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ABSTRACT

Learning at a distance has been on the fringe of educational acceptance since the first correspondence course was delivered through the mail system in return for academic credit. As distance learning has matured, elements of enhanced instructional design and advances in educational technology have migrated this medium of learning closer to the mainstream of academics. The use of today's educational technology tools has brought exciting possibilities for expansion of learning services and an equal amount of sharp criticism. Technological advancements have always been a part of delivering education, dating back as far as the development of the written textbook, the chalkboard, and the overhead projector. The utilization of computers and electronic means of communication is the latest, and possibly fastest growing educational tool to shape various attributes of how educational content is delivered to the learner. Efforts have been made in the scholarly journals to provide evidence that the use of computers to deliver learning is effective and efficient. Critics counter these efficiency claims by identifying inherent flaws in research designs and that the interaction between a traditional human educator can not be replaced by a digital interface. The evidence in the literature yields great strengths in both positions to the use of computers in distance education. The purpose of this paper is to present an introduction to the arguments for and against the use of recent advances in computer-assisted distance instruction, and to provide a thorough review of the current literature related to the effectiveness of learning at a distance through a technologically enhanced medium. (Contains 68 references.) (Author/AEF)

Effectiveness of Computer-Based Educational Technology in Distance Learning: A Review of the Literature

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"The weight of evidence that can be gathered from the literature points overwhelmingly to the conclusion that teaching and studying at a distance, especially that which uses interactive electronic telecommunications media, is effective, when effectiveness is measured by the achievement of learning, by the attitudes of students and teachers, and by cost effectiveness (Moore et al. 1990)."

Abstract

Learning at a distance has been on the fringe of educational acceptance since the first correspondence course was delivered through the mail system in return for academic credit. As distance learning has matured, elements of enhanced instructional design and advances in educational technology have migrated this medium of learning closer to the mainstream of academics. The use of today's educational technology tools, at the fore front are computers and the Internet, has brought exciting possibilities for expansion of learning services and an equal amount of sharp criticism. Technological advancements have always been a part of delivering education dating back as far as the development of the written textbook, the chalk board, and the overhead projector. The utilization of computers and electronic means of communication are the latest, and possibly fastest growing, educational tool to mold and shape various attributes of how educational content is delivered to the learner. Efforts have been made in the scholarly journals to provide evidence that the use of computers to deliver learning is effective and efficient. Critics counter these efficacy claims by identifying inherent flaws in research designs and that the interaction between a traditional human educator can not be replaced by a digital interface. Indeed, the evidence in the literature yields great strengths in both positions to the use of computers in distance education. The purpose of this scholarly paper is to present an introduction to the recent arguments for and against the use of recent advances in educational technology to deliver learning at a distance and to provide a thorough review of the current literature related to the effectiveness of learning at a distance through a technologically enhanced medium.

Introduction

Examining the nature of integrating technological enhancements into the delivery of education at a distance must first start with the fundamentals of distance education. Moore and Kearsley (1996) describe distance education as a planned learning event that occurs in a different place from the teaching. The nature of the separation between the instructor and learner requires special techniques in instructional design, communication efforts, and organized institutional and administrative efforts. Phipps & Merisotis, (1999) state that distance learning includes 1) synchronous communication which is the result of the instructor and the learner being present at the same time during instruction, even though the two may be physically in two different locations, and 2) asynchronous communication in which the learner and the instructor do not have direct interaction at the same time or place. They continue to characterize distance learning by the teaching and learning processes that occur when the learners are at a distance from the originator of the instructional material, and that a combination of media may be utilized including television, videotapes, audiotapes, video-conferencing, audio-conferencing, e-mail, telephone, fax, Internet, computerized software, and print based media. The operative element for the delivery of learning at a distance is the convenience of the learner rather than the institution. Providing educational environments that can be accessed at anytime of the day on any day of the week have lead to the development of asynchronous learning networks (ALN) that provide educational opportunities that are physically separated from educational institutions.

The distance education student has been labeled in the literature as a non-traditional student. Moore and Kearsley (1996) that the vast majority of distance learners are between the ages of 25 and 50 and are seeking the element of saving time by completing the education at a distance. Convenience of time is critical as the typical distance education student is a working

professional that has relatively little time to attend a traditional classroom setting or does not have a traditional classroom setting that is readily accessible to the nearby vicinity. Student reasons for enrolling in distance education courses include flexibility in course scheduling and freedom to not commute (Phipps & Merisotis, 1999). While the range of leaning topics is varied, the common element that Moore and Kearsley describe among the distance learner is that these students tend to be serious about their education, committed to complete the task, and very motivated. Powell et al. (1990) attempted to describe the characteristics of the successful distance learning student. Success was defined as a newly enrolled distance education student passing their first computer-assisted course. Self-reported characteristics of the successful distance learning student included: 1) high levels of persistence, 2) belief that the consequences of not passing as serious, 3) belief that they will succeed compared to others, 4) ability to work alone, 5) good time management skills, 6) goal oriented behavior, 7) belief that they are well prepared academically. Demographic data that related to the successful distance learning student included: 1) married status, 2) high literacy levels, and 3) being female. This description, while not exclusive of traditional students, does not comprehensively describe the average student that attends a traditional bricks and mortar academic unit.

Gubernick and Ebeling (1997) reports that the use of the Internet for delivering distance education may open new and profitable ventures for institutions of higher education as the ability to attract new, and previously untapped markets of non traditional learners become available with the openness and convenience of learning at a distance through asynchronous networks. They report that the fastest growing pool of students is the over age 25 nontraditional learner that has significant time restrictions regarding available windows of learning. As the cumulative costs of attending a bricks and mortar academic institution continue to escalate, learners will investigate

and utilize cost effective alternatives placing new competitive pressures on traditional education.

Delivering learning at a distance has taken an evolutionary approach with the development of new technologies. The advent of the correspondence course that was carried through traditional mail systems carrying communications between the learner and the instructor in terms of predetermined exercises, readings and writings. The model of distance education expanded to include the open university model that became popular in Europe in the early 1970s. Correspondence instruction was still a major mode of facilitating communication, but the nature of the comprehensive acquisition of a degree driven by the needs of the learner and not the requirements of the institution began to redefine distance education. As technology was introduced to deliver educational content, the open universities found use of pre recorded audio and video tapes in an asynchronous format followed closely by audio and video conferences allowing the learner and instructor to exist in the learning experience at the same time, but still separated by a distance. The next evolutionary step began in the early 1980s as the use of personal computers became popular. Computer-assisted instruction began to be utilized as a supplemental tool in delivering education, not only at a distance, but in parts of all educational sectors. Advances in the sophistication of computer software and graphics have had an impact on all aspects of education in the medical professions (Rajendran et al. 1990). Carmen and Kosberg (1982) describe computers as "teaching machines" that are designed to provide clearly defined expectations, to produced sequenced materials as per programming, encourage active response on the part of the user, produce immediate feedback, minimize social stress, and possess infinite patience. Gallini (1983) wrote that while computers provide a powerful dimension for learning, instruction, and assessment, there remain great possibilities for the development and stimulation of the creative thinking process in individuals. The last evolutionary push began in the 1990s

with the expansion of rapid and inexpensive mass communication abilities through the electronic mail (e-mail), the World Wide Web (WWW or Web), and the Internet. The ability to deliver fast and immediate communication effectively may have been solely responsible for the rapid increase in distance education providers over the past decade (Moore & Kearsley, 1996). LaRose et al. (1998) describe the use of the World Wide Web as the latest wave of computer based instructional technology in higher and distance education. Admittedly, the rush to compete in an ever changing higher education market, there exists questions regarding the impact and effectiveness of this new technology mediated learning experience. The Internet joins a long list of educational tools that have modified, altered, or enhanced the practice of teaching including but not limited to the textbook, the chalk board, motion pictures, radio, television, computer-assisted instruction, the mail system, interactive video, and multimedia.

