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Technology-Enhanced Presentations in Large Classrooms : Effects on Adult Academic Achievement and Computer Attitudes

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THESIS APPROVAL

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ABSTRACT

An abstract of the thesis of Pamela Rae Hilberg for the Master of Science in Psychology presented March 16, 1998.

Title: Technology-Enhanced Presentations in Large Classrooms: Effects on Adult Academic Achievement and Computer Attitudes.

Rising enrollments and budget restrictions are resulting in larger class sizes which can lead to difficulties with learning. Computer technology has been suggested as a tool that may help overcome some of these difficulties. Research on outcomes is important to find ways that technology may be used by instructors to help students with *information processing* (Gagne & Driscoll, 1988), and to see if the financial commitment required for integrating educational technology is warranted.

The purpose of the present study was to examine the academic achievement and computer attitudes of students in courses taught with traditional presentations and technology-enhanced presentations taught with two different technology strategies. Regarding learning, Technology Strategy 1 (TS-1) was expected to enhance academic achievement, because it included the use of at least three of the following four factors of visual aids which are suggested by information processing theory: (a) color background, (b) contrasting color title or bullets, (c) bulleted lists, and (d) build effects. Regarding computer technology, Technology Strategy 2 (TS-2) was expected to enhance computer attitudes, because it included the use of features which increased the *apparentness* of technology use in presentations: (a) use of active buttons to link to other websites, (b) display of top menu bars and side scroll bars, and (c) presentation on a course website accessible outside of class.

The current study was conducted as a secondary data analysis on a larger project operating on a grant provided by the U.S. Department of Education Fund for Improvement in Post-Secondary Education (FIPSE). Five hundred sixty-one university students enrolled in control and experimental sections of three courses (sociology, psychology, and biology) participated in the study. Data was collected on students' academic achievement and computer attitudes.

Data was analyzed using MANOVA models. For academic achievement, results indicated a significant interaction of technology-enhanced vs. traditional presentations by technology strategy. Post-hoc t-tests indicated that in TS-1 courses students taught with technology-enhanced presentations had lower course grades than students taught with traditional presentations, for the psychology course only. No effect was found on computer attitudes. Explanations for this unexpected finding are discussed, as are limitations of the research.

TECHNOLOGY-ENHANCED PRESENTATIONS IN LARGE CLASSROOMS: EFFECTS ON ADULT ACADEMIC ACHIEVEMENT AND COMPUTER ATTITUDES

by

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DEDICATION

To my son, Zach, for his patience and encouragement.

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In American universities, rising enrollments and budget restrictions are resulting in larger class sizes. At the same time, there is a demand for increased academic productivity. This presents an immense challenge for college instructors as they strive to improve classroom learning while simultaneously adjusting to the difficulties associated with teaching in larger classrooms (APA, 1996).

These difficulties can arise for a variety of reasons. First in large classes, there is commonly a reliance on lecture and a reduction of instructor interaction with individual students which makes keeping the attention of students during class a more complex task (Johnstone & Percival, 1976). Second, there is a basic perception problem--the instructor must adjust for the reduced ability of students toward the back of the classroom to hear and see what is going on at the front of the class (Cyrs, 1994). A third problem is the increased difficulty for the instructor to monitor students' in-class learning. To begin with, students in large classes may be less likely to ask questions to get the clarification they need when they fail to understand (Lowman, 1995). To assess student understanding, instructors commonly scan students' facial expressions and body language for signs of comprehension or confusion (Angelo & Cross, 1993). In large classrooms, it is difficult for the instructor to detect these informal measures of student learning. Also, because grading time increases as class load increases, instructors are less likely to give quizzes frequently. Without timely assessments, it is probable that instructors may not be aware of students' problems in time to remedy the situation (Angelo & Cross, 1993).

Computer technology has been suggested as a tool that may help overcome some of the problems in large classes (Baron & Orwig, 1995). Although individual computerized instruction has been studied in some detail, there has not been much research on the effectiveness of computerized presentations for large groups. This may be because this particular field is still in the development phase (Kozma, 1991). The present study compared courses using traditional presentations to those using technology-enhanced presentations for possible differences in academic achievement and computer attitudes. The study also examined academic achievement in courses using technology-enhanced presentations for possible effects of age. In this study, courses using *technology-enhanced presentations* were those taught primarily with presentation technology: either PowerPoint presentations or web-based presentations. In contrast, courses using *traditional presentations* were taught with chalkboards, overhead transparencies, or no visual aids. Of particular interest were the ways technology-enhanced presentations may be used by instructors in large classrooms to help students: a) maintain attention, b) facilitate sensory reception, c) discern important points, d) promote short-term storage, and e) achieve semantic encoding. Theories of learning provided a framework to help better evaluate the problems and their possible solutions.

THEORIES OF LEARNING

Behavioral Theories

Current learning theories have their roots in *behaviorism*, which defines learning as "a relatively permanent change in *behavior* due to experience" [italics added] (Ormrod, 1990, p.6). These theories began with an emphasis on forming associations. The first major behavioral theory focused on reflexes and was introduced by Ivan Pavlov (1927) early this century. Pavlov's *classical conditioning* asserted that repeatedly pairing an *unconditioned stimulus* that would induce a reflexive or *unconditioned response* with a neutral stimulus (*conditioned stimulus*) resulted in the conditioned stimulus alone inducing the "reflexive" response (*conditioned response*).

In 1913, Edward Thorndike extended learning from reflexes to voluntary behaviors with what is called *instrumental conditioning*. Thorndike stated his *law of effect* as follows:

> When a modifiable connection between a situation and a response is made and is accompanied or followed by a satisfying state of affairs, that connection's strength is increased: When made and accompanied or followed by an annoying state of affairs, its strength is decreased. (Thorndike, 1913, p. 4)

Refining Thorndike's *instrumental conditioning*, B.F. Skinner's *operant conditioning* emphasized the importance of the behavioral goal (1938). He focused on strengthening the desired outcome or response, rather than strengthening the connection between the stimulus and the response. In investigating academic achievement, student motivation and class attendance should be measured and statistically controlled. Skinner asserted that a behavioral response that is followed by reinforcement is more likely to occur again, while a response that is followed by punishment is less likely to occur again. This perspective provided a method for purposely influencing behavior. Although this view does not deny the existence of internal learning processes, there is no reference made to these processes. Because he proposed that learning could be understood sufficiently by using observation of behavior and its consequences, Skinner labeled his popular perspective on learning *behaviorism*. Behaviorist principles have been very effective in many areas, especially classroom discipline and self-modification of behavior (Gagne & Driscoll, 1988).

During the popular era of behaviorism, some psychologists continued to include cognitive processes in their explanations of behavior (Bartlett, 1932; Tolman, 1932). Although his understanding of Skinner's explanation of the learning of language in *Verbal Behavior* (1957) is controversial, Noam Chomsky (1959) directed attention back to the internal mental processes of learners when he published his attack on Skinner's views of language development (Solso, 1991, p. 301). Chomsky believed that behaviorism failed to explain why people often organize or modify what they learn, restating general meanings rather than precisely repeating what they have heard. The tendency to focus on the meaning of the message, rather than the exact message, suggested that people mentally manipulate and organize information that they learn. For example, when toddlers exactly mimic words spoken by adults, this could be attributed to learned associations. However, when children test a language rule, they may speak in a way that they have never heard. For example, a toddler may notice that we usually add an "s" to the end of a word to indicate plurality. After a long walk, the toddler says, "my foots hurt." Rather than merely imitating what was heard, the toddler used mental processing adding an "s" to the word "foot" in an attempt to make it plural.

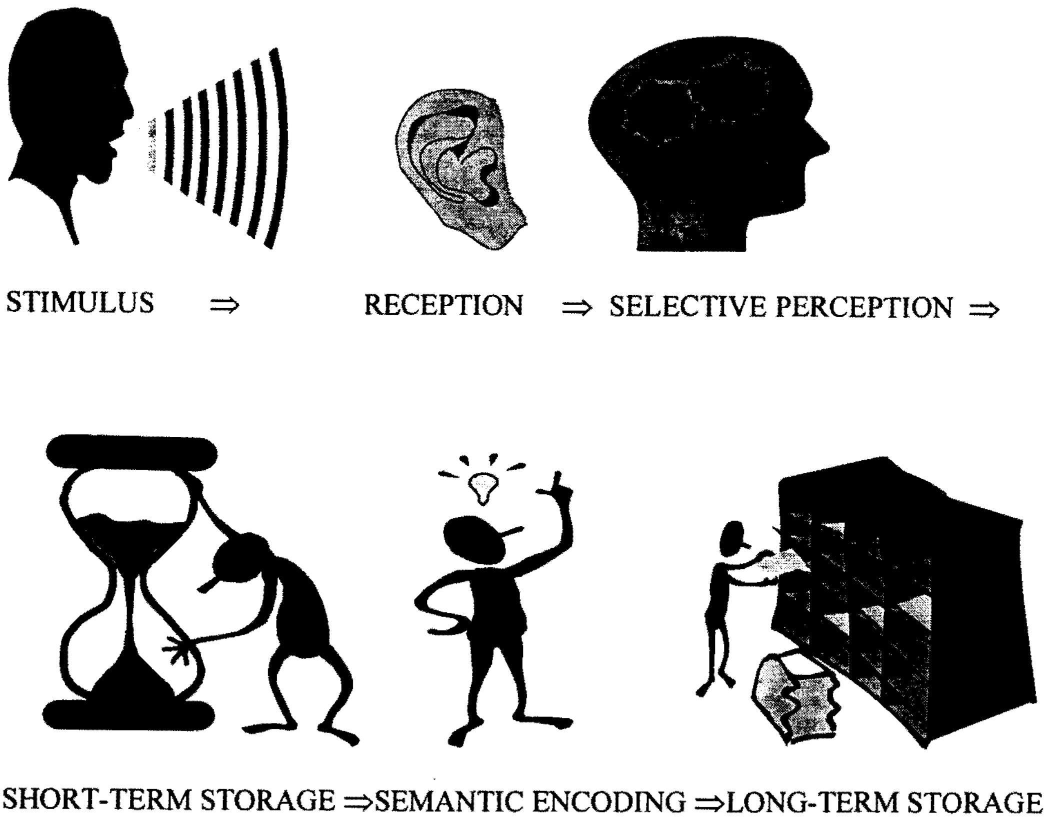
Cognitive Theories

In response to interest in internal mental processes, *cognitive psychology* developed. Cognitive psychologists generally define learning as "a relatively permanent change in *mental associations* due to experience" [italics added] (Ormrod, 1990, p.6). Cognitive psychology has its roots in *Gestalt theory* which asserts that learners perceive stimuli as whole patterns rather than parts (Wertheimer, 1945). As Gestalt psychologists studied this phenomenon called *pattern recognition,* they acknowledged that the individual's perception of stimuli is often different from what is actually received by the senses. Their contribution to cognitive theory is the idea that individuals actively organize perceptual stimuli in certain predetermined ways.

Information Processing Theories

A current expansion of cognitive theory is *information processing* which focuses on the steps that individuals go through when they learn. These steps can occur in either a serial or parallel fashion, but are more easily understood when studied as a serial sequence (see Figure 1).

Figure 1. Information-Processing Stages



A leading theorist in the information processing field is Robert Gagne (Gredler, 1992). According to Gagne's information processing theory (Gagne & Driscoll, 1988), there are eight steps in the process of learning: (a) reception, (b) selective perception, (c) short-term storage, (d) semantic encoding, (e) long-term storage, (f) search/retrieval, (g) performance, and (h) feedback. These eight steps of information processing, and strategies for facilitating these steps, are shown in Table 1 below. In addition, Gagne notes the necessity of attention as a prerequisite to the learning process.

Table 1. Processes of Learning and the Influence of External Events

LEARNING PROCESSES	EXTERNAL EVENTS WHICH MAY INFLUENCE THE PROCESSES
0. Attention	Change in stimuli; use of color
1. Reception	Legible visual aids; amplified sound
2. Selective perception	Emphasizing features of stimulus material
3. Short-term storage	Suggesting the activation of rehearsal and chunking
4. Semantic encoding	Presenting meaningful encoding techniques, such as images
5. Long-term storage	Not known; avoiding interference
6. Search/Retrieval	Presenting cues to aid search
7. Performance	Practice in a variety of contexts for transfer of learning
8. Feedback	Informing learner of degree of correctness of response

(Adapted from Essentials of Learning for Instruction (p. 39) , by R. M. Gagne and M. P. Driscoll, 1988, Englewood Cliffs, New Jersey: Prentice Hall.)

Although the learner has some control over all of these steps in learning, they can also be influenced by environmental factors. Applying this theory to teaching can provide instructors with classroom environment factors which may facilitate student learning.

Before learning can begin, the learner must first pay *attention* to, or notice, the stimuli presented. This is similar to a radio that cannot pick up a radio signal unless it is first tuned to the proper station. Instructors can gain and maintain attention by changes in stimuli. Only after attention is gained can *reception,* the capture of sensory stimuli in the learner's sensory register, occur. Suppose that during a lecture on human development, students were paying attention and an instructor presented textual information about parenting styles on a screen in front of the class. An example of reception would be when the learners' visual systems became aware of the sensation of printed material projected on the screen.

The second step in the learning process is *selective perception.* Selective perception, which is sometimes called *pattern recognition* (see Anderson, 1985), refers to the learner's interpretation of the sensory stimuli that have been registered by the senses. Directed by the pattern of features in the stimuli, previous knowledge of the learner, and information regarding expectancies for future use of the data, stimuli are quickly identified in a way that is somehow meaningful to the learners. If a human development instructor presented printed material on a screen, selective perception would occur when the students recognize that the patterns on the screen represent words and those words are identified (see the following example).

Parenting Styles

- Authoritative
- Permissive
- Authoritarian
- Neglectful

Once the stimuli have been interpreted in a meaningful way, they can be kept briefly in *short-term storage*. Short-term storage enables the learner to remember the first word presented while the instructor presents the remaining words. However, information in short-term storage may be quickly forgotten, for two reasons. The first reason is information's brief duration of about 20 seconds (Anderson, 1985; Peterson & Peterson, 1959). Second, short-term storage has limited capacity of about five to nine items (Miller, 1956). To be retained in short-term storage, information must either be rehearsed or reduced by *chunking* into meaningful groups. Rehearsal, or repeated practice of material to be remembered, keeps the information briefly available. We may use rehearsal when we are given a telephone number. If we have nothing to write with, we continually repeat the number to ourselves. Using rehearsal, we can remember the number long enough to make the telephone call.

Miller (1956) noted that short-term memory seemed to be limited to holding about seven items. This was true whether the seven items were single letters or entire words. This led to his assertion that by grouping smaller pieces of information into bigger chunks, the amount of information that could be held in the short-term memory could be increased. He gave as an example the process of learning radio-telegraphic (Morse) code.

A man just beginning to learn radio-telegraphic code hears each *dit* and *dah* as a separate chunk. Soon he is able to organize these sounds into letters and then he can deal with the letters as chunks. Then the letters organize themselves as words, which are still larger chunks, and he begins to hear whole phrases.

In a classroom, the instructor can apply this strategy to help students extend their short-term memory by chunking the four words describing types of parenting styles into two pairs, as displayed below:

<u>Parenting Styles</u>

- Authoritative/Authoritarian
- Permissive/Neglectful

This can reduce the effort in remembering the parenting styles, because students have two chunks of information to remember instead of four chunks.

