In presenting this professional paper in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this professional paper for scholarly purposes may be granted by my major professor, or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this professional paper for financial gain shall not be allowed without my written permission.

Signature Eugene Anderson

Date May 24, 1971

HIGH SCHOOL DRAWING EXPERIENCES AS RELATED TO GRAPHIC LANGUAGE STUDIES AT NORTHERN MONTANA COLLEGE

by

DALE EUGENE ANDERSON

A professional paper submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

MASTER OF EDUCATION

with concentration in

Administration

Approved:

Robert J. Heikkila
Head, Major Department

Robert J. Heikkila
Chairman, Examining Committee

K. Goering
Graduate Dean

MONTANA STATE UNIVERSITY
Bozeman, Montana

June, 1971

ACKNOWLEDGMENTS

Acknowledgment is made of the assistance, direction, and motivation provided in my behalf toward the preparation of this paper to Dr. Robert Thibeault, Head, Educational Services Department, Montana State University, and to the following faculty and staff members at Northern Montana College: Dr. R. L. Allen, Division of Education; Dr. Earl Hepler, Department of Vocational-Technical Teacher Education; Mr. T. E. Diebel, Dean, Vocational-Technical Division; Mr. Wesley McEwen, Department of Agricultural Technology; Mr. Orval Brenden, Chairman, Drafting Department; and Mr. Lawrence Jochim, Registrar, and his staff.

To my family--Mother, Thale, Craig, and Tom--for their love, tolerance, and consideration, my thanks.

Most of all,thanks to my wife, Thelma, for her love, inspiration, and skill with the typewriter.

TABLE OF CONTENTS

LIST OF TABLES

Abstract

The problem of the study was to investigate the significance of high school drawing experiences as reflected by achievement in graphic language studies at Northern Montana College in Havre.

Data were gathered from the office of the dean of the Vocational-Technical Division and from the office of the registrar at Northern to provide the basic factual information necessary. These data included the number of students enrolled in drafting over a five-year span (1963-68), their respective amounts of high school drawing experiences, and the achievement level and drawing courses completed at Northern for each of these people. 176 students were considered, after the elimination of those students to whom the study was not applicable.

The students, with their respective identities protected, were grouped into the following five categories, relating to the duration of their previous high school drawing experiences: none, 6 weeks, 12-18 weeks, one year, and two years or more. The data were compiled and arranged so that an analysis of variance could be computed, and a level of significance determined, to ascertain just what effect their high school work in drawing had on accomplishment in graphic language studies at Northern.

Recognizing that a multitude of variables could influence achievement level, it was hoped that this study would constitute a first step by exploring one means of reducing the number of variables which must be considered in any effort to modify instruction, course content, sequence, or curriculum at both the secondary and post-secondary level.

Upon reviewing the results of the study, it was concluded that unless a student with previous experience had had at least two years of this experience, his achievement level would not be enhanced. It was found, however, that there was no significant difference between the achievement level of students with no previous experience and those with two years or more. It is recommended that investigation of other variables such as intelligence, motivation, and related influences be undertaken in order to further isolate specific determinants affecting achievement.

Chapter I

Introduction

Northern Montana College, one of the six units comprising the Montana University System, is a co-educational institution with an enrollment of approximately 1500 students. The college is located in north-central Montana, at Havre.

Northern Montana College (hereinafter referred to as "Northern") is structured within three basic divisions--Education, General Studies, and Vocational-Technical. Each of these divisions contains numerous departments organized around major subject areas or specific disciplines. All departments at Northern are responsible for student development within their major areas, in addition to fulfilling service course requirements inter-divisionally, and support course functions inter-departmentally whenever their respective disciplines are required.

This study deals primarily with one department within the framework of the Vocational-Technical Division--Drafting, which has prime responsibility for graphic language studies for: students enrolled in the two-year terminal program in drafting, the three-year Associate Degree program in construction engineering technology, and the four-year Bachelor of Science Degree program with the extended major in drafting

in Vocational-Technical Education.

Examples of inter-divisional service course work for the Drafting Department would be the offerings provided specifically for pre-engineering students from the General Studies Division, usually a three-quarter sequence of graphic language studies; and the three-quarter sequence required for industrial arts education students from the Education Division. (This offering for industrial arts students can be thought of as partially a support course function, in that industrial arts majors and the Industrial Arts Department exist within the framework of the Vocational-Technical Division for administration, and students in this major area remain principally within the scope of this division for their trade and industrial training.) A course offered by the Drafting Department in drawing interpretation for the Automotive and Diesel Department would be a specific example of inter-departmental support course work by the Drafting Department.

Because of the extensive responsibility resting with the Drafting Department in preparing technical personnel for industry and teachers for Montana schools, inquiry into factors influencing student performance is mandatory.

This report will concern itself with an investigation

of previous contact with drawing courses at the high school level as a contributing factor to success in more advanced college drafting courses.

Statement of the Problem

The problem of this study was to investigate the significance of high school drawing experiences as reflected by achievement in graphic language studies at Northern Montana College.