So with the current state of distance education expanding service areas and testing new educational waters, many critics have judged the use of technology to deliver education without a face-to-face primary as inferior and ineffective. Many of these claims are unfounded, yet not disproved either. The inherent battle in academics was established placing the use of computer mediated asynchronous learning networks against the traditional classroom environment. The use of computers as instructional tools is debatable due, in part, to a lack of adequate controlled experimental investigations to accurately assess it's comparative effectiveness as an instructional modality (DeAmicis, 1997; Toth-Cohen, 1995). The response to change, while some believe as predictable in academics, is a fear of the unknown and fear of letting the reigns of education slip from the academic community. Many studies have been conducted to scientifically prove that the computer mediated means of delivering education at a distance is not only effective, but efficient. Likewise, there have been an equal number of studies designed to show that student

satisfaction is best suited with the traditional lecture based mode of inquiry. The use of technological enhancements and computerized interactions to deliver the content message of instructors to learners at a distance, rather than relying on the Socratic method of face-to-face lecture, discussion, and dialogue is what has made the current views of distance education as a novelty (Moore & Kearsley, 1996).

The potential benefits of computer assisted instruction to deliver learning have been theorized to be many and a significant amount of scientific investigations have been conducted attempting to prove the overall effectiveness of enhanced learning from computer interaction. Hazari & Schnorr (1999) believe that the interactive medium provided by the computers and the Internet allow for opportunities for immediate feedback and assessment in order to monitor students progress, the pace of learning, or to evaluate instructional design. Feedback from learners provides the instructor with a formative evaluation of teaching during the semester allowing for appropriate course corrections and modifications. The utilization of computers for delivering education at a distance is partly dependant on the type of feedback to the learner. Three factors appear to determine the effectiveness of feedback: 1) the degree to which the feedback provides useful information about the correctness of the response, 2) the immediacy of the feedback, and 3) the level of the involved material. Therefore, feedback is influenced by learner characteristics such as confidence and competence in the material to be learned (Waldrop, Justen, Adams, 1986). The use of computers to deliver Web-based instructional materials have infiltrated many aspects of higher education to provide supplementary as well as stand alone learning experiences. One of the most powerful elements of this instructional mode is the ability to engage learners in an interactive format (Hazari & Schnorr, 1999).

Billings (1986) cites advantages of using computers to deliver instruction that include the

ability to use several instructional strategies, vary instructional events, individualize instruction, provide accessibility, promote consistency, and facilitate privacy in learning. The author also reports that the time for learning can be reduced by 25-33%. Hmelo (1989-90) also concluded that the use of computers to deliver content in allied health profession education serves to consistently decrease the time spent on the educational intervention. Examples of technologically enhanced educational delivery styles using the Internet as the medium include 1) audiographic supplements of text, 2) videographic supplements of text, 3) the virtual class room which incorporates email, discussion boards, listservs, and chat rooms in place of live classroom interactions, and 4) multimedia enhanced text based self paced tutorials with an instructor as a facilitator (LaRose et al. 1998; Althaus, 1997; Yaverbaum & Nadarajan, 1996).

Other potential benefits include the ability to promote personalized instruction (Billings, 1986; Hebda, 1988; Kinney et al. 1997; Webster & Hackley, 1997; LaRose et al. 1998;), prompt feedback (Billings, 1986; Hebda, 1988; Kosmahl, 1994; Hayes et al., 1991; DeAmicis, 1997; Barker, 1988; Webster & Hackley, 1997; LaRose et al. 1998), self-paced learning (Kinney et al., 1997; Kosmahl, 1994; Hayes et al. 1991; DeAmicis, 1997; Barker, 1988; Gutierras, 1989; Stephens & Doherty, 1992), increased flexibility in faculty workload (Billings, 1986; Kosmahl, 1994; Schmidt et al., 1991), continuous access to instruction (Billings, 1986; Kinney et al., 1997; Kosmahl, 1994), realistic simulations, enhanced instructional capabilities, the empowerment of the learner (Webster & Hackley, 1997; LaRose et al. 1998), and the encouragement of problem solving skill development (Billings, 1986; Hebda, 1988; Kosmahl, 1994; DeAmicis, 1997; Freeman, 1987). Many distance educators currently utilize the Internet to distribute static documents which severely limits the potential applications and learning boundaries for students. Most educational web sites provide at the minimum static information like a syllabus, schedules,

contact information, and course announcements. Others utilize the interactive features to include synchronous or asynchronous communication, online testing, bulletin boards, chat rooms, streaming audio, and streaming video (Hazari & Schnorr, 1999). Tools that can be used to enhance the interaction between the learner and instructor, the learner and other learners, and between learners and the content include e-mail, listservs, bulletin boards, file transfer protocols (ftp), chat, and the World Wide Web (WWW) (Hazari & Schnorr, 1999; Moore & Kearsley, 1996).

Computer-assisted instruction is sometimes presented as a suitable and effective alternative for traditional lecture formats to promote learning. However, much of the literature surrounding the use of computer based distance learning in health care promotes the use of computers as an adjunct to traditional instruction and not as a replacement (Stephens & Doherty, 1992; Guy & Frisby, 1992; Modell, 1989; Boucher et al, 1999). There is striking evidence of the fact that there exists a relative paucity of true, original research dedicated to explaining or predicting phenomena related to distance learning (Phipps & Merisotis, 1999).

Phipps and Merisotis (1999) are skeptical to the results presented regarding the effectiveness of learning at a distance. They believe that a closer look at the reliability and validity of the investigations reveal that most effectiveness studies should not be taken at face value. Russell (1999) has published an annotated bibliography summarizing the effectiveness of educational technology in a distance education environment. In this compendium is presented over 350 articles, publications, and dissertations all claiming that there exists no significant difference on the learning effects when comparing technological modes of delivery. The author believes that it appears from the mass of literature that the use of technology does not impact the learning process for the better or for the worse. The position advanced by Russell (1999) and

Clark (1983; 1985; 1991; 1999) is that the no significant difference phenomenon is not a failure of academic investigators to prove cause and effect, but rather indeed is significant in itself that when learning results are equivalent, equal benefit may be gained from all parties involved. The nature of distance education relies on the independence of the learner. The distance education student must embrace the freedom and opportunity to learn on an independent schedule determining when and how to seek out information; however, some students may not be pedagogically equipt to assume this great responsibility (Moore & Kearsley, 1996). Phipps and Merisotis (1999) believe that unlike more traditional modes of distance education (two-way interactive video), the use of computer-assisted learning requires special skills and more sophisticated technical support if students are going to fully and effectively interact with the originating source of the educational content. The following sections will expand on the discussion of the no significant difference phenomenon presented in the literature followed by a discussion on the mode of instructional delivery impacting the educational message, and a review of the literature related to the use of computers in distance education.

What is the Difference?