Semantic encoding refers to a more thorough processing of information to make it more memorable. In this step, the information is linked to the learner's previous experiences in a way that makes sense to the learner. Information to be learned may be classified under previously learned categories, linked to related prior knowledge, or connected with a visual representation of the information. For example, the instructor may begin by describing parental interactions with their children as either warm and affectionate or cold and distant. This warmth or coldness dimension is a concept which would be familiar to most adult students. Then, the instructor can classify authoritative and permissive parents into the group of parents who exhibit warmth toward their children. They can also classify authoritarian and neglectful parents into the group of parents whose behavior toward their children is cold or distant. This creates a link between the students' previous knowledge and the new information to be learned, making the terms meaningful to the students, and enhancing the organizational processing that promotes long-term storage.

Another way to facilitate semantic encoding would be presenting pictures representing each parenting style. According to Paivio's (1986) *dual coding* theory, information is mentally represented in two forms, verbal and imagery. Providing visual aids to assist learners in representing information through imagery has been found to enhance learning (Anderson & Kulhavy, 1971; Kulhavy & Swenson, 1975; Westman, 1990). For example, authoritative parenting could be represented by pictures of parents displaying warmth and reasonable limit-setting. One caution regarding dual encoding, however, is that providing too much information graphically, or neglecting to call attention to the connections between the different media, may lead to interference or drawing incorrect conclusions. An effective strategy is to verbally state the same information provided by the image (Levie & Lentz, 1982).

Long-term storage refers to the maintenance of information until it is needed for future use. At this point, information has been learned. However, until the student demonstrates their knowledge, we cannot be certain that learning has taken place. It is unknown if the instructor can do anything to help with long-term storage, except perhaps avoid interference by limiting the amount of information presented at one time. Instructors need to design presentations using adequate aids to learning without overwhelming students with too much stimuli.

Search/retrieval refers to finding and recalling previously learned information, so that it can be used for a demonstration of learning or linked with new information to be learned for semantic encoding. Retrieval can be facilitated by *external cues*, such as category and context. For example, the instructor could ask students what the four parenting styles are, providing the category of parenting styles as a cue. The instructor could also provide a common feature as a cue, asking which parenting styles are classified as exhibiting warmth.

Performance refers to an observable behavior that indicates the learner has learned the information. For example, the ability of students to correctly answer an exam item or discussion question about parenting styles would indicate that they have learned the information.

Feedback refers to information that learners receive regarding their performance and, therefore, their learning. Feedback can occur in different forms. For example, students may recognize on their own that they can list the warm parenting styles without looking at their notes. Alternatively, an instructor can provide feedback by responding to student comments and through scores on test items, exams, or written assignments. Feedback is the step which completes the learning process.

LEARNING AND AGE

Another critical factor in learning is age. Although many people assume that college students are young adults who have recently completed high school, the enrollment of older students is increasing (Keller, Mattie, Vodanovich, & Piotrowski, 1991; Panek, Partlo, & Romine, 1993). In 1992, almost 50% of America's college and university students were at least 25 years of age, and about 20% were 35 years or older (Apps, 1992). Clearly, our colleges and universities must attend to the needs of older students.

Older students often encounter more barriers in the educational process than younger students. One major problem is lack of time and energy to devote to school due to responsibilities at home and work (Apps, 1991; Kasworm, 1990). This can reduce available class time and study time, as well as time to use the library or computer facilities on campus. In addition to these situational barriers, Cross (1981) noted institutional barriers within universities, such as restricted hours that classes, libraries, and computer facilities are available. Cross also discussed dispositional barriers of older students, such as low confidence and difficulty thinking of oneself as a student.

More specific to learning, older students are more likely to have perception problems that can make learning more difficult. With age, the senses of hearing and vision tend to deteriorate somewhat (Apps, 1991; Lorge, 1955). When teaching students over age 40, special attention to facilitation of perception is recommended. Presenting visual aids of adequate size and contrast, as well as reducing extraneous noises that may interfere with hearing, can help insure students receive the information being sent by their instructors (Witherspoon, 1991). Also, older students tend to take longer to process information. This may be because when learning, people consider the relationships between new information received and prior experiences. Because older students generally have a more abundant store of previous experience than younger students, they could take longer to process new information than younger students who have fewer experiences to consider. Regardless of the reason for their slower information processing, external aids to the processing of information to be learned should be especially helpful and are recommended for use with older students (Apps, 1991; Witherspoon, 1991).

EDUCATIONAL TECHNOLOGY

In past years, a variety of technological tools have been used to facilitate learning. The term "multimedia" was previously used to refer to the combined use of various traditional visual aids, such as textbooks, chalkboards, overhead projectors, movie projectors, and props. Conveying information effectively to large groups of people with traditional methods was difficult. For example, material presented on a chalkboard or overhead projector is most easily viewed in smaller classrooms. Although instructors could use individual handouts to improve information transmission, the costs associated with using handouts in large classes can be prohibitive. Handouts also need to be developed enough ahead of schedule to allow for the copying time required to supply handouts to all students in a class. Currently, *multimedia* is usually defined as computer-based technology, which allows many types of media to be presented simultaneously. For large groups, these media include text presentation, graphics, animation, sound, and video. In addition, electronic communication methods, such as electronic mail (e-mail) and the Internet, can provide more individual interaction between members of large groups (Barron & Orwig, 1995). Five types of technological tools are important in educational settings: (a) presentation technology, (b) digital images, (c) video, (d) e-mail, and (e) the Internet.

Presentation Technology

Presentations can be delivered using such tools as presentation software, web-based technology, or laser disks. There is an increasing demand for presentations, even in the educational setting, to display information in a more polished manner than ever before. Today's students, especially traditional-aged college students, have become accustomed to seeing expensively produced commercial television fare with such features as scene changes, cuts, and dissolves (Manley-Casimir & Luke, 1987). Technology-enhanced presentations can help to provide the more professional look expected in the 1990's. There are two main authoring systems for development of technology-enhanced presentations: presentation software (slide and scripted types), and web-based (with hypermedia) software (Barron & Orwig, 1995).

Presentation software programs, such as Microsoft PowerPoint, are designed for easy development and delivery of electronic slide shows for use in group settings. Similar to traditional slides, computerized slide shows have a linear format, and the computer is used to advance or reverse from one slide to the next within the presentation. Some users find the linear format of presentation software restrictive, while others appreciate the structure it gives their presentation.

Creating a PowerPoint presentation is relatively easy as the program provides templates for typing the presentations. PowerPoint presentation software offers two features which facilitate *progressive disclosure* of information, which can prevent information overload for students. First, the use of PowerPoint software limits the amount of information that can be presented at one time to the amount that will fit on each individual slide. In addition, PowerPoint presentation software offers the availability of build effects on individual slides which display bulleted items one at a time, building up to the total information on the slide. (Appendix A shows an example of build effects.)

PowerPoint slides can be used to present text, tables, graphs, images, animations, sound, and brief videos. The software offers a wide variety of special effects available to change the way bulleted items "build" and slides "transition" from one slide to the next. Using presentations in electronic form makes revising and delivering presentations easier than using traditional overhead transparencies. For example, rather than manually removing a transparency, then searching for and replacing it with the next one, electronic slide shows allow the presenter to move to the next slide with a simple touch of a button. Appendix B shows an example of a brief Microsoft PowerPoint presentation.

In contrast to the linear format of presentation software, *web-based technology* allows the user to choose their own path in exploring the information. This is accomplished through the use of active areas on the screen, called ***buttons***, that jump the user to related topics, graphics, or more detailed information. While offering more flexibility for presentation, these additional options make web-based technology more difficult to develop. A special feature of web-based technology is that instructors can use it to create special course-specific "*websites*," with course information which can include presentations which can be accessed by students through the *Internet* (see below).

Web-based tools are designed for interactive access by individuals, but can be projected onto a large display screen for group settings. In that case, the presenter controls which information paths are taken. Like presentation software, web-based presentation tools can be used to present text, tables, graphs, images, animations, sounds, and brief videos. Web-based presentations can be viewed in various ways. Using the side scroll bar (a common feature of many word processing programs), they can be "scrolled through" in a linear fashion. In addition, web-based presentations can be viewed following a non-linear path, as desired by the user, through the choice of appropriate buttons described above. Appendix C shows an example of a section of a web-based presentation with one of the images that can be accessed by using a button.

Textbook editors are now producing presentations that accompany textbooks on laser disk in a variety of topic areas. *Laser disks* are similar to large 11-inch, two-sided music CD's. Laser disks can be used to present text slides, graphic slides, animation, and brief video segments. These presentations can be shown in their entirety in a manner similar to an electronic slide show. For example, linear slide shows with text, graphs, photographs, and video excerpts are usually available for each chapter in the textbook. Another way to use laser disks is to select specific portions of the show for presentation by using bar or number codes provided by the manufacturer.

Digital Images

Digital images can be presented using laser disks, electronic overheads, or presentation technology. Images on laser disks include still graphics, animation, and moving video images, as described above. *Electronic overheads* are similar to traditional overheads, except transparencies are unnecessary. Images are computerized and projected to a screen directly from such items as graphs, photographs, note pages, textbooks, and props. Electronic overheads can be useful for very large groups, because they have extended zoom capacity in contrast to traditional overheads. Digital images, which are not protected under copyright or which instructors author themselves, can also be made available on a website for students to study outside of class.

Video

Although moving *videos* replaced movie reels some time ago, videos have traditionally been displayed on television screens suited for small groups. Using computerized presentation, videos can be enlarged sufficiently for larger groups to view them. Computerized video also allows the presenter to view the video on a computer screen in front of them, and control the video presentation from a control panel within easy reach.

E-mail

E-mail provides an electronic communications method which uses a mail-like format. Users can create listings in electronic address books of e-mail addresses for both individuals and groups of people that they communicate with on a regular basis. E-mail is quick and convenient, because messages can be sent to individuals, or groups, at the sender's convenience. Recipients can "check their mail" when their schedule permits. Appendix D shows an example of e-mail.

Internet

The *Internet*, also referred to as the worldwide web, is an international electronic communications system. In addition to providing a technique for creating and viewing web-based presentations, the Internet gives users the ability to connect their computers to other computer systems in distant locations. In this way, the Internet provides users quick, easy access to huge databases of information from an enormous variety of sources. In the area of education, these range from granting agencies and universities to university departments and individual courses. Organizations can request their own Internet address or gain access to the Internet as individuals do, through commercial vendors.

LEARNING AND TECHNOLOGY

Attention

According to Gagne, attention is a prerequisite to learning. Attention has been shown to be gained by changes in stimuli and color, as well as through the use of images (Gagne & Driscoll, 1988). Although students may view images from their textbooks or instructors can present images on handouts, technology makes the use of images easier. Having all students carry their texts to class, or instructors preparing and carrying large supplies of handouts can be inconvenient. Computerized presentations with images, stimuli changes, and color changes can be carried to class by the instructor on one computer disk. Rather than using several overhead transparencies to supplement a lecture, images can be integrated with text into one technology-enhanced presentation.

Presentation software, such as PowerPoint, provides frequent stimulus changes by displaying information on a series of individual slides which can be presented with various attention-getting transition effects, such as "fly in from left." Web-based presentations provide stimulus changes through the use of scrolling, and active buttons which jump to related information or graphics.

However, Manley-Casimir and Luke (1987) remind educators that special effects that gain attention may not facilitate comprehension. The attentional and educational aspects of the Children's Television Workshop program, *Sesame Street,* have been topics of considerable debate (Anderson, Levin, & Lorch; 1977). In a review of research on the educational impact of *Sesame Street*, results suggest positive effects on such skills as counting, classification, and vocabulary (Children's Television Workshop, 1990). Results are mixed on the attentional effects of *Sesame Street*. One claim is that the rapid pace of the program fosters short attention spans

(Halpern, 1975), but others disagree and suggest there is an increase in viewers' attentional abilities (Anderson, Levin, & Lorch; 1977).

Attention can also be influenced by students' motivation to learn. Research has shown that intellectual curiosity and valuing learning for its own sake have led to greater engagement in learning tasks (Nicholls, Jagacinski, & Miller, 1986). Anderson, Shirey, Wilson, and Fielding (1988) found that interest in reading materials and other motivational elements influenced learning an average of 30 times more than other variables. Although motivation has a substantial impact on learning, this study will remain focused on environmental factors which facilitate learning according to Gagne's information processing theory (Gagne & Driscoll, 1988) and which are more under the control of instructors.

Reception in Sensory Register

The first step in Gagne's information processing theory is reception in the sensory register. In large classrooms, the perception of students who may be out of range for optimal hearing and vision is aided by the use of a microphone and the larger text made available by use of technology-enhanced presentations shown on large display screens. This can be especially helpful for older students, or others who may have perception problems. Also, use of color can provide an increased contrast of stimuli and background on visual aids.

Selective Perception

The second step in information processing is selective perception. Presentation technology can be used to emphasize important features of stimulus material, promoting perception of desired information. Presentation software employs use of titles, color schemes, and bullets which help the audience with selective perception when viewing text. Bulleted items can be presented with build effects which allow the presenter to add one item at a time to the visual display, fading previous items to a less noticeable color if desired. Web-based presentations may also include titles, color schemes, and bullets if included by the designer. Both presentation software and web-based presentations allow for the use of images and graphs to help students focus on important points.

Storage in Short-Term Memory

The third step in processing information is storage of organized patterns in short-term or working memory. Limits to short-term memory make it difficult for learners to process large amounts of information at a time (Miller, 1956). Many students have difficulty recording the critical ideas when taking notes on a fast-paced lecture (Kiewra, 1985). They are unable to hold information in their short-term memory and decide which information is important, while simultaneously taking notes. Presenting material visually, in an organized way, and divided into small meaningful pieces can facilitate short-term memory. A form of rehearsal can be used in the classroom by displaying course information visually, while simultaneously stating the same information orally, providing learners with repeated exposure to the material. Although instructors can choose to use presentation technology in a variety of ways, the process of developing technology-enhanced presentations can encourage instructors to refine their teaching goals and instructional information (McQuillan, 1995).

Although web-based presentations can be designed to present information in small, organized segments, the authoring templates of PowerPoint presentation technology especially facilitate this process. First, the amount of information that will fit on each slide is limited. Second, bulleted items can be easily presented with build effects, which allow the presenter to add one item at a time to the visual display. There is also the option of fading previous items to a less noticeable color.

Presenting information in these smaller chunks places less strain on students. Appendix A shows an example of progressive disclosure through the use of build effects.

Semantic Encoding

In a review of learning with media, Kozma (1991) cites many studies which demonstrate that combining visual aids with auditory information leads to greater recall than either visual or auditory stimuli alone. Similarly, in a comparison of narrative information presented with either television or radio, less distortion and loss of information was observed in the television group (Hayes, Kelly, & Mandel, 1986). Barker and Manji (1989) found auditory information to be less effective than images, mainly because of its transitory character. Presenting words or pictures usually allows learners longer access to the information. Barker and Manji also provided evidence that for certain types of learning, such as category matching, the time needed to understand pictures is less than the time needed to understand words. Shepard (1966) noted that the recall of certain information is dependent on imagery. For example, it is difficult to recall the number of windows in one's house without creating a mental image of the house. In recognition tests, imagery was found to improve post-test performance (Anderson & Kulhavy, 1971; Kulhavy & Swenson, 1975).

Although psychologists have known for several years that visual images enhance understanding of auditory messages (Paivio, 1986), this knowledge has not been consistently applied in the classroom. This may be due to the extra effort that instructors must expend to use visual aids. Technology-enhanced presentations allow instructors to present colorful, high-quality images more easily. Paired with a verbal description, learning could be enhanced. For instance, some concepts such as positive and negative correlations are difficult to understand without the use of visual aids. Using an electronic presentation, instructors could easily supplement their verbal presentation with a variety of colorful, graphic examples with the touch of a button (See Appendix E). The quality of these technology-enhanced graphics would most likely be superior to graphs drawn on a chalkboard or overhead.

