7-1988

A Comparison Study of Teaching Basic Drafting Concepts Using Computer-Assisted Equipment and Traditional Methods to Beginning Drafting Students at the Secondary Level

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Abstract

The purpose of this research was to determine if basic drafting concepts and skills can be learned by students using computer-assisted drafting equipment as well as those students who were taught using traditional drafting equipment. The two methods used in this study were a traditional style, using drafting boards with drafting machines, and the second was using computer-assisted drafting equipment (CAD).

A COMPARISON STUDY OF TEACHING BASIC DRAFTING CONCEPTS USING COMPUTER-ASSISTED EQUIPMENT AND TRADITIONAL METHODS TO BEGINNING DRAFTING STUDENTS AT THE SECONDARY LEVEL

A Research Paper Presented
to the Graduate Faculty
of the Department of Industrial
Technology
University of Northern Iowa

In Partial Fulfillment of the Requirements for
the Non-Thesis Master of Arts Degree

by
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July, 1988

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Chapter 1
Initial Research Statements

With the availability of low cost computer-assisted drafting equipment, the drafting industry has gone through dramatic changes in the last thirty years. All levels of business, industry, and education have seen the implementation of computer-assisted drafting equipment. With the availability of this equipment, the drafting instructor at the secondary level must be making curriculum decisions as to how this equipment will be used in the instructional process.

Purpose

The purpose of this research was to determine if basic drafting concepts and skills can be learned by students using computer-assisted drafting equipment as well as those students who were taught using traditional drafting equipment. The two methods used in this study were a traditional style, using drafting boards with drafting machines, and the second was using computer-assisted drafting equipment (CAD).

Problem

The problem of this project was to compare two methods of instruction in teaching drafting. One method involved using computer-assisted drafting equipment (experimental group). The second method involved using traditional drafting boards and drafting machines (control group). The scope of the problem was defined by specified questions to be answered by the research.

Research Questions

The following research questions are answered in the study:

1. What differences exist between the control and experimental groups with respect to drafting knowledge gained as measured by test scores?

2. What differences in time exist between completion of assignments using the control method (traditional) and that of the experimental (CAD) method?

Statement of Need

In a presentation to a group of instructors at Okaloosa-Walton Jr. College Goetsch stated "no technological advance in the past three decades has impacted so profoundly on the occupation of drafting as the advent of computer-aided drafting" (1981). Literature reviewed by this researcher revealed the fact that all of the studies which have been conducted in the area of CAD instruction have used students already experienced in drafting. Also, the studies reviewed, were conducted at the post high school level or at the university level. As the availability of CAD equipment continues to reach further into the secondary level at the senior high and the junior high areas, the drafting instructor will have to be making curriculum decisions on the approach to be used in teaching basic drafting concepts. The two basic choices being: using traditional style equipment or CAD equipment.

Technology has moved from the triangle and T-square to the drafting machine and now to computer-assisted drafting equipment. The instructor must decide whether or not this technological advancement is beneficial to the teaching/learning process. Other disciplines are facing this same type of question. Instruction in typing has taken a similar course; moving from the manual typewriter, to the electric typewriter, to the memory typewriter, and finally to the wordprocessor. Can the typing teacher stay with a manual typewriter and be as effective, given what the student will encounter in the business world? This researcher believes that the teacher will not be as effective, because he has not prepared the student for the "real world". Likewise, CAD equipment is being utilized in every aspect of drafting (Goetsch, 1981). Therefore, the drafting student who is only able to use a T-square and triangle will not be prepared for the "real" world of drafting. At what level, then, should the drafting student be exposed to CAD technology. Should he/she first learn the basic concepts and then go to the CAD equipment or begin with the computer itself. This then is the question, "Can the beginning drafting student take advantage of CAD technology to learn the basic concepts of drafting or will the student benefit more by beginning with the traditional equipment?" Direction is needed to investigate the utilization of CAD equipment in the educational process. This study is needed to address this issue.

Limitations

This study was conducted in view of the following limitations:

1. An instruction period of twenty-six hours over a four week period. This included a fifty minute period each school day plus a three hour session on two different Saturday mornings.
2. Concepts and materials selected from the literature by this researcher, and validated by his research advisor at the University of Northern Iowa.
3. A CAD program entitled MATC-CAD.

Assumptions

This study was conducted with the following assumptions being made:

1. An instructional time of four weeks would be an adequate length of time to present the basic concepts to each group.
2. A positive gain in scores on a Pre/Post test would be adequate evidence of learning.

Definition of Terms

The following terms as defined here were used throughout this study:

1. CAD -- An acronym meaning computer-assisted drafting.
2. Traditional method -- Teaching drafting using a drafting board and drafting machine. This can be with a small portable drawing board or using a drafting table/desk with a chair or stool.
3. MATC-CAD -- Computer-assisted drafting program developed by the Milwaukee Area Technical College in Milwaukee, Wisconsin.
4. Turnaround-Time Ratio -- A comparison of the total time required to complete an entire project or series of tasks with traditional versus a computer graphics system.
5. CAD Station -- The hardware and software equipment necessary to perform computer-assisted drafting. The equipment includes, a computer CPU, storage device, monitor, plotter and the CAD program which functions through the hardware.

Chapter 2

Review of Literature

The review of literature is focused on three areas as they pertain to this study. The topics included in this review of literature are : (1) use of computer-assisted instruction and its costs; (2) research within the graphics area as it applies to computer-assisted drafting and instruction and (3) the concepts necessary in teaching basic drafting.

