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The impact of computer based interactive instruction (CBII) in improving the teaching-learning process in introductory college physics

Afif A. Jawad

THE IMPACT OF COMPUTER BASED INTERACTIVE INSTRUCTION (CBII) IN IMPROVING THE TEACHING-LEARNING PROCESS IN INTRODUCTORY COLLEGE PHYSICS

by

AFIF A. JAWAD

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DEDICATION

I dedicate this dissertation to my life-partner, Natalie, and to my sons Muhamed and Badri, the joys of my life. Also, I dedicate this dissertation to my parents, Ali and Saada Jawad, for all they did for me, for without them, nothing would have been possible.

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Chapter I

INTRODUCTION

Overall, education appears to have at least two goals. The first goal is to acculturate youth within their society. The second goal is to prepare youth as potential contributing members of that society by providing skill and experience that promotes entrance within a career. Considerable criticism seems to be directed toward the lack of accomplishment of the latter goal based upon students' inability to demonstrate understanding of basic skills within Science and Math (SCANS report, 1991). Yet, many rewarding career paths require mastery of these subjects. Within the American society, concern for the inability of students to be successful in Science, Math and Engineering has resulted in a number of programs being designed, in some way, to improve student success in these areas.

Programs like CUPLE, Interactive Journey through Physics CD-ROM, Modellus, Photosynthesis, Heredity, HyperChem Lite, MathType, Mathcad, and Electronics Workbench, etc. have been introduced as ways of improving the success of students within science, math and engineering. School-to-Work programs also have been attempted within many secondary schools as motivational interventions designed to link the subject content of Math and Science courses to job-based experiences.

Unfortunately, the real issue may not be neither a matter of more intensive programs nor bridging environments between academics and work. The real issue may be the boredom that is associated with the study of these subjects. Typically, the study of Math and Science can be characterized as lecture based instruction, and workbook-based problems or exercises that are supplemented with some form of reading (usually a textbook). For the most part, this form of instruction incorporates very little learner control or variety. Given the reliance upon textbooks as a vehicle for promoting student learning, evidence of students' difficulties in learning from text is particularly disturbing (Britton, Woodward, and Brinkley, 1993; Driscoll, Moallen, Dick, and Kirby, 1994; Garner, 1992).

Some academic institutions appear to be having some success in Math and Science with an alternative delivery approach, Computer Based Interactive Instruction (CBII). Although the use of computers may be being driven more by competitive image than other motivations, rumors of improved learning are prevalent. Interestingly, while there is a large quantity of research regarding specific aspects of learning through computers, there appears to be a lack of information regarding the impact of computers upon student success. Little programmatic research appears to exist that examines the overall impact of computer based delivery upon the achievement of students at the academic program level, particularly in math and science.

Background

Most math and science teachers, implement traditional and contemporary teaching strategies, because, some may argue, they do not have time to acquaint themselves with the new technologies. Most math and science teachers do not allow the students the opportunity of choosing the medium for delivering instruction. Unfortunately, the traditional teaching environment may not be friendly to all and may deprive some portion of the population of the significant scientific background that might allow them to contribute to science and technology, and ultimately, to the future economy of the country.

Strong, 1995, points out that:

> Educational institutions must recognize that the world has changed. Employers and students have needs that our current delivery system is not meeting. We face financial constraints that will not quickly disappear, as well as both global and private competition. Doing more of what we are currently doing will not solve these problems. To survive these challenges, we must find new ways to deliver education to our students. The use of academic computing can contribute to solving some of these problems. Over the next five years the use of technology combined with other measures will dramatically change the nature of the teaching /learning process.

Chris Dede (1996) points out that the most dangerous experiment being conducted with our students is keeping education the same when every other aspect of society is dramatically changing. He argues that the very nature of education must be changed so that it reflects, rather than opposes learning.

According to John E. Roueche (1993):

> The challenges posed by the press of technology, local and global economic demands, the changing nature of and need for knowledge, and the influx of nontraditional students, make it quite clear that a serious refocusing of our purpose is needed.

Based on national concerns as reflected through government supported efforts including the SCANS project, there is a need for educators to be able 1) to create an appealing and stimulating classroom environment that promotes student interest in the learning of math and the sciences, and 2) to implement traditional and contemporary teaching strategies in concert with the use of computers and other technologies.

Better curriculum designs, that would support instructional methods which are consonant with the ways different people interact and learn, appear to be appropriate. Ediger (1996) suggests that a curricular design based upon sequential learning objectives, experiential learning opportunities, alternative delivery methods and applied evaluation procedures would allow students to experience quality learning.

<u>Need</u>

In many physical science and engineering fields, it is common to find overall attrition rates that vary from 30 to 70 percent (Task Force on the Engineering Student Pipeline, 1988). Lipson and Tobias (1991) report that many of those who drop out are among the best students. They wrote

> it is a tragic mistake to assume that the majority of students who drop science at the college level do so because they are not able or motivated enough to succeed at it. Good students may be lost at the college level not because they fail their science education but because their science education is failing them.

Instructional delivery is usually based upon choices made by instructional designers. The bases for selecting delivery systems included some of the following considerations: content, students, cost, and organizational practice. Traditionally, textbooks have satisfied these requirements. In fact, textbooks have been the educational media of choice and a mainstay of educational delivery for many years. Unfortunately, textbooks are dependent upon student reading, which too often is a passive experience based upon the relatively static nature of printed words and diagrams. This is particularly true when compared with the other educational media like television, to which students have daily exposure. Other criticisms of textbooks have to do with structure, feedback, and the lack of ability to motivate students, including encouraging them to develop a long-term interest in math and science.

Computer Based Interactive Instruction (CBII), a multimedia technology, may have great, as yet unrealized, promise for teaching physics by facilitating learning. With thoughtful and interactive application of computer technology, it would seem likely that science and math educators may make their subjects more accessible, enticing, and enjoyable for all students. CBII may be the vehicle that will draw upon student's natural impulses causing them to be more willing to relinquish old assumptions and open to the power of the technologies that are reshaping work environments.

Many have argued that the use of computer-based technology has the potential to substantially change and improve the teaching-learning process (Lepper and Gurtner, 1989; Papert, 1980). Technology offers teachers innumerable methods of enhancing instruction, and plays a major role in reducing professional pressures on teachers and increasing the efficiency of student comprehension.

However, Magnusson (1996) mentions that research, to date, has not convincingly demonstrated that the use of computer-based technologies can produce the development of conceptual understanding, which may be consistent with its promise. This position should not be surprising in that, by itself, computer-based technology would seem ill equipped to improve learning.

Over the past several decades, results from research in physics education have shown that many students leave the introductory course without a functional understanding of the material (McDermott, 1984). Since introductory physics acts as a starting point to the academic careers of so many students in so many different fields, it seems necessary to know what works and what does not work.

General Statement of Problem

Rapidly advancing technology is forcing many educational institutions, particularly higher education, to think of better means of more effectively delivering instruction to their students. As a result, many universities have developed or adopted, computer-based programs for their students. One area that has seen extensive integration of CBII is Physics. In physics, some computer programs have been designed to enhance successful instruction and to provide students with experience in applying the concepts and principles developed in lecture. Such programs require students to analyze, synthesize and extrapolate from the information provided in order to derive meaning, thereby providing a series of interactive "problem-set" programs. These programs attempt to provide the students with feedback specifically designed to point out errors in reasoning and/or provide clues to the appropriateness to the approach.

A major issue to consider is bringing science (physics) to everyone. In general, some students seem to accept biology and chemistry, and avoid mathematics and physics, which are the stepping stones to engineering and technology. The gap between the two seems to be an instructional problem. However, it may be possible that the delivery system may have a greater influence upon students.

Specific Statement of Problem

Not long ago, most physics instructors were largely unaware of the outcomes of research in physics education. Today, several programs have been developed on the basis of educational research (Laws, Rosborough, Poodry, 1995). These programs include: Physics by Inquiry, Tutorials in Introductory Physics, Tools for Scientific Thinking, Real-Time Physics, and Work-Shop Physics.

In 1981, Ormerod pointed out that secondary students ranked physics as one of the most difficult school subjects. Males often chose to take physics, but females appeared to chose other courses because they considered physics to be too difficult. Kelly (1981) asserted that males may have been more willing to continue in science, even with the perceived difficulty, because they believed it to be relevant for future employment.

The issue of making physics acceptable to everyone has become more prominent with the introduction of the computer into the classroom. Many physics educators believe that this can be done through the use of inquiry and other tutorial programs. As a result of this growing belief, many schools now are using computers in teaching physics, but, with little attention to the results.

Purpose of the Study

There is a need for an instructional delivery system that will foster the active, mental participation of students in the learning process (Shaffer, 1993). This is a particularly relevant concern for the field of Instructional Technology. Instructional Technology processes attempt to enhance learning guided by knowledge of what students know and can do, rather than what they *should* know and *should* be able to do. Often, Instructional Technology uses computer technology as a basis for improving learning for students.

Understanding the relationship between an institution's choice of instructional delivery systems, for difficult subjects like physics, and its potential impact upon students, could be an important key to encouraging students to pursue high impact career directions that are frequently viewed by students as too difficult or inaccessible.

CBII has been used for more than ten years in college physics programs. Physics instructors estimated at 50 percent, use CBII in one form or another. Yet, for some institutions, CBII still appears to be controversial. This study proposes to examine and compare the institutions that use CBII for physics instruction with those institutions that do not to determine the differential effects, if any, of the use of CBII delivery upon student retention, grades, etc. Interestingly, little exploration of the relationship between delivery system choice and student pursuit has occurred.

This study proposes to explore the relationship, if any, between institutions' choice of instructional delivery system and student pursuit of college-level introductory physics courses. A survey methodology will be used to compare and contrast key faculty perceptions within institutions that use CBII with other institutions where more traditional instructional delivery choices are used.

More specifically, this study proposes to determine the extent to which computers are used in the introductory physics courses in colleges and universities, and the resulting impact of that use upon the students' registration for such courses.

Research Questions

This study attempts to answer the following questions:

1. What is the influence of using computer based physics homework assignments upon instructor opinions about student comprehension of physics instruction?
2. What is the influence of using computers in physics lecture presentations upon instructor opinions about student comprehension of physics in-

struction?

3. What is the influence of using computers in physics laboratory assignments upon instructor opinions about student comprehension of physics instruction?

4. What is the influence of using computer simulation examples in lecture presentations upon instructor opinions about student comprehension of physics instruction?

5. What is the influence of using computer problem solving techniques in lecture presentations upon instructor opinions about student comprehension of physics instruction?

6. What is the influence of using computer based experiments in laboratory assignments upon instructor opinions about student comprehension of physics instruction?

7. What is the relationship between annual college tuition among those institutions that use and those that do not use computers in physics instruction?

8. What is the relationship between annual college tuition among those institutions that use and those that do not use computers in physics laboratory classes?

9. What is the relationship between college enrollment among those institutions that use and those that do not use computers in physics instruction?

10. What is the relationship between college enrollment among those insti-

tutions that use and those that do not use computers in physics laboratory classes?

Hypotheses

Corresponding to the research questions, the following hypotheses are proposed.

H1: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that give computer based homework assignments to introductory physics students and those instructors that do not.

H2: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers during lecture presentations and those instructors that do not.

H3: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers laboratory classes and those instructors that do not.

H4: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer simulations during lecture presentations and those instructors that do not.

H5: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer problem solving during lecture presentations and those instructors that do not.

H6: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer based experiments during laboratory classes and those instructors that do not.

H7: There is no significant relationship between annual college tuition and the use of computers in physics lecture presentations.

H8: There is no significant relationship between annual college tuition upon the use of computers in physics laboratory classes.

H9: There is no significant relationship between college enrollment and the use of computers in physics lecture presentations.

H10: There is no significant relationship between college enrollment and the use of computers physics laboratory classes.

Context of the Study

Two and four year Catholic higher education institutions will be studied. The use of a parochial education system is based upon the following rationale: These are institutions that have not seen much study and consequently should represent a truer research arena.

The educational significance of this study can be seen in its attempt to examine the likely effects of introducing new technologies into traditional learning areas. With the widespread expectation of a paradigm shift in the methods of teaching physics, and science as a whole, the need for a study of CBII implementation may become, increasingly important.

Assumptions

The methodology and procedures used in this study are based on the following assumptions:

1) CBII is a tool for improving upon course delivery that may in crease the quality of instruction and student learning.
2) Students who have the opportunity to use CBII learn to use these techniques.
3) The data gathered by a survey instrument will provide a necessary base from which to determine current instructional practices.
4) A study of contemporary CBII teaching and learning methodology should assist to improve the curriculum and methods of teaching in the future.