Access to Information

Due to the decreased individual instructor-student interaction in large classrooms, students' access to information can become a problem. E-mail provides a tool that can increase both students' access to information and interaction. Using e-mail, students can get questions answered by instructors at their convenience, rather than trying to find a time when both student and instructor are free to meet personally. Some faculty may find that e-mail increases their workload as they need to respond to many individual messages, which may be more time intensive for the instructor than answering questions in class or during office hours. Professors may elect to use a listserv or group address for the class. This way the instructor may type only one message, and send it to all students in the class who have e-mail addresses. This can be especially effective for answering frequently asked questions for large classes. Additionally, instructors can send students new information between classes using this strategy. Student-to-student interaction may also be facilitated with e-mail. Students can share questions and insights, providing the means for an electronic study group.

The Internet also increases students' access to information. Instructors can provide course information on an Internet website that students can access electronically. In addition to the traditional method of paper hand-outs, information provided on the website can include such items as: the course syllabus, lecture outlines, supplementary materials, and quizzes. Although installing the material on the website may be more time intensive than using handouts, use of web-based materials can reduce paper use and difficulties replacing items lost by students. A course website can also provide buttons leading to additional learning aids, such as graphics, animations, and other relevant websites. Although this discussion of educational technology covered a variety of technological teaching tools, this study focused primarily on the use of presentation technology.

Disadvantages of Educational Technology

Despite the advantages of using technology as a teaching tool discussed above, there are also two main problems associated with the use of computers. First, the financial expense of providing classrooms designed for use of educational technology is very high (Kozma, 1991). In addition, there are also the costs for computer hardware, computer software, reliable maintenance, and adequate assistance. If instructors or students do not have convenient access to computers on campus, or encounter technical difficulties without proper support, they may avoid future use of computer technology.

A second dominant difficulty associated with implementing computer technology is computer anxiety in prospective users (Igbaria & Parasuraman, 1989; Meier & Lambert, 1991). As an intervention, computer experience has been associated with reducing computer anxiety. For example, Howard and Smith (1986) surveyed a random sample of 111 managers across 13 organizations. They found that as computer experience increased, computer anxiety decreased significantly. In addition, another study found that college students with more computer experience scored significantly higher on computer liking than students with less experience (Pope-Davis & Twing, 1991). Avoidance of computers, due to anxiety associated with them, reduces the likelihood of individuals gaining the experience which may improve computer attitudes. Special effort by universities may be needed to encourage students and faculty to use technology. As careers and organizations requiring employees to possess computer skills multiply, these skills are becoming a necessary part of preparing students for future employment (Pope-Davis & Twing, 1991). In addition, educational technology may prove to be beneficial in the learning environment. For these reasons, it may be worthwhile for educational institutions to work to improve computer attitudes and make the necessary financial commitment to implement technology.

RESEARCH PURPOSE

There are many factors which influence student outcomes. For example, course organization and planning, student motivation, time on task, problem-solving through discussion, and prompt performance feedback to students have all been shown to enhance scholastic achievement (Bailey, 1981; Benton, 1982; Brandt, 1971; Dunkin, 1986; McKeachie & Wilbert, 1986). To attempt to study everything that affects learning at once would be extremely difficult. The current study focused on the investigation of the effects of technology-enhanced presentations on the academic achievement and computer attitudes of adult students in large classes.

Technology Strategy

This study examined possible ways technology may be used by instructors in large classrooms to help students: (a) maintain attention, (b) facilitate sensory reception, (c) discern important points, (d) promote short-term storage, and (e) achieve semantic encoding. Information processing theory suggests four factors of visual aids which may promote learning in classroom presentations, as described above: (a) color background, (b) contrasting color title or bullets, (c) bulleted lists, and (d) build effects. For this study, *technology strategy* referred to a combination of information processing recommendations and technology use. *Technology Strategy 1* (TS-1) designated technology-enhanced presentations in which three or more of the four factors of visual aids were used. Since information processing theory suggests use of these factors aids learning, courses using TS-1 were expected to enhance learning. *Technology Strategy 2* (TS-2) referred to technology-enhanced presentations which used less than three of the above four factors, and were not expected to enhance learning.

However, in this study TS-2 courses had features that TS-1 courses lacked: (a) use of active buttons, (b) display of top menu bars and side scroll bars (features of many popular computer applications), and (c) presentations on a course website accessible by computer for students outside of class. Therefore, TS-2 was a more apparent use of computer technology-enhanced presentations, with the instructor modeling computer use for students. Also, students may have gained direct computer experience by using the course website outside of class. Because computer attitude has been found to improve with increased computer experience (Meier & Lambert, 1991; Pope-Davis & Twing, 1991) and attitudes may also be improved by observing a model (Bandura, 1971), students in technology-enhanced courses which used TS-2 were expected to show improvement in computer attitudes from pre-course to post-course measurements. Courses which used TS-1, a less apparent use of computer-enhanced presentations without a course website available for use outside of class, were not expected to improve computer attitudes.

Approach and Hypotheses

Data was collected from courses that used technology-enhanced presentations and matched control courses that used traditional presentations. The technology-enhanced courses were taught with either TS-1 or TS-2 technology strategies. Many competing hypotheses may exist to explain potential differences in the courses. Using the same instructor for both the courses using technology-enhanced presentations and courses using traditional presentations was an attempt to control as many confounding factors as possible. A true experimental design with random assignment of students to courses and careful control of instructors' teaching would be preferable, but was not possible for the current study.

Data on attitudes towards computers was collected during the first week and last week of the quarter. The instructors used the same set of exam questions in both the technology-enhanced and traditional course, and results of these were collected as well as final grades. Research has indicated that prior grade point average (GPA) is significantly correlated with future academic achievement (Pettijohn, 1995). Therefore, to avoid possible confounding from this variable, previous GPA served as a control variable for academic achievement.

As described above, information processing theory maintains that learning can be facilitated by the use of stimulus changes, color, microphones, organization of information, and images (Gagne & Driscoll, 1988). Presentation technology can facilitate the use of these strategies in large classes. Information processing theory led to the following hypothesis of technology's role in enhancing learning:

HYPOTHESIS 1: After controlling for previous GPA, courses using technology-enhanced presentations will show higher student academic achievement than courses not using technology-enhanced presentations.

Although presentation technology tools allow for presentation of information in ways that facilitate learning according to information processing theory, instructors can choose to use these tools in various ways. Information processing theory suggests four factors of visual aids which may promote learning in classroom presentations: (a) color background, (b) contrasting color title or bullets, (c) bulleted lists, and (d) build effects. From this technology-enhanced courses can be separated into two groups: Technology Strategy 1 (TS-1), which includes courses using technology-enhanced presentations with three or more of the four factors of visual aids, and Technology Strategy 2 (TS-2), which includes courses with technology-enhanced presentations with less than three of these factors. Since information processing theory suggests use of these factors aids learning, an additional hypothesis was tested:

HYPOTHESIS 2: After controlling for previous GPA, students in courses taught with technology-enhanced presentations using Technology Strategy 1 will show significantly higher academic achievement than their matched control courses taught with traditional presentations, whereas there will not be a significant difference in academic achievement between courses taught with technology-enhanced presentations using Technology Strategy 2 and their matched control courses taught with traditional presentations.

As societal reliance on technology increases, individuals need to adapt and strive to attain computer competence. As discussed previously, one of the difficulties associated with computer technology is computer anxiety in prospective users. Because computer experience has been associated with positive computer attitudes (Meier & Lambert, 1991; Pope-Davis & Twing, 1991), and attitudes can also be changed through observation (Bandura, 1971), an instructor's use of classroom technology may improve student computer attitudes through modeling.

Presentations using TS-2 in this study were often more observable as being computer-generated and were made available on a course website for students to review outside of class. Because TS-2 more obviously models technology use than TS-1, and students could gain direct computer experience outside of class using the course website, student computer attitudes may improve more between the beginning and end of the term in courses using TS-2 than in courses using TS-1.

As mentioned above, increasing computer experience is associated with more positive computer attitudes. Students who own a computer are more likely to have computer experience and pre-existing positive attitudes toward computers. To avoid possible confounding due to owning a computer, this variable will be statistically controlled for. Therefore, the following hypothesis will be tested:

HYPOTHESIS 3: After controlling for whether or not students own a computer, a greater increase in student computer attitudes from the beginning of the course to the end of the course will be seen in courses using technology-enhanced presentations taught with Technology Strategy 2 as compared to their matched controls, than in courses using technology-enhanced presentations taught with Technology Strategy 1 as compared to their matched controls.

In addition, factors exist that may make learning in large classrooms more difficult for students over age 40 than for those age 25 or under, such as slower information processing and deteriorating perception (Apps, 1991; Lorge, 1955; Witherspoon, 1991). Because presentation technology may reduce these problems, the final hypothesis is:

HYPOTHESIS 4: In courses using technology-enhanced presentations, students over 40 years of age will have higher academic achievement than students aged 25 years or under, after controlling for previous GPA. This higher academic achievement in students 40 years of age after controlling for previous GPA, as compared to students aged 25 years or under, will not be seen in courses using traditional presentations.

Confounding in Research on Technology

Prior research has exposed potential problems in studies of classroom technology involving the same faculty in experimental and control courses. These will be examined before describing the methods used for this study.

Evidence exists for confounding in studies comparing conventional classroom teaching methods with individualized computer-based instruction (CBI) designed by the same instructors (Clark, 1985). Competing with computers for their jobs, instructors may conceal or weaken the effectiveness of CBI, either purposely or unintentionally (Heinich, 1970). This threat to validity is not expected in the proposed study, because here technology is not replacing instructors, but is being used as an instructional tool by them within the conventional classroom environment. An opposite risk to validity can occur when instructors enhance the technology course, resulting in finding a false positive effect of technology. Such problems in research on instructional technology include discrepancies in curriculum content or variation in instructional methods between control and experimental conditions (Clark, 1985). Contributing to the stability of these factors, the courses investigated in this study were taught by instructors who have developed their curriculum and teaching methods over several years of teaching these topics. In addition, curriculum content was monitored by examining the syllabus for each course and teaching methods were monitored by inspecting teacher observation rating forms.

Method

Background

The current study tested the hypotheses as a secondary data analysis on a larger research project operating on a grant provided by the U.S. Department of Education Fund for Improvement in Post-Secondary Education (FIPSE). This study limited its sample to courses in which the control (using traditional presentations) and experimental (using technology-enhanced presentations) instructors were the same. Also, only a portion of the larger study's data was analyzed. The variables relevant to this project include: technology-enhanced presentations, student age, academic achievement, computer attitudes, prior GPA, and owning a computer.

Parent Study

The three-year FIPSE project was designed to 1) improve students' experiences in large classes; 2) establish an infrastructure to help implement technology, including faculty and curricular development; and 3) evaluate the effectiveness of educational technology on student learning and cost efficiency (Perrin & Rueter, 1996).

Faculty participate in the project for two years, using a cumulative process designed to link course objectives, technology, and assessment. During the summer before the first academic year began, faculty transformed their courses by integrating multimedia presentation technology and e-mail into them. Faculty determined course objectives, classified the objectives according to Bloom's cognitive levels (Bloom, Englehart, Furst, Hill, & Krath, 1956), chose educational technologies to support the cognitive level of their course objectives, and revised classroom assessment techniques to fit chosen objectives and technology. Experimental faculty also met with control faculty to develop common exam questions to be used in both experimental and control sections of each course as a measure of student understanding.

During the second year, multimedia created in the first year was transformed into technological tools to be used on an individual basis: pre-enrollment quizzes and tutorials. Pre-enrollment quizzes are anonymous, computer-assisted quizzes of prerequisite knowledge designed to aid students in enrollment decisions and course preparation. Tutorials are interactive media which students use for practice apart from class. In the third year, participating faculty will share their new knowledge and experience with other faculty.

Each academic year, the transformed courses using technology-enhanced presentations were matched with control courses using traditional presentations. For the larger FIPSE project, some of these matched courses are taught by the same faculty, others are taught by different faculty. Nineteen professors from a diverse group of academic departments have redesigned their courses to incorporate technology-enhanced presentations and classroom assessment. Control professors teach their courses using traditional presentation methods.

Total enrollment for the 14 pairs of courses throughout the first academic year was 3,502 students. All students completed a pre-course survey and post-course survey, presented in Appendices F and G, respectively. These surveys provided information about students' previous computer experience, attitudes toward computer technology, general classroom motivation, course-specific motivation, learning style, and course satisfaction. Instructors provided individual student scores on common exam questions used by matched experimental and control courses. Teacher observations were done to provide information about individual teaching styles. Instructor interviews were used to classify technology use as Technology Strategy 1 or Technology Strategy 2. Student records provide students' prior GPA and students' course grade points.

Development and testing for reliability and validity of the data collection instruments for the FIPSE study took place during the 1995-1996 academic year. Concise surveys were desired to reduce time students spent completing the instruments. Details on development of data collection instruments used in this study are covered under the materials section below.

Current Study

Variables. The independent variables under investigation in this study were: (a) type of presentations, (b) technology strategy used, and (c) student age. Experimental courses were those taught with *technology-enhanced presentations* which used either PowerPoint or web-based technology. Instructors for the experimental courses participated in the FIPSE summer workshop. Control courses were those taught with *traditional presentations*, using either chalkboards, overhead transparencies, or no digital visual aids.

Technology strategy was determined from instructor interviews, dividing technology-enhanced courses into two levels. Information processing theory suggests the following four factors of visual aids in classroom presentations may promote learning: (a) color background, (b) contrasting color title or bullets, (c) bulleted lists, and (d) build effects. *Technology Strategy 1* (TS-1) refers to technology-enhanced courses in which three or more of these four factors were used. *Technology Strategy 2* (TS-2) refers to technology-enhanced courses in which less than three of these four factors were used.

Student age was determined from the pre-course demographic survey. Then, students were categorized into two groups: those over 40 years of age and those 25 years of age or younger.

Dependent variables under investigation included academic achievement and computer attitudes. Two measures of *academic achievement* were studied: course grades and percent correct on common exam questions. *Computer attitudes* were measured twice, pre- and post-course. There were three survey measures of computer attitude: (a) computer liking, (b) computer usefulness, and (c) computer confidence. Higher scores indicated more positive computer attitudes.

Two covariates were controlled for in this study. Research has indicated that prior grade point average (GPA) is significantly correlated with future academic achievement (Pettijohn, 1995). Therefore *previous GPA* served as a control variable for academic achievement. Also, research indicates that computer attitudes improve with computer experience (Meier & Lambert, 1991; Pope-Davis & Twing, 1991). It would have been desirable to measure computer experience with an existing scale already tested for validity and reliability. This was not possible for this study since it was a secondary data analysis, and the instruments for the larger FIPSE study did not include such a measure. However the surveys included a question asking whether or not the students owned a computer. It is likely that students who owned a computer had pre-existing positive attitudes toward computers. Therefor, *computer ownership* served as a control variable for computer attitude.

