

1988

A Study to Determine the Effectiveness Audio-Visuals Have on Teaching Computer Aided Drafting

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A STUDY TO DETERMINE THE EFFECTIVENESS
AUDIO-VISUALS HAVE ON
TEACHING
COMPUTER AIDED DRAFTING

A Research Project
Presented To
THE VOCATIONAL EDUCATION DEPARTMENT
Old Dominion University

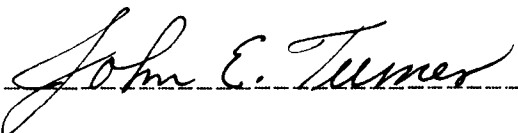
In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Education

By
Clyde D. Wiggins
July 1988

A P P R O V A L P A G E

This research paper was prepared under the direction of Dr. John Ritz and Dr. John Turner for Vocational and Technical Education 636. It is being submitted to the Graduate Program Director as partial fulfillment of the requirements for the Degree of Master of Science in Education.

Approved By

A handwritten signature in cursive script that reads "John E. Turner". The signature is written over a horizontal dashed line.

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A handwritten signature in cursive script that reads "John M. Ritz". The signature is written over a horizontal dashed line.

Dr. John Ritz,

Graduate Program Director

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CHAPTER I

INTRODUCTION

Industrial arts since the early 1980's has been in a transitional era, moving from the study of traditional industry into the study of sophisticated high technology. To keep abreast with this transitional period, many states throughout the country have changed the name of Industrial Arts to Technology Education or something similar to reflect the move toward technology. Programs and curricula are being analyzed and altered to meet this transitional challenge. Eminent to this transition is the interfacing of computer applications throughout Technology Education.

In the midst of this transition, Norfolk Public Schools has incorporated computer aided drafting throughout its Technology Education programs. At least one CAD system has been placed in the Exploratory Technology program at each of the middle schools. All five high schools in the city are now using CAD in all of the drafting classes.

The move and transition from Industrial Arts to Technology Education has created new challenges for the drafting teacher. Not only must the drafting teacher concern himself/herself with understanding and applying computer concepts to the classroom, the teacher must give some consideration to developing effective teaching methods.

STATEMENT OF THE PROBLEM

The problem of this study was to determine the effectiveness of teaching an introduction to computer aided drafting, using audio-visuals versus the lecture method to basic drafting students at B. T. Washington High School. The researcher will compare the performance of students (enrolled in basic drafting) who are taught an introduction to CAD by teacher-lecture with the performance of students taught using both of these instructional methods.

HYPOTHESIS

There is a difference in the performance of basic drafting students who are taught computer aided drafting using audio-visuals and basic drafting students who are taught computer aided drafting using teacher-lecture method.

BACKGROUND AND SIGNIFICANCE

In today's society one cannot escape observing the extensive use of computers. A visit to local department stores, banks, or fast food chains brings one in contact with computers and heightens one's awareness. Major businesses and industries are using the computer's power to increase productivity and reduce labor and management costs. Industrial workers are being taught to deal with computers in information flow charts, decision making, and

production capacities. In education, computers have been incorporated in almost every content area.

Vocational education has as one of its goals preparing students to perform competently in the world of work. It has been predicted that by 1990, seventy-five percent of all workers will be using computers on the job (Rodenstein, 1984, p. 10). Rodenstein continues on to say that it is clear that the technological changes brought about by computers have a profound impact on the way vocational educators prepare students for the work world. The computer has changed the way teachers teach and what they teach. "There is no longer a question of whether to teach computer use. The question is what and how to teach the use of the computer as a tool for everybody's personal and business use" (Agee, 1985, p. 52). This study will determine the effectiveness of using audio-visuals to teach an introduction to computer aided drafting to students enrolled in basic drafting. The teacher must use all the resources and equipment available to provide the student with opportunity for productive learning.

Learning is a two-way communication link between the information presented and the individual learner (Butler, 1972, p. 152). Verbal communication can be used to carry out most of the functions of an instructional lesson. However, it is limited to presenting stimulus situations in verbal terms. The use of audio-visuals can be used to supplement the lesson in making it more meaningful and realistic (Garrison, 1972, p. 322). The teacher must always

remember that the primary purpose is to place the learner closer to reality.

Audio-visuals (instructional media) are all printed and electromechanical devices which are transmitted between the student and what he/she is supposed to learn. The use of audio-visuals must match the kind of learning involved in the lesson. There is no single best medium or mix of media for presenting a lesson, because each learning event leading to the attainment of an objective may require a different mix.

The use of audio-visual aids increase learning by helping to arouse and sustain interest, to motivate, to present information in a variety of ways, and to provide the kinds of experiences which allow for the transfer of knowledge and skill to new tasks (Freidman and Berg, 1969, p. 7).

The effectiveness of the lecture method of teaching can be greatly increased by supplementing this method of instruction with audio-visual aids. The effective teacher must select the best approach to teaching a unit on computer aided drafting.

LIMITATIONS OF THE STUDY

This study was limited to two basic drafting classes at B. T. Washington High School in Norfolk, Virginia. The diversity of audio-visual equipment used in this study was limited to the use of the video tape recorder and the overhead projector.

BASIC ASSUMPTIONS

This research study assumes that students learn more effectively by using their visual skills than their auditory skills. The two groups have equal ability because the students are enrolled in the general education tract. These classes are specifically designed at the entry level of drafting skills.

PROCEDURES

Subjects for this study were two classes of basic drafting students at B. T. Washington High School. Both classes were classified as general education, thus having equivalent ability levels. One class was selected to represent the control group and was instructed by teacher-lecture. The other class was selected as the experimental group and was instructed using audio-visuals. A post-test (see Appendix G, p. 51, 52) was administered to both groups to determine the effectiveness of instructing students using audio-visuals.

DEFINITION OF TERMS

The following terms are used throughout this study.

