

THE EFFECTIVENESS OF WORKING DRAWINGS ON WOODWORKING
PROJECTS IN NINTH GRADE INDUSTRIAL ARTS

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by

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CHAPTER I

INTRODUCTION

The writer has held the opinion that if a student would make a working drawing of his project before he started work on that project he would achieve a better final product. The actual study had its beginning September, 1956, in the Helena Junior High School, with two ninth grade classes in industrial arts. One group made a working drawing of its projects, while the other group made the project without making a working drawing. Which group did a better job in making its projects? Did making a working drawing of a project before starting construction help a student in understanding how the finished project would look? Did it take less time in construction? Did he need less help while working on his project? These were some of the questions that led to the selection of the problem for this investigation.

Statement of Problem

The attempt to answer the question "do students do better when making working drawings before working on projects?" led to the selection of the title of this study "The Effectiveness of Working Drawings on Wood-working Projects in Ninth Grade Industrial Arts". This

paper is a report of two classes of ninth grade students selected because of their nearly equal ability in industrial arts. Will a student, who makes a working drawing of his project before he starts work on that project, do a better job on the project than the student who did not make a drawing?

Definition of Terms

In order to make the reading of this paper more understandable, some terms have been defined. The definition of the word project that has been given by Smith¹ states that "project refers to as an educational job--one involving reasoning plus habit formation, managerial plus operative ability and sustained interest because the work is largely projected by the pupil instead of the teacher." Drawings used for construction have been called working drawings, and most sources² agree that two or more views are necessary. Giesecke, Mitchell, and Spencer³ have said that "such drawings should describe the objects so completely that no

¹Smith, Homer J., Improving Instruction in Industrial Arts, p. 57.

²Giesecke, Mitchell, and Spencer, Technical Drawing, p. 498.

³Ibid., p. 498.

additional information will be needed by those who are to erect, construct, or manufacture the object represented." The three-view is the way the project looks from the front, the view above that, how the project looks from the top, and the view to the right, is the right side or end view of the project. Gallington, and Giachino¹ has defined the term industrial arts as "a phase of general education in which the primary purposes are to familiarize students with the tools, products, processes, and occupations of industry as well as the social and economic phenomena."

Projects that were proposed by the students were desirable for many reasons. One way in which they were desirable was that the original and creative aspect of industrial arts was in some measure developed if students were encouraged to work out their own projects. The making of the drawing before building the project may have served to some extent to foster this creative and design function of industrial arts. That this influence on creativeness occurs when students propose projects has been clearly brought out by Wilber² in his statement

¹Gallington, R., and Giachino, J., Course Construction in Industrial Arts and Vocational Education, p. 13.

²Wilber, Gordon O., Industrial Arts in General Education, p. 87.

"it has been suggested that whenever possible, students should be encouraged to choose and even design their own projects."

Sources of Data

The materials used in the writing of this paper have been obtained from a study of such published materials in elementary and secondary education as books, pamphlets, public documents, reports, magazine articles, and unpublished works. Notes were taken while observing the students and these notes and observations were included in this paper.

Need for the Study

The writer believes that boys twelve to fourteen years of age, or older, need to see a direct relationship between what they are doing and how it may be put into practical use. The boys are still somewhat concerned with doing those things which they believe will be of direct use or value to themselves. Working Drawing is no longer taught as a separate course. It is now integrated with the other activities and it is especially emphasized as a necessary part of the subject woodworking. Projects to be made in woodworking are first drawn

and then made by the students. One finds this trend indicated rather clearly and definitely in literature by the authors Gruhn and Douglass of the most recent textbook on the junior high school in their statement:

The time has come to have the student do more individual planning and to record this planning through the accepted practices of correct working drawing procedure. The subject areas should be fewer in number allowing more time for planning, construction, and related information.¹

Procedure

An overall picture was formulated for solving the problem by using two ninth grade junior high school classes equal in mechanical ability as determined by mechanical ability tests. The experimental method was the approach used in making this study to determine which group would do a better job in making its projects. One was arbitrarily selected as the group to make working drawings of their projects before starting to construct them. Both groups met every day, five days a week, one hour a day, for eighteen weeks. Occasionally this schedule was rearranged due to assemblies and other school

¹Gruhn, W., and Douglass, H., The Modern Junior High School, p. 107.

activities, but the amount of time spent in class was kept equal. Both classes were given the same lectures, demonstrations, movies, and other tools of learning. The finished projects were graded by the writer and this determined the result of the investigation.