Participants

Participants (N=925) were selected from the student population of Portland State University (PSU), an urban university in the Pacific Northwest. From the parent study, this study included only courses in which both the traditional and technology-enhanced sections were taught by the same faculty. This criteria resulted in retaining three courses: one science course and two social science courses. The science course was a junior-level biology course, one social science course was a sophomore-level sociology course, and the other was a junior-level psychology course. All three courses were taught by Doctoral-level, full-time faculty members. The experimental courses were taught using technology-enhanced presentations, and the control courses were taught using traditional presentations, without technology-enhancement. The instructors taught their traditional section Fall term 1996 and their technology-enhanced section Winter term 1997. Students were not notified prior to registration which courses used technology-enhanced presentations and which used traditional presentations. Students enrolled in courses using traditional presentations became the control group (N=462), while students enrolled in courses using technology-enhanced presentations became the experimental group (N=463). See Table 2 for demographic statistics by subsample.

Table 2. Summary of Demographic Information

Demographic Information	Technology Enhanced	Traditional	Total
N	463	462	925
Gender:			
Female	45%	45%	45%
Male	27%	32%	30%
No Response	28%	23%	25%
Learning Disability	3%	4%	4%
Mean Age	24.16	24.04	24.09
(SD)	(6.72)	(6.40)	(6.56)
Mean Prior GPA	2.88	2.91	2.90
(SD)	(.61)	(.54)	(.58)
Mean Undergraduate Hours	12.89	13.45	13.18
(SD)	(5.07)	(3.94)	(4.54)
Mean Care Obligation Hours	2.46	1.75	2.11
(SD)	(12.84)	(6.60)	(10.23)
Mean Hours Employed	11.77	12.26	12.02
(SD)	(14.10)	(13.64)	(13.86)
Reason Taking Course:			
Major/Minor	27%	29%	28%
General Requirement	29%	35%	32%
Elective	19%	20%	19%
Only Available	1%	4 %	3%
Other	4%	3%	4%
No Response	20%	9%	14%

Materials

Pre-course and post-course surveys. Self-report questionnaire packets were administered to students the 2nd week of the term (pre-course) and the last week of the term (post-course). Both packets included a request for the last six digits of students' social security numbers, to be removed after pre-course and post-course measures were matched. Pre-course packets included a consent form, demographic questions (see below), questions regarding computer access and experience, a computer attitude survey, a general motivation survey, a course-specific motivation survey, a question regarding the reason for taking the course, and a question indicating preference for courses with or without technology. Post-course packets included a consent form, a computer attitude survey, a course-specific motivation survey, a learning style survey (holist vs. serialist), a question indicating preference for courses with or without technology, and a course evaluation including questions regarding computer experience during the course. This study used the following information from the pre-course survey: age, computer ownership, and computer attitudes. From the post-course survey, this study used only the computer attitude scale.

Demographic information. Demographic information was limited to those variables which were anticipated to be most consequential and for which control may be necessary. These included student age and time constraints such as number of hours spent working, caring for children or elders, and number and level of credit hours. The questions regarding computer access and previous computer experience were also included on the demographic instrument. These were questions about computer ownership, number of hours spent using computers, and experience with various systems and applications.

Computer attitude survey. A list of 97 questions was compiled using six surveys relevant to computer attitudes. The selected surveys included the (a) *Computer Survey* (Stevens, 1982), (b) *Attitudes Toward Computers* (Reece and Gable, 1982), (c) *Computer Attitude Scale* (Gressard and Loyd, 1986), (d) *Computer Use Questionnaire* (Griswold, 1983), (e) *Computer Anxiety Index* (Maurer and Simonson, 1983), and (f) the *Blomberg, Erickson and Lowery Computer Attitude Task* (BELCAT; Dukes, Discenza and Cougar, 1989). The items examined computer anxiety, computer confidence, computer interest, and computer liking assessed in three areas: (a) affective ("I sometimes get nervous just thinking about computers"), (b) behavioral ("I avoid using computers whenever possible"), and (c) cognitive ("I think I could do advanced work on computers").

After duplicate and irrelevant items were eliminated, 56 items remained. Some of these items were revised slightly to fit the college student population under investigation. The survey was piloted using a Likert scale with anchors of (1) Strongly Disagree and (6) Strongly Agree. Half of the items were worded positively ("I like learning on a computer"), and half were worded negatively ("I hesitate to use a computer for fear of making mistakes I cannot correct"). Negative items were recoded for the analysis, and higher scores reflect a more positive attitude towards computers.

Two biology courses were surveyed for the pilot study. The total number of participants (N=194) was approximately equally divided between the two courses. Factor analysis and item analysis were used to eliminate items which did not contribute to the validity of the scale. A principle components analysis was done, and the eigenvalues and scree plot were examined. This resulted in a three-factor solution with a total of 18 items. The computer *usefulness* subscale contains six items (items 1, 2, 8, 10, 12, and 18). The computer *liking/ interest* subscale consists of four items (items 4 ,6, 14, and 16). The computer *confidence/comfortableness* subscale contains eight items (items 3 ,5, 7, 9, 11, 13, 15, and 17). Reliabilities were .8048, .7129, and .8753 for the usefulness, interest/liking, and confidence/comfortableness subscales, respectively. (Perrin & Rueter, 1996). See page I-B in Appendix F and page II-A in Appendix G for the pre-and post-course computer attitude surveys.

Teacher observation form. An observation form was developed to capture as much information as feasible on behaviors which could account for possible differences in teaching styles. A list of 72 items based on the work of Weimer, Parrett, and Kerns (1988) was compiled. It was desired that items were confined to a single page for ease of recording observations. Therefore, teaching behaviors to be observed were limited to a group of 32 items related to effective teaching, in the categories of organization, clarity, interaction, and enthusiasm (Benton, 1982; Rovecher & Blake, 1986). Some of these were deleted, revised slightly, or combined to condense items whenever possible, reducing the list to 20 items. Organization was rated by items such as, "Lecture follows an organized format (stays on topic and follows a logical sequence)." An item used to measure clarity was, "[Instructor] provides examples." Interaction was rated by items such as, "[Instructor] makes eye contact with students." An item used to measure enthusiasm was, "[Instructor] expresses interest and enthusiasm in course content."

Items in reference to classroom technology use were also included. These items were generated by the FIPSE research team. These included amount of instructor satisfaction with technology ("dissatisfaction, neither dissatisfaction nor satisfaction, or satisfaction with use of technology"), instructor's degree of proficiency in technology use ("not proficient, medium, proficient"), the availability of course materials and presentations on a course website, and specific frequency counts of various technological tools used in presenting prepared written text, live written text, still graphics, and moving graphics. The number of these visual aids using color were also tallied. The form was piloted by three members of the FIPSE research team in six classes. Adjustments were made to the observation form using qualitative feedback from the seven-person research team.

Teacher observation forms were used to distinguish courses using technology-enhanced presentations from courses using traditional presentations. In addition, they were used for comparisons of teaching style and technology use between courses taught with traditional presentations and those taught with technology-enhanced presentations. The factors investigated related to instructor organization, clarity, interaction, and enthusiasm. These factors were: (a) reviews, (b) gives organized lecture, (c) repeats, (d) gives examples, (e) speaks clearly, (f) varies vocal tone & volume, (g) uses a pace that facilitates note taking, (h) asks if any questions before proceeding, (i) solicits questions or comments, (j) responds to student questions, (k) makes eye contact, (l) uses humor, and (m) expresses enthusiasm. Observers rated instructors on each of these factors assigning scores from "1" to "3", with "1" being "not much," "2" being "somewhat," and "3" being "often." Multiple observations (ranging from seven to 12) of each instructor were completed by a range of four to seven different raters. A sample of the resulting observation form is presented in Appendix H.

Instructor interviews. Instructor interviews provided information about visual aids regarding use of color background, contrasting colored title or bullets, bulleted lists, and build effects. Assessing use of these four factors differentiated technology-enhanced presentations designated as TS-1, which used three or more of the factors recommended by information processing theorists (Gagne & Driscoll, 1988), from technology-enhanced presentations designated as TS-2, which used less than three of these factors. A sample of the instructor interview form is presented in Appendix I.

Student performance. In addition to information from student self-report questionnaires, teacher observations, and instructor interviews, data on participants' prior academic achievement and academic achievement in the course was collected from student records and instructors. This study examined two types of information obtained from student records: previous GPA, and course grade points. The study also examined scores on exam questions common to both the course section using technology-enhanced presentations and the section using traditional presentations. Instructors provided these scores for the common exam questions, which were developed prior to the beginning of the course.

Procedure

Pre-course and post-course surveys. One of the primary investigators brought a sufficient number (determined from course enrollment) of pre-course surveys to each course at the beginning of a regular class period during the second week of the term. Each of the primary investigators was aided by at least one research assistant. Research teams began distributing surveys to arriving students approximately 15 minutes before the class period started. At the official starting time for the class period, the primary investigator spoke to the class about the research project. This included giving a brief description of the study, explaining that the instructor had agreed to participate in the study, informing students that participation was voluntary and confidential, explaining that completing the pre-course questionnaire packet took about ten to 15 minutes, and notifying them that they would be asked to complete a similar survey at the end of the term. All students in attendance were asked to complete the questionnaire packet at that time. Instructors remained in the classroom while surveys were completed. After about 15 minutes, completed surveys were collected by the research team, and the team left the classroom. Students received no incentive for completing the pre-course questionnaire packet. See Table 3 for participation rates.

Table 3. Participation Rates for Courses Using Traditional and Technology-Enhanced Presentations

Course	Pre-Course Surveys	Week 1 Enrollment	Pre-Course Participation	Post-Course Surveys	Week 10 Enrollment	Post-Course Participation
TRADITIONAL PRESENTATIONS						
Sociology	97	133	72.93%	75	133	56.39%
Psychology	125	197	63.45%	144	198	72.73%
Biology	114	120	95.00%	76	106	71.70%
TECHNOLOGY-ENHANCED PRESENTATIONS						
Sociology	62	85	72.94%	48	103	46.60%
Psychology	147	211	69.67%	168	211	79.62%
Biology	104	116	89.66%	72	110	65.45%

The last week of class, students in attendance were asked to complete the post-course questionnaire packet during the beginning of a regular class period. Data collection followed the same protocol as described above, except two steps were taken in an attempt to raise participation. First, students were offered a piece of candy and an opportunity to enter a drawing for one of four $25.00 gift certificates to the PSU Bookstore for completing the post-course survey. Second, expecting highest attendance at the final exam session, research teams returned for those sessions attempting to recruit participants not in attendance at the collection time during the last week of classes. Returning to classes at the final exam time to collect more surveys did not raise participation substantially.

Teacher observations. To allow for teaching style comparisons between courses using traditional presentations and courses using technology-enhanced presentations, trained research assistants completed teacher observation forms for each class (see Appendix H). Each instructor was observed a minimum of three times. To enhance reliability, two trained observers conducted each observation resulting in at least six individual observations of each instructor. Pairs of observers (usually one graduate and one undergraduate student) arrived ten minutes before class started and observed the instructor and students through the entire class session.

Instructor interviews. All three instructors in this study were interviewed, either in person or via e-mail, to gain information regarding their strategy for technology use in the technology-enhanced course they taught. The information included: (a) presentation platform used, (b) reason, (c) font style and size, (d) use of color backgrounds, (e) use of colored font or images, (f) use of bullets, (g) use of build effects to present bulleted items, and (h) use of different colored title or bullets. Technology strategy was assessed using four factors of visual aids which information processing theory suggests may promote learning in classroom presentations: (a) color background, (b) contrasting color title or bullets, (c) bulleted lists, and (d) build effects. Technology Strategy 1 (TS-1) refers to technology-enhanced courses in which three or more of these four factors were used. Technology Strategy 2 (TS-2) refers to technology-enhanced courses in which less than three of these four factors were used.

Prior GPA and course grade. The University electronic student records system provided students' GPA before their participation in this study, as well as their course grade points earned in the applicable course.

Common exam questions. Prior to the beginning of the first term of the study, faculty formulated a set of common exam questions for measuring student understanding of the course material in both courses, the control course taught with traditional presentations and the experimental course taught with technology-enhanced presentations. Faculty provided student scores on these common exam questions as percent answered correctly.

Results

Sample

The age range of the overall sample was comparable to the general university student population (15 - 57 and 16 - 56+, respectively). However, the average age of the sample (24.0) was lower than that of the university population (28.5). The sample was also higher in women and lower in men than the general university student population. The sample was comprised of 63% women and 37% men, contrasted to the general university student population which was 53% women and 47% men. (Portland State University, 1996). See Table 4 for additional comparisons of demographic information for the sample and the population.

Table 4. Demographics of the Sample

	Sample	**Population**
Sex Ratio (Women/Men)	63/37	53/47
Age Range	15 - 57	16 - 56+
Mean Age	24.0	28.5
Mean Number of Credits Taken	13.18	10.08
Full-time (nine or more credits)	83%	51%
Freshmen	14%	15%
Sophomores	13%	15%
Juniors	38%	25%
Seniors	25%	31%
Non-graduate Post-baccalaureates	8%	6%

Teaching style

Table 5 presents the findings on teaching style for each course. Observers rated instructors on each of these factors assigning scores from "1" to "3", with "1" being "not much," "2" being "somewhat," and "3" being "often." The median across raters for each item included on the teacher rating forms were used to examine consistency of teaching style and strategies between courses using traditional presentations and courses using technology-enhanced presentations. This was done descriptively, rather than statistically, due to the small sample size. The median ratings for the 13 factors showed consistency (equivalent median ratings for traditional and technology-enhanced courses) in teaching style for all three courses for the following five factors: gives organized lecture, repeats, gives examples, uses a pace that facilitates note taking, and asks questions before proceeding. Furthermore, the biology instructor seemed to show similarity in two other areas: reviewing, and soliciting student questions or comments. The psychology instructor appeared to be consistent on four additional factors: varies vocal tone and volume, responds to student questions, makes eye contact, and expresses enthusiasm. The sociology professor was observed to display uniformity for seven additional factors: reviews, speaks clearly, varies vocal tone and volume, responds to student questions, makes eye contact, uses humor, and expresses enthusiasm.

There were also inconsistencies in teaching style between courses using technology-enhanced presentations and their matched control courses taught with traditional presentations. In the biology course, the instructor appeared to display less use of humor, but more of the following five factors in the technology-enhanced course: speaks clearly, varies vocal tone and volume, responds to student questions or comments, makes eye contact, and shows enthusiasm. Differences on four factors were seen in the psychology courses. This instructor used more humor, solicited more student questions and comments, and reviewed more often in the technology-enhanced course. However, the psychology instructor was observed as speaking less clearly in the course taught with technology-enhanced presentations. The sociology instructor showed inconsistency on only one factor: soliciting student questions and comments appeared to occur less often in the technology-enhanced course.

Regarding classroom environment and scheduling, the sociology instructor was the only faculty who taught the traditional and technology enhanced sections of the course in the same classroom, on the same days of the week, and at the same time of day. The biology instructor taught traditional and technology-enhanced course sections in different classrooms, but on the same days of the week and at the same time of day. The psychology instructor taught the traditional and technology-enhanced course sections in different classrooms, at a different time of day, and on different days of the week. This resulted in two, longer class sessions per week, rather than three, shorter class session per week.

In addition, the course syllabi for the two courses were compared to assess uniformity of course content between the courses taught with traditional presentations and the courses taught with technology-enhanced presentations. These syllabi indicated the course content for the courses using traditional and technology-enhanced presentations were essentially identical.