Review of Studies on Computer-assisted Instruction

In a review of 51 independent evaluations of computer-based teaching in grades six through twelve; Kulik, Bangert, and Williams (1983) stated a variety of conclusions in their findings. Three databases: (1) Lockheed's DIALOG on line information service, which is a gateway to 170 databases of research information; (2) ERIC (Educational Resources Information Center), a data base on educational materials and (3) Psychological abstracts, were searched using the following criteria to limit the number of studies which the computer produced:

(1) The studies had to take place in actual classrooms in grades 6 - 12.

(2) Studies had to report on measured outcomes in both the computer-based instruction and the control group.

(3) Studies had to be free from crippling methodological flaws. For example, studies where the control group and study group differed greatly in make-up were excluded.

The studies were also reviewed and limited to those applications which dealt with the following computer-based instruction techniques: (1) drill and practice, (2) tutoring, (3) computer-managed teaching, (4) simulations, and (5) programming the computer to solve problems.

The task of synthesizing the data was accomplished using two methods of review. The two methods were the "box-score" and "meta-analysis" methods. Box-score review reported the number of studies which either favored or did not favor the factors under comparison. An example of a "box-score" rating could be stated as twenty-one of the studies for quality XYZ favored or had a positive result for the control group and ten of the studies reported favorable results for the experimental group. This sets up a point comparison for the studies and how they agree or disagree with a particular factor under consideration.

The reviewers who used the "meta-analysis" approach came to their conclusions with more of a quantitative numbers result. "Meta-analysis" uses the statistical methods to summarize overall findings and arrive at relationships between the studies outcomes. These relationships were expressed in a quantity described as Effective Size (ES). Effective size can be defined as the difference between the means of two groups divided by the standard deviation of the control group (Kulik, Bangert, Williams, 1983). As the rating moves higher, the correlation between the results of the study and the factor being studied is greater. A rating of .61 for an item would hold greater significance and be more favorable than a factor of .12.

The findings from this review were grouped into the following areas, (1) retention rates of material learned, (2) attitudes toward subject matter, (3) attitudes toward computers, (4) attitudes toward instruction, and (5) time of learning. In the category of retention rates, time intervals ranged from two to six months for retesting. In four of the studies, scores were higher in the computer based groups. However, none of the scores was large enough to be considered statistically significant. One study reported retention rates that were significantly higher in the control group. The average ES score favored the computer based instruction groups. The average ES score was reported at .17 standard deviations higher than the non-computer groups.

Of the ten studies that dealt with attitudes toward subject matter while using computers, eight had positive results. Only three studies had an effect large enough to be considered statistically significant. The ES score was .12 in favor of computer-based instruction. This effect was felt to be small at best.

In the area of attitudes toward computers and attitudes toward instruction, results were reported favorable from all of the control groups. In three of the studies on attitudes toward computers, the ES score was significantly positive with a rating of .61.

The attitudes toward instruction factor did not show as large of ES rating, .19 as the attitude toward computer group. The .19 difference was considered very small by the reviewers (Kulik, Bangert, & Williams, 1983).

In the category of time to learn, only two studies contained data which could be compared. The first study reported a time savings of thirty-nine percent using computer-based instruction. The second study reported a time savings of eighty-eight percent.

Early use of computer-based instruction was also costly. As reported in Business Week in 1967, a Los Angeles computer expert put the cost of developing computer-assisted instruction program software for two classes at approximately $500,000 dollars or about $400 dollars per student contact hour ("Computers find," 1967). As the technology developed, the cost associated with computer-assisted instruction dropped significantly. Jamison (1972) reported the cost of computer-assisted instruction in his study at thirty cents per student contact hour. These studies were conducted on large mainframe systems. Since the introduction of the micro-computer in the mid 1970's this researcher has not found studies available that address the issue of cost effectiveness.

Research in the Graphics Areas

There has been research completed in the graphics area at all levels of instruction. These projects have ranged from use of graphics at the elementary level to the college level, (Barr 1984), and in a variety of application areas. When the application has dealt directly with computer-assisted drafting, and instruction has been introduced or included in part of the study, the students are already experienced drafting students (Schwendau 1983, Barr, 1984). There is little doubt that computer-assisted drafting equipment improves the performance of the experienced drafter. This is reflected in the turnaround-time ratio which is used by industry to compare the time a project is completed using the traditional method and using computer-assisted equipment.

The formula for turnaround-time ratio can be expressed in the following equation:

$$\text{Turnaround-time ratio} = \frac{\text{Manual Time}}{\text{CAD Time}}$$

This ratio is a comparison of the total time required to complete a series of drawings or tasks using manual drafting verses CAD equipment. The following example will illustrate the turnaround-time ratios which are typically found in industry. An organization has a design project which was completed by the manual method in 410 manhours. A similar part of the same project was completed using CAD equipment in 80 manhours. The turnaround-time ratio could then be calculated.

$$\text{Turnaround-time ratio} = \frac{\text{Manual time (410 hrs.)}}{\text{CAD time (80 hrs.)}}$$

The turnaround-time ratio would be calculated at a ratio of 5.1:1. This ratio is not an uncommon figure arrived at in industry. Turnaround-time ratios have been reported as high as twenty to one according to earlier studies (Merichel, 1985).