They are listed and defined to assist the reader's comprehension of this experiment.

Audio-visual.....	Materials used in instruction to relate a concept.
CAD.....	Computer Aided Drafting
Lecture.....	Method of instruction for imparting information by verbal communication.
Media/Medium.....	A means of effecting or conveying information.
Modalities.....	Styles or methods of learning.
Teaching Method.....	Orderly procedures that direct learners in developing skills and habits, acquiring knowledge, and in developing positive attitudes.

SUMMARY

In Chapter I of this study, the problem and hypothesis were identified. The problem of this study was to determine the effectiveness of teaching an introduction to computer aided drafting using audio-visuals. Included in this chapter were background and significance of the study, the limitations, assumptions, and definition of terms. Also, a brief description of the procedures used to gather relevant data was given.

Following Chapter I, a review of literature pertaining to the problem of the study, a detailed explanation of the procedures used to collect and analyze data and the results will be included. The final chapters will reveal, and give a summary of the research study and conclusions made based on the data collected.

CHAPTER II

REVIEW OF LITERATURE

Chapter II will investigate the lecture method of teaching and the techniques of audio-visual aids as they relate to the modalities of learning. Presented in this chapter are sections covering learning modalities, teaching methods/techniques, lecture, and audio-visual techniques.

A review of literature revealed a vast amount of information related to computers. This information has been written primarily on the implementation and use of computers in the classroom, particularly the drafting class, and on the selection of tutorial software. However, there is very little information published on how to effectively teach computer aided drafting.

Computer aided drafting is a current technology that cannot be ignored. Statistics indicate that by the year 2000 there will be 1,220,000 jobs created for CAD workers (Becker, 1987, p. 24). This suggests that CAD should be taught in the schools to aid industry in meeting those anticipated future needs by exposing students to computers. Computers have changed the way instructors teach and think. Teachers are no longer faced with the question whether or not to teach computer use. The question is what approach is the best instructional method to teach computer aided drafting. In determining the most effective method, the

teacher must give consideration to and examination of learning modalities and teaching techniques.

LEARNING MODALITIES

Owings Mills defines learning modes as styles or methods of acquiring knowledge or skills (Vocational Workshop, 1987). Primarily, there are three modalities of learning: auditory, visual, and tactile-kinesthetic. The teacher must give consideration to these modes of learning when determining the most effective method to use when teaching a unit or lesson. According to Henak (1984, p. 10), most material is learned through the visual mode. A great deal of teaching and learning takes place through speaking and hearing. While the spoken word is significant and important to the learning process, the use of visuals will aid in the understanding of new concepts. When physical skills are required, learning by doing must take place.

Once the teacher has identified the learning modes that are most successful with each student, activities may be chosen and used to strengthen the student's ability. When the student has learned successfully with a particular mode, alternate techniques may be introduced and tried so that the other modes may be developed for future understanding.

TEACHING METHODS/TECHNIQUES

A comprehensive study of available literature in the field of education has revealed extensive listings of teaching methods as conceived and classified by various authorities. Andrews and Erickson (1976, p. 151) discuss in the text, Teaching Industrial Education: Principles and Practices, teaching methods that are generally accepted teaching practices and procedures suitable for instruction in industrial education. These methods include demonstration method, lecture method, seminar, and discussion method. Andrews and Erickson (1976, p. 151) define teaching methods as broad, basic, coordinated procedures, each one sufficient in scope to be used rather exclusively for teaching segregated learning units. They also define techniques as procedures used to give variety to the teaching process and to stimulate and maintain interest in it.

Because of the nature of this study, this review of literature will discuss the lecture method of teaching and the use of audio-visual aids as a technique of teaching.

LECTURE

Lectures can be exciting teaching methods if they are well planned and skillfully delivered.

The lecture is a method of instruction for imparting information and stimulating critical thinking,

largely by the verbal message with a minimum of class participation (Silvils and Bohn, 1975, p. 284)

"The lecture is essentially the basic method of teaching outside of involving students in manipulation work, research, seminars, and discussions" (Andrews and Erickson, 1976, p. 155). The shortest way to the acquisition of facts by students is to tell them these facts.

And while the argument has been advanced that "telling is not teaching," the lecture method at least offers opportunities for presenting useful and essential facts with a minimum expense of time (Andrews and Erickson, 1976, p. 156).

Lectures should be kept to a minimum and confine oral presentations to very brief periods. Teachers should avoid talking unnecessarily. Andrews and Erickson (1976, p. 156) suggests the following considerations for the organization of effective lectures:

1. Scope. Definite aims should be expressed for student outcomes, and the presentation should be limited to one topic.
2. Opening. An interesting introduction will capture the attention of most of the students and provide a need to want to know more about the topic.
3. Body. This is organized in two parts--the information and the method--both must be used simultaneously for presenting the sequential outline of facts in a clear, concise, and expository manner.

Miller and Rose (1975, p. 130) suggest the following steps to be used in preparing a short lecture.

1. Identify the exact purpose. This should be specific enough to indicate exactly what you expect to talk about.
2. Write out the introduction. This may be done in outline form or in full; however, since this is the sales talk for ideas, it should be planned carefully and as interesting as can be made. This also sets the aim of the lecture in the teacher's mind.
3. Outline the body of the lecture. Start with the

main points, which should seldom exceed ten. List facts and illustrations that will put them over. Always include questions.

4. Prepare the summary. List the main points and the basic principles and/or make up questions that will cause the students to think through and use the information which has been presented.

To be effective, the teacher must commit sufficient time to organize and adapt the topic to the student and to rehearse and polish the delivery. This kind of preparation requires a great deal of time, therefore, the number of skillfully found lectures are small. Most teachers prefer the informal lecture in which students participate therefore being more interesting to students. "Either of these forms of lecture will be more effective if supplemented with visual aids and objects" (Henak, 1984, p. 28). Andrews and Erickson (1976, p. 156) tend to support this viewpoint in chapter 10 of their textbook when they wrote:

Whenever possible, the lecture should be augmented by electronic and other aids.....Because various senses are involved, the learning experience may be more beneficial.