Table 5. Teaching Style Median Ratings by Course & Type of Presentation

Teaching Factor	**Course**					
	Biology		**Psychology**		**Sociology**	
	Traditional n= 7	Tech-Enhanced n= 10	Traditional n= 9	Tech-Enhanced n= 9	Traditional n= 7	Tech-Enhanced n= 12
1. Reviews	2.0	2.0	2.0	3.0	2.0	2.0
2. Gives organized lecture	3.0	3.0	3.0	3.0	3.0	3.0
3. Repeats	2.0	2.5	3.0	3.0	3.0	3.0
4. Gives examples	2.0	2.5	3.0	3.0	3.0	3.0
5. Speaks clearly	2.0	3.0	3.0	2.0	3.0	3.0
6. Varies vocal tone and volume	1.0	2.0	3.0	3.0	3.0	3.0
7. Uses a pace that facilitates note taking	3.0	3.0	3.0	3.0	3.0	3.0
8. Asks if questions before proceeding	1.0	1.0	1.0	1.0	1.0	1.0
9. Solicits student questions	2.0	1.5	2.0	3.0	2.0	1.0
10. Responds to student questions	1.0	3.0	3.0	3.0	2.0	2.0
11. Makes eye contact	2.0	3.0	3.0	3.0	3.0	3.0
12. Uses humor	3.0	2.0	2.0	3.0	3.0	3.0
13. Expresses enthusiasm	2.0	3.0	3.0	3.0	3.0	3.0

Academic Achievement

Of the 925 participants in the study, 561 had complete data for the MANCOVA used to analyze Hypothesis 1 and Hypothesis 2, with 47% (N = 263) in the courses using traditional presentations and 53% (N = 298) in courses using technology-enhanced presentations. The two dependent variables were course grade and common question score. The two independent variables were traditional/technology-enhanced presentations and Technology Strategy 1/ Technology Strategy 2. Technology Strategy 1 (TS-1) refers to technology-enhanced courses in which three or more of the four factors of visual aids which information processing theory suggests may promote learning were used. Technology Strategy 2 (TS-2) refers to technology-enhanced courses in which less than three of these four factors were used. The MANCOVA revealed a significant interaction effect of traditional/technology-enhanced presentations by technology strategy, after controlling for prior GPA (Wilks' Lambda = .98, $F(2,555) = 3.96$, $p < .05$). Table 6 displays the course grade point and common question score adjusted means and standard deviations.

Table 6

Adjusted Means and Standard Deviations of Course Grade Points and Common Question Scores by Type of Presentation and Technology Strategy

TYPE OF PRESENTATION	TECHNOLOGY STRATEGY 1		TECHNOLOGY STRATEGY 2	
	Grade Points	Question Score	Grade Points	Question Score
Traditional:	N= 210		N= 53	
Adjusted Mean	3.01	82.28	2.55	70.32
(SD)	(1.10)	(13.04)	(1.40)	(15.06)
Tech-Enhanced:	N= 248		N= 50	
Adjusted Mean	2.76	81.76	2.92	74.44
(SD)	(1.29)	(12.21)	(1.36)	(13.33)

Due to the interaction with technology strategy, the main effect of technology-enhanced vs. traditional presentation as stated in Hypothesis 1 must be interpreted in the context of the interaction. Results indicated that technology-enhanced courses showed higher course grade points than traditional courses in courses using TS-2, but lower course grade points than traditional courses in courses using TS-1. Correspondingly, technology-enhanced courses showed higher scores on common exam questions than traditional courses in courses using TS-2, but slightly lower scores on common exam questions than traditional courses in courses using TS-1. Figures 2 and 3 illustrate the interaction of type of presentation by technology strategy for course grade points and common exam scores, respectively.

Figure 2. Course Grade Points by Traditional/Technology-Enhanced Presentations and Technology Strategy

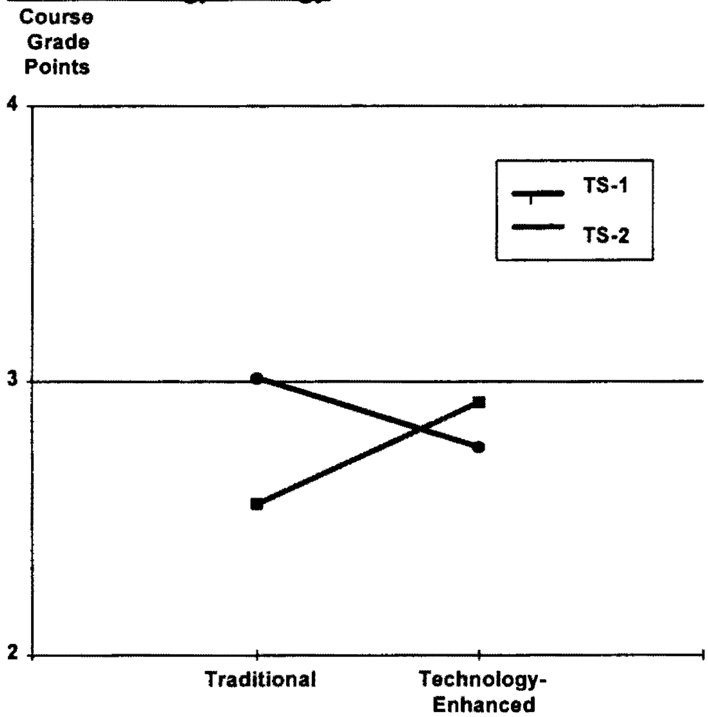
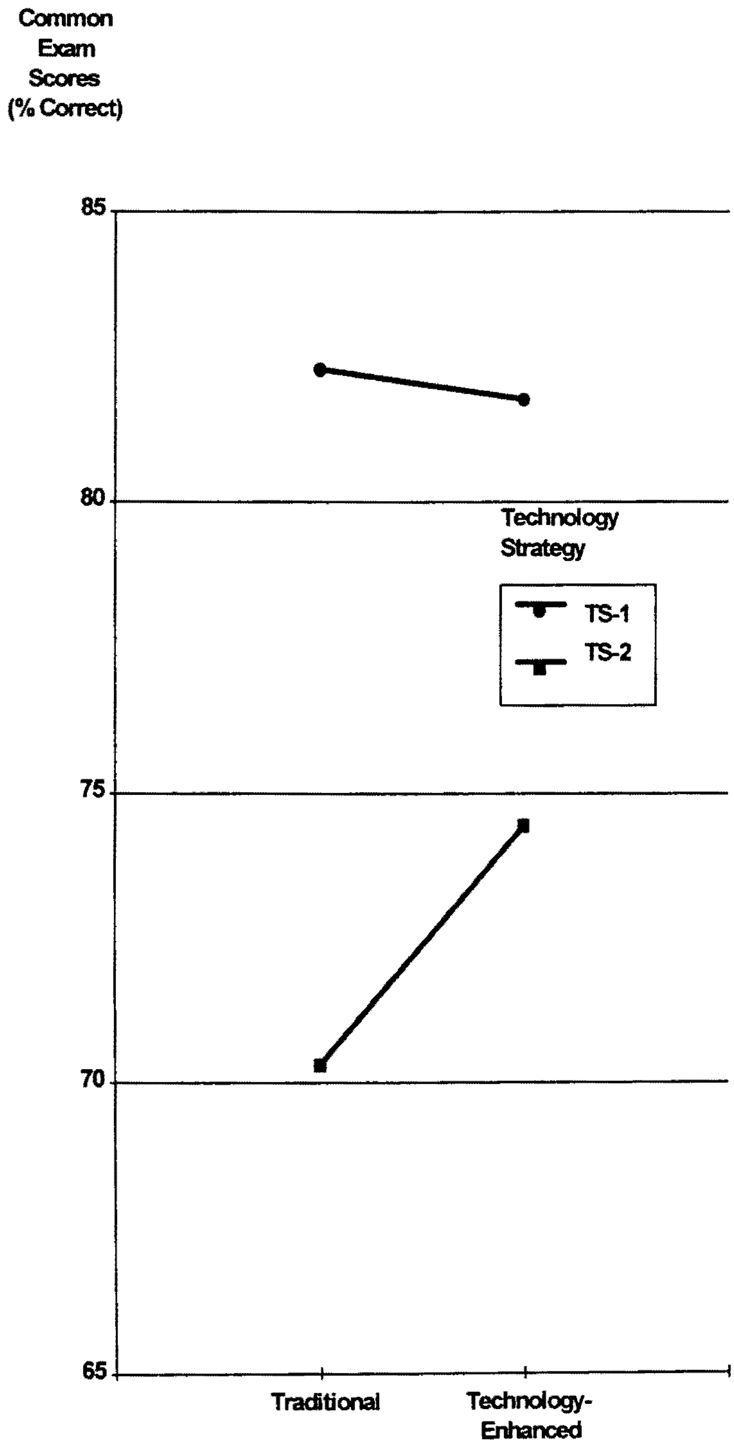


Figure 3. Common Exam Scores by Traditional/Technology-Enhanced Presentations and Technology Strategy



To interpret the interaction, two follow-up MANCOVA's were done. The first analysis included only participants in TS-1 and the second included only participants in TS-2. These analyses indicated that there was a significant effect of type of presentation (technology-enhanced or traditional) only for courses using TS-1 (Wilks' Lambda = .98, $F(2,454) = 5.14$, $p < .01$). Examination of the corresponding univariate tests revealed that the technology-enhanced courses scored significantly lower on course grade points ($F(1,455) = 8.48$, $p < .01$). No significant differences were found for the common exam question scores. The nonsignificant effect for TS-2 may be due to the small sample size (N = 103), as compared to TS-1 (N = 458).

Further investigation of the effect of type of presentation on academic achievement was conducted to examine data by course. Table 7 lists the course grade point means and standard deviations by course and type of presentation, and Table 8 displays the common exam score means and standard deviations. Means were analyzed with post-hoc t-tests. Results indicated that psychology was the only course for which there was a significant difference in course grade points by type of presentation (technology-enhanced or traditional), $t(358) = 3.26$, $p = .001$. As seen in Table 7, mean psychology course grade points were higher in the course taught using traditional presentations (3.10) than in the course taught using technology-enhanced presentations (2.69).

Table 7

Course Grade Point Means and Standard Deviations by Course and Type of Presentation

Subsamples:	**Traditional Presentations**			**Technology-Enhanced Presentations**		
Courses:	**N**	**M**	**SD**	**N**	**M**	**SD**
Sociology (TS-1)	108	2.41	.99	95	2.30	1.21
Psychology (TS-1)	163	3.10	1.08	197	2.69	1.31
Biology (TS-2)	95	2.14	1.40	100	2.32	1.36

Table 8

Common Exam Score Means and Standard Deviations by Course and Type of Presentation

Subsamples:	**Traditional Presentations**			**Technology-Enhanced Presentations**		
Courses:	**N**	**M**	**SD**	**N**	**M**	**SD**
Sociology (TS-1))	51	77.30	19.51	57	81.87	18.45
Psychology TS-1)	98	91.72	9.48	112	88.05	9.33
Biology (TS-2)	53	70.32	15.77	50	74.44	13.74

Computer Attitudes

Of the 971 total participants, 453 had complete data for the repeated-measures MANCOVA conducted on the pre- and post-course scores of computer attitude. The independent variables were: measurement time (pre- or post-course), technology strategy (TS-1 or TS-2), and type of presentation (technology-enhanced or traditional). The covariate was computer ownership, and the dependent variables were three measures of computer attitude: computer liking, computer confidence, and computer usefulness. Higher computer attitude scores reflected more positive attitudes. Results indicated that the interaction of type of presentation by technology strategy by measurement time was non-significant for computer liking, computer confidence, and computer usefulness. None of the three possible two-way interactions, technology strategy by measurement time, technology strategy by type of presentation, and type of presentation by measurement time, were significant. There were also no significant main effects on computer attitudes for measurement time, technology strategy, or type of presentation. Means and standard deviations for computer liking, computer confidence, and computer usefulness by technology strategy and type of presentation are displayed in Table 9.

Table 9

Pre & Post Computer Attitude Means and Standard Deviations

Subsamples:	**Traditional Sections**			**Technology-Enhanced Sections**		
	N	M	SD	N	M	SD
TECHNOLOGY STRATEGY 1:	169			162		
computer liking-PRE		2.99	1.10		3.09	1.10
computer liking-POST		3.09	1.08		3.12	1.09
computer confidence-PRE		4.28	1.10		4.40	1.06
computer confidence-POST		4.29	1.11		4.40	1.00
computer usefulness-PRE		4.89	.81		5.04	.79
computer usefulness-POST		4.94	.82		5.06	.73
TECHNOLOGY STRATEGY 2:	67			60		
computer liking-PRE		3.12	1.14		3.20	1.03
computer liking-POST		3.12	1.12		3.24	1.05
computer confidence-PRE		4.26	1.20		4.45	1.01
computer confidence-POST		4.35	1.20		4.51	1.05
computer usefulness-PRE		4.99	.84		4.99	. 89
computer usefulness-POST		5.02	.77		5.08	.85

Age

Data for this hypothesis could not be tested due to an insufficient number of participants in the over 40 age group. Of the 490 participants with data for age and course grade points, only 2.7 % (N = 18) of the participants were over age 40, while 51.1%
(N = 344) of the participants were 25 years of age or younger. These percentages were not expected and differ from that of the general university population, in which 12.7 % of the students were over age 40 and 48.2% of the students were 25 years of age or younger (Portland State University, 1996). The sample size in the over 40 age group does not provide sufficient statistical power to test the hypothesis.

Discussion

Overall, the results did not support the hypotheses for this study. Courses using technology-enhanced presentations showed higher academic achievement with Technology Strategy 2, rather than with Technology Strategy 1 as anticipated. This effect was significant only for the overall course grade points, not for the more specific measurement of percent correct on common exam questions, and was found only in one course. No improvement in computer attitudes was found for the technology-enhanced courses. Age effects could not be tested due to insufficient sample size in students over age 40.

Information Processing Revisited

There may be many reasons that the results of this study did not provide evidence to support the effectiveness of technology-enhanced presentations using Technology Strategy 1. For example, there was unanticipated variance in the number of images displayed in technology-enhanced presentations of different courses, which could affect many steps in the course of information processing. There were also differences in teaching style behaviors, possibly due to classroom factors, that may have affected student learning. Finally, there were issues of instructor and student variability, measurement, participation rates, and internal and external validity.

Attention.

According to Gagne, attention is a prerequisite to learning. Attention has been shown to be gained through the use of changes in stimuli, such as a variety of visual aids presenting text or images (Gagne & Driscoll, 1988). The hypotheses for this study were based on the assumption that all instructors using technology-enhanced presentations would use a fairly equivalent number of images which facilitate the attention process. A review of the teacher observation data, however, showed that this was not the case here. It was found that, on average, the instructor who used TS-2 displayed more images than the instructors who used TS-1 (average number of images calculated as median rating of images used during several classes, with each class being observed by two raters). The biology instructor's (TS-2) median number of still graphics was more than twice as many as the sociology instructor's (TS-1) median number of still graphics, and more than four times as many as the median still graphics used by the psychology instructor (TS-1). Regarding use of moving graphics in observed classes, the biology instructor displayed a median of six, the psychology instructor displayed a median of five, and the sociology instructor did not display moving graphics at all. This higher use of visual images by the biology instructor (TS-2) may have led to increased student attention, which is a prerequisite for the processing of information. This, in turn, may have led to the higher (although not significant) course grades and common question scores in the technology-enhanced condition for the biology course.

Sensory reception.