In the era of rapidly changing technology, it is critical to assess and evaluate the effectiveness of educational technology and distance learning (Carew et al. 1997). When describing the effectiveness of computer-mediated learning at a distance, the definition of effective must be carefully identified. Kirkpatrick (1998) describes four different levels of assessment or effectiveness. Level I effectiveness is describe as the participants reaction to the learning interaction and is often measured using satisfaction surveys or "smile" sheets. Level II

effectiveness is the measurement of the cognitive gains from the training program and is often measured using a post-test of knowledge. For comparative purposes, the pre-test and post-test design shows changes that occurred as a result of the educational intervention. Level III assessment is designed to address whether or not the cognitive learning has carried over into practical application. In an educational environment, this is difficult to measure, but some professional programs gain this data by having students perform learned skills in a clinical environment under the direct supervision of a professional. Level IV effectiveness is of particular concern to the administrators of educational programs as it describes the cost effectiveness of the educational intervention. This level, by far, is the most under investigated level as the wide ranging definitions of direct and indirect costs to all of the stakeholders in higher education is difficult, if not impossible to measure. For the ease of data collection, most investigations related to the effectiveness of computer-mediated instruction in a distance education program is directed at level I (student satisfaction) and level II (cognitive achievement).

Several authors have taken the position that the use of computers to deliver educational content is received positively by the learners (level I). Rajendran et al. (1990) suggests that students positively perceive the use of computers as a learning tool and that the use of computers may actually assist to produce more effective learning. Students perceived that the adjunct use of computer programs was helpful and useful in promoting learning in human anatomy courses; however, no significant differences were observed between final examination scores of the students who utilized the computer assisted instruction and those who did not (Walsh & Bohn, 1990). Berube et al. (1999) suggested that the increase utilization of computer assisted instruction may indicate that there exists a greater acceptance of this mode of instruction as an

adjunct to learning. Carew et al (1984) reported that the majority of students utilizing computer assisted instruction found it to be useful while only a small percentage (2.5%) believed it to be of no significant benefit. The vast majority of the students believed that the interaction with the computer enhanced their grade for the course. Statistical evidence produced a significant difference (.001) in the final average grade of the course with students utilizing the CAI achieving higher scores than the counterparts who chose not to use the supplemental instructional aid.

The use of computer-assisted instruction works to increase the motivation of the student (Lepper & Gurtner, 1989). Immediate and appropriate feedback has been cited as a factor that enhances student motivation to succeed in an asynchronous environment. Gagne and Briggs (1992) pioneered the efforts to include timely feedback, evaluation, and assessment into components of instructional design to produce effective learning. Interaction and feedback are major components influencing a learners motivation to complete a web-based course and lessen the psychological distance that is present in asynchronous learning networks (Moore & Kearsley, 1996; Cornell & Martin, 1997; Comeaux, 1995). Web interactivity helps to engage learners in the active application of content, principles and values, and provides them with feedback that promotes understanding, growth, and maturity (Hazari & Schnorr, 1999). Larson (1994) reported that a majority of graduate level nursing students were very positive regarding their distance learning experience with two-way interactive video and would request similar opportunities in the future when made available. The same students did, however, note great dissatisfaction with the accessibility of the library from a distance. Multimedia distance learning courses appeared to be more favorable and appealing to potential learners leading to increased enrollment, while more conventional compressed video courses seem to be alienating potential

students (Pipes and Wison, 1996).

Some scholars have reported that the use of computers did produce benefits in enhancing achievement over other modes of instructional delivery (level II). Belfrey and Winne (1988) reported that nursing students that used computers assisted instruction learned more in a less amount of time than the students that received traditional instruction. At the secondary level, Gammon et al. (1999) described the use of asynchronous learning mediums including the Internet and the World Wide Web to enhance the educational effectiveness of science instruction. Self paced instructional modules utilized via the computer were effective in promoting the acquisition of the necessary competencies in nutritional assessment for college level nutrition students (Pearson, 1992). Cloninger et al. (1988) demonstrated that post-test scores were significantly greater for students that utilized computer simulation programs for inventory management in a college level nutrition program when compared to students who did not utilize the program.

Technologically enhanced instruction and positive student satisfaction does not necessarily implicate the technology itself, but rather a multi-factor analysis including learning tasks, learner characteristics, student motivation, the style of the instructor, and the art of teaching or instructional design (Phipps & Merisotis, 1999). Regarding the nature of how student attitudes are affected by the use of computerized instruction, there exists little evidence to guarantee learners could or would learn more from the interaction (Bennett, 1991). Bennett (1991) concludes that it is plausible to use computers as an adjunct to learning that may enhance achievement, but the substitute of computers as the primary mode of instruction should be questioned. It is apparent that student attitudes improve toward the use of computers and instruction through the interaction with the computerized instruction, but not necessarily to the

subject matter being studied. Students learn more quickly when using supplemental computer instruction and may be of greatest benefit to the disadvantaged student with lower abilities. Bennett argues that there exists great promise for the use of computers as a supplement, but there remains a significant need to identify specific interactions that will enhance learning.

Martin and Rainey (1993) found no significant difference between the attitudes between students who took a regular high school classroom course in anatomy and physiology when compared to a like group of students who took the same course through interactive satellite. A significant difference was demonstrated, however, when the satellite group achieved higher scores on an achievement test. Cheng et al (1991) found a significant difference in the overall perception of instruction between three groups of learners: computer-assisted, face-to-face, and correspondence. The perceptions of the computer-assisted learners was less positive than that of the conventional classroom students. The absences of personal interaction was cited by Billings (1986) as a major disadvantage of using computers to deliver instruction. Moore et al (1996) support that the immediate presence of an instructor is related to level I student satisfaction scores and include the likelihood of taking future courses, perceived value, quality of instruction, and interest in the subject.

Asynchronous distance learning as a whole appears to be at a great disadvantage in providing immediacy behaviors from the instructor. Non-verbal which appears to be more critical in satisfying students is almost impossible to convey through a computer mediated environment even with the most advanced virtual technology. The use of audio supplements to a mostly text based web course while it may provide verbal immediacy, still lacks the vital non-verbal cues. Tape delayed products can become stale in the sense that a new generation of learners are personally incorporated into the learning environment and can not be addressed by

name, nor receive a smile, or ask and receive a direct question (LaRose, 1998)

Many authors have found that the use of computers to deliver educational content provides no clear advantage over other modes of instructional delivery in judging academic achievement (level II). No significant difference was found in the performance of students who used computer based videodiscs and those students who utilized cadaver demonstration (Guy & Frisby, 1992). Thompson (1987) found no significant difference in using CAI and written programmed text for the performance and retention of learning in physical therapist assistant students. Schmidt et al. (1991) found no significant difference between the use of computers to deliver learning and traditional lecture for teaching content in a nursing program. Barker (1988) found no significant difference between written exam scores and motor performance scores in professional physical therapy students who used CAI to learn sliding board transfers. Kinney et al. (1997) reported an investigation conducted at the Medical College of Georgia utilizing physical therapy students that "there was no significant differences in post-test scores between the [computer assisted instruction group] and lecture groups" when learning the content related to carpal tunnel syndrome. Justen, Adams, and Waldrop (1988) found no significant difference in the achievement outcomes of students working individually or in small groups with computer-assisted instruction.

Message or Messenger?

The need for immediate and effective communication in a distance learning environment has driven the inclusion and experimentation of new and different delivery mechanisms and modes. The debate on the use of technology seems to have taken a turn away from the need for delivering effective distance education, but rather does technology enhance learning itself.