Definition of Terms

The following definitions are provided for clarifying some of the key terms used.

CBII Computer Based Interactive Instruction includes a series of teaching and learning practices that incorporate the use of the computer. Such practices involve the use of the computer to: supplement lectures, mediate lab activities and provide direct instruction to students.

Interactive A method of learning in which students can start or stop action at any time, jump forward or backward, adjust the speed, observe an animation with or without explanation and test their understanding of the concepts. Thereby potentially overcoming any misconceptions through the use of learner control.

Physics the scientific study of the interaction of MATTER and ENERGY. Classical, or Newtonian, physics refers to the scientific studies made prior to the introduction of the quantum principle (Brennan, 1992, p.239).

Introductory Physics A two semester course introducing the students to their basic knowledge of the principles of physics. The first semester explores the areas of mechanics, heat and wave motion (sound); the second semester explores the areas of electricity, magnetism, optics, and an introduction to modern physics (Jenkins, 1994, p.13). There are two forms of introductory physics (College and University Physics) intended for students who are attempting to obtain a Bachelor's degree in one of the physical sciences, engineering, medicine, or another professional field.

College Physics A trigonometry-based version of the introductory physics course, oriented toward students majoring in medicine, allied health professions, the life sciences, and other areas. Students take this course for a physics background and not for a working knowledge of it, typically, students are in lecture for three hours and in the laboratory for another three hours (Jenkins,1994, p.14).

University Physics A calculus-based version of the introductory physics course, oriented toward engineering, physics and computer science. An extensive background in calculus is required in this course. This allows a more in-depth look at many of the physics principles (Jenkins, 1994, p.14).

Learning An internal change in the organization of knowledge that results from the insight or reinforced practice. Learning cannot be directly observed; it's existence has to be inferred from observed behaviors (Vockell and Asher, 1995, p.450).

Likert scale A technique of equal-interval measurement whereby a respondent is given a statement and is asked to place his or her response into one of these five specific categories: strongly agree, agree, uncertain, disagree, and strongly disagree behaviors (Vockell and Asher,1995, p.450).

Summary

There is general agreement that students are not successfully pursuing math and science-oriented careers, such as physics. Several approach programs have been created to address this situation. One approach, Computer-Based Interactive Instruction, attempts to attract students by introducing a new approach in the method of instruction. It is hoped that both bright-but-bored students and students who believe that math and science are difficult will be attracted to these courses through the CBII teaching method. CBII seems to be having some success, but there has been little attention given to the impacts of using the method. This study attempts to look at whether or not CBII is a successful teaching tool in a science course such as physics.

This study proposes to examine CBII as a delivery system among Catholic higher education institutions in the United States. The study proposes to investigate CBII's potential with physics. Chapter II presents the

relevant information from the literature focusing on the necessity of searching for better delivery methods. Chapter III details the design used within this study to explore the impact that CBII has had in the study of physics between Catholic institutions that use CBII for the study of physics and those Catholic institutions that do not use CBII. Chapter IV reviews, summarize and analyzes the data collected through the study's methodology and Chapter V discusses the results and recommends next steps.

Chapter II

REVIEW OF RELATED LITERATURE

Introduction

The lack of students in scientific fields like physics has become a pre-eminent issue. Most higher education faculty agree that those pursuing science and those avoiding it should be narrowed. Can CBII (Computer Based Interactive Instruction) be the solution to the problem?

Scope of the Literature review

In 1985, Journet complained that physics instructors measure scientific literacy by the quantity of information that a student has absorbed, instead of the process and role of physics in exploring and understanding the universe. Although Johnston and Aldridge (1984) wrote about the need to respond to the crisis in science education, they did not offer any possible solutions. They did, however, mention the cultural disadvantages of women as one of the causes of the crisis.

E. Mazur (1992) noted that success in solving quantitative problems is not a reliable measure of conceptual understanding. He suggests the presence of underlying difficulties that apparently are not adequately addressed by traditional physics instruction.

Hewitt (1983) suggested that the current introductory course be replaced with "a qualitative study of the central concepts of physics with emphasis on mental imagery that relates to things and events that are familiar in the everyday environment" (p. 305). Brouwer (1984) recommended a conceptual approach to physics teaching that forces students to make their conceptions explicit by explaining them to one another and to the instructor.

Sadker and Sadker (1994) report that "girls are more likely to be invisible members of classrooms. They receive fewer contacts, less praise, fewer complex and abstract questions, and less instruction on how to do things for themselves" (Sadker and Sadker, 1990, p.15). Why do female students avoid taking physics? Do they think differently than men? Studies have considered a possible relationship between male hormones and specific abilities associated with male learners, like spatial ability. However, these studies generally have found no evidence to support such a relationship (Streitmatter, 1994).

A study done by Baker and Leary (1995), suggested that the females did not like instruction that isolated them. They also did not want to be passive learners. They prefer instruction that permits them to interact with others (group work, partners, and discussion). Baker and Leary concluded that those teachers who can really connect with females in their classrooms can definitely improve student perceptions regarding science.

Peters (1990) pointed out that motivation to learn comes from teacher-generated rewards and punishments, and that teaching is isolated from students' interests and learning.

Understanding current conditions in physics classrooms is a necessary precursor to a change. Student's performance reveals a very strong dependence between the student's answers and his/her personal meaning of what was taught to him/her; "students' past science experiences and attitudes toward science play an important role in their commitment to the choice of science and non-science college majors" (Narchi, 1990).

By using CBII (Computer Based Interactive Instruction) in teaching introductory college physics, one should be able to observe if the women in the class will perform better than the same type of student not using CBII in problem solving and attitude. "There were no sex-related differences in achievement, attitude, and personality characteristics" (Ryser, Gail Renee, Ph.D., 1990).

Likens, in 1990, concluded from a study to determine if the laboratory does enhance the learning of cognitive lecture concepts, that the traditional physics laboratory does not aid in understanding the cognitive lecture concepts. Also according to Liao, 1990, the use of CAI can enhance students' cognitive performance. By using CBII in introductory college physics the simulations will assist in teaching complicated concepts involving dynamic interactions of the various physical concepts. The software will allow the student to start and stop the action at will. He/she can jump forward/backward, adjust the speed, change the input, observe the animation with/without explanation and test his/her understanding of the concepts. Misconceptions may be overcome through the use of computer images.

Advantages of Computer-Based Instruction

A computer revolution is alleged to be sweeping through higher education (Johnson, 1980; Osgood, 1984). The computer is perhaps the single most important technological phenomenon affecting our society today. In many scientific areas, computers have shown themselves to be one of the most powerful tools for research yet derived (Koshland, Jr. 1985). However in the educational system, the impact of this powerful technology is only beginning to be felt. It has a great potential in helping educators to provide a better learning environment for students (Bonner, 1984; Bork, 1984).

In education, CBII is considered the threshold of genuine educational innovation. However, the confusion is in how to successfully implement this innovation. Nuralazam, 1988 pointed out that computers are not widely used in teaching physics because of 1) financial constraints faced by many institutions; and 2) resistance to change by physics instructors.

Yet, the potential exists to use computers in teaching physics. Little is known about the degree to which it has been realized or about the reasons that influence its utilization in learning institutions.

In using CBII we hope to see that the computer simulations will allow the students to participate in "real life" situations.

Summary

The difference between the number of men and women in math and science courses has been a subject under discussion for sometime. It is generally agreed that more women are needed in these areas. Could CBII methods of instruction in a scientific field such as physics and engineering help attract and retain students, especially physics students. Studies show that many students do not like to feel isolated in the classroom and prefer instruction that allows them to interact. One only has to look at the traditional method of instruction and the traditional physics laboratory to understand why students may resist physics. Although CBII and computers in general are considered revolution in education, using the new technology is confusing to some instructors. However, since CBII may be a part of the solution to attracting and retaining students in the fields of math and physics, the effort should be made to use the new technology.

This chapter provided the presentation of relevant information from the literature as it focused on the necessity of searching for better delivery methods especially in the teaching of the sciences(physics). This information was provided as it further explains the status of the problem as presented in chapter I, especially the need to compete in the global economy.

Chapter III presents the plan for using this information as a premise for further study of instructional delivery systems in the sciences. Chapter IV reports the execution of the plan, and Chapter V evaluates and explains the findings.

Chapter III

METHODOLOGY

This chapter describes the methodology and procedures used in this study. Specifically, it sets forth details concerning research design, assumptions, target population and sampling, instrument development, data collection procedures, research limitations, and methods of data analysis.

Research Design

Because of the broad base of inquiry required to answer the specific research questions, the survey methodology has been selected as the method for conducting this investigation. The survey method is appropriate to gather answers to the questions imposed by the study, and to solicit additional comments. A survey questionnaire (Appendix A) was sent to 211 institutions selected for this sample.

Population and Sampling

The target population for this study is students taking introductory college physics in Catholic colleges and universities. Over 200 two and four-year Catholic colleges and universities are used as a sample population. The use of the parochial education system is presumed upon the following rationale: these are institutions that have not been the subject of much study and, consequently, should represent a truer research area.

All institutions present in this population will be sampled. The institutions will be selected by degree granted, and by size. Table 1 shows the number of institutions in each sub group.

The educational significance of this study can be seen in its attempt to evaluate the likely effects of introducing new technologies into traditional learning areas. With the widespread expectation of a paradigm shift in the methods of teaching physics, and science as a whole, the need for a study of CBII may become increasingly important.

Target Population

To identify the target population of Catholic Colleges and Universities and the stratification data, the 1997 issue of Hep (Higher Education Publications, Inc.) was used. According to the catalog the total number of Catholic Colleges and Universities across the USA is 211. These institutions include theological seminaries, a law school, etc.

In the following Table, Coll. represents Colleges, and Uni. represents Universities.

Table 1 presents the number of colleges and universities and their enrollment.

Enrollment	Number of Coll. & Uni.
number < 2000	132
2000 < number < 5000	44
number > 5000	35
	Total 211

Table 1
Number of Colleges and Universities and their Enrollment

The enrollment in these colleges and universities range from a minimum of 25 students to a maximum of 17,422. Less than 2,000 students constitutes the enrollment at the majority of the institutions. Only 35 have over 5,000 students enrolled. The rest have between 2,000 and 5,000 students.

Table 2 presents the number of colleges and universities and their Carnegie classifications. There are 37 theological institutions among the Catholic Colleges and Universities in the USA. They represent about 18% of the institutions and do not teach physics. There is also one Law School that does not offer physics. Several institutions are graduate schools, and they do not teach introductory physics.

Carnegie Class	Carnegie Codes	Number of Coll. & Uni.
	0	3
Research I	211	1
Research II	212	2
Doctorate I	213	5
Doctorate II	214	6
Masters I	221	61
Masters II	222	17
Baccalaureate I	231	5
Baccalaureate II	232	56
Association of Arts	240	14
Religious	251	37
Other Health	253	2
Engineering	254	1
Law	257	1
		Total 211

Table 2
Number of Colleges and Universities and their Carnegie Classifications.

For information on the Carnegie Classifications, Appendix D, the 1997 issue of Hep (Higher Education Publications, Inc.) was used.

Table 3 presents the number of colleges and universities and their annual fees.

Only 10 of these colleges and universities requires less than 4,000 dollars in annual fees. The majority require an annual fee of more than 8,000 dollars. The rest charge between 4,000 and 8,000 dollars.

Annual Tuition & Fees	Number of Coll. & Uni.
number < 4000	10
4000 < number < 8000	37
8000 < number < 12000	83
number > 12000	81
	Total 211

Table 3
Number of Colleges and Universities and their Annual Fees

Table 4 presents the number of colleges and universities and their calendar system.

Calendar System	Number of Coll. & Uni.
semester	180
quarter	8
trimester	2
4 /1 / 4	16
other	5
	Total 211

Table 4
Number of Colleges and Universities and their Calendar System

The majority of the institutions are on the semester system.

Table 5 presents the number of colleges and universities and their program type. The followings will be used in the table.

<u>TypeOBB</u> = Occupational Below Bachelor's

2YPBC = 2-Year Principally Bachelor's Creditable

Two year principally bachelor's creditable: refers to the first two years of college work.

LA&G = Liberal Arts & General

Liberal arts and general: refers to four or five year baccalaureate or post baccalaureate degree programs in the liberal arts and sciences.

TP = Teacher Preparatory

Teacher preparatory programs: refers to programs of at least four years duration.

