A STUDY TO DETERMINE WHETHER THE TEACHING OF ISOMETRIC DRAWING WILL AFFECT SPATIAL PERCEPTION

APPROVED:

Major Professor

Minor Professor

Chairman of the Industrial Arts Department

Dean of the Graduate School

N.E.B.

Draper, Kenneth A., A Study to Determine Whether the Teaching of Isometric Drawing will Affect Spatial Perception. Master of Science (Industrial Arts), August, 1973, 40 pp., 3 tables, 5 illustrations, bibliography, 22 titles.

This is a study to determine whether the teaching of isometric drawing will affect spatial perception.

The data were obtained from a standardized instrument administered to a control and experimental group. The control group was an eighth-grade homeroom class, and the experimental group was an eighth-grade drafting class.

Illustrations of the material taught are given. The data are presented in tables and analyzed by a t-test of significance.

Chapter I of the study includes an introduction, statement of the problem, purpose of the study, limitations of the study, definitions of terms, source of data, organization of the study, and related studies.

Chapter II is a review of literature concerning the function of visual perception. It deals with the monocular and binocular cues.

Chapter III tells how the study was implemented. It describes the sampling, the instrument used to evaluate the study, the material presented during the study, and the manner in which the study was analyzed.

Chapter IV is the analysis of the study. It deals with the procedure in which the study was analyzed, the presentation of the scores of the samples, and the analysis of the study by a t-test of significance.

The summary, findings, conclusions, and recommendations are presented in Chapter V.

The following findings are based on the data as presented in the study:

1. The difference between the mean of the scores of the pre-test and post-test of the control group was an increase of 1.063.

2. The difference between the mean of the scores of the pre-test and post-test of the experimental group was an increase of 2.250.

3. The experimental group had a 1.187 greater increase in the mean of the test scores than did the control group.

4. The t-test of significance of the pre-test scores of the control and experimental group was shown to be insignificant at the 0.01 level.

5. The t-test of significance of the post-test scores of the control and experimental group was shown to be insignificant at the 0.01 level.

6. The t-test of significance of the scores on the pre-test and post-test of the experimental group was insignificant at the 0.01 level.

7. The means of both the control and experimental groups were very seriously affected by atypical scores, a result which is reflected in the statistical treatment of the data.

8. The change effected in spatial perception ability as a result of teaching isometric drawing is insignificant at the 0.01 level, as measured by the t-test.

Based on the findings of the study, it can be concluded that the teaching of isometric drawing will effect a change in spatial perception ability.

Recommendations were made on the basis of the findings and conclusions. It is recommended that a study of spatial perception be made in industrial arts courses which use pattern and layout work. A study similar to this one should be made utilizing a larger sampling. A study similar to this one should be made utilizing oblique projection. A study similar to this one should be made utilizing multiview projection. A study similar to this one should be made that would utilize color in the teaching of isometric drawing. Drafting teachers should become more aware of spatial perception ability. Drafting teachers should utilize all media available including three-dimensional objects and colored projection materials.

A STUDY TO DETERMINE WHETHER THE TEACHING OF ISOMETRIC DRAWING WILL AFFECT SPATIAL PERCEPTION

THESIS

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

Kenneth A. Draper, B. S.

Denton, Texas

August, 1973

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

CHAPTER I

INTRODUCTION

There are many factors that influence the process of education. Efforts have been made to study every aspect from the physical plant up to the whole philosophy of education. Many of these studies deal with the child's ability in the classroom. The position has been put forth that all the abilities of a child should be carefully evaluated if he is to be afforded the maximal help (3, p. 2). One area that has received a great amount of attention is that of visual perception. Some believe that it has received too much attention and that the training of visual perception will not aid in the educational process (4, p. 44). However, there is evidence that suggests that this training would be highly desirable. Frostig states, "Imagery and such thought processes as drawing inferences, understanding cause and effect, and so on, are necessary if he is to comprehend" (3, p. 7).

In view of such a position, there have been several studies to determine whether visual perception can be affected. These have involved several different approaches. This study is such an attempt but with a different approach.

Statement of the Problem

The problem of this study was to determine whether the spatial perception abilities of drafting students could be affected by the teaching of isometric drawing.

Purpose of the Study

Spatial perception ability appears to be necessary in drafting, blueprint reading, pattern layout work, and the production of goods and materials in a technological society. This study was undertaken to determine if this ability could be affected by the teaching of isometric drawing at the eighth-grade level.

Limitations of the Study

The following limitations were placed on this study:

1. This study was limited to thirty-two students at Azle Junior High School in Azle, Texas, during the spring semester of the 1972-73 school year.

2. This study was limited to drafting students at the eighth-grade level.

3. This study was limited to the application of isometric drawing to spatial perception.

4. This study was limited to the effects of teaching isometric drawing on spatial perception as measured by the Spatial Visualization Test of the Dailey Vocational Test (2) series.

Definition of Terms

For purposes of this study, the following terms are defined:

1. Perception - the process through which one becomes aware of his environment by organizing and interpreting the evidence of his senses (5, p. 154).

2. Sensation - the reaction to the occurrence of change in the stimulus (4, p. 553).

3. Spatial perception - the ability to perceive a three-dimensional object in space.

4. Visual perception - the brain operations which involve interpreting and organizing the physical elements of a stimulus (4, p. 554).

Source of Data

The source of data for this study was an experimental group of eighth-grade students enrolled in drafting and a control group of eighth-grade students not enrolled in drafting at Azle Junior High School in Azle, Texas. The method of evaluation was a t-test of significance performed on the statistical data gathered by a pre-test and post-test administered to both groups.