Justen et al. (1990) reports that the usefulness of computers in education is no longer seriously questioned, however, the appropriate delivery of the instructional content remains open to debate. Clark (1983) explicitly believes that the mode of delivery does not, in and of itself, alter the learning aspects of the delivered content. The presence of meta-analysis of media comparison studies clearly identify that media do not influence learning under any circumstance. The author believes that the use of media in education are simply "...vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition." The analogy expands to the nature that the choice of delivery mode may impact the cost of delivery or the available network, however, there is no impact on how the content produces learning.

Clark (1991) believes that the message of learning is being mistaken for the mode of delivery. He believes that it is both possible and plausible to produce a wide variety of multimedia presentations that deliver the same content, none of which will significantly alter the ability to learn the material in a better or enhanced manner. The analogy is presented as to when the pharmacist alters the mode of delivery for a prescribed medication. The methodology of delivery must be kept separate from the mode of delivering the content. Clark defines instructional method as "any way to shape information that compensates for or supplants the cognitive processes necessary for achievement of motivation." Clark believes that the evidence is overwhelming that media does not influence achievement, but rather is a proxy in research investigations. Indeed, the very nature of the media makes them interchangeable attributes for the delivery of content. Clark (1985) identified that when instructional methodology is held constant between treatment (computer based) and control groups (live lecture), no significant learning differences exists between the two groups. This argument lends heavily to the nature of

the methodology (drill & practice, case based, narrative) as the impact effect for learning as opposed to the mode of delivery (computers, print, lecture).

Clark (1991) and Salomon (1984) believe that the mode of delivering educational content is not solely responsible for motivating students to learn. The student's beliefs about their chances to learn and succeed from any given media are different for different students and for the same students at different times. Motivation for success is likely to be a interaction between educational technology and the perceptions of the student. Clark (1983) issues a warning that based on five decades of research, there is no clear evidence that media impacts learning or attitude, and does not believe that future scholarly investigation is warranted to pursue this issue further. In general, confounding evidence is typically responsible for gains that are observed, and the gains are often the result of novelty effects and long term gains are not maintained. One confounding event of research describing the differences between computer generated courses and lecture based course equivalents is the abscess of same instructor control. While similar or like content is often compared, the fact that different instructors are delivering the material via different technological modes is a confounding factor that limits these investigations (Clark, 1991).

Kozma (1994) seeks to redefine the argument made by Clark (1983) in such that there is no relationship between the use of media and the impact upon learning. Kozma believes that if there is no relationship between the message and the messenger, it is because instructional designers have not yet made one. With the growth and expansion of technology to deliver everything from entertainment to product consumption, the educational community must work to identify the relationship or the future shape of delivering distance education will not benefit from the expertise of those best suited to develop and deliver the content: the instructor. Kozma

believes that the traditional investigative efforts of matching a surface feature of technology with responses on a test of knowledge fail to include any cognitive, affective, or social processes that are inherent in the learning process. The author believes it is inherently wrong to identify learning as only a product of the environment or of the internal processes of the individual. Indeed learning is a product of the interaction of both. The research focus for describing the effects of media on learning should be directed at the understanding of the relationship between the interaction of the cognitive processes and the characteristics of the environment.

Eisle (1984) believes that computers have become a fairly well accepted medium for delivering education. He believes there are a list of relevant research questions that need to be answered including:

1) how effective is the learning delivered via computer?

2) what content is best delivered via the computer?

3) how does the use of the computer influence other learning variables?

4) what are the learning "by-products" from using computers?

5) what personality characteristics correlate to effective use of computers?

6) how is attitude toward learning affected?

7) what effects will computerized instruction have on instructional design?

The following section will produce an in depth investigation of the literature related to the use of computers in a distance learning environment.

Review of the Literature

Boucher et al. (1999) conducted a study to determine the effectiveness of

computer-assisted instruction (CAI) to teach the anatomy, biomechanics, and pathomechanics of the temporomandibular joint (TMJ). The sample for the study included 26 males and 40 females for a total of 66 first- and second- year physical therapist students at Southwest Texas State University. There were 30 first-year students who had not had any relevant didactic exposure to materials being studied, and there were 36 second-year students who had completed course work in anatomy, kinesiology and basic orthopedic assessment, however, none of the course work was directly related to the temporomandibular joint.

The subjects were randomly divided into a control and treatment group with each group receiving 15 first-year and 18 second year students. The study utilized was a two-group pretest-posttest experimental design. The subjects were administered a 25-question pretest of knowledge two days prior to the treatment. The test of knowledge was developed by the instructors of the course consisting of relevant anatomy, biomechanics and pathomechanics of the TMJ. The control group received a traditional lecture covering the material related to the TMJ supplemented by static overhead illustrations. The treatment group received the same lecture, but it was supplemented by a multimedia computer program with animated graphics and sound. The same pretest was then reordered and given as a posttest at the conclusion of the individual presentations.

The pretest data was analyzed using a t-test for independent samples to assess equivalent knowledge levels between the two groups. No significant difference was found in the pretest scores between control and treatment groups. A univariate analysis of covariance (ANCOVA) with the pretest scores as the covariate and the posttest scores as the dependant variable was run to determine significant differences between the student groups ($p < .05$). The ANCOVA revealed no significant difference in the posttest scores depending on the type of instruction

received. The effect of year for the students was found to be significant ($p = .000$) with the first year students scoring significantly less than second year students in both the control and the treatment group.

Boucher et al. concluded that regardless of the instructional method type utilized, posttest scores were greater than pretest scores demonstrating that learning did result from both teaching formats. They did conclude, that while both traditional lecture and computer-assisted instruction were effective in promoting learning, one was not statistically significantly over the other. Interestingly, a significant observation was made regarding the achievement examined by the year of the student in such that data suggests that second year students were better able to handle this particular academic material than first year students regardless of the mode of instruction. It support of other investigations that demonstrate CAI to be effective, but not superior to traditional instructional methodologies, the high costs associated with the development of instructional software should be considered when determining which type of instruction is to be utilized. The authors conclude that no clear evidence is provided to warrant the additional time spent by faculty in the development of computer-assisted instruction. While the study by Boucher et al. is in support of the no significant difference phenomenon, the comparison in this study was made between two modes of instruction with human based lecture as the primary mode of delivery. The computer-assisted instruction was supplemental in the lecture format. This study could be expanded to make a comparison between the use of lecture and CAI only. This proposed study may produce evidence that CAI remains as effective as lecture as a stand alone instructional methodology.

Perceptions by marketing students that utilized web-based instruction was the focus of a study by Siu and Chau (1998). The purpose of the investigation was to identify how marketing

students perceived the usefulness of an educational website designed to teach students how to properly utilize the Internet when conducting marketing research.

A total of 54 marketing students at Hong Kong Baptist University were recruited into the study. The student must have successfully completed an orientation seminar relating to the prior use of the educational website prior to entry in the study. A survey tool utilizing a five point Likert scale was used to discern student perceptions related to the technological design and information content of the educational website. Data from the survey tool was collected and descriptive statistics were utilized to describe the data.

The perceptions of the students were effectively divided into to general content areas: 1) information content and effectiveness, and 2) user friendliness and navigability. The data revealed that the students were more satisfied with the information content of the web learning experience and were less satisfied with the navigability and user friendliness.

Regarding the nature of the learning experience, the authors believed that students viewed the information content as satisfactory as the student could identify relevance in the materials being presented. Most of the students believed that the materials being presented would benefit them in future research investigations. Conversely, the authors noted that dissatisfaction by the students centered mostly on technical issues related to the ability of the individual to successfully navigate through the Internet educational experience. The authors believed that the students were more motivated to utilize the Internet when a clear understanding of how the tasks are actually to be accomplished. It is critical to appreciate that the quality of instructional design related to the learning experience, regardless of content, is critical to enhancing motivation and promoting effective learning.

