. No significant differences, however, were detected among student groups regarding these dimensions ($p \geq$ .215, Kruskal-Wallis).

To further analyze the effects of treatment preferences, we grouped attendance and grades according to students' first, second, and third treatment preferences (see Table 4). The statistics related to grades were consistent with those discussed previously. When students participated in discussions that used their most preferred method, their daily quiz grades did not differ significantly from discussions that used their second or third preference for pedagogical technique (p = .134, Friedman). Exam grades, however, were affected by preference; students earned higher exam grades when they were exposed to their preferred pedagogical technique. Student exam scores differed significantly when their preferred method was used in class rather than the methods that they preferred less ($p < .001$, Friedman).

Differences were also detected when class attendance was analyzed according to students' first, second, and third treatment preferences (see Table 4). Students attended class more often when their preferred pedagogical method was used in class, and the difference in attendance when their first, second, and third preferences were used was significant (p = .036, Friedman).

TABLE 2. Grades and Attendance Associated With Each Treatment

Grade/attendance	Chalk	Overhead	Software	*M*	*p*	Test
Quiz grades	76.99	74.29	75.55	75.61	.337	Friedman
Exam grades	74.46	72.90	73.19	73.52	.917	Friedman
Attendance	95.90	94.87	95.64	95.47	.311	Friedman

TABLE 3. Exam Grades Associated With Treatments and Preferences

	Students who prefer					
Grade	Chalk (n = 26)	Overhead (n = 10)	Software (n = 42)	*M*	*p*	Test
Grade when chalk was used	78.88	68.60	73.12	74.46	.084	Kruskal-Wallis
Grade when overhead was used	68.69	81.30	73.50	72.90	.037	Kruskal-Wallis
Grade when software was used	69.08	71.70	76.10	73.19	.093	Kruskal-Wallis
M	72.22	73.87	74.24	73.52	.419	Kruskal-Wallis
p	.015	.004	.228	.917		
Test	Friedman	Friedman	Friedman	Friedman		

Implications for Academia

Overall, students in this project performed no differently on exams and daily quizzes among pedagogical approaches that utilized a chalkboard, an overhead projector, or computer-projected software. These findings, therefore, differ with those of Jensen and Sandlin (1992) and Alavi (1994), who found that computer-assisted teaching

TABLE 4. Grades and Attendance Associated With Preferences

Grade/attendance	First preference	Second preference	Third preference	*M*	*p*	Test
Quiz grades	77.08	74.68	75.07	75.61	.134	Friedman
Exam grades	77.69	70.94	71.92	73.52	< .001	Friedman
Attendance	96.54	94.74	95.13	95.47	.036	Friedman

resulted in higher exam grades for the students in their studies. This project did, however, reveal that when students' preferred pedagogical techniques are used in class, their class attendance and exam grades may be higher than when a less preferred method is used. Although this finding contradicts Clark's (1983, pp. 450, 455) conclusions that (a) media do not influence learning under any condition, and (b) students often prefer media that result in less learning for them, the finding is aligned with those of other studies. As discussed previously, Kozma (1991), Ott et al. (1990), and Butler and Mautz (1996) concluded as a result of their studies that student performance is affected by the interaction between pedagogy media and students' characteristics and preferences.

A possible administrative implication of this finding is the possibility that students could determine their pedagogical preferences prior to coursework and enroll in course sections that use their preferred method; for example, a student who preferred projected software would be enrolled in a course section in which projected software is utilized, while another student who preferred the overhead projector as a pedagogical device would be enrolled in a different course section in which the instructor used an overhead projector in facilitating class discussions. The practical application of this suggestion would be problematic, however, as it would involve validly determining student preferences, offering multiple course sections that use the gamut of pedagogical techniques, and staffing those course sections with instructors qualified to use the specific methods. Alternatively, some educators may contend that exposing students to a variety of learning environments, regardless of preferences, may enhance students' abilities to learn under diverse instructional methods.

The study also suggests that many students do not currently benefit as much from computer-assisted classroom pedagogy as they do from other techniques. One third of the students in the study not only preferred discussions that used a chalkboard, but they also had higher exam grades when a chalkboard was utilized in the classroom. Application of computer projection technology, consequently, may foster less learning in many students.

Conclusions and Limitations

The results of this study indicate that there are no overall student learning differences among three classroom pedagogical techniques: use of presentation software, use of an overhead projector, and use of a chalkboard. In general, the students in this study performed no better or worse on daily quizzes and exams among these three methods. When student preferences are considered, however, the study findings reveal that students' performances may improve when their preferred pedagogical method is used in class. Although a majority of students in the project preferred the use of presentation software in the classroom and benefited when it was used, many students preferred chalkboards and overhead projectors and performed better when those methods were used.

As explained previously, this study was conducted at one private university and involved one instructor. Although this design prevented confounding related to multiple instructors and multiple universities, extension of the findings to other instructors and universities may be inappropriate.

An additional limitation of the present study is the evolving nature of computer hardware and software and their pedagogical applications. As Jensen and Sandlin (1992) suggested, empirical studies of computer-assisted learning may be quickly outdated with improvements in the technology that teachers use in the classroom. Advances in presentation software, computers, and projection equipment may result in more students and faculty who prefer the use of hardware and software in their classes. And, as the results of this study suggest, if the proportion of students who prefer the use of pedagogical software increases, learning by the overall student group may be enhanced from classroom use of such technology. Although computer use in all college classes may not be warranted at this time, advances in technology may eventually make pedagogical software and hardware so beneficial that older methods and devices, such as chalkboards and overhead projectors, are widely recognized as archaic and are used by fewer and fewer instructors.

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