AUDIO-VISUAL TECHNIQUES

"All learning is multi-sensory in nature, and each of the senses- hearing, sight, touch, smell, and taste- plays a role in formulating reactions to any stimulus" (Leonard, Fallon, and Arx, 1972, p. 94). Each adds another dimension and makes a unique contribution to the learning process. Most learning experiences involve sight and hearing more than the other senses; thus audio-visual aids are employed.

Audio-visuals used in teaching is a technique of presenting a unit or lesson with an enlarged operating model of some object or device, overhead transparencies, projected slides, filmstrips, or movies, accompanied by a recording or the teacher. It may be done also with a coordinated bulletin board display.

Audio-visual aids are devices which permit a more effective use of a multi-sensory approach to learning than just words can provide. Audio-visuals used in the classroom increase learning. Audio-visual aids, by adding picture and sound, by bringing the faraway in time and place into the classroom, or by enlarging what is too small to with the naked eye, make words stand for something and lend meaning to facts and concepts which are vague when conveyed only in words (Freidman and Berg, 1969, p. 6).

Through the incorporation of many types of media, the effectiveness of teaching and learning is thought to be increased. Teachers feel there are many positive contributions that can be realized since media tend to:

1. reduce verbalism
 2. provide perceptual uniformity
 3. provide realism
 4. add interest
 5. motivate activity
 6. reduce failure
- (Andrews and Erickson, 1976, p. 168).

Andrews and Erickson also point out that many teachers feel the reasons for failing to make use of media in teaching can be attributed to:

1. excessive time
2. technical assistance usually unavailable
3. inconvenience in use
4. depersonalization of instruction

The use of audio-visual aids usually requires more work on the part of the teacher, but students often find the results more interesting and enjoyable. "It is important for teachers to become aware of the following principles of use for all types of media" (Andrews and Erickson, 1976, p. 169).

1. Selection. Audio-visual aids to classroom communication should only be used when appropriate to the specific situation.
2. Preview. Whether the materials are commercially or personally produced has little bearing on the fact that all should be viewed prior to use in order to determine their capacity to clarify or amplify the subject under study.
3. Utilization. If the first two steps have been taken into consideration, successful use of the media is usually assured. However, it should be remembered that each type of medium necessitates special room and class arrangements.
4. Evaluation. Following the lesson, it is important for the teacher to determine whether or not the audio-visuals improved the teaching and the learning.

"The greatest use of audio-visual aids lies in their appeal to the senses, ability to attract and hold attention, and ability to focus attention on essential elements to be learned at the proper time" (Miller and Rose, 1975, p. 171).

"Any subject can be taught more effectively through the appropriate use of visual aids" (Miller and Rose, 1975, p. 64). The effective teacher uses all the resources available in an expert fashion when they are needed. The teacher should use visual aids when and only when they help to facilitate learning.

The influence of media on learning has been the subject

of educational research since Thorndike suggested pictures as a labor-saving device in instruction. A large number of research studies are supported by the hope that learning will be enhanced with the proper mix of medium, student, subject matter content, and learning task. Research on media in education has covered a wide and diverse range of topics, settings, and domains. Its methodologies vary from basic experimental work in the laboratory through field experiments in educational institutions, to large-scale evaluations of programs and products in current use by schools. Underlying the diversity, there are common research objectives that guide researchers in classifying diverse studies. Three identified objectives of media research are to obtain knowledge about the instructional effectiveness of a chosen media, to increase the understanding of how media function and what psychological effects they have on learners, and to enhance the practice of education through providing and evaluating improved media, materials, procedures, and technologies. Most researchers have aimed at more than one objective to obtain valuable practical and theoretical results. According to W. H. Allen (1971, p. 9), G. N. Gordon (1969) and other researchers media research has yielded very little results. Olson (1974, p. 6) commented on the accumulated research on media by stating that:

We know neither how to describe the psychological effects of ... technologies(media) nor how to adapt them to the purposes of education. The impact of technologies both ancient and modern on children's learning is either negligible or unknown

Richard Clark in his abstract, 'Reconsidering Research on Learning from Media' (1983, p. 447), reported that research results in the past decade have been reasonably unambiguous and unanimous. Taken together, they provide strong evidence that media comparison studies that find causal connections between media and achievement are confusing. Previous reviews dealing with significant findings for media versus conventional instructional delivery were sometimes misleading. Clark contends that these findings should be expressed as the number of standard deviations separating experimental and control groups, or as improvements in percentile scores on a final examination.

J. Kulik, Kulik, and Cohen (1979, p. 330) in their review of Postlethwait's audiotutorial instruction studies found 42 adequate studies, of which 29 favored audiotutorial instruction and only 13 favored conventional instruction. Of those 42, only 15 reported significant differences, but 11 of the 15 favored audiotutorial and only 4 favored conventional instruction. This analysis strongly favored the learning benefits of the audiotutorial approach over more conventional means. However, treatment of this data would show only .2 standard deviations differences in the final exam scores of both groups. Kulik and his colleagues reported that this difference was equivalent to approximately 1.6 points on a 100-point final examination. This small effect is not instructionally significant.

Based on five decades research (Clark, 1983, p. 450) suggest that there are no learning benefits to be gained from employing different media in instruction. Some research studies claim that there are learning benefits to using one medium over another. However, surveys of media research indicate that confounding has caused these studies to make such a claim and that the great majority of these comparison studies clearly indicate no significant differences.

