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ABSTRACT

The purpose of this study was to investigate whether exposure to multimedia and presentation software on laptop computers influenced student achievement in a secondary level anatomy and physiology science course. Group A used laptop computers with A.D.A.M. (Animated Dissection of Anatomy for Medicine) multimedia software and PowerPoint presentation software during the first and second quarter of the 1997-98 school year. Each of the students in Group A was given full-time possession of a laptop computer, including permission to take it home. Group B served as a control group and did not have access to the laptop computers, although MedWorks software and the Internet were available on five workstation computers in the science classroom. Access was reversed for the second half of the year and Group B students used the laptops while Group A served as the control group. Instruction for both groups centered on lectures, lab activities, and open-ended projects. The study demonstrated that students learned more when they had access to laptop computers, were exposed to multimedia software, and created projects with presentation software. Contains 23 references. (AEF)

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Effects of Laptop Computers with Multimedia and Presentation Software on Student Achievement

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Effects of Laptop Computers with Multimedia and Presentation Software on Student Achievement

Computers are becoming a mainstay in elementary and secondary classrooms (Grimm, 1995). Two major reasons for their attractiveness are their appeal to students and educators' beliefs that the technology may enhance learning (Mehlinger, 1996). Laptop computers and multimedia and presentation software are two educational technology trends that have drawn recent attention. As emerging educational technologies practices are introduced to the classroom, research is needed to investigate their impact on student achievement. Beasley and Waugh (1996) warned that research is lagging far behind advances in the capabilities of the multimedia technology. The purpose of this study was to investigate whether exposure to multimedia and presentation software on laptop computers influenced student achievement in a secondary level anatomy and physiology science course.

Background of the Study

Software Use in Biology

Multimedia and presentation software are two popular educational applications. They offer a unique blend of formats for displaying and organizing information. Both programs display information in many different formats that can be arranged in a variety of helpful combinations. The format attributes of multimedia, such as recorded language, graphics, video, and music, accommodate a variety of learning styles (Ayersman, 1996; Provenzo, Brett, & McCloskey, 1999).

Multimedia and presentation applications promote a constructivist approach to learning by encouraging complex interactions between learners and content. Constructivism involves learning in context; learners construct much of what they learn and understand as a function of their experiences (Schunk, 2000). The marriage of multimedia and presentation software provides an avenue by which students can learn through the act of organizing information. Presentation software such as Microsoft's PowerPoint™ or Roger Wagner's HyperStudio™

transforms students from passive receptacles of knowledge to active learners who make decisions about how to direct their learning (Thorsen, 1998). Presentation applications also facilitate the development of research skills and encourage cooperative learning and problem solving (Sharp, 1996). Jonassen, Peck, and Wilson (1999) proposed that "students-as-producers-of-technologies engage in much more meaningful learning than students-as-receivers-from-instructional-technologies" (p. 112).

Previous research indicates that using multimedia in biology improved students' achievement scores. Ritt and Stewart (1996) reported that students who used anatomy and physiology multimedia software scored 10 points higher on lab practical exams than those who did not. Ninety percent of the computer users in their study indicated that the multimedia software greatly enhanced their understanding of the subject matter.

A meta-analysis by Christmann, Badgett, and Lucking (1997) indicated that computer assisted instruction (CAI) had a small positive effect on achievement scores. The researchers warned that not all subject areas had such findings. They did find a positive effect for high school biology. Meta-analyses by Fletcher-Finn and Gravatt (1995) and Liao (1992) showed similar findings with a moderate effect size favoring CAI. Lu, Voss, and Kleinsmith (1997) also reported positive effects of using CAI in high school biology classes. Other studies specifically for high school biology report a positive effect when using CAI when compared to traditional instruction (Lazarowitz & Huppert, 1993). Hounshell and Hill (1989) used computer simulations as a supplement to a biology course to cover topics such as genetics and population studies. The authors reported significantly higher student achievement scores with the computer-assisted approach over the traditional classroom approach.

A.D.A.M.—The Inside Story is a common multimedia application for anatomy classes. Matray (1996) reported that A.D.A.M. provides learners with an opportunity to review systems that could not be viewed in a "real life"

environment. Learners are able to control their learning environment as they view the systems of the human body.

Jonassen et al. (1999) noted that despite multimedia's popularity, the research supporting positive effects of multimedia on learning was limited. Provenzo et al. (1999) predicted that the promise for multimedia and hypermedia has just begun. They suggested that "when combined with other computer-based technologies such as the Internet...multimedia and hypermedia have the potential to transform learning and instruction" (p. 187).

Laptop Computers

Laptops are becoming familiar learning tools for students. The portability of laptops is attractive to many educators who have limited equipment and who desire greater mobility and access for students. This technology has been shown to improve teacher and student technology literacy, student responsibility and independence, and the quality of student products (Fouts & Stuen, 1997; Gardner, Morrison, Jarman, Reilly & McNally, 1994).