Purpose of the Study

The purpose of this study was to gain information and statistical data which would furnish insight and assist in the search for clues leading to improved student performance in graphic language studies at Northern.

Drafting instructors at Northern have long desired some information which might reflect some trends in student success patterns. It was hoped that this study would constitute a first step by exploring one means of reducing the number of variables which must be considered in any effort to modify instruction, course content, sequence, or curriculum in the interest of student attainment. This variable would be the influence of high school drawing experiences and their contribution to success in drawing courses at Northern.

Due to the multi-role function of the Drafting Department referred to in the introduction, this study also contains implications for teachers and for scope-sequence surveys in curriculum development for both high school and post-secondary industrial arts instruction of graphic languages.

General Questions to be Answered

1. Do high school drawing courses aid student achievement in post-secondary graphic language studies at Northern?

2. To what extent is this achievement observable?

3. Does the amount of high school experience in this area appear to be a significant factor?

4. If so, what is the minimum amount required to indicate this significance?

General Procedure

The following three-step process constituted the procedure for the study.

First, data were gathered from the office of the dean of the Vocational-Technical Division and from the office of the registrar at Northern to provide the basic factual information necessary. These data included the number of students enrolled in drafting from 1963-68, their respective amounts of high school drawing experience, and the achievement level and drawing courses completed at Northern for

each of these people. Second, this information was compiled and arranged so that an analysis of variance between the means and within the means could be computed, and a level of significance determined, to ascertain just what effect their high school work in drawing had on their accomplishments in graphic language studies at Northern.

Third, literature concerning similar studies from other schools, together with literature considered relevant to this particular study, was examined.

Limitations

This study was confined to students enrolled as drafting majors from 1963-1968 (a five-year study).

This study investigated only one variable affecting achievement level in college drawing courses at Northern, that variable being the length of time spent in high school drawing courses.

This study was further limited to drawing courses only, both on the high school and post-secondary level. No related or general education courses were considered.

This study was also limited by the assumption that a comparative grade reflected achievement level in the college courses under consideration and within the scope of this study.

Definition of Terms

High School - grades 9 through 12.

Graphic language - the science of drawing.

Achievement level - the average, for each individual, of all grades earned in all attempted graphic language courses.

Summary

Northern Montana College, one of the six units of the Montana University System, is structured within three divisions: Education, General Studies, and Vocational-Technical. The Drafting Department is a part of the Vocational-Technical Division and is responsible for providing graphic language studies for all students taking such instruction.

Aware of their responsibilities for preparing technical personnel for industry and teachers for Montana schools, faculty members of the Drafting Department are concerned with strengthening their program. One phase in which it was felt there was potential for investigation was whether high school drawing experiences had a significant effect on success in college graphic language studies.

Data obtained from college records provided information for a statistical analysis of this question.

Relevant literature was examined.

Information gained from this study illuminated one of the variables to be considered in modification of instruction or curriculum.

Chapter II

Review of Literature

International direction toward creation of world languages such as Esperanto has proved a dismal failure, contributing to unresolved stress and world tensions through lack of communications. However, the graphic language constitutes a true universal language, in existence and continuous use since earliest times. Though lacking oral expression, it is a means whereby technicians readily converse and instantaneously interpret technical precepts as applied to solutions of problems, projects, or conceptions in some state of proposal or development. (For example: The proposed plans for the new treating plant in the Syrian Desert, prepared by draftsmen and engineers from the Netherlands who speak only the Dutch language, are as readily discernible and easy to interpret for the Montana engineer without a foreign language background as though they had been prepared in Helena by Montana draftsmen.) This language is truly universal, possibly contributing in some small measure toward international stability.

In order to perceive the true values of graphic language studies, an examination of the ancient cultural heritage and its transmission via this medium attests to man's efforts toward infinite continuity in application of this

expression--a span of nearly 6000 years. On exhibit at the Louvre in Paris can be found what is considered to be the oldest technical drawing in existence. This work by Gudea, an early Chaldean engineer, dates approximately 4000 B. C., and is an engraving upon a stone tablet of the plan view of a fortress.

> From the beginning of recorded history, man has used drawings to represent objects to be built or constructed. Of these earliest drawings, no trace remains today, but we definitely know that drawings were used for man could not have built as he did without using fairly accurate drawings. In the Bible the statement is made that Solomon's Temple was 'built of stone made ready before it was brought thither.' Each stone and timber was carved or hewn into shape, brought to the site, and noiselessly fitted together. It is evident that accurate drawings were used, showing the exact shapes and sizes of the component parts [Giesecke, Mitchell, Spencer, Hill & Loving, 1969, p. 2-3].

A treatise on architecture dated 30 B. C. by the architect Vitruvius appears as the first written material of note dealing with technical drawing. Man's refinement of the graphic language to modern standards has been an inordinately slow developmental process. Many of the tools and devices of early vintage closely resemble those still in use today, performing much the same function.