Newer research has focused its attention on the beliefs and attributions students place on media. Salomon (1981, p. 312) suggested a model for conceptualizing the differences in persistence which result from different media attributions. His model suggests precise relationships between the perceived difficulty of media, the self-efficacy of students, and the resulting efforts they will invest in learning from a given media. Salomon reported that it was typical for students to attribute great difficulty to learning from computers but to think of video as shallow and easy. In a related study, Saracho (1982, p. 210) reported that in a year long study involving over 250 third to sixth grade students those assigned to computer-assisted instruction in basic skills liked the computer less but learned more in the computer condition than from other media.

SUMMARY

This chapter presented various modalities of learning as a basis for understanding the effects they have upon teaching methods and techniques. This chapter also presented the effects of the lecture method of teaching and the technique of using audio-visual aids have on learning. A comparison of research studies on the effects media have on learning was presented in this chapter. Chapter III will explain in detail the methods and procedures used to determine the effectiveness of the lecture method versus the use of audio-visuals.

CHAPTER III

METHODS AND PROCEDURES

This chapter will outline the methods and procedures used in determining the effectiveness of teaching an introduction to computer aided drafting using audio-visuals versus the lecture method to basic drafting students. Pertinent information concerning the population will be given. Also provided in this chapter are sections on teaching methods and techniques, data collection and summary.

POPULATION

The population of this study consisted of two Basic Drafting classes at B. T. Washington High School, Norfolk, Virginia. There was a total of twenty-one (21) students enrolled in the two groups. Both groups were taught by the same instructor. One group was taught by the lecture method with no supplement aids. The other group was taught using audio-visual aids. There were ten (10) students in the control group and eleven (11) students in the experimental group. Both classes were classified as general education students, thus having equivalent ability levels. None of the students had prior computer aided drafting experience.

TEACHING METHODS AND TECHNIQUES

In introducing computer aided drafting, both classes received similar instruction. The control group was taught using the lecture method without the use of any supplemental aids. The experimental group was taught using the video tape recorder and the overhead projector. The video tape was used to dramatize the impact of CAD on society. The tape also presented a description of CAD applications in industry and in education. Transparencies showing the CAD system (hardware and software) were used with the experimental group to enhance the students' understanding and arouse interest.

The textbook Mastering CAD with the Robo System CAD-2, Apple II Version by Henry M. Hawkins and Kolan K. Bisnee, 1986, was used in the presentation of the introduction (see Appendix C, p. 36). Both groups had to complete a study outline (see Appendix D, p. 44) at the conclusion of the presentation. The students were then given review questions (see Appendix E & F, p.47, 49) and a crossword puzzle to complete. The students were administered a post-test after the completion of the introductory unit.

DATA COLLECTION

A post-test was designed to collect the necessary data relating to the effectiveness of the teaching methods. This test was given at the conclusion of the unit. Both the control group and the experimental group were given the

same test. The test consisted of definition of terms, identification, matching, and essay questions.

The tests were scored and data organized for an analysis. The means and standard deviations were calculated for each group's performance on the post-test. In order to determine if there was a significant difference in the performance of both groups, a t-test was used.

SUMMARY

This chapter described the population selected for this study in detail. The methods and procedures used for collecting necessary data for this study were given. Chapter IV will provide the findings from the test administered and an analysis of the test results.

CHAPTER IV

FINDINGS

INTRODUCTION

It is generally accepted that the purpose of all experimental research is to generalize the investigators findings and make transfer to other subjects and other situations. The investigator is not primarily interested in limiting the conclusions to only the particular groups used as his subjects. The investigator would like to be able to conclude that such a finding would be reproducible in other settings.

The purpose of this study was to determine the effectiveness of teaching an introduction to computer aided drafting using audio-visuals versus the lecture method to basic drafting students at B. T. Washington High School. The results of the data collected from testing are presented in this chapter. All students were given the same information on a handout to initiate the study. The control group consisted of ten (10) students and was taught using the teacher-lecture method. The experimental group consisted of eleven (11) students and was taught using the video tape recorder and the overhead projector.

The control group engaged in a class lecture on how CAD

is used in industry and everyday applications. The control

will to ask and respond to

questions. The video tape recorder was used to present and dramatize to the experimental group the impact of CAD on society. The tape presented a description of CAD applications in industry and in education. Transparencies showing the CAD system (hardware and software) were used with the experimental group to enhance the students understanding and arouse interest. The textbook, Mastering CAD with the Robo System CAD-2, Apple II Version by Henry M. Hawkins and Kolan K. Bishee, 1986, was used in the presentation to both groups. Both groups completed a study outline at the conclusion of the presentation. The students were then given review questions and a crossword puzzle to complete. The students were administered a post-test after the completion of the introductory unit.

The post-test consisted of definitions, identification, matching, and essay questions. The hypothesis was addressed by calculating the mean scores (see Appendix A & B, p. 32, 34) of the post-test and using the t-test to determine if there was a significant difference in the two means. The hypothesis states that there is a difference in the performance of basic drafting students who are taught computer aided drafting using audio-visuals and basic drafting students who are taught computer aided drafting using the teacher-lecture method.

With total $N=21$ the normal curve values of 2.080 (5 percent level) and 2.831 (1 percent level) were used to determine the significance of the difference. The calculated t ratio = .94 (see Appendix B, p. 34), it does not

exceed 2.080 nor 2.831. Therefore, the researcher can assume that the observed difference between the means is not significant at either the 5% level nor the 1% level of significance. It would seem justified in failing to reject the claim (null hypothesis) that there is no difference between the two methods of instruction, based upon the sample data.

SUMMARY

The purpose of this study was to determine the effectiveness of using audio-visuals versus the teacher-lecture method to teach an introduction to computer aided drafting to basic drafting students at B. T. Washington High School. This was achieved by selecting a control group and an experimental group. The control group was taught by using the teacher-lecture method and the experimental group was taught by using the video tape recorder and the overhead projector. Results of the test given at the completion of the unit to gather data were recorded and noted. The results indicate that the performance of the two student groups was not significantly different. Chapter V provides a summary of this study along with conclusions and recommendations that resulted from the interpretation of the collected data.