LaRose et al. (1998) reported an investigation that compared the educational

effectiveness in both student perception of learning and in academic achievement when delivering identical content through two different instructional delivery modes: live lecture based instruction and audiographically enhanced course on the World Wide Web (WWW). The subjects recruited into this study were volunteers from an enrollment list of students in an introductory telecommunication course from a large mid western university. Forty-nine total subjects participated in the investigation with 15 female and 34 male students. Twenty of the students were freshmen level with the remaining 29 being upper level.

A controlled experimental design was established placing the participants randomly in either a treatment (audiographically enhanced WWW course, n = 25) or control group (lecture based, n = 24). The identical content was presented with the audio enhancement to the WWW course recorded from the same course offered the previous semester. The treatment group did not attend traditional class, but rather completed assignments on the WWW while the control group attended the regular lecture based offering of the course. Similar educational content was attempted to be held constant by encouraging same material, readings, textbooks, and lecture outlines being made available to both groups. Achievement was measured by using three 75-item four-choice multiple guess exams. The test items were drawn from the textbook and lecture outline. Both the control and the treatment group had the exams administered on a printed paper form. The control group entered their answers on a traditional mark-sensing sheet, while the treatment group entered the answers into a computer program designed to receive this data. The three tests taken by the students during the semester were then summed for a total score for the participant. The student attitudes and perceptions were measured using the standard Student Instructional Rating System (SIRS) forms used by the university in which the study was conducted. The forms consisted of 21-items on a 5 point Likert-type scale with 5 being the

superior score and 1 being the inferior score. Gender, grade point average, and class ranking was coded for comparison of the data. Attendance to the educational session was recorded and reported as a percentage of the total number of available sessions.

Non parametric statistics were utilized to differentiate the randomization between the control and the treatment group. A Chi-square analysis revealed no significant differences between the groups based on gender or class level distribution. Analysis of Covariance was used in which student achievement and the student attitude were dependant variables and the treatment condition was the independent variable. Gender, grade point average and class level were identified as covariants in all analyses using the simple factorial model. Statistical analysis revealed no difference for the main effect of the treatment condition on total test scores. Statistically significant findings did produce that males scored higher than females overall and learners with higher grade point averages scored higher on the exams regardless of the treatment condition. In comparing student achievement to either attendance or student satisfaction, there was no apparent effects. The authors also reported that no statistically significant differences were identified between the two groups in perceived immediacy of the instructor or overall attitude toward the learning experience.

The authors concluded that there was no difference in achievement scores for students receiving the educational content from a live lecture or a similarly constructed audiographically enhanced web based course. The authors were unable to confirm that the students in the live lecture based course were more satisfied with the experience than the students interacting with the audiographically enhanced web course. The summation of the authors presents that the use of audiographically enhanced web based education is as educationally effective, immediate and enjoyable to learners as live instruction. They expand the notion that the minimal expense

related to producing an audio based web course leads to an optimal balance of educational effectiveness with cost effectiveness. The authors statements regarding cost effectiveness are only speculative as direct costs were not tracked as part of this investigation. Problems reported by the authors, while not an aspect of the investigation, were accessibility issues for the students using the on campus computer services. Follow up interviews with the students also produced concerns that were not measured in the study including the desire for eye contact from a real person and the ability to ask spontaneous questions. A significant limitation of this study was that although the content was held similar, the actual instructor delivering the content was different. The recorded voice of the instructor from the previous semester was not the same person who led the lecture based course for this investigation. Another limitation of this study in terms of effectiveness for distance learning is that all the participants in this study were traditional residential students while most distance learning students are actually non-traditional adult learners. The small sample size of this investigation leads to the possibility of limited statistical power enough to rule out a type II error. The design of this study could have been enhanced with a pre-test / post-test design to assess knowledge compared in one group versus the other. It may be more relevant to compare the statistical change in learning pre to post as it is to compare only post scores. Larger sample sizes are definitely warranted, although may be difficult to obtain and rigidly control. An interesting side note for this investigation was the reported attendance percentage for both groups. The lecture based group attended on average only 63% of the available lectures, while the web based group completed on average only 48% of the available units. While not statistical significance resulted in comparison, these numbers appear to be an indicator of possible low satisfaction or motivation for both groups toward this particular educational content.

Carew et al. (1997) evaluated the effectiveness of computer-assisted instruction by determining if the use of a software program designed to reinforce classroom lectures produced higher cognitive achievement scores. A secondary purpose of this investigation was to assess the opinions of the participating students regarding the usefulness of the computerized instruction. Two-hundred forty-three (243) total students were enrolled in four different sections of an introductory nutrition course at the University of Vermont. Voluntary participation produced 160 students who utilized the computer assisted instruction and 83 who did not utilize the mode of instruction. The computer software provided a supplement to the lecture based course with periodic self assessment tools for the user.

Data was collected pertaining to the first and second level of program assessment (Kirkpatrick, 1998). An 11-item forced choice Likert type survey was utilized to determine the students' attitude toward the use of the computer assisted instructional program. The same tool was used as a pre course survey and a post course survey and the Cronbach alpha test indicated a 0.84 level of statistical significance revealing a reliable attitude tool. A table of specifications was utilized to develop and ensure validity of a 50 item multiple choice assessment tool for cognitive achievement that was given on the first day of the course and on upon the completion of the course.

The attitudinal data described that 87% of the users believed that the computer-assisted instruction was either very useful (41%) or useful (46%). Seventy-eight percent of the users believed that the instructional delivery via the computer enhanced their scores in the course. Only a small percentage (11%) felt that the interaction with the computer had no impact upon their grade. Changes in attitude from the beginning of the course to the end of the course were analyzed. Students initially agreed that the use of a computer would help them to better

understand the material and by the end of the investigation, this opinion was increased further. A noted increase in attitude was found from the initial survey when the students were asked if the interaction with the computer would be enjoyable and convenient. A change in the perceived time demands was noted upon the completion of the course where initially, students did not feel the interaction would be time consuming, and by the completion of the course, the users were in agreement that more time was spent utilizing the program than originally believed. The achievement data was analyzed using a two-way analysis of variance (ANOVA). A statistically significant difference was found between all students in the pre-test and post-test achievement scores with the post-test scores being significantly greater. A significant difference was also presented when users of the computer-assisted instruction tending to have scored greater on the achievement test than non users.

The authors believe that the statistically significant results support previous research demonstrating that learning is enhanced with the use of computer-assisted instruction when compared to a group that learns the same content, but does not utilize the CAI. Learners expressed the opinion that course grades were improved from the interaction with the computer software and that the program reinforced the traditional lecture materials and content. Overall, the student attitudes toward the use of the computer were positive and generally improved through continued interaction with this mode of instruction. Students did not report any major disadvantages with the use of CAI although many did believe it was somewhat time consuming.

Kinney et al. (1997) studied the effects of computer assisted instruction on physical therapy students when they assessed the efficacy and efficiency of the CAI versus traditional instructor lead instruction for the students learning evaluation and treatment for a related medical condition (carpal tunnel syndrome). Ten junior level physical therapy students volunteered for

the study. There were 3 males and 7 females enrolled into the investigation. The education level of these college students had demonstrated significant course work in the anatomical and kinesiological sciences previous to the initiation of the investigation. The students had prior knowledge and experience with the computer simulation technical operations.