Organization of the Study

This study is organized into five chapters. Chapter I is the introduction and contains sections for the statement of the problem, purpose of the study, limitations of the study, definition of terms, organization of the study, and related studies. Chapter II is a review of material related to spatial perception. It summarizes the basic visual processes. Chapter III is the implementation of the study. It describes the sampling, the evaluation instrument, teaching unit, and indicates how the data were collected. Chapter IV presents the data and the results of the analysis. Chapter V is the summary, findings, conclusions, and recommendations of this study.

Related Studies

Several studies have been performed relating to spatial perception. Those found to be most closely related are cited here.

1. Babcock (1) performed a study utilizing creative problem-solving situations in descriptive geometry classes. He concluded that a course in descriptive geometry involving creative thinking would not improve visual thinking.

2. Frostig (3) has performed many studies in the area of perception. However, her work deals more with learning disabilities and emphasizes reading deficiencies.

3. Kleinhans (6) used slope, slanted, and tilted visual fields to perform a study of spatial perception. The study was concerned with the effect of spatial orientation. He

concludes that, "It is easier to determine eye position in a horizontal plane than in a vertical plane, 'and . . . misperception of orientation is more pronounced in sloped than slanted fields'" (6, p. 5029-B).

4. Palow (7) performed a study to determine at what grade level and age children acquire the Euclidean spatial abilities. His study supports the position that this ability is acquired at about the seventh grade or age twelve.

5. Robinson (8) performed a study exploring the use of spatial concepts of children. Her study involved the use of polar coordinates in locating objects with which students were familiar. She drew the conclusion that there is a progression in the use of spatial concepts.

6. Sedgwick (9) performed a study in an attempt to determine the effect of a course in descriptive geometry on spatial perception. His study was concerned with descriptive geometry and used college-level students as the subjects; in contrast, this study utilized isometric drawings and used eighth-grade students as the subjects.

CHAPTER BIBLIOGRAPHY

1. Babcock, James Gray, "An Experimental Study to Determine the Effects that Creative Problem-Solving Situations have upon Creative Thinking Ability and Visual Thinking Ability of Selected Students enrolled in College Descriptive Geometry Classes," unpublished doctoral dissertation, Industrial Education Department, Utah State University, Logan, Utah, 1970.

2. Dailey, John T., Spatial Visualization Test, The Dailey Vocational Test, Boston, Houghton Mifflin Co., 1964.

3. Frostig, Marianne, "Visual Perception, Integrative Functions and Academic Learning," The Journal of Learning Disabilities, V, (January, 1972), 1-15.

4. Hammill, Donald, "Training Visual Perception Processes," The Journal of Learning Disabilities, V, (November, 1972), 552-559.

5. Kagan, Jerome, and Ernest Havemann, Psychology: An Introduction, New York, Harcourt, Brace, and World, Inc., 1968.

6. Kleinhans, John Lindley, "Perception of Spatial Orientation in Sloped, Slanted and Tilted Visual Fields," unpublished doctoral dissertation, Department of Psychology, Rutgers University, New Brunswick, New Jersey, 1970.

7. Palow, William Paul, "A Study of the Ability of Public School Students to Visualize Particular Perspectives of Selected Solid Figures," unpublished doctoral dissertation, College of Education, University of Florida, Gainsville, Florida, 1969.

8. Robinson, Lucile Thurston, "An Exploratory Study of the Utilization of Spatial Concepts by Children," unpublished doctoral dissertation, College of Education, Stanford University, Stanford, California, 1970.

9. Sedgwick, Lorry King, "An Attempt to Determine the Effect on Spatial Perception of Instruction in Descriptive Geometry," unpublished master's thesis, Industrial

Education Department, Southern Illinois University, Carbondale, Illinois, 1961.

CHAPTER II

VISUAL PERCEPTION

To examine the visual perception process, one must first understand that there are several sensory functions. All equipped with receptor cells, these functions are sensitive to light (visual), sound (auditory), touch (tactual), taste (gustatory), smell (olfactory), and others (6, p. 553). Each function, by way of a nerve system, sends its information to the brain to be, "constructed, defined, verified and modified" (6, p. 553).

The visual aspects seem to be more than just simple impulses. Kagan states that, "We seek to identify and 'make sense' out of the objects in the environment" (8, p. 154). An organization of the visual processes must then follow that will identify the responses. Dember states:

> The sources of input information about depth and distance can be classified as those that are available to a single eye and those that require the simultaneous activity of both eyes. The first class is labeled monocular, the second binocular. Both types of information are normally utilized by the individual, but in the laboratory it is possible to separate the two classes and study their effect independently.
>
> Within the class of monocular cues there are several varieties. The kinds of binocular cues are limited to two, convergence and retinal disparity. We shall consider these two types of binocular information after a description of the following major monocular cues; proximal size, proximal brightness, shading, texture

gradients, linear perspective, interposition, and movement parallax (1, p. 170).

Monocular Cues

Proximal Size

Proximal size is the perceived size of an object. This perception is the result of a judgment of the distance of the object in relation to the size of the image that is formed on the retina of the eye (2, p. 80). Several factors seem to influence this process. The perception of size is analyzed by the formula "If R equals the retinal size, C the object size, and D the distance, then R=C/D or C=RD" (2, p. 80), a fact which suggests a mathematical interpretation. However, Segall suggests that this perception is influenced by cultural factors in his statement, ". . . obvious examples of perceptual tendencies shaped largely by experience" (9, p. 73). Whatever the factors might be that determine the perceived size, Kagan indicates its importance when he says, ". . . we tend to perceive objects in their correct size regardless of the size of the actual image they cast on our eyes" (8, p. 177).