The second step in Gagne's information processing theory is selective perception (Gagne & Driscoll, 1988). Courses using Technology Strategy 1 (psychology and sociology) showed significantly lower academic achievement (as measured by mean course grade and common question score) in the technology-enhanced presentation condition than in the traditional presentation condition. Closer examination of the data revealed that the only significant difference was a lower course grade in the technology-enhanced presentation condition for the psychology course. From the median ratings of teaching style behaviors, this instructor was observed as speaking less clearly in the course using technology-enhanced presentations than in the course taught with traditional presentations. Students' inability to hear what the instructor was saying would have interfered with their reception of information. If students were unable to hear the information the instructor gave them, they could not proceed to process information further. Therefore, changes in teaching style factors of the psychology instructor, from the traditional presentation condition to the technology-enhanced presentation condition, may have reduced teaching effectiveness leading to lower student academic achievement. It should be noted that the two psychology courses (traditional presentation condition and technology-enhanced presentation condition) were taught in different classrooms, and this change in the instructor's speaking clarity may have been due to variations in microphone equipment or acoustics between the two classrooms.

Conversely, the biology students achieved slightly higher course grades in the course taught with technology-enhanced presentations, although this difference was not statistically significant. Median observation ratings demonstrated teaching style differences between the biology course using traditional presentations and between the biology course using technology enhanced presentations. In the course taught with technology-enhanced presentations, the biology instructor was observed to decrease the use of humor, but to increase the following five factors: (a) speaks clearly, (b) varies vocal tone and volume, c) responds to student questions or comments, (d) makes eye contact, and (e) shows enthusiasm. Sensory reception of students would be facilitated by the instructor speaking clearly and varying vocal tone and volume. Perhaps changes in teaching style factors increased teaching effectiveness leading to somewhat higher student academic achievement in the technology-enhanced biology course, as compared to the traditional biology course. As was the case in the psychology courses, the two biology courses (traditional presentation condition and technology-enhanced presentation condition)were taught in different classrooms, and the change in the instructor's speaking clarity and varying vocal tone and volume may be attributable to variations in acoustics or microphone equipment between the two classrooms.

Selective perception.

The second step in Gagne's information processing theory is selective perception (Gagne & Driscoll, 1988). Facilitation of selective perception can include using contrasting colored titles, bulleted lists, and chunking of information.

Chunking larger amounts of information into smaller chunks or pieces (Miller, 1956) has been shown to increase the ability to store information in short-term memory. Gagne recommends that instructors use this strategy by presenting information one item at a time, using *progressive disclosure*. Although technology-enhancement can make use of progressive disclosure more professional-looking, experienced instructors may have developed effective strategies for presenting information on visual aids one item at a time using traditional methods. Therefore, even though it was assumed that technology-enhanced presentations would include more effective visual aid strategies than traditional presentations, methods for visual aid use recommended by information processing were demonstrated without the aid of technology. For example, in this study, the psychology instructor used progressive disclosure of information in the course taught with traditional presentations. This was accomplished by covering each overhead transparency with a piece of paper, and slowly uncovering the printed information point by point. Therefore, the traditional and technology-enhanced conditions of the psychology course did not differ in a significant way on this presentation strategy.

Short-term memory.

The third step in processing information is storage of organized patterns in short-term memory. Limits to short-term memory make it difficult for learners to process large amounts of information at a time (Miller, 1956). Barker and Manji (1989) found auditory information to be less effective than images, mainly because of its transitory character. Presenting words or pictures visually generally allows learners longer access to the information. Barker and Manji also provided evidence that for certain types of learning, such as category matching, the time needed to understand pictures is less than the time needed to understand words. Therefore, the use of images may improve students' ability to hold information in short-term memory. In this study, the instructor who used TS-2 displayed more images than the instructors who used TS-1 (average number of images calculated as median rating of images used during several classes, with each class being observed by two raters). The biology instructor's (TS-2) median number of still graphics was more than twice as many as the sociology instructor's (TS-1) median number of still graphics, and more than four times as many as the median still graphics used by the psychology instructor (TS-1). Regarding use of moving graphics in observed classes, the biology instructor displayed a median of six, the psychology instructor displayed a median of five, and the sociology instructor did not display moving graphics at all. This higher use of visual images by the biology instructor (TS-2) may have led to increased student ability to hold information in short-term memory, which in turn could enhance learning.

Semantic encoding.

The fourth step in information processing is *semantic encoding,* which refers to a more thorough processing of information to make it more memorable. In this step, the information is linked to the learner's previous experiences in a way that makes sense to the learner. Information to be learned may be classified under previously learned categories, linked to related prior knowledge, or connected with an image that visually represents the information. There is much support for the use of images that represent information to be learned (Anderson & Kulhavy, 1971; Barker & Manji, 1989; Kulhavy & Swenson, 1975; Paivio, 1986). In a review of learning with media, Kozma (1991) cites many studies which demonstrate that combining visual aids with auditory information leads to greater recall than either visual or auditory stimuli alone. Similarly, in a comparison of narrative information presented with either television or radio, less distortion and loss of information was observed in the television group (Hayes, Kelly, & Mandel, 1986). Shepard (1966) noted that the recall of certain information is dependent on imagery. For example, it is difficult to recall the number of windows in one's house without creating a mental image of the house. In recognition tests, imagery was found to improve post-test performance (Anderson & Kulhavy, 1971; Kulhavy & Swenson, 1975). As noted above, a review of the teacher observation data showed that, on average, the instructor who used TS-2 displayed more images than the instructors who used TS-1. The biology instructor also created animations especially for presentation of the material on genetics. This higher use of visual images by the biology (TS-2) instructor may have led to increased semantic encoding, which is a prerequisite for the storage of information in long-term memory. This, in turn, may have led to the higher course grades and common question scores in the technology-enhanced condition for the biology course.

Instructor and Student Variability

Another factor that could influence the results of research on adult academic achievement is instructor and student variability. These may include such factors as differences between social science and biology students, and differences in attitudes toward technology between instructors.

Instructor effects.

All instructors in this study were experienced faculty, were committed to quality teaching, and had developed their courses over many years. It may be that student achievement had already reached such a high level with these instructors that there was a "ceiling effect," or no further improvement to be gained by adding technology-enhancement. A possible explanation of differences in course grades is the use of slightly different grading curves in the courses taught with technology-enhanced presentations and those taught with traditional presentations for each course. This would not affect scores on common exam questions.

Instructor attitudes may have influenced student achievement. Outside instructor interviews (Morris, 1997), revealed information regarding instructors' attitudes toward their course which used technology-enhanced presentations. For example, the biology instructor teaching the TS-2 course expected to enhance student learning with animations. In addition to presentation during class, these animations were also available for review on the course website outside of class. Conversely, the psychology instructor using TS-1 expressed negative attitudes toward technology-enhancement. During the third week of the term, this instructor commented that technology classrooms are "really well-designed for technology, and not designed very well for teaching (p. 17)." The psychology instructor also stated, in an interview toward the end of the term for the course using technology-enhanced presentations, that the technology "was no better for the students, and much harder for [the instructor]" (p. 20). The negative attitudes of the instructor may have affected student attitudes about the possible benefits of classes taught with technology-enhanced presentations. However, negative instructor attitudes regarding the course using technology-enhanced presentations may have also been influenced by other factors, such as longer lecture schedule, requirement of lowered lighting for viewing technology-enhanced presentations, and increased distance from podium to students.

Student effects.

For this study technology strategy and type of course were confounded. Technology Strategy 1 was used by instructors teaching social science courses (sociology and psychology), and Technology Strategy 2 was used by the instructor teaching a science course (biology). It may be that learners use different strategies in social science and science classes.

Fields of study often correspond with certain interests. For example, science students in the biology course may have had more previous assignments requiring computer use, have been more technology oriented, and valued technology-enhancement more than instructor-student interaction. In contrast, social science students in the sociology and psychology courses may have been more people-oriented and valued instructor-student interaction more than technology-enhanced visual aids.

Other possible student effect factors include motivation and class attendance. Learner motivation has been shown to be an important variable in academic achievement (Gagne & Driscoll, 1988; McCombs & Whisler, 1997). Attending class is one type of time-on-task behavior which impacts student performance (American Association of School Administrators, 1982).

Computer Experience

The inconclusive findings regarding increase in computer attitudes may have been due to an insufficient amount of exposure to computer technology in the TS-2 courses. Howard and Smith (1986) found that computer knowledge was not significantly related to computer attitudes, while hands-on computer experience showed a significant inverse relationship to computer anxiety. Data was not available on student use of the course website. It would have been helpful to have information regarding how many students accessed the website, the duration of use, and which webpages were visited.

Student Age

Possible age effects could not be investigated due to insufficient number of participants over age 40. It is unclear why the percentage of students over 40 was lower in this study than was seen in the general student population.

Limitations

Validity. The lack of support for technology-enhanced educational presentations in this study should be evaluated with an awareness of the study's limitations. Weaknesses in the design lead to problems with internal validity. TS-2 was used by only one instructor and in one course, biology. This inhibits generalizability and created a confound of Technology Strategy with course, and Technology Strategy with instructor. Also, students were not randomly assigned to courses. Although students were not notified whether courses would be taught with technology-enhanced presentations or more traditional presentations, it is possible that students who favored use of technology chose courses taught in classrooms which had the capacity for technology use. In addition, teaching style factors and technology strategies were evaluated for amount of consistency and noted, but not manipulated with careful control. Faculty had great concern for their teaching effectiveness and several years of experience to acquire successful teaching strategies, possibly leaving little room for improvement. Also, instructors may have developed their course materials for their technology-enhanced course during the previous term. This could have led to altering their teaching methods in the control term, diffusing the effects of technology development (such as enhanced organization) into their course taught with traditional presentations.

Because this was a field study, certain factors could not be matched for the courses taught with technology-enhanced presentations and those taught with traditional presentations. These included: (a) classroom, (b) term of the year, (c) days of the week, and (d) time of day. For the psychology and biology courses, traditional and technology-enhanced sections were taught in different classrooms. For all courses, the traditional section was taught in Fall 1996 term and the technology-enhanced section was taught in Winter 1997 term. The psychology sections were taught on different days of the week and time of day. The psychology instructor complained that teaching the technology-enhanced course on Tuesdays and Thursdays resulted in excessively long class time, as compared to the Monday, Wednesday, Friday schedule for the traditional course.

Participants included only Pacific Northwest urban university students from three courses, preventing generalization to other geographic locations, other courses and other colleges or universities. The definitions of technology-enhanced presentations and Technology Strategies 1 and 2 were operationalized by this study and may not generalize to other research.

Participation rate. Many subjects did not complete both the pre- and post-course surveys. Participants received no incentive for completion of pre-course questionnaires. Steps were taken to increase participation at the post-course measurement time. Students who completed the post-course questionnaires were offered candy and a chance to win four $25 gift certificates to the PSU bookstore. In future studies, effective incentives for increasing student participation for both pre- and post-course surveys should be explored.

In addition, the sample size for TS-2 was much smaller than that of TS-1. This reduced the statistical power of the analyses for TS-2 and may have contributed to the fact that the higher academic achievement for TS-2 in the technology-enhanced course was nonsignificant.

Measurement. The possibility of measurement errors was increased by the difficulty of finding a concise, easy-to-use teacher observation scale which had been tested for validity and reliability. Items from an existing questionnaire were condensed to produce an observation form which assessed teaching style descriptively, rather than statistically. In addition, there was no rating regarding the helpfulness to student understanding of teaching factors investigated, such as repeating or rephrasing, and giving verbal examples. Also, technology strategy factors could have been better measured and controlled by examining one factor at a time. For example, comparing classes with visual aids differing only by presence or absence of progressive disclosure, or color compared with black and white visual aids may have produced clearer results. This study had no assessment that measured if the visual aids used repeated information that was presented orally, providing a form of rehearsal for students.

A stronger design should include pre-course measures of course-specific knowledge, as well as the common exam questions, to better assess what students learned during the term of the course. Also, use of a previously validated measure for computer experience would have improved the covariate used for computer attitudes. In addition, accurate data on student computer experience during the term, such as time spent using the course website, would have made the investigation on improving computer attitudes more useful.

Future Directions

With the trend toward integrating educational technology on college and university campuses and the immense financial commitment required, further research is needed to determine if these investments are warranted, and if so, how educational technology can be used most effectively. There are many issues to consider. One criticism of research on educational technology is that apparent effectiveness on student outcomes may be due to the novelty of computerized instruction (Clark, 1985). As the novelty of educational technology wears off, there may be a reduction in its attention-getting ability. This could be investigated with longitudinal research.

However, for present clarification regarding educational technology use, it would be helpful to control variables much more than was possible in this project based on a secondary data analysis. A larger, more diverse group of participants randomly assigned to treatment groups is needed to test effects on various subjects. A wide range of courses must be investigated to provide results that can be generalized to many fields of study. Pre- and post-course measures of common exam questions could provide more reliable outcome assessments. In investigating academic achievement, student motivation and class attendance should be measured and statistically controlled. Specific computer attitude measures could be linked to the type of computer experience or modeling experienced in the technology-enhanced courses. For example, student attitudes regarding computer usefulness may not improve without required computer assignments for which technology provides an easier, or more convenient, method of completing the assignments.

Comparisons between technology-enhanced and control courses taught by both the same and different instructors could help reduce possible confounds in teaching effects. It would also be helpful to have concise measures of teaching style and technology strategy that have been tested for validity and reliability to use in studies of educational technology. Particularly for technology-enhanced presentations, factors which are anticipated to facilitate learning should be tested with controls for each factor to furnish clarification on effects of specific factors.

This study indicated that students in technology-enhanced courses whose instructors used more visual aid factors recommended by information processing theory for presenting textual information failed to demonstrate higher academic achievement than students whose instructors used fewer of the information processing recommendations. The present results were somewhat inconclusive, and this may be due to weaknesses of this particular study. Further investigation of the use of images, rather than text, on visual aids should be conducted to clarify criteria for effectiveness in teaching different courses and topics. A clearer understanding of the conditions under which information processing theory can be applied effectively may be discerned through future research on educational technology using information processing recommendations. Further investigation into the use of images on visual aids should be conducted to clarify criteria for effectiveness in teaching different courses.

The growing trend of educational technology use in college classrooms brings with it an extensive financial investment. Further research is required to determine if the financial commitment needed to support technology-enhanced presentations is justified. If it is, guidelines are needed for ways that these presentations can be used most effectively. Whether or not technology-enhanced presentations are effective, increasing use of computers in the workplace indicates a need for further research on ways to prepare students for using computer technology in their future occupations.