Basic Drafting Concepts

When teaching basic drafting, either with drafting machines and boards or CAD equipment, the beginning student is introduced to the following topics: (1) line types, (2) correct usage of drafting equipment, (3) lettering techniques and drawings specific drafting symbols, (4) multiview drawings, and (5) dimensioning (French, 1978, Giachino, 1968). The following discussion of each of these topics relates the content taught to the beginning drafting student. The order may vary in presentation of the topics, but these make up the first units which students are exposed to in a typical beginning drafting course at the secondary level (Foster, 1984).

Line Types

The different types of lines which are used in drafting must be explained to the beginning student. The theory governing line types and their uses is the same with either method of instruction, traditional or CAD. Achieving the results of rendering lines on a drawing sheet is considerably different according to the method chosen.

There are eight types of lines used in technical drafting which are rendered on the drawing surface. The lines which are used to describe objects can be identified with the following names (Foster, 1984);

1) Visible line	2) Hidden lines
3) Section line	4) Center line
5) Dimension/extension line	6) Cutting plane line
7) Break line	8) Phantom line

To achieve student proficiency in the use of the different line types, a number of exercise drawings are given as practice. Through the repeated practice of the assignments, the beginning student develops the skill necessary to produce consistent lines of the different types.

With the CAD method, the student must know the theory behind the different line types even though the method of producing the actual line is much different than the manual method. The theory would include, for example, knowing the visible line is used to draw lines which represent the different surfaces of an object. The line can be defined as an edge view of a plane or intersection of two surfaces. The hidden lines represent the intersection of two surfaces which cannot be seen in the respective view. These and similar rules cannot be ignored with the computer method. The student still must be able to place lines in their proper location, and use the lines according to the stated rules (Merickel, 1985).

Correct Use of Drafting Equipment

In either form of drafting, traditional or CAD, the equipment which the student will be using must be identified and demonstrated according to function and proper use. With either method, instructional time is required for this very important content.

With the traditional method of drafting, a great deal of variance can exist between equipment the instructor might choose to use or has available to use, in a given educational institution. The time of completion for this unit will vary depending on what equipment the instructor has selected or has available to use.

The CAD method involves a demonstration and instruction of equipment similar to the traditional method. However, since the computer is the driving mechanism behind any CAD system, instruction will be needed on operation of the system and how it functions. Topics should include a general discussion on how the computer works, powering up the system, starting the drawing process, entering basic system commands, and saving drawings. Depending on the level of sophistication of the CAD system, additional instruction will need to be given on many of the advanced operations of the program. These advanced operations allow the operator to increase the amount of output with the system.

Lettering Techniques

The production of the final drawing will include specific graphic symbols such as finish marks, and lettered notes. The standard lettering style on technical drawings is the single-stroke commercial Gothic lettering (Foster, 1984). The draftsperson must include consistent, legible lettering on drawings. Most drawings contain only uppercase lettering.

The same theory of application of lettering applies with the CAD method as it does with the traditional method. The technique is much different when using the computer-assisted equipment. The production of lines and letters, with CAD equipment requires a two step process. With the first step, the text is placed on the computer's "drawing surface". The second step is to have the computer drive a plotter which actually renders the lines onto a drafting media such as vellum or mylar. All lettering and other graphic symbols that were "placed" on the drawing with the system commands will now appear on the final drawing.

Multiview Drawings

When producing a multiview drawing, the rules of orthographic projection are the basis for guiding the draftsperson to a successful completion. The theory of technical drawing and the representation of views falls into two areas of understanding, (1) visualization, and (2) implementation (French, 1978). Visualization is the ability to conceptualize how an object would appear in one's mind. Implementation is the actual representation of the object on paper. A technical drawing, when prepared properly, will gain a more accurate representation of the object than a photograph or written description. The ability or talent of seeing how an object will appear, (visualization) must be learned by the beginning student when using either method of instruction. Implementation of an object will take two different paths, according to which method of instruction is used, traditional or CAD.

Dimensioning

The ability of the draftsperson to render lettering, notes, and dimensions consistently is of prime importance. The two dimensioning methods of unidirectional and aligned are important concepts to understand. The unidirectional system involves placing dimensions on the drawing surface so all the dimensions read from the bottom of the sheet. The aligned method involves placing the dimensions in line with the dimension lines (French, 1978). There are several general policies for applying dimensions, notes and symbols on orthographic drawings. These policies are too numerous to discuss in detail within the context of this study. It should be noted, however, that the general practices followed by draftspersons are adhered to so closely that they almost represent rules (French, 1978).

Chapter 3
Methodology

This particular study was a comparative study. The comparison of teaching methods used to instruct students in the area of basic drafting were explored. The procedure used for this study included:

1. Identification and selection of the concepts introduced in basic drafting courses at the secondary level.

The process of identification and selection of the concepts used for instruction during this project were arrived at in a two step process. The first step included a review of past studies completed in the graphics area. The second, included a review of current textbooks being used at the secondary level for instruction of basic drafting. During this study, the traditional and CAD groups of students were introduced to the following basic drafting concepts; rules of lettering, dimensioning and placing notes, line types, introduction to drafting equipment, geometric constructions, and multiview drawings.

2. Development and verification of a teaching outline to instruct the two groups in the basic concepts of drafting using traditional and computer-assisted methods.