Gardner et al. (1994) explored the effects of providing portable computers to 235 students from 9 schools (one special, one primary, and seven secondary-level). Students had full-ownership of the portable computers for one year. Their findings were mixed. The portable computers did not have a positive effect on achievement gains for mathematics and English. However, there was a positive impact on science achievement. They also reported that students with laptop computers were more motivated and acquired information technology literacy more quickly.

In other research (McMillan & Honey, 1993), teachers indicated that laptop technology increased their ability to undertake more inquiry-oriented activities, project-based activities, and long-term assignments. They found that students improved markedly in their ability to communicate persuasively, to organize their ideas effectively, and to accurately use a broad vocabulary. Researchers from the Copernicus Project in Washington State (Fouts & Stuen,

1997) noted that writing skills were the most directly affected by the use of laptops, followed by communication and presentation skills.

It may be that whether or not laptops are used in the classroom is less important than how they are used. As Clark (1991) proposed, "Learning is influenced more by the content and instructional strategy than the type of medium" (p. 34). Constructivist-based learning activities appear to be more beneficial. Bradshaw and Massey (1996) noted that laptops level the playing field because all students use the same tools and have similar access to information.

Design of the Study

Methodology

This quasi-experiment utilized a control group/experimental group counterbalanced design. Two classes (Group A and Group B) of anatomy and physiology students served as a sample of convenience (Gall, Borg, & Gall, 1996). Group A used laptop computers with A.D.A.M. (Animated Dissection of Anatomy for Medicine) multimedia software and PowerPoint™ presentation software during the first and second quarter of the 1997-98 school year. Each of the students in Group A was given full-time possession of a laptop computer, including permission to take it home. Group B served as a control group and did not have access to the laptop computers, although MedWorks™ software and the Internet were available on five workstation computers in their science classroom. Access to the technology was reversed for the second half of the year and Group B students used the laptop computers while Group A served as a control.

Both groups of students were taught the same curriculum by the same teacher. Instruction centered on lectures, lab activities, and open-ended projects. The students with the laptops reviewed the course material with the A.D.A.M. software. They also used PowerPoint™ to create a presentation on one aspect of the curriculum. Therefore, the treatment involved fulltime possession

of a laptop computer, interaction with the A.D.A.M. software, and opportunities to create multimedia presentations with PowerPoint™.

Participants

Participants were first year anatomy and physiology students from a small rural high school in Idaho. The anatomy and physiology course was an elective course that was usually taken in the junior or senior year. The participants were assigned to one of two groups based upon class schedule. Group A consisted of 2 twelfth grade students and 9 eleventh grade students for a total of 11 participants. Group B consisted of 1 twelfth grade student, 14 eleventh grade students, and 1 tenth grade student for a total of 16 participants. Prior to the study, the two groups did not differ on overall cumulative GPA, $t(25) = .93$, $p = .36$, $d = .49$ or previous biology grades, $t(12.26) = 1.89$, $p = .08$, $d = .89$ (see table 1 for group means and standard deviations). The difference in previous biology grades was approaching statistical significance.

Table 1

Prior Biology Grades and Grade Point Averages

Area	Group A (n = 11)		Group B (n = 16)	
	M	SD	M	SD
Biology Grades	2.94	1.27	3.70	.51
Previous Cumulative GPA	3.44	.65	3.65	.51

Instrument

Student achievement in the anatomy and physiology class was measured each school quarter. Over the course of the school year, student achievement was based on 12 teacher created exams. Each exam contained an average of 40 multiple-choice questions and two essays. The majority of the exam questions

were taken from the instructor's guide that accompanied the classroom text. Both groups completed the same exams.

Results

A repeated measures ANOVA was used to analyze the data. The between variable was group membership. The repeated measures were the students' grades for each of the four quarters of the school year. There was no difference in the overall achievement of Group A and Group B for the year, $F(1, 25) = 4.06$, $p = .06$ (see table 2). This would be expected because each group served as the experimental group and the control group for part of the study.

Table 2

Analysis of Variance of Repeated Measures

Source	SS	df	MS	F	p	Eta^2
			Between subjects			
Group	1072.46	1	1072.46	4.06	.06	.14
Error	6604.71	25	264.19			
			Within subjects			
Quarters	3780.46	3	1260.15	37.43	.001	.60
Quarters * Groups	355.57	3	118.52	3.52	.02	.12
Errors (Quarters)	2524.75	75	33.66			

There was a significant difference in the overall achievement of the groups across the four quarters of the school year, $F(3,75) = 37.43$, $p = .001$. As the school year progressed, the content of the course became more difficult and the students' grades dropped.