Proximal Brightness

The intensity of the image projected on the retina of the eye is the proximal brightness. Hochberg states, "The percentage of the light a surface reflects is its albedo, and we observe this physical characteristic with surprising accuracy, even though the amount of light reaching the eye from that object may vary widely" (7, p. 50). The albedo mentioned by Hochberg has been explained in the following mathematical formula: "A=R/I, where A is the albedo, R the intensity of reflected light, and I the intensity of incident light" (2, p. 58). Although it may vary, this reflection can serve as a cue to distance (1, p. 171).

Shading

Objects drawn on a two-dimensional plane are often given the appearance of depth by shading and shadows (1, p. 171). Three-dimensional objects are seldom seen in such a way that they have consistent illumination. As the light falls on an object, a gradual transition in shading will be produced by a curved surface and an abrupt transition will be produced by an angle or corner (3, p. 144). Gregory points out that, "Shadows are important for they supplement the single eye, to give something surprisingly close to binocular depth" (5, p. 185). When added to a two-dimensional view of an object, this effect can serve to orient the object and indicate its depth.

Texture Gradient

One of the more significant distance cues is texture gradient. Gibson states that, "The word gradient means nothing more complex than an increase or decrease of something along a given axis or dimension" (3, p. 73). This gradient might be the blades of grass in a field, bricks along a wall, or even the rough texture of a concrete walk. Regardless of the material, the texture density of a surface is the proximal elements per any given unit (1, p. 171). When these elements are viewed from a close distance, they are more distinct. At a greater distance, each surface unit takes on a greater density, but the specific texture of the material is less distinct.

Linear Perspective

Another of the major monocular distance cues is linear perspective. Lines that are parallel to one another seem to converge on the retina of the eye as they get farther away. This converging on the retina seems to be a very special case of the size-distance relation and is demonstrated by the fact that the object will also decrease in size in proportion to its distance (1, p. 173). It should be noted that perspective drawings are used extensively in the technical fields. As Giesecke states, "Perspective, or central projection, excels all other types of projection in the pictorial representation of objects because it more closely approximates the view obtained by the human eye . . ." (4, p. 555).

Interposition

When an object overlaps another, there is a partial blocking on the retina of the fartherest object. This provides a cue to the distance of the objects and is called interposition. Forgus states that, ". . . the contour which appears to be complete, regular, and continuing in one direction is seen as nearer, while the contour which takes a sharp turn in direction is seen as farther away" (2, p. 210).

Movement Parallax

The last of the monocular cues is movement parallax. This is a cue to distance observed while the individual is in motion. An object that is nearer the observer will appear to move (in the opposite direction of movement of the observer) at a faster rate than an object that is farther in the distance. The closer object will seem to move faster because it also seems to move farther (1, p. 174). This cue is generally utilized while an individual is riding in a car or on a train, and the vision is directed to objects along the roadway.

Binocular Cues

It should be remembered that binocular cues require the simultaneous activity of both eyes (1, p. 170).

Convergence

Gregory points out that,

> Many of the organs of the body are duplicated, but the eyes, and the ears, are unusual in working in close co-operation: for they share and compare information, so that together they perform feats impossible for the single eye or ear (5, p. 50).

The first of the two binocular cues is convergence. This is ". . . how the eyes pivot inward for viewing near objects, and distance is signalled to the brain by this angle of convergence" (5, p. 51). A response of the eye very closely associated with convergence is accommodation. Hochberg states that,

> Normal vision would be quite impossible without the cooperation of all these muscular actions, and they must all be taken into account in some fashion in order to assign any spatial meaning to a given stimulation of the retina (7, p. 27).

He goes on to explain the muscular actions involving accommodation and convergence:

> For any point in space at any moderate distance from the eye, the lens must be stretched or relaxed to some degree which is precisely related to the distance, in order to bring the point to a sharp focus on the retina. This process is called accommodation. Similarly, the eye must converge at some angle, which is precisely related to the fovea of each eye . . . These adjustments undoubtedly do occur. If we could sense the degree of tension in the muscles responsible for these adjustments, we would have an additional set of depth cues. For these two nonvisual cues are closely tied to spatial distance (7, p. 43).

It is important to note that these two responses "are not visual at all" (7, p. 44); instead, they are muscular. And, it has been pointed out that, ". . . we do not learn to accommodate, converge, fixate, and move the eyes, although it is possible that practice improves these functions" (3, p. 222).

These two processes, working in conjunction, produce one stimulus for perception. As Gibson states, "Accommodation and convergence are responses of the eyes to a condition of their images (blur and disparity) which may concurrently produce that inner response we call 'depth'" (3, p. 111). Gregory seems to place stronger emphasis on this idea in his statement, "A remarkable thing about the visual system is its ability to synthesize the two somewhat different images into a single perception of solid objects lying in three-dimensional space" (5, p. 50). Although it is conceded that accommodation and convergence are potential distance cues, everyone does not agree that it is as precise or useful as presented here (1, p. 175).

Retinal Disparity

The second of the binocular cues is retinal disparity. To understand disparity, one must come to an understanding of the receptive process of two eyes. Dember explains this point:

> For each point on the left retina, there is a point on the right retina such that the two corresponding points are stimulated by the same part of

> the distal stimulus. This geometric correspondence is accompanied by an anatomical correspondence. That is, corresponding geometric points report to the same cortical point (1, p. 175).

This process is related to the fact that the eyes are separated by a distance of about 2 1/2 inches; therefore, it is a process of relating two different images. Or, as Hochberg points out, "Our eyes view the world from slightly different positions, so that there is in general a difference, or disparity, between the images . . ." (7, p. 37). The two eyes must then work in conjunction when fixating on a visual stimulus.