The addition of scientific principles to graphics by the advancement of the theory of projections of objects

upon imaginary planes of projection contributed greatly toward language development in the early part of the Fifteenth Century.

Leonardo da Vinci's treatise on painting published in 1651 "is regarded as the first book ever printed on the theory of projection drawing; however, its subject was perspective and not orthographic projection [Giesecke et al, 1969, p.4]." This publication undoubtedly had substantial significance for those who followed. Technological advances, such as the invention of graphite (lead) pencils during the Eighteenth Century, increased the practicability of the graphic language extensively.

The year 1795 saw the revelation of descriptive geometry. For a period prior to that time, this conception of Professor Gaspard Monge of the Polytechnical school in France had been surpressed as a national secret of critical military importance. This development can be thought of as the addition of the missing ingredient. It stabilized and correlated the fragmentary pieces of drawing theory into one inter-related entity, furnishing the grammar so necessary to round out the language.

De-emphasis of artistic characteristics in the use of the language was the essential outcome of the introduction

of the blueprint process at the Philadelphia Centennial Exposition in 1876. This development directed the language use into a more streamlined technical aspect, in application of this new tool, to efficiently satisfy the needs and economies of industry.

Final adoption of third-angle projection, the basic standard most compatible to United States industrial expansion at the close of the Nineteenth Century, has proved a wise selection in the interest of language simplification (Giesecke et al, 1969).

> Of prime importance in (the) movement (to standardize drafting) has been the work of the American Standards Association (ASA), which with the American Society for Engineering Education and the American Society of Mechanical Engineers as sponsors, has prepared the American Standard Drafting Manual, ASA Y-14, published in 17 separate sections [Giesecke et al, 1969,p.6].

To those who would entertain the misconception that the graphic language is in a state of demise, reflection should be made on the 6000 years of its viable heritage, summarized in the preceding brief history and emphasized in the following quotation by Anslyn (1967).

> The higher level mental acrobatics of the human mind cannot be duplicated and computers will always act as servants,solving problems by application of known methods to problems. It takes the human mind--which is pliable and adaptable to various unknowns--to reach the level

> known as decision-making. The human brain so far is the cheapest and most efficient piece of E.D.P. equipment known, as it operates on 25 watts and 60 cycles of electronic power. And it is capable of making an unlimited range of decisions and creative thought which . . . no machine will ever replace [p.28].

Today, some form of drafting or mechanical drawing is offered in most secondary schools in the United States. Because of the increased emphasis on engineering principles subsequent to the launching of Sputnik, closer attention is being directed toward those offerings in the modern high school. The National Defense Education Act of 1958 with its allocation of funds for technical education, and the Vocational Act of 1963, providing monies for a variety of purposes to prepare students for job opportunities, have stimulated interest in all technical and vocational education.

Both technical institutes and engineering colleges are interested in the character and span of high school preparation which would prove most advantageous to the matriculating student. The Educational Relations Committee of the Engineering Graphics Division of the American Society for Engineering Education has devoted considerable attention to high school-college relationships, since "the output of the high school teacher is the input of the college freshman

teacher [1966, p. 52]." This comittee suggests that because there are no set standards for high school drawing courses, either in content or duration, many difficulties arise in structuring courses for entering college freshmen.

The committee is composed of representatives of colleges within the United States, engineering graphics professors with extensive experience in high school and college drawing instruction. Their combined efforts have resulted in the development of the following drawing course spanning five 45-minute periods per week for 36 weeks, recommended for high school students in either the junior or senior year. This course, to include little homework, is as follows:

	TOPIC	TIME (Periods)
1.	Use and care of instruments	3
2.	Lettering	7
3.	Geometric constructions	11
4.	Orthographic projections, principal views	26
5.	Freehand sketching	15
6.	Sections and conventions	14
7.	Auxiliary views, primary and secondary	15
8.	Isometric drawing	13
9.	Oblique drawing	10
10.	Shop processes	8
11.	Threads and fasteners	10
12.	Dimensioning	17
13.	Working drawings, including assemblies	17
14.	Testing	14
		180

The committee emphasizes that:

> the order of topics as listed indicates a possible logical sequence, but not the only one, of course. . . . Any experienced and competent teacher of the subject immediately realizes on inspection of the prepared course content that it contains material which is neither new nor advanced. Let us point out here that what we propose is a basic course in technical drawing [American Society for Engineering Education, 1966, p. 53]."

Suitable textbooks considered appropriate include any of the following: Basic Technical Drawing by Spencer, Essentials of Drafting by Svensen, Engineering Drawing, 2nd edition, by Zozzora, and Mechanical Drawing by French and Svensen.

Emphasizing that man communicates in three ways--verbal and written; symbolic (using mathematical and scientific formulas); and graphical (using lines and points) --the committee questions the advisability of devoting "countless years of study to master the first two with the third generally expected to be acquired in an incidental manner without formal instruction [p. 54]."