CHAPTER V

SUMMARY

The transition from Industrial Arts to Technology Education has created new challenges for the drafting teacher. The drafting teacher must not only concern himself/herself with understanding and applying computer concepts to the classroom, but must give some considerations to developing effective teaching methods.

In determining an effective method (lecture method vs. using audio-visuals) of teaching introductory computer concepts in the drafting classroom, two intact groups of basic drafting students at B. T. Washington High School were used in the research process. At the end of the experiment a post-test was administered to assess the performance and comprehension of the groups.

The means, standard deviations, and differences in the means for both the control group and the experimental group were computed in order to test the hypothesis. The t-test was used to test the significance of the difference between the means obtained for both groups.

CONCLUSIONS

The findings from this study showed that there was no significant difference in the performance of the two groups based upon the teaching methods used. The test scores and the results of the t-test indicated that the students who

were taught using audio-visuals experienced no significant difference from the students who were taught by the teacher-lecture method. Therefore, the hypothesis of this study is invalid. The means of the two groups are not significantly different. Consequently these results indicate that the performance of the two groups on the Computer Aided Drafting Test was not significantly different.

A pre-test on computer awareness and/or applications is one factor that might have made a considerable distinction. Some students may have had more exposure to computers (toys, games, etc.) than other students. Another factor not taken into consideration might have been the learning modes of each individual student that composed the two groups. While most students learn either by hearing or by seeing, there are other students who learn by doing. The review of literature of this study indicated that once the teacher has identified the learning modes that are most successful with each student, activities should be chosen and used to strengthen the student's ability. When the student has learned successfully with a particular mode, alternate techniques should be introduced and tried so that the other modes may be developed for future understanding. Students may be turned-off by the increased use of video tapes in schools. One wonders what difference may have been found if another media was used.

As stated earlier, this study failed to show that audio-visuals increase the performance of students enrolled

in the basic drafting class. The experimental group showed no more confidence and understanding of computers than did the control group. Nor was the experimental group more attentive to the video tape than the control group was to the teacher's lecture. The results of the evaluation showed that there was no significant difference in the retention of the two groups.

RECOMMENDATIONS

Based upon the findings, observations, and subsequent conclusions of this study, the researcher submits the following recommendations:

1. This study be replicated in its present design using other types of audio-visuals in order to determine if the experimental method is more or less effective.
2. A similar study should be conducted using other content areas in order to determine the effectiveness of using audio-visuals.
3. Based upon observations by the researcher, the study should be modified to see if significant changes in motivation, attitude, and interest occur during the experimental period.

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APPENDIXES

APPENDIX

A

POST-TEST RESULTS

<u>Experimental Group</u>		<u>Control Group</u>	
<u>Score</u>	<u># of Students</u>	<u>Score</u>	<u># of Students</u>
94	1	100	1
83	3	92	1
81	1	78	2
78	1	72	2
72	2	67	1
67	1	64	1
64	2	42	1
		39	1
Total = 11		Total = 10	

APPENDIX

B

RESEARCH DATA

Experimental Group

$$N = 11$$

$$X = 76.5$$

$$S = 81.70$$

$$S = 9.04$$

Control Group

$$N = 10$$

$$X = 70.4$$

$$S = 330.84$$

$$S = 18.19$$

t-TEST

$$t = \frac{6.1}{42.29} = \frac{6.1}{6.5} = .94$$

APPENDIX

C

Chapter 1

CAD SYSTEMS

1.1 OBJECTIVES

As a result of completing this chapter, the user should be able to

1. explain the history of Computer Aided Design (CAD)
2. describe the uses of CAD both in industry and education
3. describe the major components of a CAD system, including the computer, software, and storage, input, and output devices

1.2 INTRODUCTION

Some think of CAD as being Computer Aided Design while others refer to it as Computer Aided Drafting. Occasionally, the term CADD is used for both Computer Aided Drafting and Design. More commonly either or both are referred to simply as CAD. Since drafting is an inseparable part of the design process, it really doesn't matter which definition is used.

Drafting, whether computer aided or not, is a means of communicating ideas in a manner that will be understood by the machinist, welder, woodworker, tailor, and many others. The design process goes beyond drafting and allows the designer to test ideas using trial constructions and/or models. This is where the computer benefits the drafter and/or designer by making it possible to use simulations that give the results in much less time and for a lot less money. CAD is one of many areas that are starting to make extensive use of the computer.

1.3 HISTORY OF CAD

If one thinks of drawing as a method of recording pictorial information, and communicating it to others, then man's involvement with drawing goes back a long way. Since earliest times there has been a need to count and remember things. Early man used fingers and toes to count upon. Later, sticks and stones were used for counting and marks were made on the walls of caves or notches carved on sticks or in stone to record what was seen. Simple counting marks were replaced by the use of symbols, which reminded observers of the wildlife they or others had seen as well as how many had been noted.

This combined need to store graphic as well as numeric data evolved after thousands of

years into the written and pictorial forms used by the Egyptians. Several thousand years later, the Romans constructed detailed building plans using drafting tools very similar to those in use today: the straight edge and compass, for example.

While no major developments occurred over the next few thousand years, drafting practices were steadily refined and standardized. By the early 1900s, the multi-view drawing had become a universally understood language. The thirties through the fifties saw major improvements in drafting media (vellum, polyester film, etc.) and hardware (drafting machines, scales, templates, pens, etc.).

The revolution in design practice began in the sixties, when computers were increasingly used to simulate and analyze complex mechanisms, ranging from automobile suspensions to entire space vehicles. At about the same time, the first steps were being taken to automate the drafting process. Through automation, it was hoped to do away with tedious calculations, trial constructions, tolerancing problems, and the like.