P = Professional Occupational: refers to programs beyond high school designed to provide students with knowledge and skills necessary for immediate employment.

Professional programs: refers to separate programs of at least four years beyond high school and organized around a professionally oriented academic discipline.

Business, fine arts, music, nursing, religious, or technical emphasis: refers to programs that are organized around a specific discipline.

Program Type	Number of Coll. & Uni.
P	29
LA&G	13
LA&G + P	16
LA&G + TP	29
LA&G + TP + P	97
2YPBC	8
LA&G + 2YPBC	1
LA&G + OBB	1
LA&G + OBB + P	1
LA&G + OBB +TP	2
LA&G + OBB + TP + P	6
OBB + 2YPBC	7
LA&G + OBB +2YPBC + TP + P	1
	Total 211

Table 5
Number of Colleges and Universities and their Program

Table 6 presents the number of colleges and universities and the predominant sex of the student body. The majority of the colleges and universities are coed.

Gender	Number of Coll. & Uni.
Male	16
Female	23
Coed	170
Coordinate	2
	Total 211

Table 6
Number of Colleges and Universities and the Predominant Sex of the Student Body

Table 7 presents the number of colleges and universities and their style.

Institution Style	Number of Coll. & Uni.
Stand alone Campus	206
Branch Campus	5
	Total 211

Table 7
Number of Colleges and Universities and their Style

Table 8 presents the number of colleges and universities and their IRS (Internal Revenue Service) status.

IRS Status	Number of Coll. & Uni.
501 (C) 3	211

Table 8
Number of Colleges and Universities and their IRS Status

In this population, each institute has a separate address and will be contacted individually. Those institutions that do not offer introductory physics will be omitted from the study. The above tables give a good picture of the sample chosen for the study. The size, enrollment, degrees, classification, program type, style, and the gender of the student body represent the variety of the sample for the study.

Research Questions

This study attempts to answer the following questions:

1. What is the influence of using computer based physics homework assignments upon instructor opinions about student comprehension of physics instruction?

2. What is the influence of using computers in physics lecture presentations upon instructor opinions about student comprehension of physics instruction?

3. What is the influence of using computers in physics laboratory assignments upon instructor opinions about student comprehension of physics instruction?

4. What is the influence of using computer simulation examples in lecture presentations upon instructor opinions about student comprehension of physics instruction?

5. What is the influence of using computer problem solving techniques in lecture presentations upon instructor opinions about student comprehension of physics instruction?

6. What is the influence of using computer based experiments in laboratory assignments upon instructor opinions about student comprehension of physics instruction?

7. What is the relationship between annual college tuition among those institutions that use and those that do not use computers in physics instruction?

8. What is the relationship between annual college tuition among those institutions that use and those that do not use computers in physics laboratory classes?

9. What is the relationship between college enrollment among those institutions that use and those that do not use computers in physics instruc-

tion?

10. What is the relationship between college enrollment among those institutions that use and those that do not use computers in physics laboratory classes?

Hypotheses

Corresponding to the research questions, the following hypotheses are proposed.

H1: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that give computer based homework assignments to introductory physics students and those instructors that do not.

H2: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers during lecture presentations and those instructors that do not.

H3: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers laboratory classes and those instructors that do not.

H4: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer simulations during lecture presentations and those instructors that do not.

H5: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer problem solving during lecture presentations and those instructors that do not.

H6: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer based experiments during laboratory classes and those instructors that do not.

H7: There is no significant relationship between annual college tuition and the use of computers in physics lecture presentations

H8: There is no significant relationship between annual college tuition upon the use of computers in physics laboratory classes

H9: There is no significant relationship between college enrollment and the use of computers in physics lecture presentations

H10: There is no significant relationship between college enrollment and the use of computers physics laboratory classes

Data Collection Procedures

A survey questionnaire was sent to all the Catholic colleges and universities in the USA selected for the sample. The items in the questionnaire were selected to gather answers for the study. The questionnaire was designed specifically for this study by the researcher. The questionnaire was developed and used to measure the number of colleges and universities using CBII to teach physics.

A letter was sent to the president of each institute requesting the name of the chair of the physics department, or the name of the person who taught physics during 1996-1997. A letter from the President of Madonna University, Sr. Mary Francilene, CSSF, accompanied this request in an attempt to encourage the largest number of replies possible. The survey was then mailed to all 211 institutions. Most of the surveys were addressed to the presidents of the institutions because of the lack of response to the first request. A copy of Sr. Francilene's Letter accompanied the survey to encourage a good response. A second letter (Appendix C) and a copy of the questionnaire were mailed to those that did not respond. Sixty-two were sent via ground-mail to the institutions that did not have a web site, and 72 were sent via e-mail to faculties with e-mail or to their web-masters for those with a web-site but no e-mail in addition to ground mail. A third copy of the questionnaire was then mailed to all who did not respond. Several phone calls were made to encourage some response.

The results of this study will provide insight into the significance of the need to design and develop instructional strategies in a curriculum that matches the needs and abilities of the students and enrich the research base.

The survey was printed on 11 x 8.5 beige paper (Appendix A). The questions were placed in an orderly fashion. Using a Likert scale of 5, will hopefully encourage a response. A distinctive logo, placed on the upper-hand corner, was used to assist in making the survey easy to find among the papers on a participating faculty member's desk again to encourage a prompt response.

Instrumentation

The instrumentation consisted of one comprehensive questionnaire. The questionnaire included 60 items. Seven of the items were general to identify the respondent: his/her name, title, address, phone number, e-mail, gender, and the university. Thirteen items were in the form of questions requesting information concerning course titles, prerequisites, student enrollment, class demographics, testing methods, and grading system. Three items were in the form of questions requesting information on the usage of computers in the classroom, during lecture and during the laboratory session, and the method of judging the effectiveness of the computer-based instruction. Two items requested information on the particular instructional method being used for lecture and for lab.

Thirty items were designed as closed form questions using Likert Scale. Five of them ask for opinions on what instructors feel is the best technology to deliver physics instruction. Seven search for the method of instruction from which students seem to learn the most. Fourteen items seek to understand the instructors' opinions on available computer simulations/animation. Two items deal with students' attention and confidence; another two, with student's behavior in using computers in the classroom.

Three items are in closed form questions. The first question deals with the excellence of simulation teaching; the second asks if instructors recommend using simulations in teaching physics; the third asks if those using simulations, feel it has improved the quality of the course. The last two items of the questionnaire are for additional comments and request to receive a copy of the findings. Most of the items call for several responses. Instructors are invited to explain their choices in 5 locations and, in one place, to list some of the major software packages they use.

These items were designed to gather answers to the questions posed in chapter 1. Subsequent to the fact that no appropriate survey instrument already exists, the questionnaire was developed specifically for this study by the researcher.

Data analysis was conducted using descriptive statistics and the Chi-Square test of association to explore relationships among variables.

Internal Consistency

The 33 question variables that used a Likert scale in the survey instrument were numbered Q19 to Q51. For these question variables, an internal consistency analysis was conducted using Cronbach's Alpha. The resulting alpha value was .78 indicating a high internal consistency between these statements.

Timeline

The questionnaire was mailed to all Catholic Colleges and Universities in the United States asking the physics instructors to kindly respond as soon as possible. The questionnaire was mailed in a sealed envelope, accompanied by a letter and a return envelope.

Three weeks later, a second letter was sent to those that did not provide a prompt response.

Two weeks latter, a third questionnaire was sent via ground mail and via e-mail to those whose addresses were available, where no e-mail address was unavailable, the questionnaire was sent to a web-master. Several phone calls were also made to Physics Department Chairpersons.

Universities count of less than 2000 students

These often do not have individual departments for each science area. Usually they have only one full-time faculty member teaching the physics course as well as other courses in other areas.

Count between 2000 and 5000 students

These institutions may or may not have separate physics departments. Usually they have more than one full-time physics instructor.

Count greater than 5000 students

These institutions usually have separate physics departments with several full-time physics instructors.

Limitations of the Study

1. The results of study are limited by:

    a) the number of colleges and universities.

    b) the number of students in each college and university.

    c) the current practice of teaching introductory college physics in 2-4 year Catholic universities in the USA.

2. The self reporting questionnaire and the inability to verify the results.

3. The use of the voluntary response to the questionnaire.

4. The questionnaire was the only data gathering device in the study.

5. The manner in which the questionnaire sought to collect some data by separating the different instruments used in teaching could prove to be a shortcoming in the method of data collection.

Data Collection Procedure

A letter was sent to the president or administrator of each college or university asking him/her to give the name of the faculty member teaching Introductory College Physics. The letter was accompanied by a supporting letter from a respected and known president of one of these universities; its purpose was to encourage a timely response. A return self-addressed envelope was enclosed to further encourage a fast response.

A copy of the questionnaire was then sent to the indicated staff member in the physics department of the institutes that replied, the rest of the questionnaires were sent, for the second time, to the presidents or administrators with a letter asking them to forward it to their physics instructors.

There was also an agreement letter asking the faculty member to allow the usage of the information based upon total confidentiality with the promise of sending the final result of the study to the faculty member. The letter explained the purpose of the survey and outlined the importance of completing and returning it.

Data Analysis

The data from the responses was entered into a spreadsheet (Microsoft Excel) and numbered. This was latter transferred into a SPSS 7.5 file for further study. Tables are used to distribute and study the response of the institutions.

Once the responses were received, data analysis was conducted using descriptive statistics and the Chi-Square test of association to explore the relationship among variables.

The survey was designed to:

- show the differences between the ways the introductory course is handled at small, medium, and large universities, as well as the usage of CBII in these institutions;
- provide a necessary base from which to determine current instructional policies;
- provide data that might assist in improving the curriculum and methods of teaching in the future.

Summary

This chapter discussed the methods and procedures used in conducting this study. This included all aspects dealing with determining the most logical method of gathering the data, the instrument to be used, the data to be obtained, and the structure of the data analysis. The methods and procedures described in this chapter are consistent with the nature of the investigation as described in Chapter I and II.

Chapter IV reports the actual data found as a result of the execution of the plan defined in Chapter III. Chapter V evaluates the data presented in Chapter IV and discusses its relationship to the effect of using CBII as an instructional delivery system in higher education students. Chapter V also discusses future implications and recommendations for future research.

Chapter IV

FINDINGS

Introduction

Chapter IV presents and analyzes the study's findings. It includes the participant data demographics, an evaluation of the hypothesis, the data tabulation, and the comments made by the respondents.

The previous chapter discussed the methodology used in this study. Ten research questions were presented dealing with the usage of computers (CBII) in teaching introductory physics. Some questions dealt with the potential relationship of certain demographics on the effect of CBII in learning. The instrument used in this study was a survey sent to 211 Catholic colleges and universities. The instrument was administered, as scheduled in the plan described in Chapter III, to physics instructors teaching introductory physics classes in these institutions.

Participant Data Demographics

The questionnaire was sent to 211 colleges and universities in 38 states. The size of the universities range from less than a thousand to over 15,000. Table 9 represents the number of institutions and the size of student body. There are 159 institutions with less than 3,000 students, however only 38 of the 159 responded to the questionnaire. Among the 24 institutions with students between 3,000 and 6,000, only 12 responded. From the 28 institutions with student count between 6,000 and above

15,000, only 12 responded. See tables 9 and 10.

Let X = Number of students

Size of Institution	Number of Institutions
X< 3000	159
3001 < X < 6000	24
6001 < X < 9000	14
9001 < X < 15,000	12
X >15,000	2
	Total = 211

Table 9
Size and number of institutions

Responses were received from institutions ranging in size from less than a thousand to 14,001. The two largest universities did not respond.

Table 10 presents the size of the institution versus the number of institutions in that category.

Size of Institution	Number of Institutions
X < 3000	38
3001 < X < 6000	12
6001 < X < 10000	7
10001 < X < 14000	4
X > 14000	1
	Total 62

Table 10
Size and number of participating institutes

The institutions also vary in annual tuition. Table 11 presents the ranges of the annual tuition versus the number of institutes. There are 33 institutions with an annual tuition of less than 6,800 dollars, and 67 with tuition ranging from 6,800 to 10,800 dollars, annually. Almost 50% of all the institutions are within these two ranges. The rest, about 53% require annual tuition above 11,000 dollars.

$= Annual Tuition	Number of Institutions
$ < 6800	33
6801 < $ <10800	67
10801 < $ <14800	91
$ >14000	20
	Total 211

Table 11
Annual tuition and number of institutions

Table 12 represents the annual tuition of the institutions that replied.