Mechanical drawing and shop drawing comprise a two-track, back-to-back curriculum at Plainview, New York, as delineated by Mulski (1967). The mechanical drawing program includes a three-year sequence of drawing courses in preparation for entrance into college curriculums, or other

types of post-secondary technologies. Shop drawing also provides a three-year sequence and is geared for vocational students in carpentry, auto mechanics, or cooperative programs; industrial arts majors; students who plan to go directly into industry; and other students not qualifying for mechanical drawing. First-year mechanical drawing and shop drawing classes are scheduled in concurrent time blocks permitting transfers between curriculums, depending upon student achievement. Mulski indicates that follow-up studies of graduates support the soundness of this approach.

McDonald (1958) reports that the Montana Industrial Arts Association advocates that the following basic skills be developed in mechanical drawing instruction.

How to read the rule and make measurements.
How to use the common drawing tools.
How to make a one-view drawing.
Learning to letter.
Dimensioning drawings.
How to make a drawing to scale.
How to make and enlarge patterns.
How to make working drawings.
How to draw a project to be made in shop.
Fundamental concepts of designing.
Sketching.
How to change a pictorial drawing to a working drawing.
How to make a complete set of drawings for a simple mechanical object.

It was recommended by the association that the course be 60 minutes in length, 5 days a week, for at least 12 weeks.

The findings of Savchenko (1961) indicate agreement with McDonald's, insofar as the duration of the program as recommended by the Montana Industrial Arts Association was concerned; however, Savchenko reports that in his survey of industrial representatives, 80 per cent of these people recommended one year of mechanical drawing, with the remaining 20 per cent indicating that a minimum of two years would be more effective. It would appear that former reported Montana Industrial Arts Association considerations deviate from national recommendations and local advisory imperatives.

In the interest of determining relationships between high school and post-secondary education, the General Engineering Department at the University of Illinois at Urbana began the collection of data to illuminate student background and growth characteristics which might assuage faculty suspicions relating to high school drafting background and student achievement differences. These data permitted faculty program appraisal in the interest of increasing satisfaction of student needs.

Research was conducted into the location of the high school attended, scope of this experience and curriculum distribution enrollment in 1961-62 for the 900 beginning enrollees. Data analyzation involved number of courses,

length of class periods, and course content (as obtained from a student report survey) for all past drawing experiences in which these students had participated. Semester grades at Urbana formed the basis of achievement determinants from which the following conclusions were drawn: 51 per cent of the students had no previous drafting experience and achieved at the "C" level. Students with 1/6 to 1/3 years previous experience achieved identically with students with no experience. Students with one to three years previous formal experience achieved substantially higher than students with less.

Urbana provides for advance student placement by the use of proficiency examinations. Among the afore-mentioned students, there were 26 inquiries and 15 completing the exams with grades ranging from 55 per cent to 87 per cent. Eight students (0.9 per cent of 900) passed with grades of "C" or better, permitting their enrollment into more advanced courses. This compares quite favorably with:

> a national survey of engineering graphics conducted some years ago in which 145 students (0.43 per cent of 33,880) were excused from college drafting on the basis of either their high school record or industrial drafting experience [Borri, 1963, p. 22].

Stout State University in Wisconsin provides a nine-week basic drawing course, the side-stepping of which also

provides advance plaement in the interest of student enrichment. Candidate selection for advance placement is based upon satisfactory achievement in the Stout State Advance Placement Qualifying Examination, coupled with the Minnesota Paper Form Board Test. Indications resulting from a study of the procedure were that advance placement provides student acceleration and enrichment, and also serves as a basis for increased cooperation between secondary and post-secondary institutions. Also indicated was the fact that advance placement tends to eliminate duplication, thus conserving time for instructors and qualified students. No credit is allowed for omission of the beginning drawing course; therefore, the program enables the student to avail himself of enrichment through advanced courses (Erickson & Hanke, 1965).

The depth and rigor on a compressed time basis for college level courses taught in an engineering context points out the advisability of previous experience to enhance college achievement, if all enrollees have at least one year of exposure to strengthen fundamentals. Further conclusions point out that considerable up-dating, strengthening, and revision at the high school level is paramount. The decrease and de-emphasis of drawing

experience is appalling at both the high school and college levels, attesting to an urgent need for cooperation between all concerned (Borri, 1963).

It is within this frame of reference that the study was conducted.

Chapter III

General Procedures

To establish a background for the study of the effect of high school drawing experiences upon achievement in post-secondary graphic language studies, literature describing similar studies in other locations was reviewed, and literature of a general nature relating to the problem was examined. Findings and conclusions revealed in the studies attest to the value of the investigations, not only as a tool for instructional or curricular improvement, but also for the emphasis placed upon cooperation between high school and college institutions in the interest of college achievement.

Because of Northern's small enrollment, it was concluded that the validity and effectiveness of the study would best be served by surveying results of student achievement over a five-year period. The years 1963-1968, inclusively, were therefore selected. The records of all drafting students enrolled during that period were examined. Information extracted from these records included duration of high school drawing experience, and post-secondary drawing experiences (achievement level in each graphic language course attempted at Northern).