After the concepts were identified through the review of literature, an outline was generated which contained the sequence of topics to be covered during the instruction phase. The topic outlines were developed for both the traditional group (Appendix B) and the CAD group (Appendix C). Each outline was reviewed by this researcher's advisor from the University of Northern Iowa prior to the instruction phase of the project.

3. Selection of the students who would comprise each group.

The two groups of students selected for this study were selected on a voluntary basis from students at the Oelwein Community Jr. High School, grades 6 - 9. A general announcement of the study was made to the student population. Students were allowed to sign up on a first come, first served basis until a total of 20 students were signed up. A total of 21 students were in the final count and the extra student was allowed to remain as part of the study. After all of the students names were placed on slips of paper, names were drawn in a random fashion alternating to fill the traditional and CAD groups.

4. Development of the Pre/Post Test

The pre/post test was developed prior to the instruction phase of the project. The topics outlines were reviewed and questions generated which reflected their content. The pre/post test did not have a drawing component as part of the test. Since only concepts of basic drafting were being tested and not drafting skill, this aspect was not included in the testing of the groups.

5. Project overview and administration of a pre-test.

The pre-test was given to the students as part of the first two sessions of instruction. During this first meeting, both groups were in attendance. An overview of the project was explained and expectations of the students were discussed. Also a parent information sheet was given to the students, to be returned at the second session. The parent information sheet included information about the project and a request that the parent acknowledge his child's participation in the project by signing the return portion of the sheet. During the second session, the pretest was given. Both groups were in attendance for the taking of the pretest. A sample of the pre/post test can be found in Appendix D. The students were instructed to answer any and all questions they could. The students were informed that this was a pre-test and did not affect their remaining in the project.

6. Coordination of Instruction

Each session with the students consisted of a forty-six minute session. This is the time length of the class periods the Oelwein school system uses. The two groups met together during the first sessions. Several administrative functions needed to be accomplished, such as: identification of the students, establishing the students into their respective groups, assigning work stations for each student and giving them an overview of the project. Meeting times were established, and times for make-up sessions were also given.

After the first two sessions, instruction was completed with each group independently while discussing and giving instruction on the different concepts. After the concepts were explained to each group separately, the two groups were allowed to work on assigned drawings in the lab at the same time. Part of the CAD equipment is in the area where the traditional equipment is used, and it was felt that there would be too much distraction from the teaching process if one group was working on independent assignments during the instruction of the other group. Teaching continued until all of the concepts had been discussed and practice assignments given.

The traditional equipment which the students used for this study included two types of drafting table set-ups. The first type included a drafting desk/table with an eighteen inch arm drafting machine and scales attached. This table is a stand-up model used in conjunction with a high stool. There are six of these tables available in the drafting lab for the students to use. The second type of table available for the students was a low style drafting table with adjustable height and table top angles. These tables have track type drafting machines with scales attached. There are also six of these style of tables available in the lab. During the first session of instruction with the traditional group, the students were allowed to choose any table at which they wanted to work. This table then was assigned to that student as his/her work station. There were originally eleven students assigned in the traditional group. Two of these students dropped out of the study for unknown reasons.

The CAD group utilized the graphics program MATC-CAD. This software package was run on the Apple IIe computer with the following components: (1) Apple IIe CPU with dual disk drives, 5 1/4 inch; (2) green screen monitor; (3) Apple or Kurta graphics tablet. A Houston Instruments DMP-40 plotter, A/B size was attached to one station. The CAD group of students were given handout sheets on system commands, system boot procedures and the steps for exiting and savings drawings. Also made available for reference were the instructional manuals for the MATC-CAD program. There were originally ten students in the CAD group. This allowed two students per station, since there were five CAD stations available in the lab.

For the purpose of finding and comparing the turnaround-time ratio for the two groups, two problems were selected to test the amount of time for completion of the problem. The first problem was a very simple problem, to insure that the students were not hindered by figuring out the solution to the problem, but could concentrate on the drawing aspect. The second problem was of a more difficult nature, requiring more thought and drawing knowledge to complete. Each student was given the problem on an assignment sheet and the time they started was recorded. The students' time finished when they brought the finished drawing back to the instructor.

7. Administration of a post-test on the concepts of basic drafting.

The administration of the post-test was handled similarly to the pre-test. Both groups of students were assembled during the same session and the post-test was given. Students were instructed to answer the questions to the best of their ability. Since the pre-test and post-test were the same test, no further instructions were given to the students other than those given during the session when the pre-test was taken.

8. Analysis of Data

The criteria used during this study as evidence of learning was a positive gain in a series of average scores gathered from a pre-test, post-test evaluation.

The average used was a mean average calculated by taking raw test scores, finding a total of the scores and dividing by the number of scores. A mean average was calculated on each group of participants, traditional and CAD, for their pre-test score, post-test score and the amount of gain in score from the pre-test to the post-test. The group with the highest gain in average test score from the pre-test to the post-test was deemed as the group which had retained the greatest amount of information on the basic concepts of drafting. The data and its analysis is presented in the next chapter.

9. Formulation of conclusions, recommendations and observations from the data gathered during this study.

After careful review and study of the data gathered during this study, the conclusions, recommendations were formulated. The observations put forth are not based solely on scientific research conducted during this study, but results of many years of teaching students and what has been experienced in past teaching situations similar to the situations conducted during this study. These findings are presented in chapter five.