$= Annual Tuition	Number of Institutions
$ < 6800	5
6801 < $ <10800	18
10801 < $ <14800	32
$ >14000	7
	Total 62

Table 12
Annual tuition and number of participating institutions

Among those institutions that responded to the survey 39 list annual tuition of 11,000 dollars or more; these 39 institutions constitute about 63% of the total number of those that replied.

Responses to the Survey Questionnaire

In this section the overall responses to the survey questionnaire are discussed. The questionnaire sent to recipients is in Appendix A.

The questionnaire was sent to the presidents, physics department chairs and or introductory physics instructors at 211 Catholic colleges and universities. The initial mailing plus two follow-up mailings resulted in the return of 122 surveys from 110 institutions. This gives an overall response rate of 52 percent. After the elimination of the surveys from the institutions that do not teach physics, there remained 74 valid surveys from 62 institutions, giving an effective response rate of about 30%. The questionnaire (Appendix A) consists of 52 items. Table 13 presents a description of the intent of the various items.

Item	Description
1	Determines the introductory physics course being taught.
2, 3	The prerequisites or pretests for the course.
4-6	Student enrollment in the course.
7-11	Demographics of the class.
12	Testing method used in the course.
13	Method of grading used by the instructor.
14	The usage of computers in lectures and laboratory.
15	Number of students assigned per computer in the classroom.
16	Evaluation of the effectiveness of computer-based instruction.
17	Instructional methods used in lecture.
18	Instructional methods used in the laboratory.
19- 23	Method of delivery of instruction.
24- 30	The teaching tools most preferred by students.
31- 44	Characteristics of available computer simulations in classroom.
45- 46	Students' confidence in using computer simulations.
47- 48	Female students' use of computers in the classroom.
49	Rates simulation teaching experience in the classroom.
50	Recommending simulation teaching of physics.
51	Improving the quality of the course.
52	Requests instructors' additional comments (Appendix E).

Table 13
Description of intent of the various items

An independent samples t-test was used to test for any differences in means of participants' responses to items 19 through 51 versus the usage of computers in the classrooms as seen in questions 13, 14, 17, and 18.

Table 14 displays the variables tested for questions 13d, 14a, 14b, 17d, 17e, and 18c. They are as follows

1. Question 13d versus items 19 to 51
2. Question 14a versus items 19 to 51
3. Question 14b versus items 19 to 51
4. Question 17d versus items 19 to 51
5. Question 17e versus items 19 to 51
6. Question 18c versus items 19 to 51

Crosstabs analysis was then performed on items 14a and 14b versus the annual tuition, and also versus enrollment to study the effect, if any, of both tuition and enrollment on the usage of computers in these institutions.

The results, based upon a .05 confidence level, indicated that the following variables were tested as significant ($p < .05$).

H1: Items 23, 26, 33, 34, 37, 38, 44

H2: Items 19, 23, 33, 34, 36, 38, 43, 44

H3: Items 23, 43, 50, 51

H4: Items 20, 21, 22, 23, 24, 33, 34, 37, 38, 43, 44

H5: Items 21, 22, 23, 24, 29, 31, 33, 34, 35, 36, 38, 41, 44, 51

H6: Items 19, 23, 33, 34, 37, 43, 44

The non-parametric test, Chi-Square demonstrated no statistically significant difference in hypotheses H7, H9, and H10, while H8 is significant, thus rejecting the null hypothesis for H8 and accepting it for H7, H9, and H10. From hypothesis H8, rejecting the null hypothesis implies that the Annual Tuition seems to influence the use of computers in the teaching of physics in the laboratory.

Evaluation of Hypothesis

In this section, the data is presented based upon its relationship to each of the research hypothesis that have guided this study.

For all comparisons, a .05 level of confidence was used as a basis for determining significance for the observed data. The .05 level of confidence is commonly used in education research and is appropriate for exploratory studies of this type.

For the purpose of analysis of the hypotheses in this study, all data was considered to be interval in nature and, therefore, to be suitable for parametric statistical analyses. Table 14 presents all the items tested.

* = $p < .05$

	The delivery of physics instruction is best done with
19.	videos
20.	transparencies
21.	laser disks
22.	CD ROM's
23.	computer simulation
	The students appear to learn more from
24.	Simulations/animation
25.	text
26.	demonstrations
27.	lectures
28.	lectures supplemented with transparencies
29.	hands-on activities
30.	videos
	Available computer simulations/animation
31.	are easy to follow
32.	allow to visualize concepts
33.	allow a variety of teaching strategies
34.	provide students interactions
35.	allow individual self pacing
36.	permit collaborative learning
37.	are interesting
38.	are fun
39.	are realistic
40.	are lively
41.	are colorful
42.	are suitable replacement of textbooks
43.	are used to facilitate learning
44.	are interactive
	The students using simulations/animation
45.	learn with confidence
46.	get individual attention
47.	females tend to be intimidated by using computers
48.	females tend to dominate the use of computers
49	I would rate simulation teaching experience as excellent
50.	I recommend using simulations in teaching physics
51.	simulation has improved the quality of the course

Table 14
Items tested

Hypothesis 1

There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that give computer based homework assignments to introductory physics students and those instructors that do not.

The t-Test for independent samples compared question 13d to items 19 -51 (Table 15) and found items 23, 26, 33, 34, 37, 38 and 44 to be statistically significant. Using a .05 confidence level, the null hypothesis is rejected. For the remainder of the items, no statistically significant difference was detected and the null hypotheses were accepted.

EVA = Equal variances assumed EVNA = Equal variances Not assumed		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ITEM 23	EVA	.736	.394	.037	.60	.28
	EVNA			.013	.60	.23
ITEM 26	EVA	10.099	.002	.068	-.39	.21
	EVNA			.012	-.39	.15
ITEM 33	EVA	1.385	.243	.001	.68	.19
	EVNA			.001	.68	.18
ITEM 34	EVA	1.923	.170	.010	.51	.19
	EVNA			.044	.51	.24
ITEM 37	EVA	.029	.866	.006	.51	.18
	EVNA			.015	.51	.19
ITEM 38	EVA	1.032	.313	.029	.43	.19
	EVNA			.049	.43	.21
ITEM 44	EVA	.494	.484	.016	.46	.19
	EVNA			.039	.46	.21

Table 15
H1. Independent samples test

Table 16 summarizes these items that were found to be statistically significant and are indicated by an asterisk.

* = p < .05

The delivery of physics instruction is best done with		
23	*computer simulation	p<.05
The students appear to learn more from		
26	*demonstrations	p<.05
Available computer simulations/animation		
33	*allow a variety of teaching strategies	p<.05
34	*provide students interactions	p<.05
37	*are interesting	p<.05
38	*are fun	p<.05
44	*are interactive	p<.05

Table 16

Statistically significant items for H1

Table 16 appears to demonstrate that computer simulations, based upon the data analyzed within this study, do affect students' comprehension of physics instruction when computer-based homework assignments are given to introductory physics students. However Computer simulations appear to encourage a variety of teaching strategies, and increase student interaction, while making the instruction more interesting, fun, and interactive for the student.

Hypothesis 2

There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers during lecture presentations and those instructors that do not.

The t-Test for independent samples compared question 14a to items 19 -51 (Table 17) and found items 19, 23, 33 ,34, 36, 38, 43 and 44 to be statistically significant. Using a .05 confidence level, the null hypothesis is rejected. In the remainder of the items no statistically significant difference was detected and the null hypothesis is accepted.

EVA = Equal variances assumed EVNA = Equal variances Not assumed		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ITEM 19	EVA	1.120	.293	.042	.57	.28
	EVNA			.033	.57	.26
ITEM 23	EVA	.304	.583	.033	.73	.24
	EVNA			.002	.73	.24
ITEM 33	EVA	.569	.453	.023	.41	.18
	EVNA			.028	.41	.18
ITEM 34	EVA	.247	.621	.000	.74	.16
	EVNA			.000	.74	.17
ITEM 36	EVA	1.565	.215	.005	.43	.15
	EVNA			.010	.43	.16
ITEM 38	EVA	14.230	.000	.028	.38	.17
	EVNA			.078	.38	.21
ITEM 44	EVA	.494	.484	.016	.46	.19
	EVNA			.039	.46	.21

Table 17
H2. Independent samples test

Table 18 represents the items that are statistically significant and are indicated by an asterisk.

* = p < .05

The delivery of physics instruction is best done with		
19	*videos	p<.05
23	*computer simulation	p<.05
Available computer simulations/animation		
33	*allow a variety of teaching strategies	p<.05
34	*provide students interactions	p<.05
36	*permit collaborative learning	p<.05
38	*are fun	p<.05
43	*are used to facilitate learning	p<.05
44	*are interactive	p<.05

Table 18
Statistically significant items for H2

The above table demonstrates that computer simulations do affect students' comprehension of physics instruction during lecture presentations to introductory physics students; and, computer simulations allow a variety of teaching strategies, provide student interaction, permit collaborative learning, facilitate learning, and are interactive.

Hypothesis 3

There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers laboratory classes and those instructors that do not.

The t-Test for independent samples compared question 14b to items 19 -51 (Table 19) and found items 23, 43, 50 and 51 to be statistically significant. Using a .05 confidence level, the null hypothesis is rejected. In the remainder of the items no statistically significant difference was detected and the null hypothesis is accepted.

EVA = Equal variances assumed EVNA = Equal variances not assumed	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ITEM 23 EVA	.631	.430	.016	.63	.26
EVNA			.016	.63	.26
ITEM 43 EVA	.208	.650	.043	.34	.17
EVNA			.042	.34	.16
ITEM 50 EVA	26.498	.000	.086	-.48	.28
EVNA			.031	-.48	.22
ITEM 51 EVA	20.968	.000	.091	-.45	.26
EVNA			.036	-.45	.21

Table 19
H3. Independent samples test

Table 20 represents the items that are statistically significant and are indicated by an asterisk.

* = p < .05

	The delivery of physics instruction is best done with	
23	*computer simulation	p<.05
	Available computer simulations/animation	
43	*are used to facilitate learning	p<.05
	In the classroom	
50	*I recommend using simulations in teaching physics	p<.05
51	*Simulation has improved the quality of the course	p<.05

Table 20
Statistically significant items for H3

Interpretation of Table 20 suggests that computer simulations may affect students' comprehension of physics instruction when given computer laboratory classes to introductory physics students. It also appears that computer simulations may facilitate learning and improve the quality of the course.

Hypothesis 4

There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer simulations during lecture presentations and those instructors that do not.

The t-Test for independent samples compared question 17d to items 19 -51 (Table 21) and found items 20, 21, 22, 23, 24, 33, 34 ,37, 38, 43 and 44 to be statistically significant. Using a .05 confidence level, the null hypothesis is rejected. In the remainder of the items no statistically significant difference was detected and the null hypothesis is accepted.

EVA = Equal variances assumed 4 EVNA = Equal variances not assumed	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ITEM 20 EVA	1.144	.288	.006	.62	.22
EVNA			.003	.62	.20
ITEM 21 EVA	.432	.513	.010	.56	.21
EVNA			.006	.56	.20
ITEM 22 EVA	.147	.703	.002	.66	.21
EVNA			.002	.66	.20
ITEM 23 EVA	2.958	.090	.000	.88	.22
EVNA			.000	.88	.19
ITEM 24 EVA	.052	.820	.044	.34	.16
EVNA			.039	.34	.16
ITEM 33 EVA	3.320	.073	.004	.49	.16
EVNA			.007	.49	.17
ITEM 34 EVA	4.245	.043	.009	.43	.16
EVNA			.017	.43	.17
ITEM 37 EVA	1.722	.194	.006	.43	.15
EVNA			.008	.43	.16
ITEM 38 EVA	9.538	.003	.003	.48	.16
EVNA			.008	.48	.17
ITEM 43 EVA	4.349	.041	.000	.54	.14
EVNA			.000	.54	.14
ITEM 44 EVA	.159	.691	.018	.38	.16
EVNA			.019	.38	.16

Table 21

H4. Independent samples test

Table 22 demonstrates that computer simulations do affect student's comprehension of physics instruction during lecture presentations to introductory physics students, and that computer simulation allows a variety of teaching strategies, provides student interaction and they are interesting, fun, and interactive.