The participants were randomly divided into two groups of five subjects each with the treatment group receiving computer-assisted instruction and the control group receiving a more traditional instructor lead instruction. The computer simulation software, which was developed at the Medical College of Georgia, operates by presenting clinical cases then asking students to progress through a rubric of clinically based decisions with each stage building upon the next. The individual case study for this investigation was evaluated for face validity by an external expert in the related field and the simulation was completed by several licensed physical therapists to ensure accuracy and technical operation prior to the initiation of the trial. A 36-item multiple choice test of knowledge was develop from a table of specification and was reviewed by three experienced physical therapy faculty members to ensure face validity. After several modifications from the experts, the final tool was implemented as a pre and post test for assessing level two achievement. The pre test was completed by each participant and the data recorded. The treatment group completed the case-based study approach with the computer as the mode of delivery and the control group completed a similar case-based study approach from a human instructor. Every effort was made to keep the case and content of the instruction identical between the two groups varying only the mode of delivery. The instructional intervention time for both groups was predetermined for a maximum of 1 hour and 15 minutes. Because of the short duration of the intervention, students in both groups, if needed, could ask questions from the instructor (in computer group, the same instructor served as a proctor) relating to any aspect

of the content. Any unresolved questions were addressed in a live manner upon the completion of the instructional interaction. Upon completion of the learning experience, the same 36-item test was used for the post test of knowledge. To measure efficiency, the investigators kept a log of the total time needed for the subjects in each group to complete the instruction mode, the pre test and post test.

The collected data was analyzed using 2 x 2 analysis of variance (ANOVA) with repeated measures on one factor to determine any significant differences between the variables (CAI/Lecture, Pre and Post Test). The total time involvement was analyzed using a t-test to determine significant differences between the computer assisted group and the lecture group. The test for statistical significance was established at the .05 level. An unexpected variance occurred in the investigation as one test item failed to produce a correct answer on any of the test attempts from either group and was therefore discarded and considered invalid leaving a total maximum score of 35 possible on the examinations. The analysis of the pre test and post test revealed a significant difference with the post test scores being significantly greater than the pre test scores. There was no statistical difference when the type of instruction was considered. The analysis of the time to complete the task revealed that the computer assisted learning group required a significantly less amount of time to complete the learning experience when compared to the instructor lead group.

The authors concluded that without consideration to the instructional delivery mode, the student post test scores were significantly greater than pre test scores. This finding suggests that the case based instructional design was probably the variable responsible promoting the effectiveness of learning, not necessarily the mode of delivering the learning experience. The significant finding in the study lends to the nature of efficiency were the computer assisted group

completed the same task with the same effectiveness in 24% less time than the instructor lead counterpart. While the efficiency effect promotes the use of CAI, this premise only considers the delivery of the instruction to the learner and not the development of the instructional tools. Every attempt was made to keep the instructional design consistent between groupings, however, the authors noted a speculation that start up costs in preparing the instructional tools were greater for the computer assisted group, but once the tools were developed, a decrease in the time required by the instructor to lead the experience was needed. This may open the possibility that faculty time may be devoted to other scholarly pursuits with the same student effects related to learning. The application of findings in this study may support the use of computers to deliver the ability for learners to work at their own pace allowing greater flexibility to learning styles and scheduling of learning situations. Convenient times may be selected by the learner to accommodate a wide variety of needs including the time demands of the busy health care professional. Limiting factors cited by the authors include the small sample size which increases the chance of a type II error. Statistical power in this investigation was very limited and the future need for a like study with increased sample sizes is warranted. Another factor this study did not consider nor measure was the long term understanding and the retention of knowledge. While the treatment was just as effective as the control, but more efficient, the assumption can not be made that the immediacy of learning as demonstrated in this investigation leads to long term integration and application of the content.

Cockayne (1991) reported on the comparative effects of different group sizes on learner achievement when using an interactive videodisc as an instructional medium. The participants of the investigation consisted of 216 students enrolled in a freshman biology class at Brigham Young University during the summer of 1989. The participants made a blind selection into a

predetermined group size depending on the time availability of the student. After all students had enrolled into an instructional session, 23 groups of single students, 28 groups of two or three students, and 25 groups of four or five students were formed.

The measurement of effect for this study consisted of immediate learning achievement and instructional time needed to complete task from which an efficiency index was calculated. The instructional mode consisted of using a biology interactive videodisc that presented short instructional sessions using motion and still pictures followed by review questions. The participants needed to input the answer to the specific questions, and then differential feedback would appear depending on the response of the individual or the group. The students in groups of more than one individual were encouraged to arrive at a consensus before answering all questions. A twelve item pretest and posttest was utilized to determine achievement. The duration in minutes was measured for the time needed for the experimental group to complete the learning unit and an efficiency index was calculated.

The collected data was analyzed using an analysis of covariance (ANCOVA) to test for significant differences among the learning group conditions. The pretest of achievement was the covariate and the significance level was established at the .05 level. The author reported no significant difference between the posttest scores related to group size. The author did report that a significant observation did result when comparing the mean completion times of the groups. The groups consisting of four or five students took a significantly longer period of time (11 minutes) to complete the same instructional tool when compared to single groups. However, when the achievement and time was indexed for efficiency, a significant observation was noted that the groups of four or five learned more efficiently than the smaller size groups.

While the author concluded that there was no evidence that the learning was more

effective for one size of group when compared to anther, there was evidence that indicated that small groups may be more efficient in delivering educational material via interactive videodisc when compared to single individual groups. This has great ramification when considering the cost, time and space needed to present this particular mode of instruction. While this was an interesting investigation related to the nature of instructional efficiency in computer-enhanced education, it was not a study in group interaction and dynamics and there was no effort to control for confounding factors such as pace of learning, learning styles, or ability level. Within the description of the means of these groups are individuals that may or may not have received the most effective mode of instruction for the individual. This particular investigation only dealt with lower level verbal learning and immediate recall and was not designed to investigate higher orders of thinking, problem solving, and long term retention.

Justen, Waldrop, and Adams (1990) examined the relationship between achievement and performance related to the interaction of feedback mechanisms with computer-assisted instruction and group size. The subjects for this investigation were voluntarily recruited from four different upper level college education courses. The total number of participants for the investigation was 68 and the group size ranged from 14 to 19.

The quasi-experimental study consisted of a 2 x 2 factorial design with the first factor being the type of CAI received (either paired or individual) and the second factor being the type of interactive feedback (minimal versus extended). The subjects in the class had the first random division with two classes identified to receive paired groupings when interacting with the CAI, and the remaining two classes to receive individual interaction with the computerized treatment. The subjects within the respective classes were then randomly divided to receive either limited or extended feedback. The CAI was a six unit lesson that introduced and reinforced concepts

related to hypothesis testing research. The module was consisted in instructional methods (drill and practice) across all groupings, except for the control of the magnitude of feedback. The limited feedback groups received information only related to the correctness of responses. The extended feedback group received a detailed summary of the correct answer following both correct and incorrect answers. A 20-item multiple choice test was issued to all groups upon completion of the project to measure level of achievement.

The data was collected and analyzed using an analysis of variance (ANOVA) to examine the significant differences between the two sizes of the instruction groups and the two types of feedback, as well as the interaction between the size of the group and the type of feedback received. The level of significance was predetermined to be at the .05 level. The analysis indicated that there was a significant difference between the type of feedback, but not between the size of the group or the interaction between the size of group and the amount of feedback. The participants that received minimal feedback, whether involved in an individual or small group, performed significantly better on the 20-item post test than students that received extended feedback from the computer-assisted instruction.