CHAPTER 4

REPORT OF FINDINGS

Reported in this chapter are the results of the pre/post test which was administered to the traditional (control), group, and CAD (experimental), group. Also included is the turnaround-time ratio for the two groups.

Pre/Post Test Results

A pre-test was administered to each group before instruction began (Appendix D). The total number of points possible on this test was 25. Pre-test results were very similar for each group as shown in tables A and B.

The control groups average for the pre-test as seen in Table A, was 7.5 points and the high and low scores were 13 points and one

Table A

Pre/Post Test Scores Control (Traditional) Group

Student	Pre/test	Post/test	Gain
1	6	23	+17
2	9	22	+12
3	7	16	+ 9
4	8	22	+12
5	7	15	+ 8
6	1	10	+ 9
7	13	25	+12
8	9	21	+12
Average	7.5	19.3	+11.4

point respectively. The experimental group as may be seen in Table B, had an average of 6.6 correct answers on the pre-test. The high score was 11 points and the low was two points. The pre/post test did not include a drawing component since only concepts were being investigated in this study. Gains made on the pre/post test are being considered evidence of learning of the basic concepts of drafting for this study. The gains made by each group were positive, with the traditional group making the highest average gain.

The average (mean) score on the post-test for the CAD group as can be seen in Table B, was 14.9 points, with an average gain for the group of 8.2 points. The highest gain by an individual for the CAD group was 14 points and the lowest gain was two points. For the control (traditional) group, the average gain in points was 19.3 questions correct. The highest gain by an individual student was 17 points and the low was eight points. The average for the traditional group calculated to be 11.4 points in gain.

When comparing the differences in average scores, as seen on Table C, it is evident the control (traditional) group made larger gains in learning the basic drafting concepts. The pre-test score difference of less than one question, indicates both groups started this study at the same level of knowledge. The additional gain in average test scores by the traditional group reinforces the conclusions drawn by this researcher.

Table B

Pre/Post Test Scores Experimental (CAD) Group

Student	Pre/Test	Post/Test	Gain
1	11	21	+10
2	8	10	+ 2
3	6	19	+13
4	5	11	+ 6
5	6	14	+ 8
6	7	21	+14
7	7	13	+ 6
8	2	4	+ 2
9	8	21	+13
Average	6.6	14.9	8.2

Table C

Differences in Average Scores

	Pre-Test	Post-Test	Gain
Control Group (Traditional)	7.5	19.3	11.4
Experimental Group (CAD)	6.6	14.9	8.2
Difference	.9	4.4	3.2

Turnaround-Time Ratio

During this study, the turnaround-times were faster for the traditional (control) group than the experimental (CAD) group (refer to Table D). A faster time of completion by the traditional group was due to the lack of time the CAD students had to become familiar with the equipment. These students were given the same amount of instructional time to acquaint themselves with the CAD equipment as the traditional students were given to acquaint themselves with their equipment. This was not enough time for the CAD group to memorize the commands necessary to gain a productive level of familiarity.

All of the CAD students had to rely on the instruction sheets which listed the system commands and what they could do on the computer. Due to this lack of familiarity, the time ratios for the CAD group were lower than the traditional group. Of the problems in which a time comparison was performed, the time ratio between the traditional group and the CAD group was 2.1:1 in favor of the traditional group on the first problem and 1.1:1 on the second problem. The lower ratio between the second problem and the first can be explained by two factors: (1) the CAD students were becoming more familiar with the system and (2) the second problem was a little more involved, allowing the CAD group to take advantage of some features on the system to generate lines faster. Such features included the rectangle command, and inserting circles. The problem included six circles, and with the CAD system inserting them was an easier task than with a circle template. This allowed the CAD group to make gains in turnaround-time as compared to the first problem.

Table D

Turn-around Time Ratio Figures

Time of Completion

Student	Prob.1 (Trad.)	Prob. 1 (CAD)	Ratio	Prob. 2 (Trad.)	Prob. 2 (CAD)	Ratio
1	19	28		24	31	
2	12	30		26	35	
3	13	21		30	22	
4	8	22		17	25	
5	6	22		30	29	
6	7	18		30	16	
7	8	22		30	25	
8	10	17		17	23	
9	----[b]	7		----	17	
10	----	24		----	34	
11	a	26		a	33	
Average	10.4	21.5	2.1:1	24.9	26.36	1.1:1

Note. Time is measured in minutes

[a]No score for this position because of only 10 students in the traditional group.

[b]No scores in this position because the student did not finish the study.

Chapter 5

Summary, Conclusions and Recommendations

Summary

This study has dealt with a comparison study of the teaching methods used to teach beginning drafting students at the secondary level. The first method was the traditional method. This consisted of using traditional drafting equipment which included drafting boards, drafting machine and small drafting tools. The second method included the use of computer-assisted drafting equipment. The system used during this study was an Apple IIe computer system using MATC-CAD software from Milwaukee Area Technical College.

The problem was to identify by which method the beginning drafting student could learn basic drafting concepts better. Research questions raised during this study included: (1) By what teaching method do students learn the basic concepts better, traditional or CAD on the basis of retention of learning as measured by a positive gain on a pre/post test score? and (2) What differences in time exist between completion of a problem using each method.