* = p < .05

	The delivery of physics instruction is best done with	
20	*transparencies	p<.05
21	*laser disks	p<.05
22	*CD ROM's	p<.05
23	*computer simulation	p<.05
	The students appear to learn more from	
24	*simulations/animation	p<.05
	Available computer simulations/animation	
33	*allow a variety of teaching strategies	p<.05
34	*provide students interactions	p<.05
37	*are interesting	p<.05
38	*are fun	p<.05
43	*are used to facilitate learning	p<.05
44	*are interactive	p<.05

Table 22
Statistically significant items for H4

Hypothesis 5

There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer problem solving during lecture presentations and those instructors that do not.

The t-Test for independent samples compared question 17e to items 19 -51 (Table23) and found items 21, 22, 23, 24, 29, 31, 33, 34, 35, 36, 38, 41, 44 and 51 to be statistically significant. Using a .05 confidence level, the null hypothesis is rejected. In the remainder of the items no statistically significant difference was detected and the null hypothesis is accepted.

EVA = Equal variances assumed / EVNA = Equal variances not assumed	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ITEM 21 EVA	.810	.371	.021	.89	.38
EVNA			.077	.89	.42
ITEM 22 EVA	1.292	.260	.001	1.24	.36
EVNA			.026	1.24	.41
ITEM 23 EVA	.351	.555	.018	.99	.41
EVNA			.021	.99	.33
ITEM 24 EVA	.578	.450	.021	.68	.29
EVNA			.125	.68	.37
ITEM 29 EVA	14.13	.000	.016	.74	.30
EVNA			.000	.74	8.79E-02
ITEM 31 EVA	1.804	.183	.001	.79	.23
EVNA			.050	.79	.31
ITEM 33 EVA	3.535	.046	.005	.84	.29
EVNA			.090	.84	.41
ITEM 34 EVA	.464	.498	.025	.66	.29
EVNA			.132	.66	.37
ITEM 35 EVA	3.281	.074	.003	.83	.27
EVNA			.002	.83	.18
ITEM 36 EVA	2.109	.151	.009	.68	.25
EVNA			.124	.68	.37
ITEM 38 EVA	1.150	.287	.011	.74	.28
EVNA			.035	.74	.27
ITEM 41 EVA	.203	.654	.048	.50	.25
EVNA			.171	.50	.31
ITEM 44 EVA	.011	.916	.010	.73	.27
EVNA			.065	.73	.32
ITEM 51 EVA	3.816	.055	.049	.83	.41
EVNA			.230	.83	.61

Table 23
H5. Independent samples test

Table 24 represents the items that are statistically significant and are indicated by an asterisk..

* = p < .05

	The delivery of physics instruction is best done with	
21	*laser disks	p<.05
22	*CD ROM's	p<.05
23	*computer simulation	p<.05
	The students appear to learn more from	
24	*simulations/animation	p<.05
29	*hands-on activities	p<.05
	Available computer simulations/animation	
31	*are easy to follow	p<.05
33	*allow a variety of teaching strategies	p<.05
34	*provide students interactions	p<.05
35	*allow individual self pacing	p<.05
36	*permit collaborative learning	p<.05
38	*are fun	p<.05
41	*are colorful	p<.05
44	*are interactive	p<.05
	In the classroom	
51	*Simulation has improved the quality of the course	p<.05

Table 24
Statistically significant items for H5

Table 24 demonstrates that computer simulations do affect students' comprehension of physics instruction in problem solving during lecture presentations to introductory physics students; and, that computer simulations are easy to follow, allow a variety of teaching strategies, provide student interaction, allow individual self-pacing, permit collaborative learning, are fun, colorful, interactive and improve the quality of the course.

Hypothesis 6

There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer based experiments during laboratory classes and those instructors that do not.

The t-Test for independent samples compared question 18c to items 19 -51(Table 25) and found items 19, 23, 33, 34, 37, 43, and 44 to be statistically significant. Using a .05 confidence level, the null hypothesis is rejected. In the remainder of the items no statistically significant difference was detected and the null hypothesis is accepted.

EVA = Equal variances assumed	Levene's Test for Equality of Variances		t-test for Equality of Means		
EVNA = Equal variances not assumed	F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
ITEM 19 EVA	3.825	.054	.030	.56	.25
EVNA			.029	.56	.25
ITEM 23 EVA	.002	.963	.021	.53	.22
EVNA			.021	.53	.22
ITEM 33 EVA	1.043	.311	.025	.37	.16
EVNA			.024	.37	.16
ITEM 34 EVA	5.982	.017	.021	.34	.16
EVNA			.022	.34	.16
ITEM 37 EVA	2.965	.089	.036	.32	.15
EVNA			.037	.32	.15
ITEM 43 EVA	1.737	.192	.000	.52	.14
EVNA			.000	.52	.14
ITEM 44 EVA	.186	.668	.005	.43	.15
EVNA			.005	.43	.15

Table 25
H6. Independent samples test

Table 26 represents the items that are statistically significant and are indicated by an asterisk.

* = p < .05

	The delivery of physics instruction is best done with	
19	*videos	p<.05
23	*computer simulation	p<.05
	Available computer simulations/animation	
33	*allow a variety of teaching strategies	p<.05
34	*provide students interactions	p<.05
37	*are interesting	p<.05
43	*are used to facilitate learning	p<.05
44	*are interactive	p<.05

Table 26

Statistically significant items for H6

The above table demonstrates that computer simulations do affect students' comprehension of physics instruction when using computer based experiments during laboratory classes to introductory physics students; and that computer simulations allow a variety of teaching strategies, provide student interaction, interesting, facilitate learning and are interactive.

Hypothesis 7

There is no significant relationship between annual college tuition and the use of computers in physics lecture presentations.

Hypothesis 8

There is no significant relationship between annual college tuition upon the use of computers in physics laboratory classes.

Hypothesis 9

There is no significant relationship between college enrollment and the use of computers in physics lecture presentations.

Hypothesis 10

There is no significant relationship between college enrollment and the use of computers physics laboratory classes.

In hypotheses 7, 9, and 10 the null hypotheses are not rejected because they are not statistically significant. The non-parametric test, Chi-Square demonstrated no statistically significant difference in hypotheses 7, 9, 10. According to the Chi-Square test, hypothesis 8 is significant, and rejecting the null hypothesis for 8 implies that the annual tuition seems to influence the use of computers in the laboratory. About 53% of those institutions that replied require tuition over 11,000 dollars. The following tables present the significant variables and their value of significance.

<u>Data Tabulation</u>

Mean Score (Standard Deviation)

Item Variable	Yes n = 15	No n = 59	p Value * p<.05
23	3.37(.70)	3.14(1.02)	.037*
26	3.80(.41)	4.19(.78)	.012*
33	3.93(.59)	3.25(.68)	.001*
34	3.80(.86)	3.29(.62)	.010*
37	3.80(.68)	3.29(.62)	.006*
38	3.67(.72)	3.24(.65)	.029*
44	3.87(.74)	3.41(.62)	.016*

Table 27

H1: Comparison of factors that affect CBII for student comprehension of physics instruction between instructors using computer based homework assignments.

Mean Score (Standard Deviation)

Item Variable	Yes n = 15	No n = 59	p Value * p<.05
19	3.23 (.97)	2.65 (1.14)	0.042*
23	3.71 (.81)	3.04 (0.99)	0.003*
33	3.68 (.72)	3.27 (0.69)	0.023*
34	3.91 (.68)	3.17 (.58)	0.000*
36	3.68 (.65)	3.25 (.56)	0.005*
38	3.59 (.91)	3.21 (.54)	0.078*
43	3.91 (.68)	3.50 (.58)	0.010*
44	3.82 (.59)	3.37 (.66)	0.007*

* p<.05

Table 28

H2: Comparison of factors that affect CBII for student comprehension of physics instruction between instructors using computer based lecture presentations.

Mean Score (Standard Deviation)

Item Variable	Yes n = 15	No n = 59	p Value * p<.05
23	3.42 (.98)	2.79 (.92)	0.016*
43	3.71 (.630	3.37 (.60)	0.043*
50	2.20 (1.15)	2.68 (.67)	0.031*
51	2.29 (1.07)	2.74 (.65)	0.036*

* p<.05

Table 29

H3: Comparison of factors that affect CBII for student comprehension of physics instruction between instructors using computer based laboratory presentation.

Mean Score (Standard Deviation)

Item Variable	Yes n = 15	No n = 59	p Value * p<.05
20	3.41 (.75)	2.79 (1.00)	0.006*
21	3.37 (.75)	2.79 (1.00)	0.006*
22	3.44 (.80)	2.79 (.88)	0.02*
23	3.8 (.56)	2.94 (1.05)	0.00*
24	3.59 (.64)	3.26 (.71)	0.044*
33	3.70 (.78)	3.21 (.62)	0.004*
34	3.67 (.68)	3.23 (.60)	0.017
37	3.67 (.68)	3.23 (.60)	0.006*
38	3.63 (.79)	3.15 (.55)	0.008*
43	3.96 (.59)	3.43 (.58)	0.000*
44	3.74 (.66)	3.36 (.64)	0.018*

* p<.05

Table 30

H4: Comparison of factors that affect CBII for student comprehension of physics instruction between instructors using computer simulations during lecture

Mean Score (Standard Deviation)

Item Variable	Yes n = 15	No n = 59	p Value * p<.05
21	3.83 (.98)	2.94 (.88)	0.021*
22	4.17 (.98)	2.93 (.83)	0.001*
23	4.17 (.75)	3.18 (.98)	0.018*
24	4.00 (.89)	3.32 (.66)	0.021*
29	5.00 (.00)	4.26 (.73)	0.000*
31	3.83 (.75)	3.04 (.53)	0.001*
33	4.17 (.98)	3.32 (.66)	0.005*
34	4.00 (.89)	3.34 (.66)	0.025*
35	4.17 (.41)	3.34 (.64)	0.003*
36	4.00 (.89)	3.32 (.56)	0.009*
38	4.00 (.63)	3.26 (.66)	0.011*
41	3.83 (.75)	3.34 (.56)	0.048*
44	4.17 (.75)	3.44 (.63)	0.010*
51	3.17 (1.47)	2.34 (.92)	0.049*

* p<.05

Table 31

H5: Comparison of factors that affect CBII for student comprehension of physics instruction between instructors using computer based problem solving

Mean Score (Standard Deviation)

Item Variable	Yes n = 15	No n = 59	p Value * p<.05
19	3.11 (.98)	2.55 (1.18)	0.030*
23	3.53 (.88)	3.00 (1.04)	0.021*
33	3.58 (.88)	3.21 (.70)	0.025*
34	3.58 (.77)	3.21 (.58)	0.022*
37	3.56 (.69)	3.24 (.59)	0.036*
43	3.89 (.57)	3.37 (.59)	0.000*
44	3.72 (.66)	3.29 (.61)	0.005*

* p<.05

Table 32

H6: Comparison of factors that affect CBII for student comprehension of physics instruction between instructors using computer based experiments.

Considerations of the Study

1. The questionnaire was composed of items based mainly on concerns from the current literature dealing with using CBII in the teaching of Introductory College Physics, while earlier studies have been done on the teaching of physics. Apparently, this seems to be the first study of its kind, comparing the usage of CBI among higher institutions. As a result, comparison with data from other studies was not possible.
2. From the onset, it was made clear to the instructors to differentiate between the two introductory courses. The existence of these two introductory courses (Calculus, and non-Calculus based) was of concern to the researcher from the beginning. While the number (211) of Catholic Colleges and Universities in the USA seems small, these institutions represent a large number of students, of diverse background and discipline, from all over the country.
3. The sampling units were based on the Carnegie Classification Code Definitions; used for the stratification by degree (Appendix D)

Summary

This chapter has served to report the available data compiled by this study. It has reported and presented the data realized by the study. The research hypotheses and their related research questions have been stated and the data analyzed for answering the questions.

An independent samples t-test was used to test for any differences in means on the participants' responses to items 19 through 51 versus the usage of computers in the classrooms as seen in questions 13d, 14a, 14b, 17d, 17e, and 18c. Crosstabs analysis was then performed on questions 14a and 14b versus the annual tuition, and also versus the enrollment to study the effect, if any, of both tuition and enrollment on the usage of computers in these institutions.

The results of the investigation as reported in this chapter have served as the basis for the conclusions, which are reported in Chapter V. Chapter V serves the purpose of identifying the meaning of the data and establishing the importance of these findings to those in the field of education.

Chapter V

CONCLUSIONS AND SUMMARY

Introduction

This chapter summarizes the results of the study, derives associated conclusions and makes recommendations based upon those conclusions. Included are an overview, a summary of the results, limitations of the study, major findings, conclusions, recommendations for improved practice and suggestions for further study.