Protecting student identity, thus preserving the sanc-

tity of permanent records was emphasized in a letter seeking official sanction to search student records directed to Dr. Joseph Crowley, President of Northern Montana College (Appendix A). The topic and purpose of the study, together with the assurance that student historical data would be treated as a matter of utmost confidence, was clearly set forth. Receipt of written authorization (Appendix B) to proceed with the study constituted the formal beginning of the project.

Subsequent to receiving permission to conduct the study, a data-collection instrument was designed (Fig. 1).

FIGURE 1

Data-Collection Instrument

Name:_____ (Perforation line) #

- Prior Drawing Experiences -							- N.M.C. Experiences -			
	6 wk.		12 wk.		18 wk.			#	Grade	
Gen.Shop Dr.							Dr. Interp.			
							Eng. Dr.	104		
Mech. Dr.							Eng. Dr.	105		
Mech. Dr. 1 yr.							Descr.Geo.	106		
Mech. Dr. 2 yr.							Elec. Dr.	216		
Mech. Dr. 3 yr.							Struc. Dr.	212		
Mech. Dr. 4 yr.							Topo. Dr.	213		
Remarks:							Arch. Dr.	215		
O							O			
T							T			
H							H			
E							E			
R							R			

Of prime importance to the effectiveness of the device in preserving the confidentiality of individual records was the provision for a means of removing student identity after posting, while maintaining a cross-check against double entry which could have destroyed the validity of the compilation. This was accomplished by means of a perforated card upon which was entered the student's name for the purpose of searching the records and gathering the data. Before the instruments were removed from the office of the registrar, the names were detached and destroyed, and the cards were intermingled to assure the loss of identity.

The instrument,as described in the preceding paragraph, provided a means for collecting the demographic data necessary to provide insight into the general questions under study in an organized and efficient manner. It provided spaces for recording the history of all previous drawing experiences in the high school for each student enrolled in the Drafting Technology curriculum at Northern from 1963-1968, inclusively.

Preparing the instrument to include offerings of Northern's Drafting Department, together with a space into which was recorded performance level for that experience, permitted the simultaneous registry of the required data while

examining each permanent record, thus conserving time and effort. Graphic language courses in the Drafting Department which were considered were: Engineering Drawing 104, Engineering Drawing 105, Descriptive Geometry, Electrical Drawing, Structural Drawing, Topographic Drawing, and Architectural Drawing.

Under a heading entitled "Remarks" information which may have had previously undetected relevance to the study was entered subjectively, for subsequent consideration.

After all data had been collected on the cards and student identity had been nullified, a review of the cards was made to determine the duration of the various high school courses, so that satisfactory group distinctions could be implemented. The cards were then separated into appropriate categories, depending upon the extent of the student's high school drawing experiences (six weeks, twelve weeks, two years, etc.) This classification provided a basis for quantifying numerical data.

Results of the study, concerning the inter-relationship between the groups, provided insight into the value of high school drawing experiences in pre-vocational and pre-technical preparation.

Chapter IV

The Investigation

The effects of high school drawing experiences on achievement level in the two-year drafting curriculum at Northern has long been a matter of conjecture among faculty members of the Drafting Department. Recognizing that a multitude of factors influence student performance in drawing, a critical look at this specific variable might help determine whether or not the extent of secondary experience did have some perceivable effect.

Since the research was ex post facto, with no opportunity for controlling contributing factors, it is emphasized that only the relationship described--the influence of the duration of time spent in high school drawing courses against achievement level in the specified college courses --were considered. These college courses comprised only those extensively graphic in nature and within the major area. Within these limitations, the study was conducted.

It was determined that all freshmen entering as drafting majors from the years 1963 through 1968 (a five-year period) would constitute a valid population to investigate, inasmuch as almost all who entered in 1968 should have completed the two year curriculum by 1970. Since this study involved only drafting majors, pre-engineering, industrial

arts, and vocational education students, who shared some of the identified classes, were not considered to be a part of this project.

Permission was requested and granted from Dr. Joseph Crowley, President of Northern, to obtain a list of these students and to examine their high school transcripts and college permanent records in the office of the registrar at Northern. A commitment was made to President Crowley to maintain the anonymity of the individual student, and a data-collection instrument upon which the desired information could be recorded, while protecting student identity was so designed.

The following steps were then taken in the collection of data:

1. A list was secured of entering drafting majors for the years 1963-68, inclusive, from the office of T. E. Diebel, Dean of the Vocational-Technical Division.

2. The data-collection cards were numbered.

3. The cards were co-mingled.

4. The students' names were filled in indiscriminately by card number above the perforation line in the space provided.

5. The appropriate information was entered where

required, from the students' permanent records in the office of the registrar.

6. The cards were taken to Lawrence Jochim, Registrar, for separation on the perforation line, and the upper portions of the cards containing the students' names were destroyed.

7. The cards were co-mingled and re-numbered as a safeguard against single-card loss.

The cards had now lost their respective individual identities, thus protecting the sanctity of student personal history, and were ready for use in data compilation.