Early efforts in CAD were laborious, slow, and expensive, using computers costing upwards of \$250,000. But in the early seventies, the microcomputer appeared and computer costs fell by factors of ten, twenty, and even one hundred. Lower computer costs made the benefits of "computerization" accessible to practically everyone. Today, in particular, CAD software of professional quality is now available for the types of microcomputers commonly found in schools and small businesses.

1.4 BENEFITS OF CAD

The area of CAD includes the use of computer-generated graphics that are created through various input devices such as the keyboard, joystick, tablet, and others. Also inherent in a CAD system is the ability to graphically display the images that were created, and to save them for future use. These images may be created on the screen or as "hard-copy" paper output.

CAD has revolutionized both the design and drafting fields by allowing the drafter to create drawings using the computer. The productivity of a drafter can be increased tenfold when using CAD in place of the more conventional drafting tools: pencil, paper, and drafting boards.

The computer has automated the tedious chores encountered in manual drafting. For example, the computer can permanently store a symbol, a group of symbols, or an entire drawing, allowing the drafter to use them over and over again in the preparation of new work. Literally, the same thing never has to be drawn twice.

The computer can make as many trial drawings, modifications, and erasures as needed before the final version is permanently stored or hard copy is made. In this way, CAD is very much like a word processor, except that graphics are being manipulated instead of words.

The computer can automatically perform difficult constructions and dimension checking as the work proceeds. This allows the designer to focus on the more creative aspects of the task instead of the bothersome details.

Finally, the computer can be coupled to a plotting device capable of generating consistently high-quality hard copy (line and letter perfect) that is completely free from erasures and smudges.

Computer aided drafting had led to tremendous increases in the productivity of drafters and marked changes in drafting practices. It should be kept in mind, however, that even though CAD increases the productivity of a drafter, its use still requires an understanding of basic drafting concepts. Basic drafting skills, many say, must still be learned by the beginner through the use of paper, pencil, and conventional drafting instruments.

1.5 APPLICATIONS OF CAD

CAD is widely used in industry and is beginning to find its way into the public school classroom. Because of the many advantages, the CAD market is expected shortly to exceed \$8 billion.

1.5.1 Industry

The key to the success of any new technique in industry is productivity. CAD has successfully increased productivity in many areas in which it has been introduced. Several things must be considered before implementing CAD.

The first concern is choosing a system that is appropriate to the application. Once the correct system has been chosen, sufficient time and training must be provided for those in the design and manufacturing areas to become familiar with what CAD can do. Once these requirements have been met, care must be exercised in the identification of jobs to be done using CAD. There are still some tasks that are more efficiently done using traditional pencil-and-paper methods.

The application of CAD is increasing very rapidly, in almost all industrial spheres, from graphic arts to machine design. CAD has been used for many years by the automobile industry for the design of new automobile bodies and chassis components. This application area has become particularly important in the development of more fuel-efficient vehicles. As we have seen, through simulations CAD allows the drafter to test ideas without the expenditure of time and money in building actual prototypes. Such simulations can be used to test the strength and safety of a design while reducing weight to an absolute minimum.

CAD is used in the area of space exploration. Spaceship designs can be tested through simulation without requiring building and launching. If design flaws are found, CAD equipment makes it a simple matter to re-draw the plans and incorporate the necessary design changes.

On a less sophisticated level, CAD is now being used in almost all types of general engineering companies. CAD systems are being used for such diverse tasks as injection mold design, sheet metal layout, and wood cabinet construction.

The field of architectural design has recently found CAD to be of great value. The drafter who is involved in the design of a new building or renovation of an existing structure can greatly benefit from the use of CAD. It can save time in the initial development of plans by the use of pre-drawn symbols such as doors, windows, appliances, etc.

During the development of a set of plans, the architect can make an unlimited number of changes or adjustments prior to producing the finished plans. Architects especially welcome the CAD system's ability to make quick and easy modifications to their drawings, which may be highly complex and subject to frequent changes.

Another advantage of CAD is its capability to transmit graphical data—even complete drawings—over unlimited distances using the telephone. Data can be sent to another division of the same company or to a subcontractor for the production of the designed item. This process offers an advantage over sending a set of paper plans in that the actual data may be used directly in the manufacturing process thus eliminating errors caused by misreading plans.

1.5.2 Education

The need for CAD instruction in public education goes hand-in-hand with industry's growing realization of what CAD can do. As recently as 1980, it would have been cost prohibitive to install a CAD system in the public school classroom. However, the decreasing cost of com-

puters and the vast improvements in software techniques have made CAD systems affordable by educational institutions.

CAD can be used in any area where creating and altering line artwork is an important part of the learning activity. It is introduced in the basic drafting course. The student first learns the basics of three-view orthographic projections, dimensioning, sectioning, etc., then begins using CAD. Although its introduction to the classroom is very recent, CAD has already achieved a reputation as the "fun way of drawing," which in no way lessens its importance as an educational tool.

Some of the courses already including CAD experiences are:

- Basic drafting—drawing construction
- Architectural drafting—floor plans and site plans
- Engineering drafting—detailed drawings of fabrication parts
- Electronics fundamentals—schematics and circuit board design
- Hydraulics fundamentals—flow diagrams
- Technology fundamentals—construction projects

1.6 COMPONENTS OF CAD

The typical CAD system consists of a computer that is equipped with a screen, an input device, one or more floppy disk drives and/or a hard disk drive, and a device that produces hard-copy output.

CAD systems, until recently, typically cost in excess of \$250,000. However, it is now possible to accomplish 80–95% of the drawing elements that can be done on systems costing in excess of \$100,000 with microcomputer-based CAD systems costing less than \$5,000.

1.6.1 Robo CAD System

The Robo CAD system consists of the CAD system software and runs on an Apple*II series computer equipped with floppy disk storage. Data are input using a special analog three-axes controller, the keyboard, or an optional digitizer. Robo CAD is designed to allow output to either a printer or a plotter and can be used with monochrome, composite color, or RGB color monitors.