The authors of this investigation believe that this report does support the use of CAI in small groups as it was demonstrated to be as effective as CAI used only by the individual. The analyzed results, however, do not support previous published reports that favor the enhancement of learning through extended types of feedback (Waldrop et al., 1986, Gilman, 1969). Application of these findings would suggest that students learn better from direct, immediate feedback without extensive analysis of the responses. Limitations are numerous and include the small size of the groups, absence of pure randomization, lack of controls for pre-existing knowledge related to subject as demonstrated through the absence of at least a pretest of

knowledge, and lack of reliability of the test instrument.

Harper and Ewing (1986) compared the effectiveness of two different instructional tools that are often utilized in distance learning. The authors set out to compare the effectiveness of computer based instruction and workbook instruction on silent reading comprehension. A secondary purpose of this investigation was to identify the preferred mode of instruction by the subjects. The subjects in the study included nine special education students that were assigned to one junior high resource room. The students were divided into two achievement groups (high and low) depending on the presence of a previous documented learning disability. The chronological age of the subjects ranged from 111.5 to 13.5 years and the total IQ performance score range on the Wechler Intelligence Scale for Children-Revised (WISC-R) was 72 - 109. The subjects included 2 females and 7 males. All students were previously identified as deficient in reading comprehension and in need of remediation.

A single subject, alternating treatment design (ATD) was developed for this investigation. Effectiveness was defined for this study as the percentage correct of items on a reading comprehension assessment and by observing the subjects' attention to task behavior. Reading comprehension scores based upon the Comprehensive Test of Basic Skills (CTBS) were obtained for each individual subject from the end of the previous academic year to determine the appropriate starting level for the instructional tools. The collection of data was divided into three phases. The first phase consisted of collecting base line information as all students simply read from a book and answered questions with pen and paper. The second phase of data collection consisted of the ATD where on one day, the student performed the reading comprehension with the computer-assisted instruction followed by an immediate post test. The second day consisted of interaction with the programmed workbook followed by an immediate post test. The pattern

reverted back to the first day and continued in this pattern over four consecutive days each week for a total of four weeks. At the end of the four weeks, the tool that was most effective for the individual student was then utilized for the remaining eight weeks. The attention to task data was collected by two trained observers with an inter-observer reliability check calculated as a percentage of agreement divided by the percentage of disagreement. The reliability of observation for the computer participation was identified at 98% and the workbook participation was identified at 95%. At the end of the course a three item survey was read out loud related to the preferred mode of instruction and the subjects wrote responses to the items on paper.

The authors reported only general conclusions related to the collected averages of achievement scores and attention to task observed scores. For the average scores of each participant, eight of the nine subjects produced greater mean responses when interacting with the computerized instruction. The data collected from the observed time on task produced no clear difference in achieving a greater time on task for one mode of instruction versus another. Upon the completion of the investigation, the student perceptions revealed that 8 out of 9 subjects (89%) preferred to work with the computer and the same proportion felt that they learned better when interacting with the mode of choice.

The authors did not present generalized discussion pertaining to the comparative effectiveness of one mode versus another. The authors did feel that the students did prefer to utilize the computer and this was possibly related to confounding factors not related to the desire to achieve in reading comprehension. Limitations of this study include the very limited sample size and population. The lack of a randomized control group in an alternating treatment design, although were some internal controls is possible, should lend to cautious interpretation of the generalized results. Another deficit in this investigation is the nature of the two instructional

modes. The identified computer-assisted instruction and the programmed workbook instructional methodology was not detailed, but it was identified that the tools were published tools created by two different authors and two different publishing companies. This study may, in fact, be assessing the difference between two different instructional methodologies and not two different instructional modes. In terms of satisfaction related to the mode of instruction, the dramatic results from this study should be considered carefully in terms of the small subject size, and the reinforcement of the novelty effect with computers and computerized instruction.

Dalton (1986) compared the effects of interactive video instruction on learner performance and attitude with computer-based instruction and traditional one-way video. One hundred thirty four (134) subjects from six different introductory level junior high industrial arts classes were recruited into the investigation.

The students were divided into high and low achieving groups depending upon their 6th grade scores on the Comprehensive Test of Basic Skills. A random division of these two student achievement groups produced three treatment groups each having an equal representation of high and low achieving students. The treatments for the investigation included three different parallel modes of instruction pertaining to safety in the industrial education course: 1) watching a one-way, non interactive video, 2) computer-assisted instruction only, and 3) interactive two-way video. All three modes of delivery were based upon the same content designed by the instructor. The design of the study was a 3 x 2 x 2 cross design with the three interactions being the mode of content delivery (3), sex of the participant (2), and the established achievement level of the participant (2). A print based post-test was administered to each of the treatment groups upon completion of the instruction followed by a survey to address the participant's attitude towards the mode of instruction.

Post-test data was analyzed using an analysis of co-variance (ANCOVA) using prior achievement scores as the co-variant. Attitude data collected from the survey was analyzed using a standard analysis of variance (ANOVA) with a predetermined significance level of .05. The authors reported that a significant difference was observed between the three treatment groups with the computer-assisted instruction group achieving the highest mean score and the one-way video group achieving the lowest mean score on the post-test. The mean results of the satisfaction survey revealed that the interactive-video receiving the highest mean score and the computer-assisted instruction receiving the lowest mean score as perceived by the participants who utilized the respective mode of instruction. The only significant difference was between the mean of the interactive video group compared to the mean of the CAI or the one-way video groups. There was no significant difference between the CAI or the one-way video group based on the mean perception scores of the participants.

The author presents three significant conclusions or implications from this research. First, the author believes that CAI to be superior to either one-way or interactive video in producing achievement for the related content. Second, interactive video produced the most significant enhancement in learner attitudes. Lastly, the attitude toward learning was not constant with previous testing for this group of students. A significant limitation to the conclusion of the author include the presence of the novelty effect on attitude. In this study, the interactive video was a new tool, where as the other two media tools had been previously utilized by this group of students. Other limitations of the presented results are significant as well and include omissions by the author related to results of the entire 3 x 2 x 2 effect. Tables were not presented related to the effect of sex or prior achievement for the individual to review the analyzed results. In fact, no discussion was presented at all related to the interaction of the sex of

the participant. Means of treatment groups were only presented as a percentage without description of the statistical results from the comparative procedures. Reliability and validity of the level one and level two instruments was not presented. The conclusions from this investigation are marginal at best without the ability to adequately review the statistical analysis.

Carmen and Kosberg (1982) reported on the effectiveness of using computer-assisted instruction to assist the teachers of emotionally handicapped children. Effectiveness was measured as achievement success on Stanford Achievement Test and by observed attention-to-task by maintaining eye contact with the designed task. The sample used in this investigation included 40 emotionally handicapped children, ages 7 to 14 years. All students attended the same residential school for the emotionally handicapped. Thirty of the participants were male and ten were female. All participants were of normal intelligence, however, they averaged two years of academic retardation in mathematics.