Upon examining the cards, it was determined that 207 students were to be considered. 31 of these students were deleted from the study for the following reasons:

3	Students who entered off schedule, enrolling in support courses only, and taking no drawing courses
5	Students entering as Adult Special Students on a provisional basis without high school backgrounds
7	Students entering via G.E.D. tests with no high school antecedal records
16	Students entering as transfer students from other post-secondary institutions, with no high school records
31	

These students could not specifically be categorized as members of any of the groups under consideration.

From information appearing on the data-collection cards, the following groups resulted; henceforth, in the tabulated

columns of the study they will be referred to as Groups A, B, C, D, and E. (Table 1).

TABLE 1

Group Categorization

Group	No. of Students	Category (Previous Drawing Experience)
A	27	None
B	50	6 weeks
C	14	12-18 weeks
D	54	One year
E	31	Two years or more
TOTAL	176	

A study was then conducted of the relationship of each of these groups to the following sequential drawing courses required of drafting majors at Northern. (Due to a recent change in the numbering system, both the old number of the course and the new number are included.)

Course	Old Number	New Number
Engineering Drawing	104	131
Engineering Drawing	105	133
Descriptive Geometry	106	132
Electrical Drawing	216	234
Structural Drawing	212	235
Topographic Drawing	213	236
Architectural Drawing	215	237

Raw data extracted from the data-collection cards concerning achievement level of each student in each group in each course follows. To establish a method of posting (tabulating) and averaging the letter grades to arrive at a group mean on a four-point system, the following numerical system was employed: A=4, B=3, C=2, D=1, E=.5, and F=0.

A simple columnar arrangement showing the frequency distribution was developed. (Appendix C).

From this frequency distribution, the following table of means was computed to establish the basis for the analysis of variance. The analysis of variance was prepared to determine the significance of the difference in means, both between and within the groups. (Table 2).

TABLE 2

Table of Means

Course	A	B	C	D	E
104	2.20	2.04	1.92	1.86	2.86
105	2.31	1.88	2.40	2.32	2.63
106	2.56	2.06	2.28	2.63	2.73
216	2.46	2.10	2.75	1.92	2.26
212	2.77	2.23	2.40	2.55	2.90
213	2.62	2.68	2.00	2.30	2.81
215	2.38	2.10	1.50	2.22	2.00
Sum	17.30	15.09	15.25	15.80	18.19
M	2.47	2.155	2.178	2.257	2.598

TABLE 2 (Continued)

Grand Sum 81.63 General Mean 2.331

Correction term = 190.38

Total Sum of Squares = 3.77

Sum of Squares between means = 1.05

Sum of Squares within the means = 2.72

SUMMARY: Analysis of Variance

Source	df	Sums of Squares	Mean Sq. Variance	S.D.
Between means of conditions	4	1.05	.262	
Within conditions	30	2.72	.0906	.3
TOTAL	34	3.77		

F=2.89

$df_1 = 4$

$df_2 = 30$

for df = 30, $t_{.05} = 2.04$

$t_{.01} = 2.75$

F @ .05 = 2.69

F @ .01 = 4.02

$SE_D = .160$

$D_{.05} = .326$

$D_{.01} = .44$

Largest difference between groups E and B =.443

Smallest difference between groups B and C =.023

The F ratio was computed as a test of significance for any mean differences. Since the variance ratio was 2.89, it was found to be significant at the .05 level (2.69). Accordingly the t test was used to evaluate differences.

Implications of this test will be discussed in Chapter V.

The percentage-completion observations of the various groups may be of interest; they have thus been included in the appendix for reference purposes only. (Appendix D). This information may indicate direction for possible future motivational studies.

Chapter V

Conclusions and Recommendations

The foregoing investigation provided sufficient information to answer the four questions posed, within the limitations and subject to the validity of the assumptions required of the study.

1. Do high school drawing courses aid student achievement in post-secondary graphic language studies at Northern?

2. To what extent is this achievement observable?

3. Does the amount of high school experience in the area appear to be a significant factor?

4. If so, what is the minimum amount rquired to indicate this significance?

Students used in the study comprised all those enrolled in the two-year drafting technology program at Northern during the period 1963-68 (those enrolling Autumn Quarter of the 1963-64 academic year through Autumn Quarter of the 1967-68 academic year). While this group was not a random sample drawn from any pre-determined population, it is possible the sample is representative of many other groups of students who enroll in two-year post secondary drafting curriculums.

The students may be considered to be self-selected, since there was no possibility of controlling who did or did

not enroll. After completing the analysis of variance and from the summarization of results, significant differences between some of the groups were observable; while differences between other groups are not considered to be significant, they are tabulated for reference purposes.

Significance was determined by the use of the test of t (.05 level, .326; .01 level, .44). The groups are listed in order, beginning with the group with the smallest difference between means. (Table 3).