It was necessary to determine that the groups were nearly equal in mechanical ability so that an effective investigation could be made of the effect of working drawings. The following chapter presents the plan used in equating the groups.

CHAPTER II

EQUATING GROUPS

Two classes were selected that were approximately the same size. Group one had 25 students and group two had 24 students. Two tests were given the first week of school. They were Bennett's Test of Mechanical Comprehension¹ and O'Rourke's Mechanical Aptitude Test.² Bennett's test contains 69 general mechanical ability questions with questions on gears, pullies, levers, physics, and general knowledge. O'Rourke's Mechanical Aptitude test has 160 questions of general nature in industrial arts about tools, use of tools, materials used in industrial arts, and tool identification. These two tests were selected because together they covered the general skills used in ninth grade industrial arts. The results of the test, as shown in Table 1, reveal that Group 1 had an average mechanical comprehension of 42.9 compared to 43.1 for Group 2. On mechanical aptitude, as shown in Table 2, Group 1 averaged 102 and Group 2 99.1. A few students in both classes dropped out and a few were added, but these students were not

¹Bennett, George K., Test of Mechanical Comprehension Form AA.

²O'Rourke, L. J., O'Rourke Mechanical Aptitude Test--Junior Grade, Form C.

TABLE 1. SCORE MADE ON BENNETT'S MECHANICAL COMPREHENSION TEST
BY PUPILS OF EXPERIMENTAL AND CONTROL GROUPS

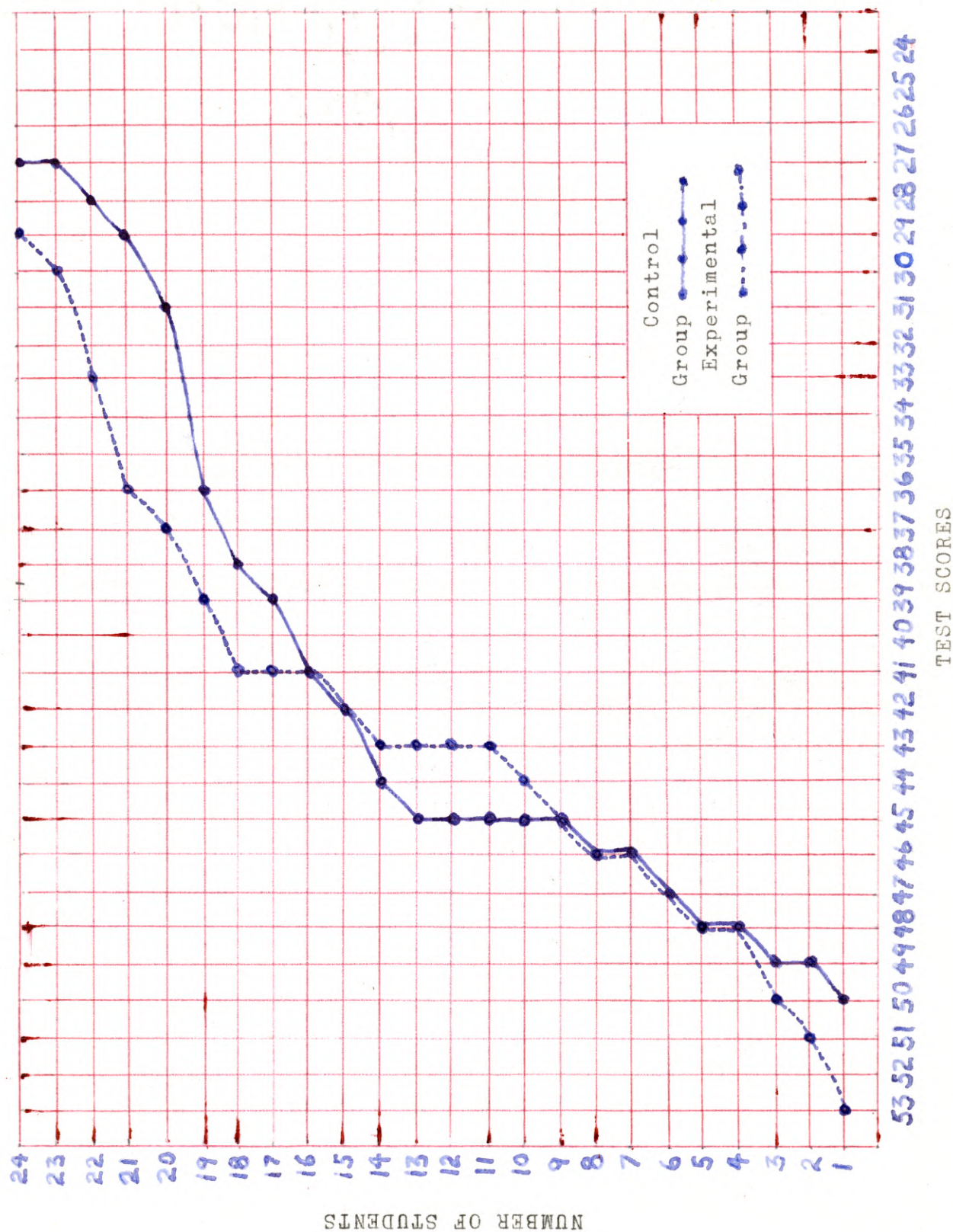
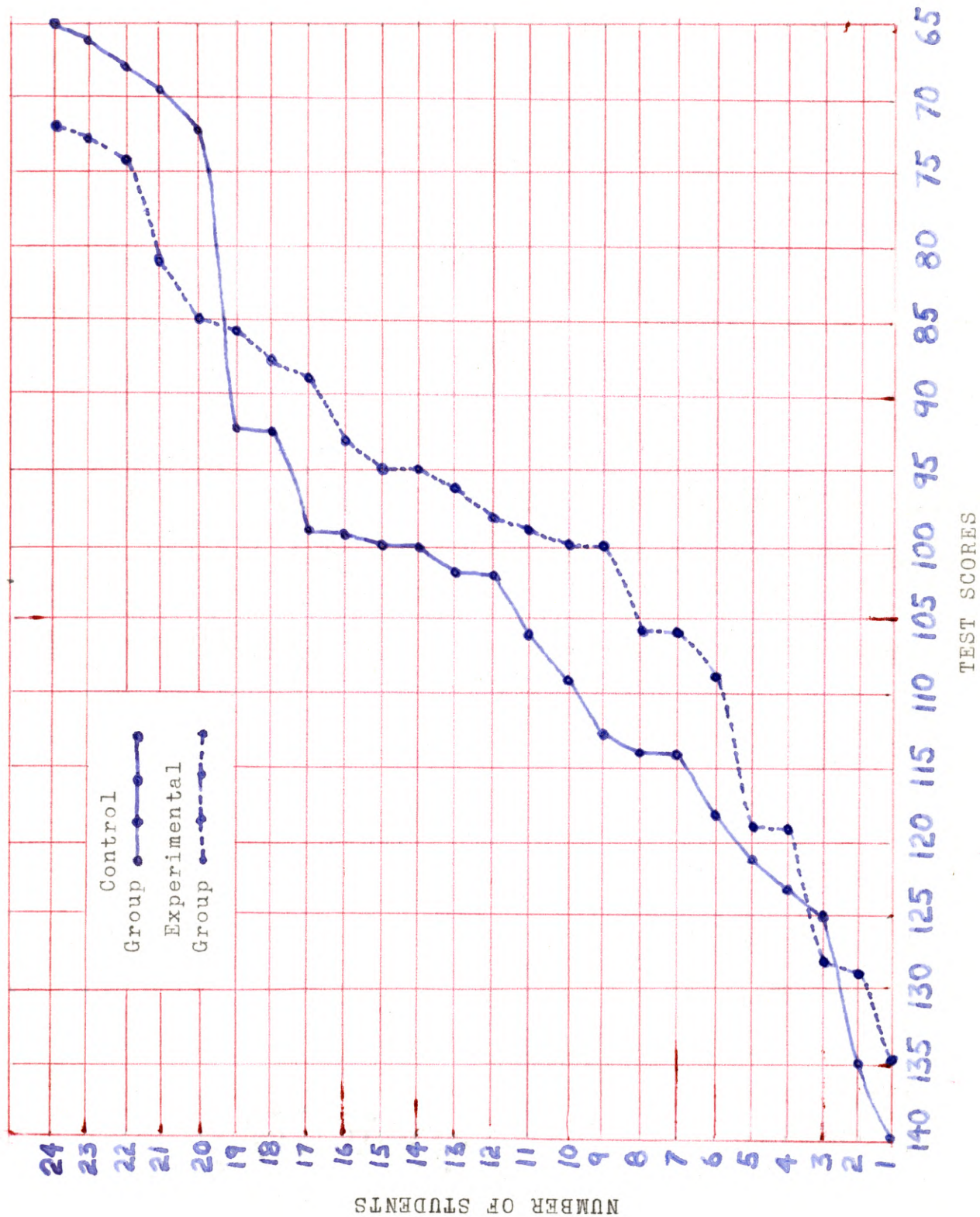