> Now, suppose that the two eyes are converged on one point on a three-dimensional object. A hypothetical surface can be passed through that point which will stimulate corresponding areas. This hypothetical surface is called the horopter (1, p. 175).

Any point outside this hypothetical surface will produce a disparate image, and as Forgus states, "it is this disparity between the two images, called binocular disparity, which is considered a cue to relative depth or distance" (2, p. 203). As this disparity increases, it seems to produce a more reliable cue for depth (1, p. 175). In most individuals this is fairly effective. Experiments indicate that it is reliable up to a range of approximately 1,900 feet (2, p. 203). Dember has also pointed out that it is an independent cue; that is, it does not depend on the identification of the stimulus or on factors such as background (1, p. 176). It was pointed out that the process of convergence and accommodation was muscular in nature. Unlike these, disparity is visual. It should be noted that, like convergence and accommodation, disparity is often exaggerated as a stimulus for distance and depth perception (3, p. 108).

The perception of depth and distance (or spatial perception) is strongly related to the visual process. Any attempt to utilize the process makes it necessary to understand each of its functions. Those stimuli, or cues as they have been referred to, that compose the body of monocular cues cannot be considered any less important because they utilize only one eye. Likewise, the binocular cues cannot be considered of greater importance. In the normal individual, all of the cues seem to possess the potential of stimulating a perceptual response.

It would seem, however, that some of the cues are directly related to the perception of a three-dimensional object. Linear perspective is a cue to depth and distance, and there is an area of drawing that teaches the drawing of such views. The convergence of the eyes when fixating on a given point suggest a possible relation to the convergence of lines on certain pictorial drawings. Disparity presents the possibility of two entirely different images being brought together to create depth perception.

In a study of visual cues and their implications, one should remember that any one stimulus may not offer a consistent response. Size, brightness, and texture gradient are primary cues, but not a requirement for the perception of depth and distance. Convergence and disparity also are not a requirement for depth and distance perception, although these require the use of both eyes. For example, many people with limited abilities can adequately perceive objects and distance. It even seems possible that spatial perception could be achieved by the tactual sensory mechanism. Therefore, to say that spatial perception is entirely dependent upon the visual functions, specifically on any one of its processes, may be gravely misleading.

CHAPTER BIBLIOGRAPHY

1. Dember, William N., The Psychology of Perception, New York, Henry Holt and Co., 1960.

2. Forgus, Ronald H., Perception, New York, McGraw-Hill Book Co., 1966.

3. Gibson, James J., The Perception of the Visual World, Boston, Houghton Mifflin Co., 1950.

4. Giesecke, Frederick E., and others, Technical Drawing, fifth ed., New York, The Macmillan Co., 1967.

5. Gregory, Richard L., Eye and Brain: The Psychology of Seeing, New York, McGraw-Hill Book Co., 1966.

6. Hammill, Donald, "Training Visual Perceptual Processes," Journal of Learning Disabilities, V (November, 1972), 552-559.

7. Hochberg, Julian E., Perception, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1964.

8. Kagan, Jerome, and Ernest Havemann, Psychology: An Introduction, New York, Harcourt, Brace and World, Inc., 1968.

9. Segall, Marshall H., Donald T. Campbell, and Melville J. Herskovits, The Influence of Culture on Visual Perception, New York, Bobbs-Merrill Co., 1966.

CHAPTER III

IMPLEMENTATION OF THE STUDY

Several factors had to be taken into account in the implementation of this study. It was first necessary to arrange a sampling for the study and then select an instrument of evaluation. Arrangement of the teaching unit and the collection of data then followed.

Description of the Sample

At the time the study was to be performed (the spring semester of the 1972-73 school year), there were three drafting classes available. The first class was composed entirely of ninth-grade students. Some of these students had previously been enrolled in drafting, and others were taking a first course. The second class was a mixture of eighth and ninth-grade students. The eighth-grade students were enrolled for the first course in drafting, but some of the ninth-grade students had previously been enrolled in a drafting course. The third class (the sampling for this study), was all eighth-grade students who had not been enrolled in any previous drafting course. At the time the study was begun, these students had studied lessons on lettering, multiview projection, and dimensioning. They had no other preparation, other than what might have been encountered in elementary school, for the representation of pictorial objects.

Also available at the time the study was performed was an eighth-grade homeroom class in which thirty students were to serve as the control sampling. Permission was secured from the principal of the school to perform the study, utilizing the eighth-grade homeroom class as the control group and the eighth-grade drafting class as the experimental group. The average size of each homeroom section was thirty students, and the average size of the drafting classes was twenty students. Subsequently, after administration of the evaluation instrument, there were data available for sixteen students in both the control and experimental group.

Selection of the Instrument

To gain the highest possible degree of validity, the instrument selected to evaluate the effect of the study was a standardized test. Cronlund has pointed out that this type of test usually contains (1) items of the highest technical quality, (2) precise directions for administering and scoring, (3) norms which usually provided information for interpreting the scores, (4) alternative forms as well as information concerning the test, and (5) manuals and accessory items for administering, scoring, and interpreting the results (4, p. 222). This seemed to be a more logical approach, as opposed to an informal classroom test which might not test the spatial concepts selected for this study. The test used was the <u>Spatial Visualization Test of the Dailey Vocational Test</u> series (2). This test was standardized over a very large sampling of the United States (1, p. 6), and contains all the material needed for the administration and scoring. Further, as Dailey states,

> The Spatial Visualization Test consists of 30 items measuring ability to visualize objects presented in two-dimensional drawings as they would appear in three-dimensional space. Specifically, the items require the subject to match the edges of a folded and unfolded figure. Each figure has from six to twelve edges so that choice is made among six to twelve answers per item. This minimizes the number of correct answers by chance and makes possible several items per diagram (1, p. 4).