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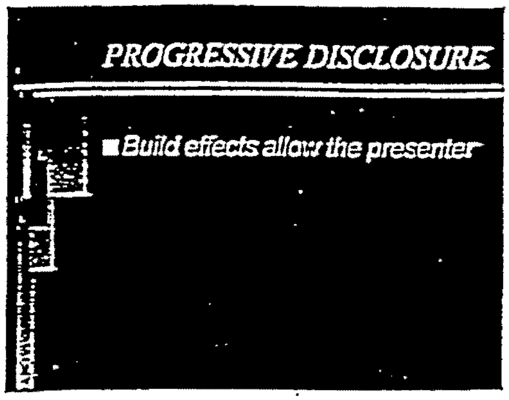
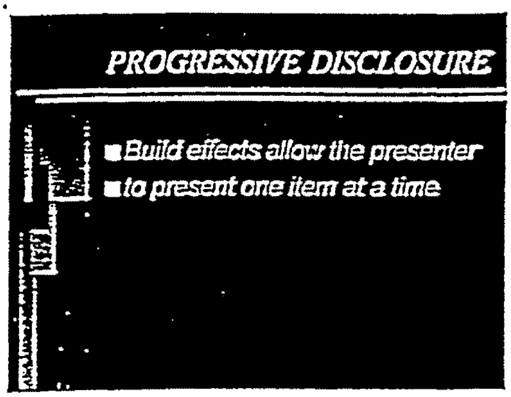
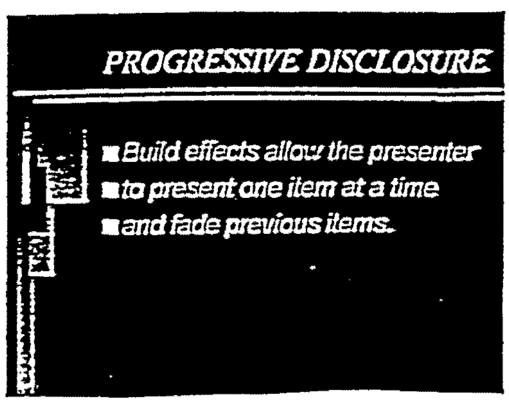
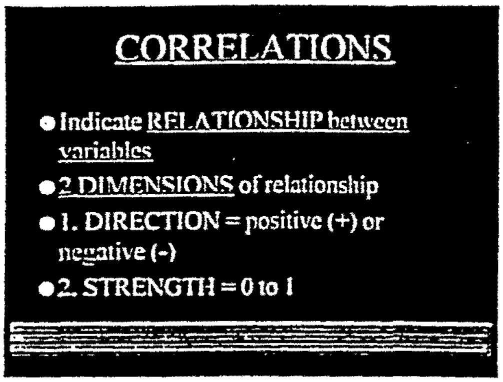
Appendix A
Build Effects/Progressive Disclosure

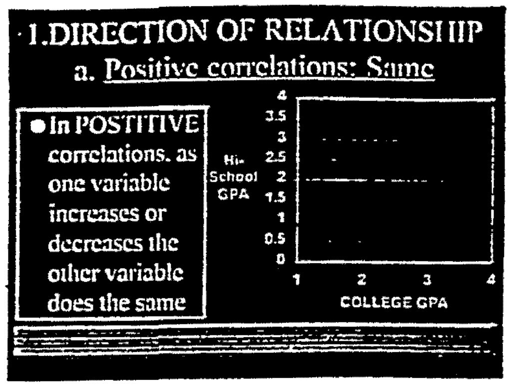


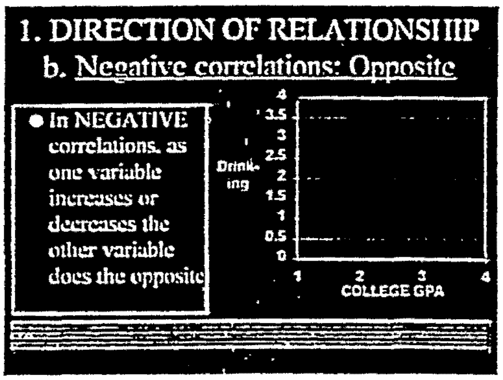


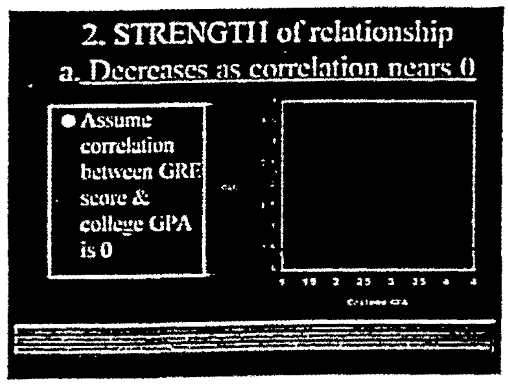


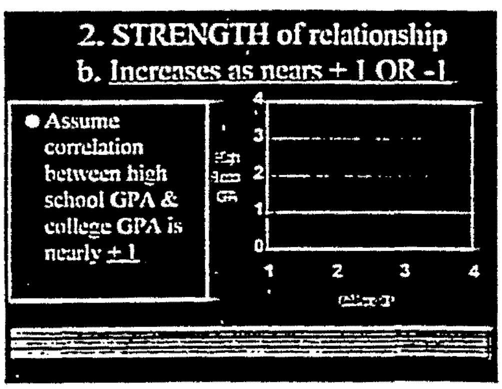
Appendix B
Brief PowerPoint Presentation

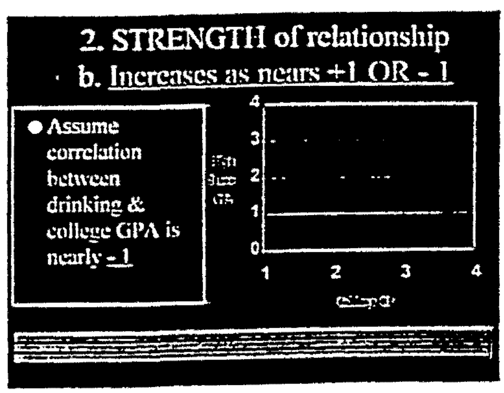












Appendix C
Brief Web-based Presentation

Chapter 8; Chromosome structural mutations

comments; 5 Feb

will give help on access to the web

on learning: recitation, web, text, workbook

thoroughness

During the next three lectures we will look at some of the major chromosome mutations, covering materials in chapters 8 and 9.

As a way of keeping tract and comparing them I ask you to fill in the chromosome mutation chart on page 32 of the workbook. The chart is compressed, so you may wish to make a larger copy. In lecture I will discuss the chart items. Hopefully, you will be able to fill in the chart on your own after listening and observing the lecture materials.

chromosome structure

- centromere location
  - CentromereLocation.GIF
- heterochromatin; euchromatin
  - Some generalities..... Heterochromatin.GIF
  - In centromeric region of corn ...Fig 8-5.

kinds of chromosomes examples

- mitotic chromosomes.... ExampleMitotic.gif
- pachytene chromosomes.... ExamplePachytene.gif
- polytene chromosomes.... ExamplePolytene.GIF; Fig 8-4

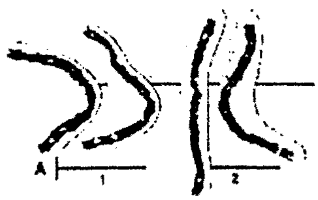
within chromosome mutations:

- deletion,
  - deletion1.GIF
  - deletion2.GIF
  - deletion loop Fig 8-7..
  - cat cry...Fig 8-9.play recorder
  - deletion mapping
    - DeletionMapping.GIF
    - location of X-linked genes Fig. 8-8.....

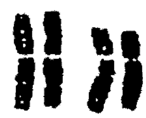
Appendix C
Brief Web-based Presentation
(continued)

GIF image 610x400 pixels http://www.im.pdx.edu/~newmanl/ExampleMitotic.gif

Examples of mitotic chromosomes



G-banded human (Rob)



Delphinium (Jill)

Appendix D
E-Mail

Session Name: odin.cc.pdx.edu 1

Date: Tue, 27 Jan 1998 18:29:01 -0800 (PST)
From: Pam Hilberg <philberg@teleport.com>
To: psu10458@odin.cc.pdx.edu
Subject: PSY 311U-CITATION FORMAT EXAMPLE

Hi Class!

Some of you haven't had exposure to APA citation format, so I'll provide an example below. This is the citation for the article I discussed in class about the effects of maternal stimulation on language comprehension & play competence level:

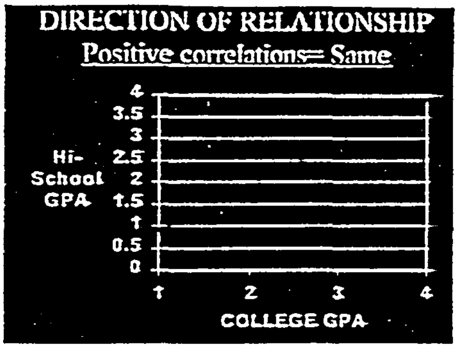
Tamis-LeMonda, C. S., & Bornstein, M. H. (1990). Language, play, and attention at one year. Infant Behavior and Development, 13, 85-98.

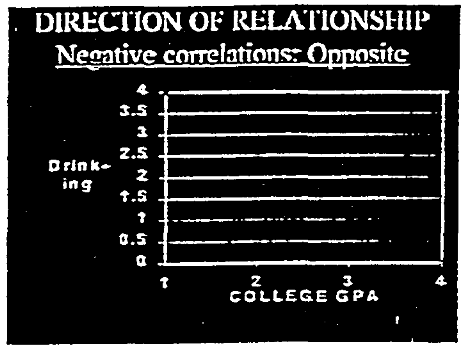
(Authors--last name first, then initials--with the last author having an ampersand (&) before their name (year of publication). Title of article only capitalizing the very 1st letter, unless there is a colon--if so: Capitalize the very 1st letter following the colon also. Title of the Journal Capitalizing Each Major Word, volume, 1st page number-last page number.)

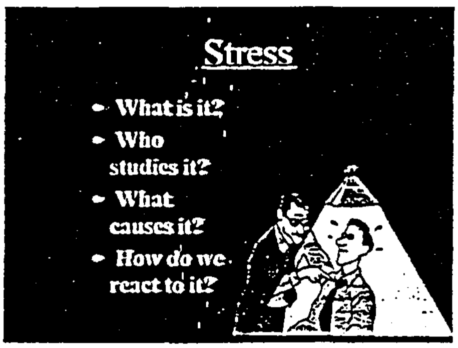
==
Ms. Pam Hilberg
Instructor- PSU Psychology Dept.

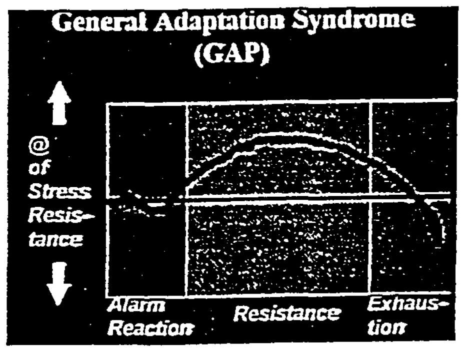
PSY311U-Human Development
Office CH317E: W 1-2 p.m.
E-mail:philberg@teleport.com
Message phone:(503)725-3903
==
*** Never doubt that a small group of thoughtful
*** committed citizens can change the world
*** Indeed, it's the only thing
*** that ever has. ---Margaret Mead

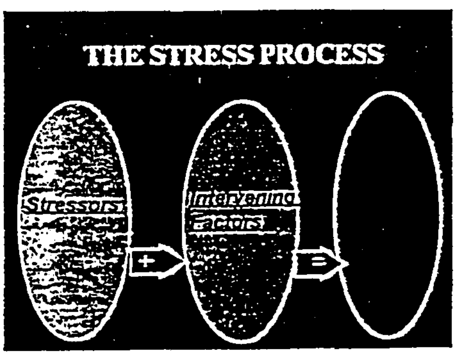
Appendix E
Graphics

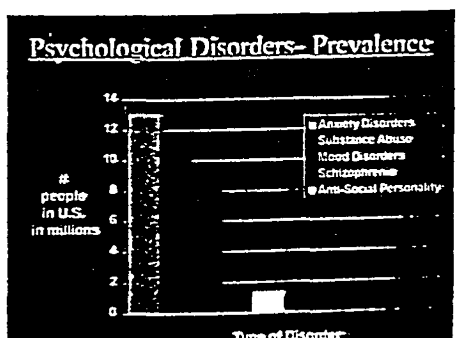












Appendix F
Pre-Course Survey Packet

Fund for the Improvement of Postsecondary Education (FIPSE)
Curriculum Revision with Educational Technology:
Improving Student Outcomes in Large Classrooms

Part I

LAST six digits of your social security number:

XXX - __ __ - __ __ __ __

Fund for the Improvement of Postsecondary Education (FIPSE)
Curriculum Revision with Educational Technology:
Improving Student Outcomes in Large Classes

CONSENT TO PARTICIPATE

Thank you for agreeing to participate in this study to assess learning outcomes in the large classroom. You will be asked to provide some general information about yourself, complete two short surveys, one at the beginning of the course, taking about 10-15 minutes to complete, and one at the end of the course, taking about 15-20 minutes to complete. At the end of the course you will also be asked to complete a course evaluation, taking 5-10 minutes to complete. Some of the items on your final exam will be used to assess your learning in this course

We ask you to put the LAST six digits of your social security number on the front of the packet so that we will be able match your pre- and post-course scores. Once we have matched these scores, your identifying number will be deleted and all analyses will be done without reference to you or any other individual. The information you provide will be kept confidential. Composite information, without reference to any individuals, will only be shared with your instructor after the final grades are in.

You will not receive any direct benefit from taking part in the study, but the study may help to increase knowledge that may help others in the future. Nancy Perrin (725-5058) or John Reuter (725-8342), co-investigators for the study, are available to answer any questions you may have about the study or what you are expected to do.

You do not have to participate in this study and if you chose not to do so, it will not affect your course grade or relationship with Portland State University.

By completing the surveys and tests you are implying that you have consented to participate in this study.

If you have any concerns or questions about this study, please contact Laurie Skokan at (503) 725-3901, Chair of the Human Subjects Research Committee, or the Office of Grants and Contracts, 105 Neuberger Hall, Portland State University, (503) 725-3417.

I-A

Gender	__F __M
Age	________years
What year are you in school? (Check one)	__ Freshman __ Sophmore __ Junior __ Senior __ Post Baccalaureate __ Masters Student __ Doctoral Student __ Post Graduate __ Not enrolled __Other:__________
How many credit hours are you taking this term?	__ undergraduate hours __ graduate hours
Do you have significant child or elder care obligations?	__yes __no If yes __ave workday hrs/wk
Are you currently employed?	__yes __no If yes __ave hrs/wk
If yes, do you use a computer in your work?	__yes __no If yes __ % of time
Do you own a computer?	__yes __no
If no, do you have have easy access to one?	__yes __no
What types of operating systems have you worked on? (Check any that apply) (Double check the one you use most often)	__ Macintosh __ DOS __ Windows __ Unix __ VMS __ Other:_________
How have you used a computer? (Check any that apply)	__Word processing __Database __Graphics/Presentation __Programming __Statistical packages __Spreadsheet __e-mail __Internet/WWW __Simulation __Games __Other:____________________
Do you have an e-mail address?	__yes __no
Can (could) you access e-mail from home?	__yes __no
Do you have access to Netscape from home?	__yes __no
Have you ever been diagnosed with a learning disability?	__yes __no
Did you complete Freshman Inquiry or Inquiry Transfer?	__yes __no

Please indicate the extent to which you agree or disagree with each of the statements below by marking the number that corresponds to your feelings, opinion, or experience.

1=STRONGLY DISAGREE
2=Moderately Disagree
3=Slightly Disagree
4=Slightly Agree
5=Moderately Agree
6=STRONGLY AGREE

		STRONGLY DISAGREE					STRONGLY AGREE
1	I am sure that I will use a computer in my future occupation.	1	2	3	4	5	6
2	All college students should have some understanding about computers.	1	2	3	4	5	6
3	I get a sinking feeling when I think about trying to use a computer.	1	2	3	4	5	6
4	I like computer problems that I can't understand right away.	1	2	3	4	5	6
5	It is easy for me to understand most technological advances.	1	2	3	4	5	6
6	I enjoy talking with others about computers.	1	2	3	4	5	6
7	I sometimes get nervous just thinking about computers	1	2	3	4	5	6
8	Having a computer always available to me would improve my productivity.	1	2	3	4	5	6
9	I have avoided computers because they are unfamiliar to me.	1	2	3	4	5	6
10	I could get good grades in classes that use computers.	1	2	3	4	5	6
11	I hesitate to use a computer for fear of making mistakes I cannot correct.	1	2	3	4	5	6
12	Computers are valuable educational tools.	1	2	3	4	5	6
13	Most things I can handle okay, but I have trouble working with computers.	1	2	3	4	5	6
14	If a computer problem was left unsolved after class, I would continue to work on it.	1	2	3	4	5	6
15	Using a computer is very easy for me.	1	2	3	4	5	6
16	Once I start working on a computer I find it very hard to stop.	1	2	3	4	5	6
17	Taking a test on a computer would scare me.	1	2	3	4	5	6
18	All college students should understand the role computers play in society.	1	2	3	4	5	6

I-C

Please indicate the extent to which you agree or disagree with each of the statements below by marking the number that corresponds to your feelings, opinion, or experience.