TABLE 3

Differences Between Means

Groups	Differences
6 weeks and 12-18 weeks	.023
12-18 weeks and one year	.079
6 weeks and one year	.102
none and two years	.128
none and one year	.213
none and 12-18 weeks	.292
none and 6 weeks	.315
one year and two years	.341*
12-18 weeks and two years	.420*
6 weeks and two years	.443**

*significant at .05 level
**significant at .01 level

These results indicate that unless a student has had at least two years previous high school drawing experience, his achievement level in the post-secondary drawing courses will not be enhanced. However, the table also reveals no significance between the achievement level of those students with two years or more and those with no previous high school drawing experience at all. It would be importunate to conclude that "a little knowledge is a dangerous thing," although the results would seem to indicate cause for reflection by high school industrial arts and mechanical drawing teachers, and those who prepare these teachers.

It is emphasized that a myriad of variables could, and undoubtedly did, influence the results obtained, and that the foregoing study investigates only one of them. Students may have graduated from small rural schools without opportunity to enjoy drawing experiences; academically-talented students may have been "counseled out" of high school industrial arts courses; the content of courses taken are known to vary widely; evaluations by the various college instructors in the different courses may vary widely; no attention has been given to motivation; and the difference in intelligence quotients of the students has not been investigated. One could continue indefinitely.

It would seem reasonable to conclude, however, that unless a student has had at least two years of previous drawing experience, he could not anticipate achieving at a higher level (in the specified post-secondary classes) than those whose participation was of a lesser degree.

Recommendations

It is recommended that further studies be undertaken to investigate other influential variables affecting achievement level in the specified courses, and in other post-secondary technical courses.

Due to increased emphasis in the technologies to meet the rapidly-changing needs of industrial processes, requirements of industry should continue to be examined and related to offerings at both levels. Closer articulation between high schools and Northern so far as course content is concerned would be valuable.

Many of the high school drawing experiences were obtained within the scope of an industrial arts curriculum. While this study may have appeared to question the value of the courses as pre-vocational or pre-technical preparation, no criticism of industrial arts is implied.

Industrial arts, as a part of a student's general education, assists in preparing each student to become a

responsible member of today's society--both as a producer and a consumer--and to take full advantage of this membership.

On the basis of the foregoing study, I concur with Moss's conclusions from a similar study (1966).

> The results, therefore, indicate that industrial arts educators should be a great deal more conservative in the future than they have been in the past about justifying senior high school industrial arts on the basis of its greater prevocational value for all youth who intend to enter post-high school trade and technical curriculums . . .
>
> It seems logical to hypothesize, based on personal observation and the results of the study, that the content of post-high school trade and technical curriculums goes far beyond the common "practical" competencies provided by most industrial arts courses. Within a short time, students with industrial arts experience find new, specialized, and more "theoretically oriented" skills being required of them, for which they have had relatively little basic academic preparation. Of course, the more these students learned in industrial arts, the greater the proportion of possible benefit obtained. It is likely,however, that as trade and technical occupations continue to increase their demands for cognitive skills, the relative prevocational value of industrial arts courses, as they are presently constituted, will decrease.[p. 24].

REFERENCES

American Society for Engineering Education, Engineering Graphics Division, Educational Relations Committee. A technical drawing course for college preparatory students. School Shop, 1966, XXV(7), 49-54.

Anslyn, S. Drafting and technical illustration. Visual Communications Instructor, 1967, 2(5), 28.

Borri, R. A new look at our drafting needs: a survey. School Shop, 1963, XXIII(1), 21-23,40.

Erickson, K., and Hanke, A. A program for advanced placement of freshman industrial graphics students. School Shop, 1965, XXIV(6), 34-35,66-68.

Giesecke, F., Mitchell, A., Spencer, H., Hill, I., & Loving, R. Engineering graphics. New York: The Macmillan Company, 1969.

McDonald, R. Suggested standards for the mechanical drawing phase of the industrial arts general shop program in Montana. Unpublished professional paper, Montana State University, 1958.

Moss, J. The influence of industrial arts experience on grades earned in post-high school trade and technical curriculums. Cooperative Research Project No. 2050, University of Minnesota, 1966.

Mulski, J. Drafting: Taught on two levels. School Shop, 1967, XXVI(5), 22-23.

Savchenko, G. The values of mechanical drawing in an industrial arts program. Unpublished professional paper, Montana State University, 1961.

Appendix

A. Letter of request for permission to conduct study. (Copy)

1203 Cougar Street
Bozeman, Montana
June 23, 1970

Dr. J. R. Crowley, President
Northern Montana College
Havre, Montana

Dear Dr. Crowley:

I would like your approval and permission to undertake a study through the records available at Northern. The purpose of the study is two-fold in nature: (1) To obtain the necessary data to complete the professional paper requirement of my master's degree at Montana State University; (2) to reflect valuable assumptions for the Drafting Department in particular and the Vocational-Technical Division in general, which, if the study is properly executed, could be effective in the development of new techniques and curricular adjustments.

The topic--does prior high school drawing experience reflect any significance on achievement in drawing courses for students enrolled in the two-year drafting program at Northern Montana College?