The ability to "visualize objects" presented in a two-dimensional form and convert to a three-dimensional object was essentially the purpose of the material presented during the study. It is this ability that seems to be the basis for spatial perception. A major advantage of this test is its twenty-minute testing period, a feature which facilitates the administering of the test in a normal one-hour class period.

All items of the test were represented in a pictorial form; most of these were isometric drawings. Each item on the test was composed of a pictorial view and a pattern layout of the object. The edges of the pictorial view were numbered, and the edges of the pattern layout were lettered. The student was to look at the object and match the corresponding edges by marking the correct answer on an accompanying answer sheet. The answer sheets were then scored by the use of a key. An item comparable to the test items is shown in figure 1.

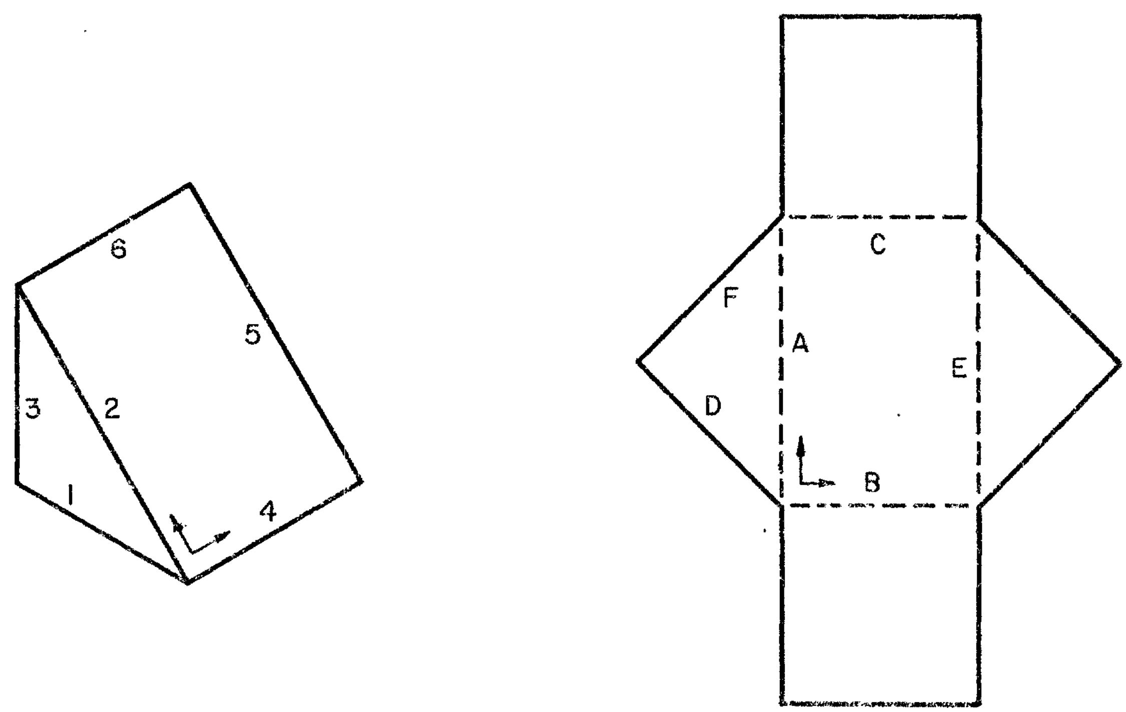

Fig. 1--Comparable item to Spatial Visualization Test

The arrows on the object serve to orient the position of the pattern. This type of item appeared to present the best means of evaluating the study.

The Teaching Unit

There are three basic types of pictorial illustrations. These are perspective, oblique, and isometric. As already noted, perspective is far superior for representing an object as it is actually seen. However, for purposes of teaching a basic representation of an object in a beginning drafting course, it has the disadvantage of being very technical. Such information as the picture plane, horizon line, vanishing points, and station point (3, p. 474) must be presented to understand the representation of the subject. Oblique drawings offer a very simple and fast means of representing an object. Their disadvantage, however, is that they can become very distorted (6, p. 31).

Isometric drawings seem to offer a preferable means of representing an object in pictorial form. An isometric drawing is oriented in such a manner that it provides a very close approximation of how the object would actually appear to an observer. The receding axis of an isometric view is such that it closely approximates a perspective view of the object. The lines of an isometric drawing do not converge, making it simple to draw. The equipment necessary to draw an isometric view is readily available at moderate expense. For these reasons, it appeared that the teaching of isometric drawing presented the most plausible means of representing a pictorial form of an object for a study of spatial perception.

Lessons were prepared for the teaching of isometric drawing covering the fundamental principles of this type of drawing. They were prepared from a textbook issued to each student (5), and arranged to cover the material in order of increasing difficulty. Drawing exercises were assigned as classwork, moving from simple geometric solids to more complex objects. The drawing exercises were selected on the basis of (1) the principal lines being parallel to the isometric axis (see Fig. 2), (2) the principal lines of the isometric view not being parallel to the isometric axis (see Fig. 3), (3) circular objects to be drawn as an isometric view (see Fig. 4), and (4) the dimensioning of isometric drawings (see Fig. 5). As a means of determining whether each student was progressing through the material as desired, informal tests were prepared in which the student was required to draw an isometric view. Four weeks were allotted to perform the study and present the material on isometric drawing.