1=STRONGLY DISAGREE
2=Moderately Disagree
3=Slightly Disagree
4=Slightly Agree
5=Moderately Agree
6=STRONGLY AGREE

Note: These questions apply to your experiences IN GENERAL.

		STRONGLY DISAGREE					STRONGLY AGREE
.	I prefer classes that challenge me to those in which I can get an easy grade.	1	2	3	4	5	6
2	I like learning about a variety of subjects.	1	2	3	4	5	6
3	I often spend time exploring an idea from class that I don't need to know for my grade.	1	2	3	4	5	6
4	I can tell for myself if I learned the subject matter regardless of the grade I receive.	1	2	3	4	5	6
5	If I don't understand something in class, I try to figure it out on my own.	1 1	2 2	3 3	4 4	5 5	6 6
6	I like classes where I have to work hard to master the material.	1	2	3	4	5	6
7	I will probably do graduate work after I finish college.	1	2	3	4	5	6

Note: These questions should be answered in regard to to THIS CLASS specifically.

1	I feel that I will do well in this class.	1	2	3	4	5	6
2	Doing well in this class is important to me.	1	2	3	4	5	6
3	I think I will enjoy studying for this class.	1	2	3	4	5	6
4	I plan to work hard at my homework for this class.	1	2	3	4	5	6
5	I feel confident that I will get a good grade in this class.	1	2	3	4	5	6
6	I am not very interested in this class.	1	2	3	4	5	6
7	I have a high standard for my performance in this class.	1	2	3	4	5	6
8	I think I will enjoy this class.	1	2	3	4	5	6
9	I think I will enjoy doing outside readings and projects for this class.	1	2	3	4	5	6
10	Most of the things I am interested in are not related to this class.	1	2	3	4	5	6
11	It will be important to me to really understand the concepts covered in this class.	1	2	3	4	5	6
12	I plan to keep up with my daily classwork.	1	2	3	4	5	6

Please put a check next to the statement that describes your reason for taking this class.

_____ I am taking it as a general requirement for my degree.

_____ It is in my major or minor field of study.

_____ I am taking it as an elective or because of my interest.

_____ It was the only class available in this time slot.

_____ OTHER

Please indicate which class you would prefer. (Make two check marks)

_____ This class If you prefer to take THIS CLASS, would you prefer:

_____ This class with technology

OR

_____ This class without technology

OR

_____ Another class If you prefer to take ANOTHER CLASS, would you prefer:

_____ Another class with technology

OR

_____ Another class without technology

Appendix G
Post-Course Survey Packet

Fund for the Improvement of Postsecondary Education (FIPSE)
Curriculum Revision with Educational Technology:
Improving Student Outcomes in Large Classrooms

Part II

LAST six digits of your social security number:

XXX - _ _ - _ _ _ _

Fund for the Improvement of Postsecondary Education (FIPSE)
Curriculum Revision with Educational Technology:
Improving Student Outcomes in Large Classes

CONSENT TO PARTICIPATE

Thank you for agreeing to participate in this study to assess learning outcomes in the large classroom. You will be asked to provide some general information about yourself, complete two short surveys, one at the beginning of the course, taking about 10-15 minutes to complete, and one at the end of the course, taking about 15-20 minutes to complete. At the end of the course you will also be asked to complete a course evaluation, taking 5-10 minutes to complete. Some of the items on your final exam will be used to assess your learning in this course

We ask you to put the LAST six digits of your social security number on the front of the packet so that we will be able match your pre- and post-course scores. Once we have matched these scores, your identifying number will be deleted and all analyses will be done without reference to you or any other individual. The information you provide will be kept confidential. Composite information, without reference to any individuals, will only be shared with your instructor after the final grades are in.

You will not receive any direct benefit from taking part in the study, but the study may help to increase knowledge that may help others in the future. Nancy Perrin (725-5058) or John Reuter (725-8342), co-investigators for the study, are available to answer any questions you may have about the study or what you are expected to do.

You do not have to participate in this study and if you chose not to do so, it will not affect your course grade or relationship with Portland State University.

By completing the surveys and tests you are implying that you have consented to participate in this study.

If you have any concerns or questions about this study, please contact Laurie Skokan at (503) 725-3901, Chair of the Human Subjects Research Committee, or the Office of Grants and Contracts, 105 Neuberger Hall, Portland State University, (503) 725-3417.

Please indicate the extent to which you agree or disagree with each of the statements below by marking the number that corresponds to your feelings, opinion, or experience.
1=STRONGLY DISAGREE
2=Moderately Disagree
3=Slightly Disagree
4=Slightly Agree
5=Moderately Agree
6=STRONGLY AGREE

Note that these questions should be answered in regard to THIS CLASS specifically.

		STRONGLY DISAGREE					STRONGLY AGREE
1	I feel that I did well in this class.	1	2	3	4	5	6
2	Doing well in this class was important to me.	1	2	3	4	5	6
3	I enjoyed studying for this class.	1	2	3	4	5	6
4	I worked hard at my homework for this class.	1	2	3	4	5	6
5	I feel confident that I got a good grade in this class.	1	2	3	4	5	6
6	I was not very interested in this class.	1	2	3	4	5	6
7	I had a high standard for my performance in this class.	1	2	3	4	5	6
8	I enjoyed this class.	1	2	3	4	5	6
9	I enjoyed doing outside readings for this class.	1	2	3	4	5	6
10	Most of the things I am interested in are not related to this class.	1	2	3	4	5	6
11	It was important to me to really understand the concepts covered in this class.	1	2	3	4	5	6
12	I kept up with my daily classwork.	1	2	3	4	5	6

II-C

Please compare both statements before marking your answer

1=I agree with the statement on the LEFT.
2=I agree (with reservations) with the statement on the left
3=I have no preference for either statement
4=I agree (with reservations) with the statement on the right
5=I agree with the statement on the RIGHT

1	When reading for this course I tended to concentrate on certain parts and skip over others, going back later if necessary to fill in any gaps or missing links.	1 2 3 4 5	When reading for this course I tended to follow the author's presentation reasonably closely, rather than skipping around a lot.
2	Generally I preferred to concentrate on one (or very few) aspect(s) of this subject at a time when I was learning about it.	1 2 3 4 5	Generally I preferred to be learning about a number of different aspects of this subject at the same time.
3	I like to approach a new subject in a broad way, often looking at widely spaced aspects of the subject and seeing how they fit together before going back to fill in any steps I may have missed.	1 2 3 4 5	I like the logical links between different aspects of a new subject to be very close so that when I am learning about a second aspect I can see clearly how it relates to the first aspect.
4	I like to deal thoroughly with the particular aspect I am working on before going on to others.	1 2 3 4 5	I find it too restrictive to wait until I have thoroughly mastered one aspect of a new subject before going on to study other aspects.

Please indicate which class you would have preferred. (Make 2 check marks)

_____ This class — If you preferred to take THIS CLASS, would you have preferred:

_____ This class with technology

OR

_____ This class without technology

OR

_____ Another class — If you preferred to take ANOTHER CLASS, would you have preferred

_____ Another class with technology

OR

_____ Another class without technology

II-E

Please indicate the extent to which you agree or disagree with each of the statements below by marking the number that corresponds to your feelings, opinion, or experience.

1=STRONGLY DISAGREE
2=Moderately Disagree
3=Slightly Disagree
4=Slightly Agree
5=Moderately Agree
6=STRONGLY AGREE

		STRONGLY DISAGREE					STRONGLY AGREE
1	The instructor communicated interest/enthusiasm about the subject.	1	2	3	4	5	6
2	The instructor's presentations were clear and understandable.	1	2	3	4	5	6
3	The instructor encouraged discussion and questions.	1	2	3	4	5	6
4	The various aspects of the course (lectures, readings, etc.) were well integrated.	1	2	3	4	5	6
5	Appropriate attention was devoted to differing opinions and approaches to the subject matter.	1	2	3	4	5	6
6	The instructor's reponses to student's questions were clear.	1	2	3	4	5	6
7	The instructor challenged/encouraged my thinking.	1	2	3	4	5	6
8	The instructor was fully prepared when presenting material.	1	2	3	4	5	6
9	The instructor was knowledgeable and confident about the subject.	1	2	3	4	5	6
10	Course objectives and expectations were made clear.	1	2	3	4	5	6
11	The instructor was fair in grading.	1	2	3	4	5	6
12	The exams covered material emphasized in class.	1	2	3	4	5	6
13	I received useful feedback about my performance.	1	2	3	4	5	6
14	The instructor was genuinely interested in having students learn.	1	2	3	4	5	6
15	The instructor was available to spend extra time with students.	1	2	3	4	5	6
16	I increased my understanding of the subject.	1	2	3	4	5	6
17	The class was a worthwhile learning experience.	1	2	3	4	5	6
18	Feedback from the classroom assessment exercises was valuable to my learning.	1	2	3	4	5	6
19	Because of this class I am more confident that I can reach my academic goals.	1	2	3	4	5	6
20	The classroom assessment exercises clarified how well I understood the material.	1	2	3	4	5	6

Please indicate the extent to which you agree or disagree with each of the statements below by marking the number that corresponds to your feelings, opinion, or experience.

1=STRONGLY DISAGREE
2=Moderately Disagree
3=Slightly Disagree
4=Slightly Agree
5=Moderately Agree
6=STRONGLY AGREE

		STRONGLY DISAGREE					STRONGLY AGREE
21	Technology enhanced my ability to learn the material.	1	2	3	4	5	6
22	I found the use of multiple multi-media images to be overwhelming.	1	2	3	4	5	6
23	The use of e mail was valuable to my learning in this course.	1	2	3	4	5	6
24	I spent too much time trying to learn to use the technology.	1	2	3	4	5	6
25	I used technology that I learned in class outside the context of this class.	1	2	3	4	5	6
26	I was at a disadvantage in this class because I do not possess adequate computer skills.	1	2	3	4	5	6
27	Because of technology I was better able to visualize the ideas and concepts that were taught in the course.	1	2	3	4	5	6
28	The use of Internet was valuable to my learning in this class.	1	2	3	4	5	6
29	Technology created a barrier between the professor and the students.	1	2	3	4	5	6
30	E-mail made it easier for me to ask questions and receive responses from the professor.	1	2	3	4	5	6
31	E-mail helped me communicate with other students in the class about course material.	1	2	3	4	5	6
32	Because of the technology I spent more time studying for this course than I would have otherwise.	1	2	3	4	5	6

33 The aspect that I found most beneficial about the use of technology was:

34 The aspect that I found most frustrating about the use of technology was:

Appendix H

OBSERVATION FORM FOR TEACHER BEHAVIORS IN LARGE CLASSROOMS

Class Day/Date/Time ____________ Bldg./Room __________ Course __________
Instructor ____________________ Observer ____________________
Start time __________ Attendance ______________ End time ______________

	TALLY (& LIKERT AT END OF OBSERVATION)	Not much	Somewhat	Often
	Reviews prior material &/or previews material to be covered. (organization) Tally-	1	2	3
	Repeats or rephrases ideas without student prompting. (clarity) Tally-	1	2	3
	Provides examples &/or non-examples. (clarity) Tally-	1	2	3
	Asks if questions/comments before proceeding. (organization, clarity) Tally-	1	2	3
	Solicits student questions or comments. (interaction) Tally-	1	2	3
	Responds to student questions or comments. (interaction) Tally-	1	2	3
N A	Explains how to use course (or any) computer technology, at least briefly. (technology) Tally-	No		Yes
	LIKERT (AT END OF OBSERVATION)			
	Speaks audibly & clearly. (clarity)	1	2	3
	Varies vocal tone, volume, & pacing. (clarity)	1	2	3
	Presentation pace facilitates note taking and comprehension. (clarity)	1	2	3
	Lecture follows an organized format. (stays on topic & follows a logical sequence) (organization)	1	2	3
	Makes eye contact with students. (interaction)	1	2	3
	Uses humor in a positive and appropriate way. (interaction)	1	2	3
	Expresses interest and enthusiasm in course content. (interaction)	1	2	3

CONTINUUM (AT END OF OBSERVATION)

INTERACTION: belittles students - to- praises, encourages students (Circle one) *belittlement—praise*
Tally- *Tally-*

N A *TECH. SATISFACTION: expresses dissatisfaction, frustration- to- satisfaction or encourages use of* *dissatisfied—satisfied*
Tally- *Tally-*

N A *TECH. PROFICIENCY: confused, not proficient- to- shows proficiency in use of* *not proficient—proficient*
Tally- *Tally-*

AVAILABILITY: Time approachable (Circle) before class only -- after class only—both before & after class—other

If not available, both before & after class, why not?

Instructor uses a microphone. (Circle One) Yes No

Has students work with partners/ groups during class. (student-to student interaction) (Circle One) Yes No

Copies of presentation slides/notes are made available to students? (info availability) (ASK THEM) (Circle One) Yes No

If yes, how? (ASK THEM)

PREPARED written TEXT- Power Point presentation slides ______ number of slides *Circle Density* High Med Low
Progressive Disclosure ? Y N
____ Not applicable HTML ______ number of slides *Circle Density* High Med Low
Legible? Y N Wolf Vision (Elmo) ______ number of slides *Circle Density* High Med Low
Meaningful color ? Y N Traditional Overhead ______ number of slides *Circle Density* High Med Low

LIVE written TEXT- ____ Chalkboard (Circle Density) High Med Low
____ Not applicable ____ E-mail (Circle Density) High Med Low
Legible? Y N ____ Internet (Circle Density) High Med Low
Meaningful color? Y N ____ Typing Text During Class (Circle Density) High Med Low
____ Wolf Vision (Elmo) (Circle Density) High Med Low
____ Traditional Overhead (Circle Density) High Med Low

N Number & type of GRAPHIC IMAGES used: Legible?: Stills Y N Moving: Y N
A Still Graphics: ____ # color ____ # black & white (or color has no meaning)
Presented with: ____ Power Point ____ Overhead ____ Wolf Vision ____ Traditional Slides ____ Lazer Disk ____ HTML
N Moving graphics: ____ # clips ____ length in minutes ____ # color ____ # black & white (or color has no meaning)
A Type: Animations/Simulations Videos Laser Disk

Appendix I
Instructor Interview Form

1. Did you use Netscape or PowerPoint for your presentations?
    _____ Netscape
    _____ PowerPoint

    · Why? ____

2. Font used for majority of text:
    _____ Style (example Times Roman, Currier, etc.)
    _____ Size

(For the remaining questions, please provide ROUGH ESTIMATES.)

3. What percent of the time did you use color backgrounds in your presentations? _____
 - If 0%, what percent of the time did you use colored font or images on white backgrounds? _____

4. What percent of the time did you use "bullets" to set off items in your presentations? _____

5. What percent of the time did you used "build effect," to present bulleted items 1 at a time? _____

6. What percent of the time did you use colors different than most of the text font for titles or bullets? _____

7. Additional comments you'd like to make ______________________________

____

____

THANK YOU VERY, VERY MUCH FOR YOUR TIME! Please reply via e-mail or print & send via campus mail to : PSY, Pam Hilberg