The research methodology consisted of two randomly selected groups and the methodology varied slightly depending on the measurement of effectiveness: achievement or attention-to-task. The entire mathematical component of academic year was divided into three equal phases and an alternating treatment design was established (ATD). At the end of each phase the achievement examination was completed by both groups. The two randomly divided groups became a treatment group that received the computer-assisted instruction in math that was delivered from a centralized computer processor over the telephone lines, and the non treatment group that did not receive the technologically enhanced instruction, but rather traditional instructor-led lecture and demonstration. At the end of each phase, the treatments were altered for each group following an "ABA" format. The ending treatment was the same as the initial treatment (or lack of treatment) for each group. The Stanford test was utilized because of its high

sub-test reliability and the presence of two forms of the examination to reduce the practice effect. The methodology for the attention-to-task consisted of a trained observer collecting data on three randomly selected students from each academic classroom for a total of student 12 observations (6 CAI and 6 non CAI). The trained observer collected data on each of the students in fifteen minute sessions during the predetermined instructional interaction over a six week period of time. This observation was conducted near the end of the academic year and the end of the investigation.

After the data was collected, analysis for both the computer-assisted and instructor-led groups consisted of comparing the means through the application of the Wilcoxen Matched Pairs Test with a significance level established at .05. It was noted during the first phase of the investigation that the computer-assisted learning group demonstrated significant gains on the Stanford Achievement Test while the instructor-led group showed no significant gains in achievement. During the second phase of the investigation, after the groups had switched modes of instruction, the new computer-assisted group again showed significant gains in achievement and the new instructor-led group did not. At the end of the third phase of observation, when the groups had reverted to their original mode of instruction, neither group demonstrated significant gains by the end of the course. The overall analysis of comparing the start of the investigation on achievement compared to the end of the investigation (all three phases considered collectively) revealed no overall significant difference in the rate of achievement in math scores on the Stanford Achievement Test. The data analysis of the attention to task revealed statistically significant observations revealing the computer-assisted instruction groups paid more attention to the task than did students participating in the instructor led group.

While the authors noted that significant gains were made when the students were

interacting with the computerized mode of instruction during two of the observed phases, overall, there existed no significant gains from beginning to end. The authors used standardized data to extrapolate evidence that this group of students achieved at a greater rate than norms, however, were not willing to confirm the cause-and-effect relationship producing enhanced achievement results from interaction with the computer due to limitations in the investigative methodology. Speculation of a novelty effect was demonstrated as both groups achieved immediate results, however, long-term results were not continually enhanced. Another limitation of the methodology was the fact that the final examination was given just prior to the release of the students for summer vacation possibly lowering the motivation of the students to produce greater results. The attention-to-task observations, which were made during the final phase in which no significant achievement was noted, may helped to identify that the novelty effect was minimal, as the students despite demonstrating no significant achievement gains, still had significantly greater attention to task averages than the teacher-led group. This authors concluded that the most significant evidence produced from this finding was that it is evident that the student's attention is held more significantly when the instruction is individualized, whether it be through human or technological interaction. It was demonstrated in this study that computer-assisted instruction is at least as effective as traditional instructor interaction methods. The ability to engage the student to improve the attention to the task at hand is very relevant to the use of technology in delivering education. This study of course is limited to the nature of the content and the quality of the instructional design of both the traditional classroom and the computerized software. An area not described in the study, but would warrant further investigation, is the relationship between the ability to maintain attention on the task and overall achievement. While this is an early study (1982) in the effects of delivering education through a computerized

medium over a telephone network, it was a clear precursor to the advent of the Internet and the ability to transmit educational content to remote cites for interaction with learners.

Conclusion

Phipps and Merisotis (1999) criticized the conclusions made in research pertaining to the effectiveness of distance learning citing that "...the overall quality of the original research is questionable and thereby renders many of the findings inconclusive." Limitations of effectiveness research relating to distance learning include lack of controls for extraneous variables, lack of randomization, lack of reliability and validity of the instruments used to measure outcomes, and limited control of reactive effects of student participation such as the "novelty" effect.

There exists two inherent fallacies with the argument that computer mediated distance education is not as effective as traditional classroom education. The first, and most relevant problem is that a clear and working definition of what the actual comparison between educational delivery modes should be. There appears to be no scholarly purpose in comparing the effectiveness of distance education in any form to that of a traditional bricks and mortar academic institution. The two delivery modes service two very distinct populations with the later serving mostly the younger post high school college student, and the former serving adult learners that are working professionals. The reformation of the question should be directed at which mode of delivery is most effective for the clientele to which it serves. A bricks and mortar academic institution that delivers high quality in-the-seat education may be very effective, but not effective for the working professional that can not attend the established classes when scheduled. Likewise, the delivery of education through the Internet may be very effective for the

busy working professional who is motivated to complete a project and manages time adequately, but not effective for the college freshman that has had no experience at intrinsic motivational learning. Although the use of computer assisted instruction in distance learning processes is recommended as a tool to support traditional teaching methodologies and sound pedagogy, many investigations have indeed sought to compare the data as a replacement for traditional instruction design (Boucher et al., 1999; Sanford et al., 1996)

The second inherent problem when arguing the effectiveness of providing distance learning through a computer-based medium is the fact that the effectiveness issue actually should be directed at the instructional design component and not the tool that delivers the content. A soundly designed learning experience in a classroom is certainly more effective than a wreck less attempt to put old lecture notes on the Web and believe that students will simply learn independently. Conversely, a soundly designed learning experience delivered through a computer-based medium on the Internet is certainly more effective than a lecture hall of 500 students listening to a monotone lecturer read from prepared notes that each student has access to prior to the start of class. The operational element found in the learning experience is the quality of the instruction and that it is designed to meet the needs of the individual learner.

In addition to the need for improved research design, other areas of research investigation are needed to help to determine the overall effectiveness of learning at a distance. Kinney et al. (1997) call for more longitudinal research to be conducted examining the cost effectiveness of time invested by faculty and start up costs by the institution versus the time saved by students when using computer assisted instruction. Outcomes related to the total academic program need to be measured as opposed to course by course comparison. Individual student factors and characteristics related to success and failure in a distance learning environment need to be

identified rather than group characteristics and averages of the "typical" learner. Addressing attrition and drop out rates in distance learning programs compared to traditional classroom instruction is needed. Individual learning styles related to the use of technology in the classroom should be investigated as well. Synergistic relationships between multi-modal technologically enhanced instruction does not appear often in the literature, but rather an investigation of the interaction between the learner and one instructional mode versus another. Existing literature lacks a theoretical or conceptual framework to base and develop relevant investigative efforts. Investigation into the utilization and effectiveness of the virtual library is needed to identify accurateness and reliability of delivering learning materials at a distance.

Distance education is a synchronous or asynchronous learning experience meeting the need of the individual learner that is separated from the instructor by a physical distance. It is possible to deliver distance learning content through a variety of effective mediums including written correspondence, video, audio, electronic communications, computer-based, and the Internet. The comparison of distance education being statistically better or worse than traditional education should not be made unless the same group of student characteristics and motivations are being considered and controlled. Schramm (1977) claimed that learning is influenced more by the content and instructional design in the mode of instruction than by the mode itself. Clark (1999) makes the argument that ". . .the point is that no matter who or what is being taught, more than one medium will produce adequate learning results and we must choose the less expensive media or waste limited educational resources." The bulk of the literature that has been published suggests that the effectiveness of using technology to deliver learning at a distance is similar in outcomes to learning in a conventional classroom. Student perceptions and satisfaction, as a whole, are also generalized as being positive regarding the mode of instruction (Phipps &

Merisotis, 1999). With this plethora of indecisive evidence producing no significant difference regarding the delivery of distance education through computers, it is now possible to accept this mode of distance learning as part of main stream education.

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