The Collection of Data

Prior to the presentation of the material on isometric drawing, the Spatial Visualization Test was administered to both the experimental and control groups. This testing occurred during the class period in which the class regularly met. At the time the test was administered, the students were told only that the test would be used in preparing

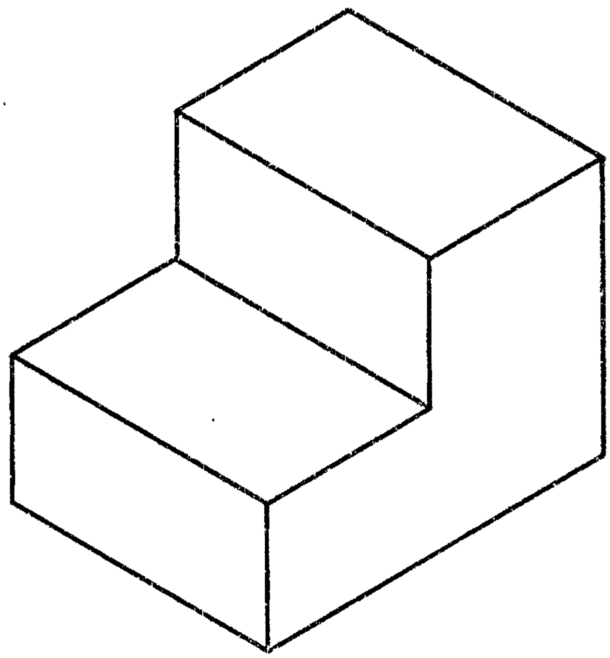

Fig. 2--An isometric view with lines parallel to the axis

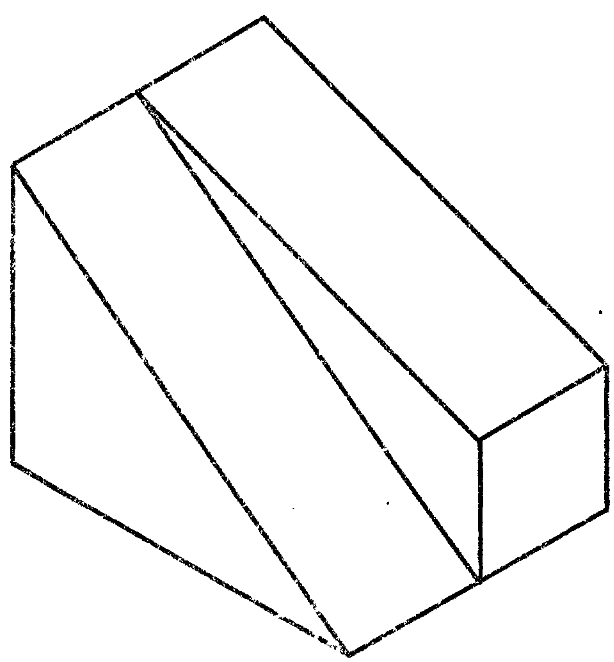

Fig. 3--An isometric view with lines not parallel to the axis

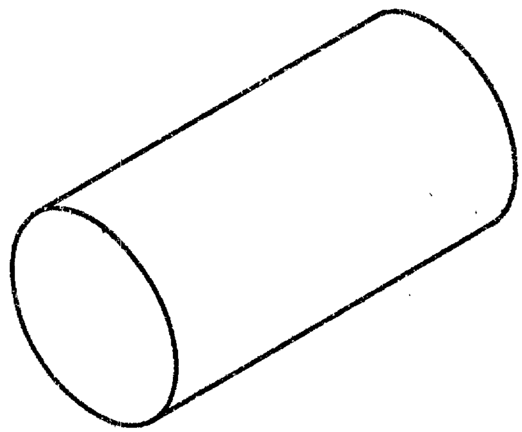

Fig. 4--A cylinder drawn in isometric

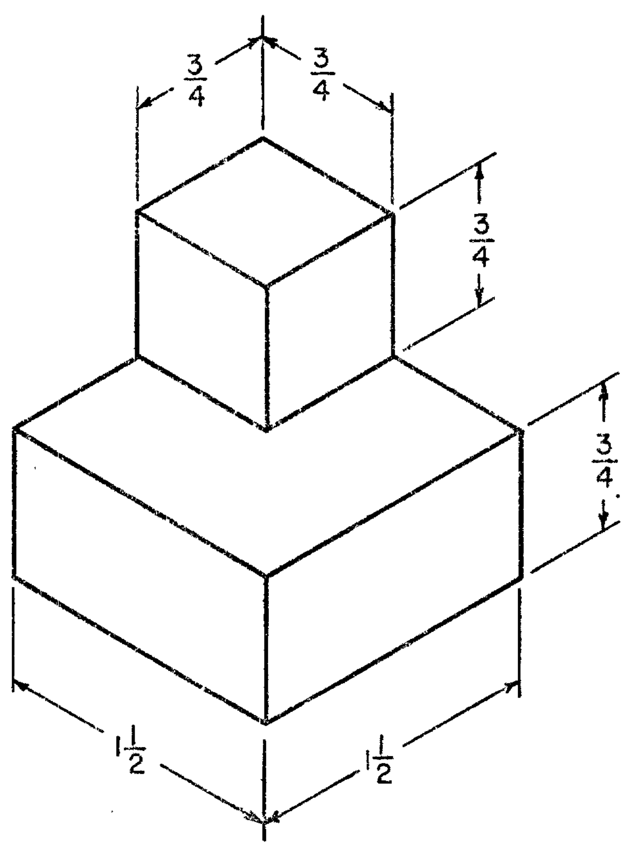

Fig. 5--A dimensioned isometric view

lessons for the presentation of the material on isometric drawing and that it was important for them to do as well as possible on the test. After administration of the pre-test, the period of instruction on the material began.