This study was designed to compare institutions using computers in delivering instruction in the traditional manner and institutions using computers in their delivery. As originally conceived, the purpose of the study was to determine which delivery method is being used in various instructional environments. Instructional environments, however, contains many components, such as the number of hours of lecture, laboratory, and problem sessions each week, the textbooks and laboratory manuals used, the physical facilities, student background and preparation, the instructors, and type of institution.

In the educational environment, computers appear to have become a major component of instructional delivery. Numerous reports have speculated on the effectiveness of computer simulations in education, and suggested that computers are valuable aids in the enhancement of learning.

Overview

Mayes, 1992, points out that:

Computer simulations allow students to assume roles that motivate

> them toward the accomplishment of realistic goals. As an instrument for problem solving, the computer assists students in making decisions, following logical steps and finding answers to problems through the use of provided information. Through its provision of educational games, the computer allows the student to learn through entertaining and recreational activities. Moreover, its problem-solving format is conducive to the creation of higher level skills tailored to the specific needs of all students across several disciplines.

Numerous studies have explored the effectiveness of computer-aided instruction (or CAI) in promoting academic achievement (Chirstmann, Lucking and Badgett 1997; Mauriel 1989).

The data sources for this study were the actual instructors teaching courses. It was made clear to the study's sample (at the beginning of the questionnaire) that only the instructor of the course should respond. This was to eliminate any unwarranted speculation by others. By using descriptive statistics a comparison between various institutions was possible through the results of the questionnaire and the application of various statistical procedures..

Chapters I and II reported information on the need for a delivery system. Chapters III and IV presented the plan and a report of the findings. Chapter V was constructed to explore and discuss the findings of the study. The chapter consists of five sections:

1. Significant outcomes of the study
2. Exploration and discussion of the research hypotheses
3. Implications of the study
4. General recommendations

5. Recommendations for future research

Outcomes of the Study

The goal of the study was to compare the institutions using computer based instruction to the institutions which did not use this delivery method of instruction with students taking introductory college/university physics. Based upon the analysis of the data gathered during this study, it is concluded that the use of CBII for delivery yields results which are better than those obtained by students in traditional classrooms.

The t-Test used for analysis showed a statistically significant difference among the groups. The difference being positive for the students in the institutions using computer-based instruction. The rationale for this difference was discussed in Chapter IV.

The study showed that the majority of the institutions use computers as a delivery system in teaching introductory physics. The instructors' choice of instructional delivery systems, for scientific subjects like physics, has a potential impact upon students which could be an important key in encouraging students to pursue high impact career directions that are frequently viewed by most students, as too difficult.

Exploration and Discussion of the Research Hypotheses

Each of the research hypotheses will be discussed relative to the findings stated in Chapter IV. The data and findings discussed are derived from responses received from instructors teaching introductory physics (college and university) and represent Catholic universities and colleges from all over the United States. Out of 211 institutions, 122 instructors responded during the time set for the study. they represent 110 institutions and represent an overall response rate of 52%. The institutions that do not teach physics were eliminated from the study, leaving 74 valid surveys from 62 institutions, or a response rate of about 30%.

Hypothesis 1

This hypothesis was based on item 13d on the questionnaire, versus items 19-51.

Item 13d. Which of the following are used in calculating student grades? Computer-based homework assignment?

H1: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that give computer based homework assignments to introductory physics students and those instructors that do not.

The hypothesis, as stated, predicts that instructors using computers in homework assignments will have a similar response to the instructors not using computers in introductory physics homework assignments.

The items that were statistically significant are represented in table 21. Specifically, items 23, 26, 33, 34, 37, 38, and 44 were statistically significant at the .05 level of confidence.

Item 23 stated that the delivery of physics is best done with computer simulations. The p value or percentage of likelihood of achieving a score by chance, was $< .037$ indicating that there is less than 3.7 percent (37 out of 1,000) chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 26 stated that the students appear to learn more from demonstrations. The p value or percentage of likelihood of achieving a score by chance, was < .012 indicating that there is less than 1.2 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 33 stated that available computer simulations/animation allow a variety of teaching strategies. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than . .1 percent chance that the hypothesis is accepted. Therefore, it is very unlikely that the two groups of instructors will have the same opinion.

Item 34 stated that available computer simulations/animation provide student interaction. The p value or percentage of likelihood of achieving a score by chance, was < .010 indicating that there is less than 1 percent chance that the hypothesis is accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 37 stated that available computer simulations/animation are interesting. The p value or percentage of likelihood of achieving a score by chance, was < .006 indicating that there is less than .6 chance that the hypothesis is accepted. Therefore, it is very unlikely that the two groups of instructors will have the same opinion.

Item 38 stated that available computer simulations/animation are fun.

The p value or percentage of likelihood of achieving a score by chance, was < .029 indicating that there is less than 2.9 percent chance that the hypothesis should be accepted. Therefore, it is very unlikely that the two groups of instructors will have the same opinion.

Item 44 stated that available computer simulations/animation are interactive. The p value or percentage of likelihood of achieving a score by chance, was < .016 indicating that there is less than .1.6 percent chance that the hypothesis should be accepted. Therefore, it is very unlikely that the two groups of instructors will have the same opinion. Hypothesis 1 is therefore rejected.

If the investigation had shown that the results were not significant, the findings of this study would still be positive. Many investigators, especially in the elementary and secondary levels have supported the use of the computer in the classroom. The higher mean scores derived in the t-Test is an indication that many instructors are now using computer based homework assignments when instructing introductory physics students.

Hypothesis 2

This hypothesis was based on item 14a, on the questionnaire, versus items 19-51.

Item 14a. Do you use computers in lecture?

H2: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers during lecture presentations and those instructors that do not.

The hypothesis, as stated, predicts that instructors using computers during lecture presentations will have a similar respond as the instructors not using computers in introductory physics lecture presentations.

The items that were statistically significant are represented in table 22. Specifically, items 19, 23, 33, 34, 36, 38, 43, 44 were statistically significant at the .05 level of confidence.

Item 19 stated that the delivery of physics is best done with videos. The p value or percentage of likelihood of achieving a score by chance, was $< .042$ indicating that there is less than 4.2 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion (Table 21).

Item 23 stated that the delivery of physics is best done with computer simulations. The p value or percentage of likelihood of achieving a score by chance, was $< .003$ indicating that there is less than .3 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 33 stated that available computer simulations/animation allow a variety of teaching strategies. The p value or percentage of likelihood of achieving a score by chance, was $< .023$ indicating that there is less than 2.3 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 34 stated that available computer simulations/animation provide students interactions. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than .1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 36 stated that available computer simulations/animation permit collaborative learning. The p value or percentage of likelihood of achieving a score by chance, was < .005 indicating that there is less than .5 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 38 stated that available computer simulations/animation are fun. The p value or percentage of likelihood of achieving a score by chance, was < .078 indicating that there is less than 7.8 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 43 stated that available computer simulations/animation are used to facilitate learning. The p value or percentage of likelihood of achieving a score by chance, was < .010 indicating that there is less than 1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 44 stated that available computer simulations/animation are interactive. The p value or percentage of likelihood of achieving a score by chance, was < .007 indicating that there is less than .7 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Hypothesis 3

This hypothesis was based on Item 14b, on the questionnaire, versus Items 19-51.

Item 14b. Do you use computers in lab?

H3: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers laboratory classes and those instructors that do not.

The hypothesis as stated, predicts that instructors using computers laboratory classes will have a similar respond as the instructors not using computers in introductory physics laboratory classes.

The items that were statistically significant are represented in table 23. Specifically, items 23, 43, 50, and 51 were statistically significant at the .05 level of confidence.

Item 43 stated that available computer simulations/animation are used to facilitate learning. The p value or percentage of likelihood of achieving a score by chance, was $< .043$ indicating that there is less than 4.3 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 50 stated that the instructor will recommend using simulations in teaching physics. The p value or percentage of likelihood of achieving a score by chance, was $< .031$ indicating that there is less than 3.1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 51 stated that simulation has improved the quality of the course. The p value or percentage of likelihood of achieving a score by chance, was < .036 indicating that there is less than 3.6 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

<u>Hypothesis 4</u>

This hypothesis was based on Item 17d, on the questionnaire, versus Item 19-51.

Item 17d. Which instructional methods do you use for lecture? Computer simulation?

H4: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer simulations during lecture presentations and those instructors that do not.

The hypothesis as stated, predicts that instructors using computer simulation during lecture presentations will have a similar response as the instructors not using computer simulation in introductory physics lecture presentations.

The items that were statistically significant are represented in table 24. Specifically, items 20, 21, 22, 23, 24, 33, 34, 37, 38, 43, and 44 were statistically significant at the .05 level of confidence.

Item 20 stated that the delivery of physics is best done with transparencies. The p value or percentage of likelihood of achieving a score by chance, was < .006 indicating that there is less than .6 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 21 stated that the delivery of physics is best done with laser disks. The p value or percentage of likelihood of achieving a score by chance, was < .006 indicating that there is less than .6 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 22 stated that the delivery of physics is best done with CD ROMS. The p value or percentage of likelihood of achieving a score by chance, was < .02 indicating that there is less than 2 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 23 stated that the delivery of physics is best done with computer simulations. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than .1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 24 stated that the students appear to learn more from simulations/animation. The p value or percentage of likelihood of achieving a score by chance, was < .044 indicating that there is less than 4.4 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 33 stated that available computer simulations/animation allow a variety of teaching strategies. The p value or percentage of likelihood of achieving a score by chance, was < .004 indicating that there is less than .4 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 34 stated that available computer simulations/animation provide students interactions. The p value or percentage of likelihood of achieving a score by chance, was < .017 indicating that there is less than 1.7 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 37 stated that available computer simulations/animation are interesting. The p value or percentage of likelihood of achieving a score by chance, was < .006 indicating that there is less than .6 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 38 stated that available computer simulations/animation are fun. The p value or percentage of likelihood of achieving a score by chance, was < .008 indicating that there is less than .8 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 43 stated that available computer simulations/animation are used to facilitate learning. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than .1

percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 44 stated that available computer simulations/animation are interactive. The p value or percentage of likelihood of achieving a score by chance, was < .018 indicating that there is less than 1.8 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Hypothesis 5

This hypothesis was based on Item 17e, on the questionnaire, versus Items 19-51.

Item 17e. Which instructional method do you use for lecture? Computer problem solving?

H5: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer problem solving during lecture presentations and those instructors that do not.

The hypothesis as stated, predicts that instructors using computer problem solving during lecture presentations will have a similar respond as the instructors not using computers in introductory physics problem solving during lecture presentations.

The items that were statistically significant are represented in table 25. Specifically, items 21, 22, 23, 24, 29, 31, 33, 34, 35, 36, 38, 41, 44, and 51were statistically significant at the .05 level of confidence.

Item 21 stated that the delivery of physics is best done with laser disks. The p value or percentage of likelihood of achieving a score by chance, was < .021 indicating that there is less than 2.1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 22 stated that the delivery of physics is best done with CD ROMS. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than .1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 23 stated that the delivery of physics is best done with computer simulations. The p value or percentage of likelihood of achieving a score by chance, was < .018 indicating that there is less than 1.8 chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 24 stated that the students appear to learn more from simulations/animation. The p value or percentage of likelihood of achieving a score by chance, was < .021 indicating that there is less than 2.1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 29 stated that the delivery of physics is best done with hands-on activities. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than .1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 31 stated that available computer simulations/animation are easy to follow. The p value or percentage of likelihood of achieving a score by chance, was < .001 indicating that there is less than .1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 33 stated that available computer simulations/animation allow a variety of teaching strategies. The p value or percentage of likelihood of achieving a score by chance, was < .005 indicating that there is less than .5 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 34 stated that available computer simulations/animation provide students interactions. The p value or percentage of likelihood of achieving a score by chance, was < .025 indicating that there is less than 2.5 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 35 stated that available computer simulations/animation allow individual self pacing. The p value or percentage of likelihood of achieving a score by chance, was < .003 indicating that there is less than .3 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 36 stated that available computer simulations/animation permit collaborative learning. The p value or percentage of likelihood of achieving a score by chance, was < .009 indicating that there is less than .9 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 38 stated that available computer simulations/animation are fun. The p value or percentage of likelihood of achieving a score by chance, was < .011 indicating that there is less than 1.1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 41 stated that available computer simulations/animation are colorful. The p value or percentage of likelihood of achieving a score by chance, was < .048 indicating that there is less than 4.8 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 44 stated that available computer simulations/animation are interactive. The p value or percentage of likelihood of achieving a score by chance, was < .010 indicating that there is less than 1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 51 stated that simulations has improved the quality of the course. The p value or percentage of likelihood of achieving a score by chance, was < .049 indicating that there is less than 4.9 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Hypothesis 6

This hypothesis was based on Item 18c, on the questionnaire, versus Items 19-51.