Conclusions

The traditional group, when using their equipment, was not dependent on the sophistication of the computer. The students were primarily concerned with the task of manipulating the drafting machines and small drafting tools. These tools require a certain amount of eye-hand coordination to be proficient. With CAD systems, the level of skill deals more with mental preparedness than with physical practice. Since all of the drafting that takes place is done with the computer system, the degree of eye-hand coordination is not as essential. Because of the complexity of operation required by the CAD system, the time it took the CAD students to generate drawings and complete the assigned problems in comparison to the traditional group was considerably longer at the beginning phase. The time difference between the groups was shorter as more experience was gained.

The concepts which can be taught using the traditional method or the CAD system are essentially the same. The techniques used with each method differ somewhat, but it was shown by the increase in pre/post test scores that students can learn by either method. This particular study resulted in the CAD group having a lower learning rate than that of the traditional group. It is the findings of this study that the traditional group was able to concentrate on the concepts with greater proficiency than the CAD group. The CAD group seemed to get "bogged down" with the system commands rather than producing the desired drawings and learning the concepts. This is reflected in the time difference in producing drawings and the pre/post test scores.

Observations

The following observations were recorded as part of this study, however they are not supported with scientific data or formal research.

1) It was the observation of this researcher that both groups of students were very attentive and receptive during the instructional periods of this study. The experimental group (CAD) students were

eager to begin each session. The control group (traditional) students were also eager to experience using the drafting equipment. This can be accounted for as both groups found this to be a new experience and was of special interest to this age group. Normally, these students do not have access to this equipment until they reach the 10th grade.

2) The older students in the control (traditional) group, (ninth graders), were able to produce the drawings in less time than the younger students, (sixth grade). The difference in time was not significant to warrant any special considerations to the younger students. These differences occur in regular teaching situations and may be expected, due to the variance in the ages and abilities of the students in the group. Also the students in the control group were not able to develop a refined level of lettering skill. The lettering quality of the students was that of a typical group of students just beginning to study drafting.

3) The students in the experimental group (CAD) when faced with a problem in running the software program would seek help from other members of their group. Because the students were working in teams of two, the student not busy with the CAD program could seek information from other teams.

4) The students in the control group (traditional) did not interact with other members of their group as much as the CAD students. These students had little trouble with the tasks presented and kept on task in completing the assignments.

Recommendations

The following recommendations are presented as a result of the research conducted during this study.

1) Further studies need to be completed to expand and increase the base of knowledge on the subject of CAD vs. manual teaching of basic drafting.

2) The instructional time for this study was conducted over a four-week period. It is recommended that any future studies be expanded to cover an entire semester. This will enable the CAD students to attain a higher level of proficiency in using the CAD system. The time allotted during this study for the CAD group to become proficient with the system was not adequate.

3) During a future study it is recommended that CAD students have their own computer terminals. During this study the time available for each student to complete his assignments was reduced because of having to share machines. This reduced the contact time each student spent on the CAD system, and gave less time for familiarization of the system commands.

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Appendix A

Dimensioning Practices for Technical Drafting (French, 1978)

Appendix B

Drafting Concepts to be Taught With Traditional Method

Drafting Concepts to be Taught with Traditional Method

I. Introduction to drafting equipment
  A. Drafting Machines
    1. Arm
    2. Track
  B. Scales
    1. 16th divided
    2. architectural
    3. engineers
  C. Templates
    1. Circle
    2. Ellipse
  D. Pencil/Leadholder
  E. Compass (Bow)
  F. Drafting media
    1. Vellum
    2. Mylar
  G. Eraser
II. Geometric Constructions
  A. Line
    1. Given length
    2. Perpendicular
    3. Parallel
    4. Tangent to a circle
    5. Tangent to two circles
  B. Circle
    1. Given Radius
    2. Given Diameter
    3. Through three points

  C. Triangle

1. Right
2. Isosceles
3. Equilateral

D. Point

E. Angles

1. Right
2. Abtuse
3. Acute

III. Line Usage

A. Object

B. Hidden

C. Extension

D. Dimension

E. Center

F. Line Priority

IV. Orthographic Projection

A. Single view

B. Two view

C. Three view

V. Dimensioning

A. Size

B. Location

C. Rules of dimensioning

1. single view
2. two view
3. three view

Appendix C

Drafting Concepts to be Taught With CAD Method

Drafting Concepts to be Taught With
CAD Method

I. Introduction to CAD equipment
   A. Computer Background
   B. Apple IIe Computer
      1. Turning on/off
      2. Loading programs
      3. Saving information
   C. Graphics Tablet
   D. Plotters
      1. A/B size
      2. C/D size
II. MATC-CAD Program
   A. Introduction of Program
      1. Log-on procedure
      2. Saving drawings
      3. Log-off procedure
      4. Loading old parts
   B. MATC-CAD Menu Areas
      1. Verbs
      2. Nouns
      3. Modifiers
      4. Masks
   C. Basic Entity Creation
      1. Lines
      2. Circles
      3. Points
      4. Fillets
      5. Text
      6. Erase

7. Screen Control
   a. Zoom up
   b. Zoom down
   c. Zoom window

III. Line Usage
   A. Object
   B. Hidden
   C. Extension
   D. Dimension
   E. Center
   F. Line Priority

IV. Orthographic Projection
   A. Single view
   B. Two view
   C. Three view

V. Dimensioning
   A. Size
   B. Location
   C. Rules of dimensioning
      1. Single view
      2. Two view
      3. Three view

Appendix D

Pre/Post Test

____
NAME

Choose the letter which best answers the question.