At the end of the period of instruction, the test was again administered. The scores obtained from the pre-test and post-test were recorded for future analysis.

It is the purpose of this chapter to describe in some detail how the study was performed. Three classes were available for the study. The class selected appeared to be most suitable. The Spatial Visualization Test of the Dailey Vocational Test series was used as the instrument of evaluation. Of the three basic types of pictorial illustrations--perspective, oblique, and isometric--isometric was used in this study. Chapter IV contains an analysis of the data collected by the pre-test and post-test of this study.

CHAPTER BIBLIOGRAPHY

1. Dailey, John T., Examiner's Manual for the Dailey Vocational Test, Boston, Houghton Mifflin Co., 1965.

2. Dailey, John T., Spatial Visualization Test, The Dailey Vocational Test, Boston, Houghton Mifflin Co., 1964.

3. Earl, James H., Design Drafting, Menlo Park, California, Addison-Wesley Publishing Co., 1972.

4. Gronlund, Norman E., Measurement and Evaluation in Teaching, New York, the Macmillan Co., 1965.

5. Spencer, Henry C., Basic Technical Drawing, rev. ed. New York, The Macmillan Co., 1962.

6. Wright, Lawrence S., Drafting, Technical Communication, Bloomington, Illinois, McKnight and McKnight Publishing Co., 1968.

CHAPTER IV

ANALYSIS OF THE DATA

It was the purpose of this study to determine whether teaching isometric drawing would affect the spatial perception ability of students at the eighth-grade level. To accomplish the purpose of this study, control and experimental groups were selected. An evaluation instrument was administered as a pre-test, the material on isometric drawing was presented, and the evaluation instrument was again administered as a post-test.

Analysis Procedure

In the process of administering the evaluation instrument, samplings were acquired from sixteen students in both the control and experimental groups. A t-test of significance was used to analyze these scores. Crocker states,

> When we are dealing with small samples (below thirty) there are usually not enough scores to give an approximation to the normal curve. As a result Student developed a test called the t-test of significance. By using it we are able to estimate the standard error of the difference between the means of two samples or two small populations (1, p. 67).

Because this study had fewer than thirty students, the t-test was deemed appropriate.

Scores

As a result of administering the evaluation instrument, scores were obtained from sixteen students in both groups. These scores offer some additional information.

Table I presents the raw scores of the pre-test and post-test of the control group.

TABLE I

RAW SCORES OF CONTROL GROUP ON THE SPATIAL VISUALIZATION TEST

Student Number	Pre-test Score	Post-test Score	Student Number	Pre-test Score	Post-test Score
1	26	28	9	24	24
2	17	26	10	14	14
3	14	7	11	7	9
4	20	26	12	10	18
5	9	1	13	8	3
6	9	8	14	8	10
7	6	9	15	6	7
8	8	10	16	7	10

The data in Table I indicate a range on the pre-test of 6 to 26. On the post-test there was a range of 1 to 28. The modal score of the pre-test was 8 and the post-test was 10. The median of the pre-test was 9 and the post-test was 10.

Table II presents the raw scores of the experimental group.

TABLE II

RAW SCORES OF EXPERIMENTAL GROUP ON THE SPATIAL VISUALIZATION TEST

Student Number	Pre-test Score	Post-test Score	Student Number	Pre-test Score	Post-test Score
1	2	7	9	16	18
2	4	7	10	5	16
3	7	3	11	11	16
4	11	13	12	19	21
5	16	11	13	8	10
6	19	18	14	8	19
7	15	17	15	17	16
8	15	17	16	12	12

The data in Table II indicate a range on the pre-test of 2 to 19. On the post-test there was a range of 3 to 21. There were five modes, 19, 16, 15, 11, and 8 on the pre-test. On the post-test the mode was 16. The median on the pre-test was 11.5, and on the post-test was 16.

The data in Tables I and II indicate that some students scored lower on the post-test than they did on the pre-test. The difference between the sum of the pre-test scores and the sum of the post-test scores of the control group indicated a gain of 17. The difference between the sum of the pre-test scores and the sum of the post-test scores of the experimental group indicated a gain of 36.

Table III presents the mean of the pre-test and post-test of both groups. The pre-test and post-test indicate an increase in both the control and experimental groups.

TABLE III

COMPARISON OF MEANS OF THE SPATIAL VISUALIZATION TEST

Group	Pre-test	Post-test
Control	12.062	13.125
Experimental	11.562	13.812

On the pre-test the control group had a higher mean than the experimental group. However, on the post-test the experimental group had a higher mean. The experimental group also had a greater gain in the mean between the pre-test and post-test than did the control group.

The t-test

The t-test of significance of the pre-test of the control and experimental group yielded a score of .230. This was found to be insignificant at the 0.01 level.

The t-test of significance of the post-test of the control and experimental groups yielded a score of .267. This was found to be insignificant at the 0.01 level.

The t-test of significance of the pre-test and post-test of the experimental group yielded a score of 1.218. This was found to be insignificant at the 0.01 level.

This chapter presented the manner in which the data collected from the study were analyzed. A t-test of significance was used due to the small sampling available. The scores from the pre-test and post-test of both groups were presented in three tables. A t-test was performed to determine any significant difference between the means of the control and experimental groups.

CHAPTER BIBLIOGRAPHY

1. Crocker, A. C., Statistics for the Teacher, Baltimore, Peguin Books, Inc., 1969.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine whether the teaching of isometric drawing at the eighth-grade level would affect spatial perception.