Item 18c. Which instructional methods do you use in the lab? Computer based experiments?

H6: There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer based experiments during laboratory classes and those instructors that do not.

The hypothesis as stated, predicts that instructors using computer base experiments during laboratory classes will have a similar respond as the instructors not using computers in introductory physics laboratory classes.

The items that were statistically significant are represented in table 26. Specifically, items 19, 23, 33, 34, 37, 43, and 44 were statistically significant at the .05 level of confidence.

Item 19 stated that the delivery of physics is best done with videos. The p value or percentage of likelihood of achieving a score by chance, was $< .030$ indicating that there is less than 3 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 23 stated that the delivery of physics is best done with computer simulations. The p value or percentage of likelihood of achieving a score by chance, was $< .021$ indicating that there is less than 2.1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 33 stated that available computer simulations/animation allow a variety of teaching strategies. The p value or percentage of likelihood of achieving a score by chance, was $< .025$ indicating that there is less than 2.5 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 34 stated that available computer simulations/animation provide students interactions. The p value or percentage of likelihood of achieving a score by chance, was $< .022$ indicating that there is less than 2.2 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 37 stated that available computer simulations/animation are interesting. The p value or percentage of likelihood of achieving a score by chance, was $< .036$ indicating that there is less than 3.6 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 43 stated that available computer simulations/animation are used to facilitate learning. The p value or percentage of likelihood of achieving a score by chance, was $< .001$ indicating that there is less than .1 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Item 44 stated that available computer simulations/animation are interactive. The p value or percentage of likelihood of achieving a score by chance, was < .005 indicating that there is less than .5 percent chance that the hypothesis should be accepted. It is very unlikely that the two groups of instructors will have the same opinion.

Hypothesis 7

This hypothesis was based on Item 14a, on the questionnaire, versus annual tuition.

Item 14a. Do you use computers in lecture?

H7: There is no significant relationship between annual college tuition and the use of computers in physics lecture presentations.

The hypothesis, as stated, predicts that there is no significant relationship between annual college tuition and the use of computers in physics lecture presentations.

The Chi-Square test showed no significant difference and, therefore, this hypothesis was not rejected.

Hypothesis 8

This hypothesis was based on Item 14b, on the questionnaire, versus annual tuition.

Item 14b. Do you use computers in lab?

H8: There is no significant relationship between annual college tuition upon the use of computers in physics laboratory classes.

The hypothesis, as stated, predicts that there is no significant relationship between annual college tuition and the use of computers in physics laboratory classes.

The Chi-Square test showed a significant difference, and, therefore, this hypothesis was rejected. This implies that the annual tuition does influence the use of computers in the physics laboratory.

Hypothesis 9

This hypothesis was based on Item 14a, on the questionnaire, versus student enrollment.

Item 14a. Do you use computers in lecture?

H9: There is no significant relationship between college enrollment and the use of computers in physics lecture presentations

The hypothesis, as stated, predicts that there is no significant relationship between student college enrollment and the use of computers in physics lecture presentations.

The Chi-Square test showed no significant difference and, therefore, this hypothesis was not rejected.

Hypothesis 10

This hypothesis was based on Item 14b, on the questionnaire, versus student enrollment.

Item 14b. Do you use computers in lab?

H10: There is no significant relationship between college enrollment and the use of computers physics laboratory classes.

The hypothesis, as stated, predicts that there is no significant relationship between student enrollment and the use of computers in physics lecture presentations. The Chi-Square test showed no significant difference and, therefore, this hypothesis was not rejected.

Summary of the Findings

H1	rejected	There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that give computer based homework assignments to introductory physics students and those instructors that do not.
H2	rejected	There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers during lecture presentations and those instructors that do not.
H3	rejected	There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computers laboratory classes and those instructors that do not.
H4	rejected	There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer simulations during lecture presentations and those instructors that do not.
H5	rejected	There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer problem solving during lecture presentations and those instructors that do not.
H6	rejected	There is no significant difference in opinions about factors that affect CBII for student comprehension of physics instruction between those instructors that use computer based experiments during laboratory classes and those instructors that do not.
H7	not rejected	There is no significant relationship between annual college tuition and the use of computers in physics lecture presentations.
H8	rejected	There is no significant relationship between annual college tuition upon the use of computers in physics laboratory classes.
H9	not rejected	There is no significant relationship between college enrollment and the use of computers in physics lecture presentations
H10	not rejected	There is no significant relationship between college enrollment and the use of computers physics laboratory classes

Table 33. Summary of findings

Implications of the study

The results of this study may have implications in many areas of educational interest. These implications are discussed in the following sections.

Instructional Technology. There are several potential implications for CBII in the field of Instructional Technology. CAI, when designed to be interactive, becomes easy to follow and allows a variety of teaching strategies. CBII provides student interactions, permits collaborative learning and is interactive. In training, CBII can be used to facilitate learning and is a suitable replacement for textbooks. If a group can be brought together for initial training of content, then the reinforcement and further discussion of the training content can be facilitated through CBII.

Higher Education. The enrollment of students in colleges and universities seems to be a challenge for many institutions. To meet the need of traditional and non-traditional students and attract them to programs, higher education institutions may take advantage of CBII as an instructional delivery tool. Being interactive, CBII will close the gap between traditional and non-traditional students by allowing individual self pacing, a variety of teaching strategies, and collaborative learning.

The Schools of the Future

Today's schools are undergoing a transformation process. Deming (1992) encouraged educators to transform schools into communities of learners committed to continuous learning for everyone, students, faculty, staff, parents and other community members. In these schools, strong relationships of mutual respect and trust replace fear, suspicion, and division. In the school of the future, grades and other rating systems will be far less significant. Collaborative learning that allows individual self-pacing should complement traditional teaching to produce schools of quality. CBII may assist in making this possible.

The Challenge of the Future

The American school system is driven by the needs of the Twentieth Century. The needs of the Twenty-first Century are driving a paradigm change from the traditional school to an institution that will better meet the challenges yet to be born. The patterns of teaching are shaped by culture and their roots are personal experience. The tendency has been to teach the way we were taught. The challenge will be to do otherwise. This study show that the students appear to learn more from simulations and animation. It is possible that with the new interactive programs and systems, a new curriculum can be designed using CBII to make teaching more innovative.

Distance Learning

Distance learning (DL) programs are being developed and offered by many higher education institutions. Distance learning programs are produced in various forms. Many institutions use the system of broadcasting using television for viewing and telephone for sound communication.

With CBII, distance learning takes a different form. The computer should control most of the activities, provide answers to questions quickly, produce simulations of certain concepts and randomly select questions and answers appropriate to the subject. This study indicates the possibility of adopting computers as an instructional delivery system.

Recommendations for Future Research

The results of this study identify several areas for future research. These areas are discussed below.

Future Software

A comparison and evaluation of available software in physics would definitely help faculty members to select better programs for their students. Many available software programs are experimental and are not interactive. Students find them boring and do not like to do separate calculations on a calculator, which is what traditional teaching is all about. This research could help determine whether today's software is more effective than older, less sophisticated software.

CBII Across the Curriculum

Very little research has been done on the effectiveness of CBII across different subject areas. In certain areas the effect seems to be decreasing. In other areas it is not yet known. A research project of this magnitude would allow us to determine the effectiveness of CBII. It would also allow the design of a curriculum which would enhance student achievement.

CBII and Gender

The results obtained in this study concerning females versus males in the classroom did not give a clear verdict on the effect of CBII on academic achievement with respect to gender and ability level. In order to provide a more in depth understanding of how to maximize the use of CBII, further study is needed.

This could provide instructional support for 1) at-risk students, 2) physically-challenged students, 3) traditional students, 4) non-traditional students, and 5) faculty involvement.

Summary

This study has determined that CBII in the classroom is effective in delivering instruction. The usage of computers in introductory physics facilitate learning and, therefore, may be suitable to use in place of the traditional delivery method used around the country. CBII as an instructional delivery method is an alternative that may result in a higher level of student learning for many higher education courses.

This study establishes a foundation for continued research and investigation into the effect of CBII on student learning and as an instructional tool.

APPENDIX A

Questionnaire

Name ....Title .... University
....Address
.... City
.... State .... Zip-Code ....Phone
.... Fax ....E-mail
....

Gender (please circle one) F M

Do you wish to receive a copy of the survey results? (please circle one) YES NO

This instrument should be completed by instructors of College and University Physics. If you teach both, please make a copy of this instrument and complete one for each course. If you do not teach either course, please give this questionnaire to the person that does. If Physics is not taught at your institution, answer the first question and mail back. Please check all the appropriate responses. Feel free to add comments to clarify your response. *All responses will remain confidential.* Mail/E-Mail as soon as possible. Thank you very much for your valuable assistance and prompt response.

At your College or University

1. Do you teach introductory
   a) College Physics (trigonometry based)?.............. YES ___ NO ___
   b)University Physics (calculus based)?.................... YES ___ NO ___

   This instrument is for which one (circle one please)? .... (a) .... (b)

2. Are there any prerequisite courses? .... YES ___ NO ___

   If yes, please explain ______________________________
   ____
   ____

3. Must students pass an entry test before registering for the course? YES ___ NO ___

4. What was the student enrollment in your physics class for 1996/97
   _______ fall
   _______ winter
   _______ spring
   _______ summer

5. What was the maximum number of students allowed?
   _______ in lecture
   _______ in laboratory
   _______ in problem session

6. During the last 5 years, student enrollment(%) in the course
   _______ increased
   _______ decreased
   _______ the same

<u>What are the demographics of your classes (approximate %)</u>

7. Students in your class? .... ______ female ______ male
8. Non-traditional students?...................... ______ female ______ male
9. Students well prepared? .... ______ female ______ male
10. Students who withdraw from the course?..... ______ female ______ male
11. Students who fail the course? .... ______ female ______ male

12 What testing methods are used in your course?

_____ problem-style exams
____ multiple choice exams
_____ quizzes
_____ other

Explain ____
____

13 Which of the followings are used in calculating student grades?

_____ tests/exams
____ homework
_____ laboratory reports
_____ computer based homework assignments read-
_____ ings/research papers/term papers/essays
_____ other

Explain ____
____

14. Do you use computers _____ in lecture? _____ in lab?
If you do, please list some of the major software packages used.

____
____

15. How many students are assigned per computer _____ in lecture? _____ in lab?
16 How do you judge the effectiveness of computer based instruction?

_____ student evaluations
____ peer evaluations (departmental)
_____ peer evaluations (non-departmental)other
_____

Explain ____
____

17 Which instructional methods do you use for lecture?

_____ discussion/presentation
____ demonstration
_____ video tape
_____ computer simulation
_____ computer problem solving
_____ other

Explain ____
____

18 Which instructional methods do you use in the lab?

_____ structured experiments
____ self-paced experiments
_____ computer based experiments
_____ other

Explain ____
____

Please indicate (circle) the degree to which you agree to each of these statements
SA = strongly agree A = agree N = neutral D = disagree SD = strongly disagree

The delivery of physics instruction is best done with					
19. videos	SA	A	N	D	SD
20. transparencies	SA	A	N	D	SD
21. laser disks	SA	A	N	D	SD
22. CD ROM's	SA	A	N	D	SD
23. computer simulation	SA	A	N	D	SD
The students appear to learn more from					
24. simulations/animation..........................	SA	A	N	D	SD
25. text	SA	A	N	D	SD
26. demonstrations	SA	A	N	D	SD
27. lectures	SA	A	N	D	SD
28. lectures supplemented with transparencies......	SA	A	N	D	SD
29. hands-on activities............................	SA	A	N	D	SD
30. videos	SA	A	N	D	SD
Available computer simulations/animation					
31. are easy to follow	SA	A	N	D	SD
32. allow to visualize concepts....................	SA	A	N	D	SD
33. allow a variety of teaching strategies.........	SA	A	N	D	SD
34. provide students interactions..................	SA	A	N	D	SD
35. allow individual self pacing...................	SA	A	N	D	SD

36.	permit collaborative learning..................................	SA	A	N	D	SD
37.	are interesting...	SA	A	N	D	SD
38.	are fun	SA	A	N	D	SD
39.	are realistic..	SA	A	N	D	SD
40.	are lively..	SA	A	N	D	SD
41.	are colorful..	SA	A	N	D	SD
42.	are suitable replacement of textbooks.......................	SA	A	N	D	SD
43.	are used to facilitate learning................................	SA	A	N	D	SD
44.	are interactive...	SA	A	N	D	SD

<u>The students using simulations/animation</u>

45.	learn with confidence..	SA	A	N	D	SD
46.	get individual attention..	SA	A	N	D	SD

<u>In the classroom</u>

47.	females tend to be intimidated by using computers...	SA	A	N	D	SD
48.	females tend to dominate the use of computers.........	SA	A	N	D	SD
49.	I would rate simulation teaching experience as excellent	SA	A	N	D	SD
50.	I recommend using simulations in teaching physics......	SA	A	N	D	SD
51.	Simulation has improved the quality of the course......	SA	A	N	D	SD

52. Additional comments

____

____

____

____

____

____

Thank you
for your patience
and support

Afif Jawad Asst. Prof.
Madonna University. Physics Dept.
36600 Schoolcraft Rd. Livonia, MI.
48150
Phone: (313) 432-5516
Fax: (313) 582-2127
E-Mail: Jawad@smtp.munet.edu

APPENDIX B

Cover letters for first mailing.