1.6.2 Software

CAD systems have a wide variety of features. All systems require both hardware and software that work together in order to accomplish the drafting task at hand. The software is the most important part of this combination. If the software is weak then the entire system, from a CAD perspective, is also weak.

The actual drafting power and versatility of the Robo system comes from its software. The software comes on a single disk and is written in assembly language, which makes it significantly faster than a program written in a higher-level language such as BASIC or Pascal. Although the Apple II series computers are 8-bit machines, Robo software handles numerical data with 40-bit precision.

1.6.3 CPU

The CPU (central processing unit) or computer which runs the software is also an important part of any CAD system. The CPU provides the internal processing of the commands given the system by the user.

The Robo CAD system is designed to be used on the Apple II series computer. CAD-1 requires 64K of RAM, which is the standard configuration of an Apple IIe. CAD-2, with its many additional features, requires 128K of RAM, which is achieved with the standard 64K and a 128K plug-in RAM board. Both systems make extensive use of the computer's memory and are therefore many times faster than other CAD systems that rely heavily on disk storage. Robo CAD systems support the use of an accelerator card, which increases drawing speeds by approximately 3.6 times.

1.6.4 Storage

Storage systems, as they relate to a CAD system, are classified as either temporary or permanent. Temporary storage occurs within the computer, whereas permanent storage typically occurs outside the computer.

Temporary Storage

RAM (random access memory) provides for the short-term storage of drawing information. Short-term means that once the power is turned off, all information that was stored will be lost. Robo CAD systems make extensive use of RAM and typically function many times faster than those that store the data for a drawing under construction on disk. In either case, the system must eventually store the information on some form of magnetic media or it will be lost when the system is shut down.

Permanent Storage

Magnetic media storage devices provide permanent storage. They are commonly either floppy or hard disks. The hard disk storage device is much faster but it is also more expensive. Most low-cost systems today make use of floppy disks for the permanent storage of data.

Robo CAD systems use a "library disk" for the permanent storage of pictorial data. The Robo system allows the user to take material from one or more library disks (i.e., windows, doors, electronic symbols, etc.) and use it in a drawing. The completed drawing can then be saved on another library disk.

1.6.5 Input Devices

Input devices are the means by which the CAD operator creates images on the computer. Commonly used input devices can be classified in one of three categories: keyboards, analog input devices, and digital input devices.

Keyboard

The first type of input device on a CAD system is the keyboard. The Robo system requires the use of the keyboard only when entering text, labels, and explicit numeric values.

Analog

Analog input devices include joysticks, trackballs, and mouse controllers. The Robo controller differs from a conventional joystick in that it provides data on three axes and can be used comfortably on a flat surface or on the user's lap. The joystick is used to position elements on the screen and the thumbwheel for size adjustments. Also on the analog controller are

three buttons: two black and one red. These buttons are used for the selection and confirmation of menu options and to cancel operations. The controller section of Chapter 2 and pages 2-3 and 2-4 of the *Robo CAD User Manual* contain more detailed information.

Digital

The digital input device, which is commonly referred to as a digitizer, provides digital input data on two axes. The Robo CAD system supports the use of a digitizing tablet. The digitizer is particularly useful for tracing an existing line drawing.

1.6.6 Output Devices

There are two types of output devices used on CAD systems. The plotter is commonly used for quality line work, whereas the dot-matrix printer is used in applications requiring greater speed and lower resolution (i.e., quick proof copy).

Plotter

The plotter is the preferred output device because it emulates hand-drawing movements. The plotter is vector driven and is capable of drawing long and short straight lines at any location and at any angle. When drawing a straight line, the plotter simply constructs the line between point A and point B regardless of their location. Many plotters have the ability to plot using different pens, either for different line widths or different line colors. Some plotters can also change pens automatically while plotting.

Robo CAD systems support a wide range of plotter makes and types. These plotters range from small A size (11" × 8½") single-pen units to large E size (48" × 36") multi-pen units.

Dot-Matrix Printer

The dot-matrix printer serves a useful purpose. It enables the CAD user to get a hard copy of the line drawing quickly. The dot-matrix printout will not have the line quality of a drawing done by a plotter but it can serve as a useful reference. The main reason for the less pleasing appearance is the dot-matrix printer's inability to draw continuous lines using vectors.

The printer creates lines using dots and can print them only at pre-set locations depending upon the resolution of the printer. Resolution is related to the number of dots per inch that the printer is capable of producing and the resolution of the screen image being printed.

The dot-matrix printer can be used with the Robo CAD system for a quick "proof" copy of a drawing that is on the screen. This process is commonly called a "screen dump."

1.7 SUMMARY

CAD has caused fundamental and far-reaching changes in the way designs are created, analyzed, and completed. The microcomputer and improved software techniques have brought CAD within the reach of practically everyone.

CAD is used extensively in industry for such diverse applications as the development of more fuel-efficient vehicles, the exploration of space, and the design of buildings. CAD is now also being used for the direct computer control of machine tools, such as lathes and milling machines.

The field of education is also beginning to make use of CAD not only for the training of future CAD users but also for the development of educational media and support materials. CAD systems are used in the areas of drafting, construction, machining, and line-art work.

CAD systems are comprised of software, a computer, storage devices, input devices, and

output devices. They range in cost from \$5,000 to more than \$300,000. The selection of a CAD system should be done carefully and must be based on the particular needs of the user.

Robo CAD is designed to run on the Apple II computer series. It uses a special disk operating system for faster file access and it makes extensive use of RAM thus reducing the need for disk access. The Robo system is one of the fastest, most powerful, microbased CAD systems on the market today.

Robo CAD is menu driven and easy to learn. The system is highly interactive through an analog three-axis joystick controller or an optional digitizer. The keyboard is seldom used, allowing the user to direct full attention to the screen workpage area.