There was also an interaction between the groups across time, $F(3,75) = 3.52$, $p = .02$. The difference between the groups at each of the four quarters was investigated with separate t-tests. There were significant differences between the two groups at the first and fourth quarters (see Figures 1 and 2). As noted earlier, we were approaching a significant difference in biology grades from the previous school (1996-97) year that favored Group B students. Group A students were given the laptop computers five weeks into the (1997-98) school year. At the end of the first nine weeks of the school year, Group B students scored higher in the anatomy and physiology class than Group A students, $t(11.13) = 2.16$, $p = .05$, $d = .67$. This was expected since the previous biology grades for Group B were higher and Group A had access to the laptops for only the last four weeks of the quarter. At midyear, there was no difference between the achievement of Group A and Group B, $t(25) = .38$, $p = .71$, $d = .11$. Group A, who had laptops for the entire quarter, were now achieving at the same level as Group B.

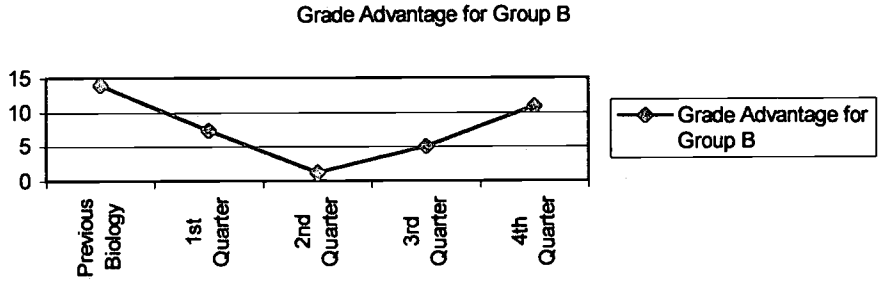

Figure 1. Grade Advantage for Group B

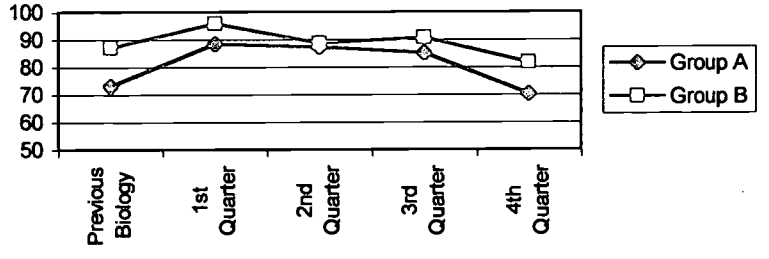

Figure 2. Means Scores for Group A and Group B Throughout the Study

Two weeks into the third quarter, the laptops were transferred from the Group A students to the Group B students. There was no difference in the achievement of the two groups at the end of the third quarter, however Group B was beginning to outperform Group A, $t(25) = 1.89$, $p = .07$, $d = .70$. The difference between the groups was once again surfacing after Group B students began using the laptop computers. By the end of the year, Group B students who had used the laptops for the full quarter were scoring a full grade higher than Group A students who were not using them, $t(25) = 2.15$, $p = .04$, $d = 1.11$.

Discussion

This study demonstrated that students learned more in a high school anatomy and physiology class when they had access to laptop computers, were exposed to multimedia software, and created projects with presentation software. Meta-analyses of computer-assisted learning by Christman et al. (1997), Fletcher-Finn and Gravatt (1995), and Liao (1992) support the findings of this study. Studies specific to computer-assisted biology classes (Hounshell & Hill, 1989; Lazarowitz & Huppert, 1993) also support the findings of this study. This research demonstrated that laptop computers with accompanying software had a favorable effect on students' achievement scores.

It is difficult to determine whether the positive outcomes are the results of possession of the laptops or the use of multimedia and presentation software. Student use of laptops may be superior to the traditional computer lab approach. When students use a computer center or a computer lab, computing often becomes a separate activity. This may decrease opportunities to use technology as an authentic integral part of learning. Compatibility issues complicate student computing access. There may be a difference between the hardware and software that students have available at home and what is available at school. Laptop computers can bridge the resource gap by allowing students equal access to technology both at school and at home. Laptops have the potential to change the dynamics of teaching. Students with laptops are able to learn at any place and

any time. This flexibility adds another powerful tool to the arsenal for acquiring and processing information.

The small sample in this study is a limitation. Obtaining statistical significance with a small sample is difficult. The effect sizes reveal that, given more power, the two groups probably did differ in their previous GPA and biology grades. Given the limited statistical power, the differences that were reported in this paper are impressive. Further research with a larger sample is necessary.

It is also recommended that further research be conducted on the individual variables in this study: laptop computers, A.D.A.M. software, and PowerPoint™ software. Research is needed to distinguish their individual effects on learning. Additionally, research is needed to investigate the impact of laptop computers and multimedia software on specific content areas across the curriculum.

Laptop computers and multimedia software provide a strong learning tool for educators. Additional research into new ways of thinking and teaching with these tools is warranted.

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