July 21, 1997

Note: If your institute does not teach Introductory Physics, please indicate *that* on the questionnaire and mail back

To: Introductory Physics Faculty Members at US Catholic Colleges and Universities

Dear Colleague,

May I request your assistance in the course of this study leading to the completion of my doctorate. The questionnaire accompanying this letter will take only few minutes of your time, compiling the results is something else. Please find the questionnaire inside the return envelope.

The nature of the study deals with Physics instruction and should be relevant to Catholic Colleges and Universities in the United States. Please note that all information and results will be presented as group data only, and will be available to participants upon request.

You will find a copy of the letter from Sister Mary Francilene, President of Madonna University, supporting my request for your assistance. Please complete the questionnaire and mail it back as soon as possible. I thank you very much.

Note:

Sincerely,

Afif Jawad Asst. Prof.
Physics Instructor
E-mail: Jawad@smtp.munet.edu
Phone: (313) 432-5516

May 13, 1997

TO: Faculty Members at U.S. Catholic Colleges and Universities

Dear Colleagues:

It is a pleasure to support the request of Assistant Professor Afif Jawad for your participation in the enclosed survey.. As a faculty member at Madonna University over the past ten years, Mr. Jawad has consistently demonstrated dedication to the areas of teaching and research.

Those of us who have completed our doctorates will remember the gratitude we felt to all of those who so graciously participated in surveys and the completion of research data. May I encourage your participation to assist Mr. Jawad in his present undertakings leading to the completion of his doctorate.

Sincerely,

Sister Mary Francilene, CSSF

Sister Mary Francilene, CSSF
President

SMF/ll
Encl.

APPENDIX C

Cover letter for second mailing.

September 2, 1997

Note: If your institute does not teach Introductory Physics, please indicate that on the questionnaire and mail back

To: Introductory Physics Faculty Members at U.S. Catholic Colleges and Universities

Dear Colleague,

On July 21, 1997, a letter was sent to you or to the president of your university requesting your assistance in the course of a study leading to the completion of my doctorate.

Because of the importance of receiving your early reply, Sr. Mary Francilene, President of Madonna University, enclosed a letter of support with my letter. The questionnaire was placed inside the return envelope.

To date I have not received your response. The questionnaire was designed to take approximately seven to eight minutes to complete. I have already received many responses, and do hope to receive yours soon because it is important.

The nature of the study deals with Physics instruction and should be relevant to Catholic Colleges and Universities in the United States. Please note that all information and results will be presented as group data only, and will be available to participants upon request.

Please find another copy of the questionnaire in case you did not receive the first one. Thank you for your anticipated cooperation.

Sincerely,

Afif Jawad Asst. Prof.
Physics Instructor
E-mail: Jawad@smtp.munet.edu
Phone: (313) 432-5516

APPENDIX D

Code Definitions

Carnegie Classification Code Definitions

The 1994 Carnegie Classification includes all colleges and universities in the United States that are degree-granting and accredited by an agency recognized by the U.S. Secretary of Education.

1. Research Universities I: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees[1] each year. In addition, they receive annually $40 million or more in federal support.
2. Research Universities II: These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees[1] each year. In addition, they receive annually between $15.5 million and $40 million in federal support.
3. Doctoral Universities I: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award at least 40 doctoral degrees annually in five or more disciplines.
4. Doctoral Universities II: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the doctorate. They award annually at least ten doctorate degrees, in three or more disciplines, or 20 or more doctoral degrees in one or more disciplines.
5. Master's (Comprehensive) Colleges and Universities I: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 40 or more master's degrees annually in three or more

disciplines.

6. Master's (Comprehensive) Colleges and Universities II: These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master's degree. They award 20 or more master's degrees annually in one or more disciplines.
7. Baccalaureate (Liberal Arts) Colleges I: These institutions are primarily undergraduate colleges with major emphasis on baccalaureate degree programs. They award 40 percent or more of their baccalaureate degrees in liberal arts fields and are restrictive in admissions.
8. Baccalaureate Colleges II: These institutions are primarily undergraduate colleges with major emphasis on baccalaureate degree programs. They award less than 40 percent of their baccalaureate degrees in liberal arts fields or are less restrictive in admissions.
9. Associate of Arts Colleges: These institutions offer associate of arts certificate or degree programs and, with few exceptions, offer no baccalaureate degrees.
10. Specialized Institutions: These institutions offer degrees ranging from the bachelor's to the doctorate. At least 50 percent of the degrees awarded by these institutions are in a single discipline.

Specialized institutions include:

- Theological seminaries, Bible colleges and other institutions offering degrees in religion: This category includes institutions at which the primary purpose is to offer religious instruction or train members of the clergy.

- Other (separate) health profession schools: Institutions in this category award most of their degrees in such fields as chiropractic, nursing, pharmacy, or podiatry.

- Schools of business and management: The schools in this category award most of their bachelor's or graduate degrees in business or business-related programs.
- Schools of art, music, and design: Institutions in this category award most of their bachelor's or graduate degrees in art, music, design, architecture or some combination of such fields.
- Schools of law: The schools included in this category award most of their degrees in law. The list includes only institutions that are listed as separate campuses in the 1994 Higher Education Directory.
- Teachers colleges: Institutions in this category award most of their bachelor's or graduate degrees in education or education-related fields.
- Other specialized institutions: Institutions in this category include graduate centers, maritime academies, military institutions, and institutions that do not fit any other classification category.

APPENDIX E

Faculty Comments

Additional comments provided by the physics instructors.

1) Effectiveness judged by talking with students and TA's.

2) Women's college giving a different response of the students in the classroom to coed classes.

3) What you do not ask is how much weight we give to simulations. So far we have not used them much, but that is changing this year. You also do not ask about the usefulness of traditional problem sets, which I think are the best way to teach many of the concepts and problem-solving skills, given the current state of educational software.

4) I don't use simulations so many of your questions are not germane.

5) I can see from the nature of your questions that your interest lies heavily in the directions of computer and animations. I agree that these are good. However, the best of all for teaching physics is an enthusiastic instructor! All else is secondary.

6) Computers so far are not used.

7) Many of the questions about simulations dealt with student use of them, but that does not occur in my course.

8) Students don't understand enough (or take enough time) to really benefit from the power of computer simulations.

9) Good lecture/demonstration still seems to be the best method of teaching physics - followed by a structured lab that verifies the theory.

10) The computer simulations I have enjoyed are JAVA/WWW based. These are cool, but tend to crash the browsers in our computer labs. This is why I have not used them for classes.

11) In demonstrations I have seen of simulations the instructor appears to be the one

having all the fun. We do simulations on the upper level of physics in the lab but generally computer power in the physics lab we have not used them in intro courses. Also the course on the introductory (calculus based) is only a 4-credit (3 hr. lec and lab) course taught in 2 semesters. This is not a lot of time to get into a lot of fun stuff.

12) I've only used computer simulations 1 semester to date.

13) No one tool can be isolated simulations, demos, labs, etc, must be strongly coordinated and based in cognitive theory. Moreover, they must be followed by whole group discussions for maximum gain, even if the professor uses probing questions with individual groups during the exercise. Students learn best when a concept is approached using a variety of tools (demo lab, lecture, collaborative problem solving) during a single session, with ample time for discussion.

14) Quality of simulations is what is important. We are still working on getting a good group of packages together.

15) I do not use simulations, so many questions are hard to answer.

16) In my opinion, watching videos and computer simulations is like watching TV. I want my students to interact with real physical objects, not simulations of such objects.

17) With one exception I cannot answer Q. 31-46 because I haven't paid much attention to computer simulations/animation for Physics. My colleague who will begin teaching the course next Fall is more interested in this area, but he hasn't tried it yet. The biggest problem we have with this course is student weaknesses in algebra and trig. I think the most effective thing we have done is provide huge amounts of personal attention. Also I have covered a much smaller number of topics at greater depth than is common for calc-based texts, and I think this has had good results.

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ABSTRACT

THE IMPACT OF COMPUTER BASED INTERACTIVE INSTRUCTION (CBII) IN IMPROVING THE TEACHING-LEARNING PROCESS IN INTRODUCTORY COLLEGE PHYSICS

by

AFIF A. JAWAD

December 1997

Advisor: Dr. Albert Stahl

Major: Instructional Technology (Education)

Degree: Doctor of Philosophy

Institutes are incorporating computer-assisted instruction (CAI) into their classrooms in an effort to enhance learning. The implementation of computers into the classroom is parallel with education's role of keeping abreast with societal demands.

The number of microcomputers in schools has increased tremendously. Computer Based Interactive Instruction (CBBI) software is available for the language arts, mathematics, science, social studies, etc.

The traditional instruction, supplemented with CAI, seems to be more effective than traditional instruction alone. Although there is a large quantity of research regarding specific aspects of learning through computers, there seems to be a lack of information regarding the impact of computers upon student success.

The goal of this study is to determine how much of CAI is implemented in higher education in the USA. Instructors from 38 states were surveyed to compare between the institutes that use Computer Based Interactive Instruction and the ones that do not and are

still applying traditional delivery method. Based on the analysis of the data gathered during this study, it is concluded that the majority of instructors are now using computers in one form or another.

This study has determined that the computer is a major component in the teaching of introductory physics, and therefore, may be a suitable substitute for the traditional delivery system. Computers as an instructional delivery system are an alternative that may result in a higher level of student learning for many higher education courses.

AUTOBIOGRAPHICAL STATEMENT

Name: Afif A. Jawad

Education:

Doctor of Philosophy, Wayne State university, Detroit, MI.
Major: Instructional Technology (Education)
Admitted to Ph.D. (Physics), Wayne State University, Detroit, MI.
Post-Master's Work in Physics
Masters of Science, Physics Major, mathematics Minor, Wayne State University, Detroit, MI.
Bachelor of Science, Physics, Wayne State University, Detroit, MI.

Professional Experience:

1986 -	Assistant Professor, Physics Department, Madonna University, Livonia, MI.
1987-1989:	Instructor in the Educational Access Program for Hispanic Youth
	Instructor in Science Teacher Education Program
	Coordinator of Multicultural Workshops
	Wrote Physics Lab Manuals
1985-1986:	Henry Ford Community College, part-time faculty
1983-1986:	Macomb County Community College, part-time faculty
1983-1998:	University of Michigan-Dearborn, part-time faculty
1972-1976:	Lebanese University, Beirut Lebanon
	Translated and edited Lebanese Public School Physics Text and Lab Manual
1972-1976:	Makassed Secondary School, Head of Math and Science Department
1968-1971:	Wayne County Community College, Lawrence Institute of Technology, Mercy College: part-time instructor while working on MS Physics at Wayne State University
1966-1971:	Macomb County Community College, Instructor, Programmed Learning Center

Professional Affiliations:

Kappa Delta Pi
American Association of Physics Instructors, member 1984-present
Michigan Association of Physics Teachers, member 1984-present
National Space Club, member 1986
Pi Mu Epsilon National Honorary Mathematics Society, elected as a member in 1989 for superior achievement in the field of mathematics

Social and Civic Affiliations:

Founder of the American-Lebanese University Graduate (ALUG) Organization
Greater Detroit Interfaith Roundtable of Christians, Jews, and Moslems
Islamic Center of America (1985-present), Member of the Board of Trustees