1. A ________ is a series of points?
   A. Box
   B. Angle
   C. Line
   D. None of the Above

2. An 'A' size sheet of drafting paper would measure the following size:
   ___________ length width ___________________

3. Lines which are used to describe the outline of something are called _________________ lines.

4. Lines which are used to illustrate something we can not see on a drawing are called _________________ lines.

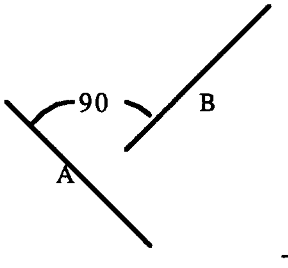
5. The ________________ of a circle is the distance from its middle to the outside edge.

6. The ________________ of a circle is the distance from its edge to edge through the middle.

7. A triangle with three equal sides is called an ______________ triangle?

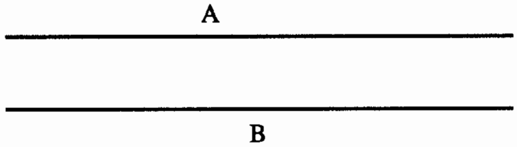
8. A triangle with an included angle of 90 degrees is a ___________ triangle.

9. The relationship between line 'A' below and line 'B' is:

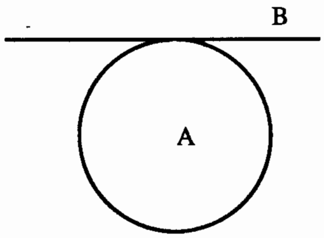


____

11. The relationship between line 'A' below and line 'B' is: ____________



12. The relationship between line 'B' and circle 'A' is ________________?



13. The number of degrees in a circle is:
   A. 180
   B. 250
   C. 100
   D. 360
   E. None of the above

14. The height dimension can be found in these two views:
   A. Front and top view
   B. Front and right-side view
   C. Top and right-side view
   D. All the views, top front, and right-side.

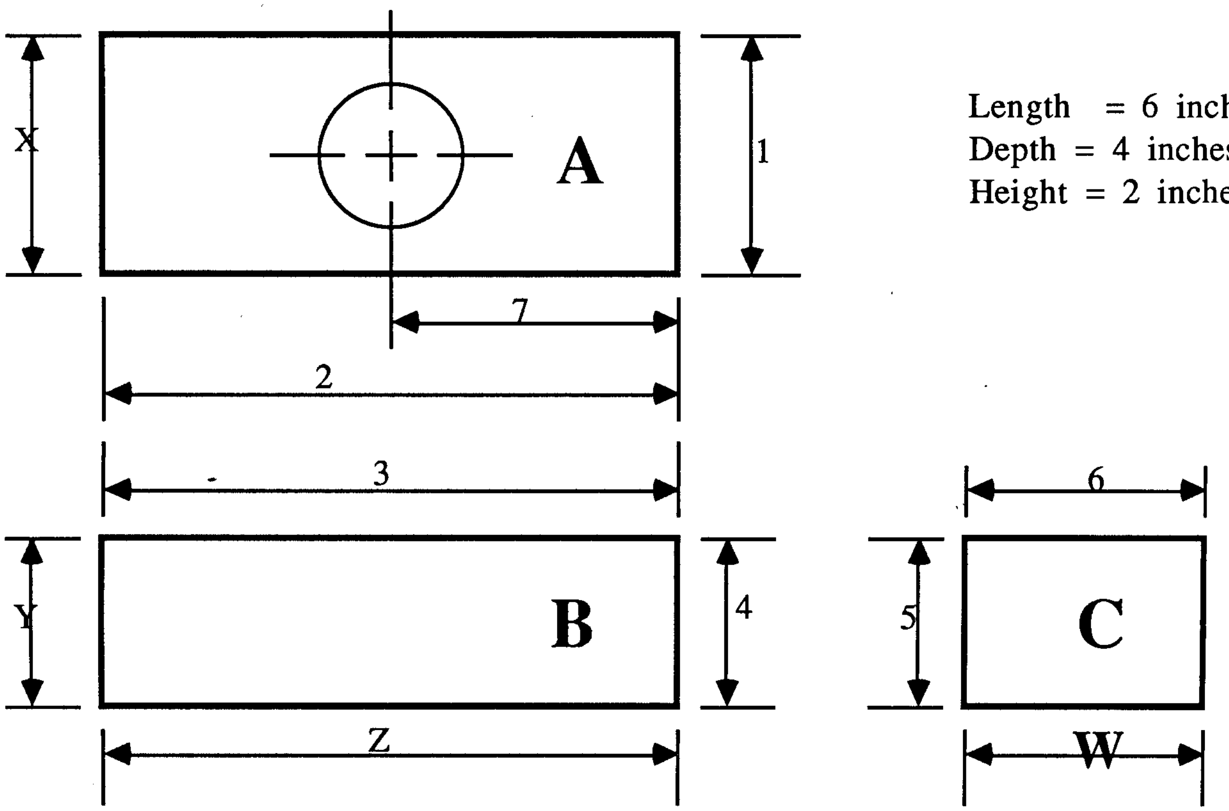
15. The depth dimension can be found in these two views:
   A. Front and top view
   B. Front and right-side view
   C. Top and right-side view
   D. All the views, top, front, and right-side

16. The length dimension can be found in which two views:
    A. Front and top view
    B. Front and right-side view
    C. Top and right-side view
    D. All the views, top, front, and right-side