The information and data needed for the study were secured, and the study was organized as follows: Chapter I includes an introduction to the study, statement of the problem, purpose of the study, limitations of the study, definition of terms, source of data, organization of the study and related studies. Chapter II is concerned with the function of visual perception. The literature on monocular and binocular cues is reviewed. Chapter III describes how the study was implemented. This description includes the sampling, the evaluative instrument, the presentation of material, and the manner in which the data are treated. Chapter IV provides the analysis of the data collected. This chapter deals with the procedure in which the data were analyzed, the presentation of the scores of the samples, and the analysis of the data by a t-test of significance.

Chapter V presents the summary, findings, conclusions, and recommendations of the study.

Findings

Based upon the data collected by this study, the findings are as follows:

1. The difference between the mean of the scores of the pre-test and post-test of the control group was an increase of 1.063.

2. The difference between the mean of the scores of the pre-test and post-test of the experimental group was an increase of 2.250.

3. The experimental group had a 1.187 greater increase of the mean of the test scores than did the control group.

4. The t-test of significance of the pre-test scores of the control and experimental group was shown to be insignificant at the 0.01 level.

5. The t-test of significance of the post-test scores of the control and experimental group was shown to be insignificant at the 0.01 level.

6. The t-test of significance of the scores on the pre-test and post-test of the experimental group was insignificant at the 0.01 level.

7. The means of both the control and experimental groups were very seriously affected by atypical scores, a

result which is reflected in the statistical treatment of the data.

8. The change effected in spatial perception ability as a result of teaching isometric drawing is insignificant at the 0.01 level, as measured by the t-test.

Conclusions

Based on the findings of the study, it can be concluded that the teaching of isometric drawing will effect a change in spatial perception ability.

Recommendations

Drafting teachers should be aware of spatial perception ability. Since some change was recorded in the experimental group of students in this study, drafting presents a media through which this ability might be further developed. Based on the findings and conclusions of this study, the following recommendations are presented:

1. A study of spatial perception should be made in industrial arts courses which use pattern and layout work.

2. A study similar to this one should be made utilizing a larger sampling.

3. A study similar to this one should be made utilizing oblique projection.

4. A study similar to this one should be made utilizing multiview projection.

5. A study similar to this one should be made that would utilize color in the teaching of isometric drawing.

6. Drafting teachers should become more aware of spatial perception ability.

7. Drafting teachers should utilize all media available including three-dimensional objects and colored projection materials.

BIBLIOGRAPHY

Books

Crocker, A. C., Statistics for the Teacher, Baltimore, Peguin Books, Inc., 1969.

Dember, William N. The Psychology of Perception, New York, Henry Holt and Co., 1960.

Earl, James H., Design Drafting, Menlo Park, California, Addison-Wesley Publishing Co., 1972.

Fergus, Ronald H., Perception, New York, McGraw-Hill Book Co., 1966.

Gibson, James J., The Perception of the Visual World, Boston, Houghton Mifflin Co., 1950.

Giesecke, Frederick E., and others, Technical Drawing, fifth ed., New York, The Macmillan Co., 1967.

Gregory, Richard L., Eye and Brain: The Psychology of Seeing, New York, McGraw-Hill Book Co., 1966.

Gronlund, Norman E., Measurement and Evaluation in Teaching, New York, The Macmillan Co., 1965.

Hochberg, Julian E., Perception, Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 1964.

Kagan, Jerome, and Ernest Havemann, Psychology: An Introduction, New York, Harcourt, Brace and World, Inc., 1968.

Segall, Marshall H., Donald T. Campbell, and Melville J. Herskovits, The Influence of Culture on Visual Perception, New York, Bobbs-Merrill Co., 1966.

Spencer, Henry C., Basic Technical Drawing, rev. ed., New York, The Macmillan Co., 1962.

Wright, Lawrence S., Drafting, Technical Communication, Bloomington, Illinois, McKnight and McKnight Publishing Co., 1968.

Articles

Frostig, Marianne, "Visual Perception, Integrative Functions and Academic Learning" *The Journal of Learning Disabilities*, V, (January, 1972), 1-15.

Hammill, Donald, "Training Visual Perception Processes," *The Journal of Learning Disabilities*, V, (November, 1972), 552-559.

Other Publications

Dailey, John T., *Examiner's Manual for the Dailey Vocational Test*, Boston, Houghton Mifflin Co., 1965.

Dailey, John T., *Spatial Visualization Test, The Dailey Vocational Test*, Boston, Houghton Mifflin Co., 1964.

Unpublished Materials

Babcock, James Gray, "An Experimental Study to Determine the Effects that Creative Problem-Solving Situations have upon Creative Thinking Ability and Visual Thinking Ability of Selected Students enrolled in College Descriptive Geometry Classes," unpublished doctoral dissertation, Industrial Education Department, Utah State University, Logan, Utah, 1970.

Kleinhans, John Lindley, "Perception of Spatial Orientation in Sloped, Slanted and Tilted Visual Fields," unpublished doctoral dissertation, Department of Psychology, Rutgers University, New Brunswick, New Jersey, 1970.

Palow, William Paul, "A Study of the Ability of Public School Students to Visualize Particular Perspectives of Selected Solid Figures," unpublished doctoral dissertation, College of Education, University of Florida, Gainsville, Florida, 1969.

Robinson, Lucile Thurston, "An Exploratory Study of the Utilization of Spatial Concepts by Children," unpublished doctoral dissertation, College of Education, Stanford University, Stanford, California, 1970.

Sedgwick, Lorry King, "An Attempt to Determine the Effect on Spatial Perception of Instruction in Descriptive Geometry," unpublished master's thesis, Industrial Education Department, Southern Illinois University, Carbondale, Illinois, 1961.