Robo CAD also supports both dot-matrix printers and plotters. Dot-matrix printers are useful for quick reference copies of work in progress. A full line of plotters for precise hard copy is also supported.

APPENDIX

D

CAD SYSTEMS

CHAPTER 1 - CAD SYSTEMS

DIRECTIONS: To show the relationship of the ideas in this chapter, complete the following outline by filling in the subtopics. The main topics have been done for you. This is a sentence outline.

- I. The term CAD refers to two definitions.
 - A. It refers to
 - B. It refers to
 - C. Since drafting is an inseparable part of the design process, it
- II. Using drawing as a method of communicating pictorial information to others goes back a long way.
 - A. Marks were made
 - B. These marks were replaced by
- III. There was a need to store graphic and numeric data formed by the Egyptians after thousands of years.
 - A. The Romans
 - B. By early 1900's
 - C. The thirties through the fifties
 - D. In the sixties
- IV. Early efforts in CAD were laborious, slow, and expensive.
 - A. However, in the early seventies,
 - B. Today,
- V. There are several benefits of CAD.
 - A.
 - B.
 - C.
 - D.
 - E.

- VI. CAD is widely used in industry because it increases productivity.
- A. The automobile industry uses it for
 - B. Space exploration uses CAD to test
 - C. General engineering companies use CAD systems to
 - D. In architectural design, the drafter
- VII. CAD is beginning to find its way into the public school classroom.
- A. The decreasing cost of computers and
 - B. CAD has achieved a reputation as the
 - C. CAD experiences are already included in many courses.
 - a.
 - b.
 - c.
 - d.
 - e.
 - f.
- VIII. There are several components of CAD.
- A. The Robo CAD system consists
 - B. All systems require both hardware and software that
 - C. The CPU provides
 - D. Storage systems are classified as either temporary or permanent.
 - a. Temporary storage means
 - b. Permanent storage means
 - E. Input devices are
 - a. Keyboard
 - b. Analog
 - c. Digital
 - F. There are two types of output devices used on CAD systems.
 - a.
 - b.

APPENDIX

E

REVIEW QUESTIONS

CAD System

1. Indicate whether the following statements are true or false:
 - a. Alphanumeric data consists of points, lines, planes, arcs and circles.
 - b. A keyboard is an output device used to output letters and numeric characters.
 - c. A hard copy unit is used primarily as an input device in a computer aided drafting system.
 - d. The processing unit is the "brain" of the computer-aided system.
 - e. The central processing unit is also called the CPU.
2. What are input/output devices referred to for short?
3. Name two different types of printers.
4. Name two different types of plotters.
5. What is the digitizing unit made up of?
6. What is another name for the digitizer?
7. What other input device can be used to enter graphic information?
8. Discuss the differences between a floppy disk, magnetic tape and hard disk.
9. What types of storage devices are used with each of the storage media in question 8.
10. What is the cursor? What does it look like?

APPENDIX

F

REVIEW QUESTIONS

Applications

- 1.** Name four different occupations where CAD could be used.
- 2.** What are menus?
- 3.** What does CAD stand for?
- 4.** How does CAD help in prospective highway development?
- 5.** Give one example of how CAD could facilitate the drafting process.
- 6.** What are some future possibilities for CAD applications?
- 7.** Name three things besides producing drawings that computer-aided drafting systems can be used to do.
- 8.** What is the single most important benefit of computer-aided drafting?
- 9.** List four skills beyond the basic drafting skills that are needed by computer drafting technicians.
- 10.** Elaborate on the following statement: Computer-aided drafting will not eliminate the need for drafters.

APPENDIX

G

UNIT TEST

CAD Systems

Directions: Select from the answer column at the left the word which best answers each of the statements at the right. Put the number of the word in the proper space in the magic square answer box. If your answers are correct, they will form a magic square. The total of the numbers will be the same in each row across and down to form a magic number.

ANSWER

1. Plotter
2. CAD
3. Software
4. Robo
5. Output
6. Simulation
7. Microcomputer
8. Componets
9. Design Process
10. Computer
11. Input
12. Industry
13. Automation
14. Printer
15. Drafting
16. Storage
17. Graphics
18. Productivity
19. Affordable
20. Keyboard

DEFINITIONS

- A. Computer Aided Drafting or Computer Aided Design.
- B. A very small electronic machine that processes and prints information from coded data.
- C. The creation of goods and services; producing useful results.
- D. The commercial production and sale of goods and services.
- E. Any of the main parts of a whole.
- F. The information produced by a computer.
- G. Information put into the computer for processing.
- H. A plan or drawing of a work to be done.
- I. A machine that can move or act by itself.
- J. Drawings used for illustration of demonstration.
- K. To look or act like; and imitation.
- L. Written or printed data necessary to the operation of computers.
- M. The part of the computer that saves information for later use.
- N. An electronic device used as a calculator or to store and select data.
- O. A system designed to run on the Apple II computer series equipped with floppy disk storage.
- P. The testing of ideas using trial constructions and/or models.

A	B	C	D
E	F	G	H
I	J	K	L
M	N	O	P

The Magic Number Is _____.

CAD Applications

1. The term CAD refers to _____.
2. In the early sixties _____ were used to simulate and analyze complex mechanisms.
3. In the early seventies _____ helped to reduce the cost of computers.
4. List five benefits of CAD:
 - A.
 - B.
 - C.
 - D.
 - E.
5. CAD is widely used in industry because it measures _____.
6. All CAD systems require both _____ and _____.
7. Short term storage of drawing information within the computer is known as _____ storage.
8. Information stored on floppy disk or hard disk, out side the computer, is known as _____ storage.
9. An input device used to enter text, labels, and explicit numeric values is the _____.
10. Two types of output devices used on the CAD system are the _____ and the _____.