17. On a drawing, if a center line and an object line must be drawn in the same place, which line do you draw?
    A. Object line
    B. Center line
    C. It doesn't matter

18. On a drawing, if a hidden line and an object line must be drawn in the same place, which line do you draw?
    A. Object line
    B. Hidden line
    C. It doesn't matter

Use the following illustration to answer the questions 19 - 24:



Length = 6 inches
Depth = 4 inches
Height = 2 inches

19. The top view of this drawing is located at letter:
    A. A
    B. B
    C. C
    D. Y

20 The front view of this drawing is located at letter:
    A. A
    B. B
    C. C
    D. X

21. The right-side view is located at letter __ in this illustration?
    A. A
    B. B
    C. C
    D Z

22. Dimension number __ is an example of a location dimension.
    A. 1
    B. 4
    C. 7
    D. 5

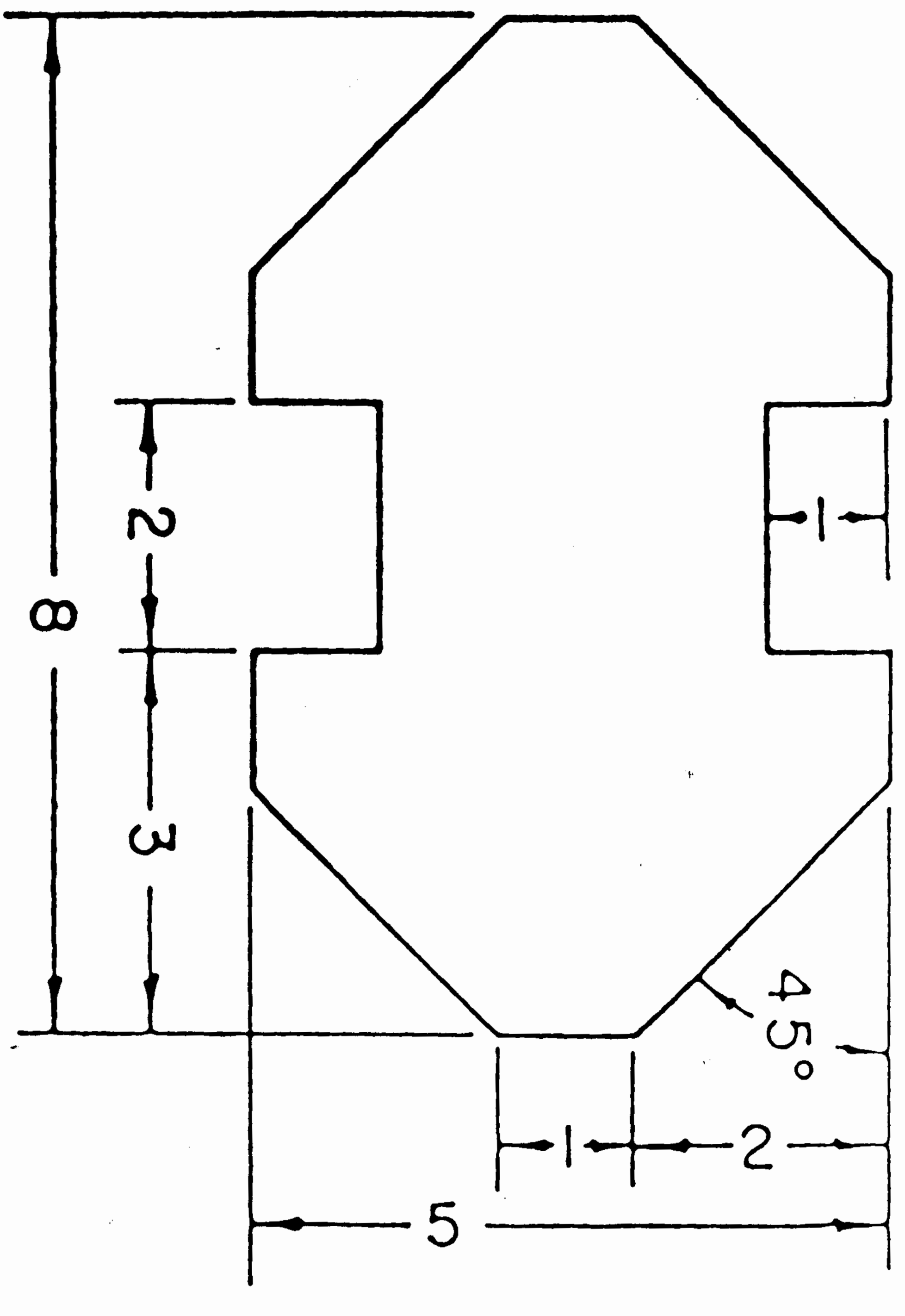
23. An example of a size dimension in the front view would be number __
    A. 3
    B. 4
    C. Z
    D. All of the above
    E. None of the above.

24 The area of the drawing which you normally want to avoid placing dimensions if at all possible is at locations:
    A. 2, 3,
    B. 1, 6,
    C. X, Y
    D. Z, W
    E. Both A and B
    F. Both C and D

Appendix E

Sample Drafting Problems Used for the Turnaround-Time Ratio Comparison

Problem 1 Used for Turnaround-Time Ratio Comparison



Problem 2 Used for Turnaround-Time Ratio Comparison