The records I would need to examine are:

From the Voc.-Tech. Division Office:
1. A complete list of all freshman drafting majors 1963-68.
2. A complete list of all drafting graduates 1965-70.

From the Office of the Registrar:
1. All previous high school drawing experience by months for each of these people, and possibly the high school achievement level. (At this time, I question whether I can work

this achievement level into the study, but the information may be advantageous.)

2. The achievement level and hours completed in drawing courses at Northern for these students.

I should be able to arrange with the Division Office and the Office of the Registrar an unobtrusive way in which I could research this material, so as to cause no undue hardship or confusion in either office.

All of the above information would be recorded on a form devised so as to meet with your approval. Upon this form would exist only a number for each of the afore-mentioned students; thus protecting their identity and the sanctity of their records.

The proposal for this study (three chapters) is now in progress in a course in Research Design in which I am enrolled. Upon completion of this portion of the work, I shall forward to you a copy for your information. The remaining two chapters of the five-chapter study would be conducted during my spare time this summer break and the succeeding fall quarter, during which I would like also your permission to register at MSU in absentia to complete this paper while handling my functions at Northern.

I would sincerely appreciate any reflections or comments you would care to make, and I do hope my proposal meets with your approval.

My address in Bozeman is 1203 Cougar Street, and my phone number (finally installed today) is 587-3808.

Thank you for your attention.

Sincerely,

Dale Anderson

cc: Mr. Thad Diebel
Mr. Orval Brenden

Appendix

B. Excerpt from letter of permission to conduct study.

. . . I see no reason why it will not be possible for you to examine the records which you mentioned in your letter. We will have to work out some system whereby the anonymity of the students whose records are involved will be protected completely. I am sure that you are aware that during the past two years there has been considerable apprehension expressed and warnings issued by national organizations in regard to use of student records. In addition, a few weeks ago a representative of the Attorney-General's office cautioned the registrars of the state to exercise every care in regard to making student records available to almost anybody and everybody. I am sure, however, that since you are a member of the faculty of the Drafting Department, we can with justification say that you are entitled to look at the records. I do hope, however, that you will work with the newly appointed registrar as well as Dean Diebel and Mr. Erickson, in setting up procedures. . .

Sincerely,

J. R. Crowley
President

JRC/th

Appendix

C. Frequency Distribution Chart

Group	Grade	Dr. 104 f	Dr. 105 f	Dr. 106 f	Dr. 216 f	Dr. 212 f	Dr. 213 f	Dr. 215 f
A	A	2	2	2	1	3	2	1
	B	5	6	9	6	2	1	3
	C	14	8	3	4	3	5	4
	D	4	2	0	2	1	0	0
	E	0	0	0	0	0	0	1
	F	0	1	2	0	0	0	0
	Mean	2.20	2.31	2.56	2.46	2.77	2.62	2.38
B	A	3	1	2	1	0	1	1
	B	14	11	10	5	8	11	2
	C	17	12	9	11	7	3	10
	D	10	5	4	1	1	0	1
	E	0	0	0	0	0	0	1
	F	4	6	4	2	1	1	0
	Mean	2.04	1.88	2.06	2.10	2.23	2.68	2.10
C	A	1	2	1	1	0	1	0
	B	3	2	1	1	2	1	0
	C	6	4	4	2	3	3	2
	D	2	2	1	0	0	0	2
	E	0	0	0	0	0	0	0
	F	2	0	0	0	0	0	0
	Mean	1.92	2.40	2.28	2.75	2.40	2.00	1.50
D	A	1	0	5	1	1	1	1
	B	14	13	10	2	4	1	1
	C	19	16	5	7	3	8	6
	D	13	1	1	1	1	0	1
	E	0	0	1	0	0	0	0
	F	5	1	1	2	0	0	0
	Mean	1.86	2.32	2.63	1.92	2.55	2.30	2.22
E	A	12	4	7	2	3	3	0
	B	7	7	8	3	4	3	4
	C	7	10	4	8	4	5	5
	D	1	1	3	1	0	0	0
	E	0	0	0	0	0	0	0
	F	3	0	1	1	0	0	1
	Mean	2.86	2.63	2.73	2.26	2.90	2.81	2.00

Appendix

D. Course Completion Percentages of Groups A-E

	A		B		C		D		E	
Students Starting	27		50		14		54		31	
Courses	No. Comp.	%	No. Comp.	%	No. Comp.	%	No. Comp.	%	No. Comp.	%
104	25	93	48	96	14	100	52	96	30	97
105	19	70	35	70	10	71	31	57	22	71
106	16	59	29	58	7	50	23	43	23	74
216	13	48	20	40	4	29	13	24	15	48
212	9	33	17	34	5	36	9	17	11	35
213	8	30	16	32	5	36	10	19	11	35
215	9	33	15	30	4	29	9	17	10	32
Possible Total Course Partici-pation*	189		350		98		378		217	
Total Student Completion	99		180		49		147		122	
Total % Completion of Group		52		51		50		39		56

* Number of students x 7 courses