TABLE 2. SCORES MADE ON O'Rourke MECHANICAL APTITUDE TEST
BY PUPILS OF EXPERIMENTAL AND CONTROL GROUPS



included in the investigation. Three groups of ninth grade students were given the tests but one group was a homeroom class which was assigned one-half hour, three times a week extra time in shop. This group did various activities during this activity period including some work on their projects. Because of this extra work they were not included in this study. The students were never informed that they were taking part in an experimental study. The results of these mechanical ability tests were not used in the final evaluation of the investigation or in grading the students. They were used only for the purpose of showing that the students of the experimental and control groups were almost equal in mechanical ability.

The method of drawing used with the experimental group is presented in the following chapter.

CHAPTER III

METHOD OF WORKING DRAWING USED WITH EXPERIMENTAL GROUP

Drawing as a means of planning has been recognized by many leaders in industrial arts. This has been clearly brought out by Gruhn and Douglass in their statement:

Drawing is a universal language, and everyone should have a certain proficiency in interpreting of performing it. Industrial arts affords effective means for the development of reading knowledge and the ability and desire of self-expression, both freehand and with the use of instruments.¹

The draftsman, architect, and the student who draws his project are all planners. Wilber² has said concerning the importance of planning that "it is probably more important from an educational stand point, that a child be able to plan his project correctly than that he be able to carry it out skillfully." Certain fundamental skills and processes for doing the working drawing were stressed.

Fundamental Skills and Processes of Working Drawing

Giesecke, Mitchell, and Spencer³ pointed out the

¹Gruhn, W., and Douglas, H., op. cit., p. 102.

²Wilber, G., op. cit., p. 2.

³Giesecke, Mitchell, and Spencer, op. cit., pp. 28-52.

importance of correct methods and skills to be used in instrumental drawing when they said "the student should learn and practice correct manipulation of the drawing instruments to the end that correct habits may be formed and maintained." The following skills and processes are the general procedure used in drawing.

1. Fastening paper on the drawing board with T-Square
2. Using correct lines and symbols in making
 - a. object lines
 - b. hidden lines
 - c. dimension lines
 - d. extension lines
3. Dimension a drawing
4. Draw views with hidden edges
5. Make arrowheads correctly
6. Make numerals
7. Letter upper-case or capital letters
8. Make front, top, and or end views and know the relationship of these views.
9. Choose the necessary views of aⁿ object
10. Measure correctly with a ruler
11. Sharpen a drawing pencil
12. Use a pencil-compass
13. Lay out a title

14. Letter notes and specifications
15. Block out views
16. Make drawing to scale
17. Make drawings of projects for the shop

The proper steps in making a drawing of the project before its construction were made clear to the students.

Rapeer points out that:

As an integral part of the industrial arts work there should be problems in constructive drawing and design, and in industrial arithmetic and geometry. The industrial drawing and design should develop in direct relationship with the shop problems, and the mathematical problems should be those needed by the industrial worker in measurements and estimates, and in time and wages.¹

The essential drawing tools were available to the students for drawing their projects.

Tools for Working Drawing

The writer had found by experience that the following items of supplies and equipment were necessary for drawing projects and provided them as standard equipment for the group.

¹Rapeer, L., Teaching Elementary School Subjects, p. 297.

1. Wooden pencil for each student
2. Drawing board for each student
3. A protractor for each student ✓
4. Wood ruler for each student
5. T-square for each student
6. Triangles, 45 and 60-30, for each student

Drawing instruments were made available to the students but were not given to each student. Other educational materials which were used were audio-visual aids, models, drawings, charts, and text books.

The drawings that were made by the students were three-view drawings. An explanation of this type of drawing is given in the following section.

Three-View Drawing

Three-view drawings were drafted by the students because such drawings describe the project so completely that no additional information is required. To represent three views in orthographic projection drawing, it is necessary to turn the plan of projection of the front view into the plane of the paper. The horizontal plane of the top view is then revolved into the plane of the paper about the hinge line, and the vertical plane of the side view is revolved into the plane of the paper about

the hinge line. For all regular three-view drawings the top view is vertically above the front view and the side view is horizontally opposite the front view. The three-view drawing was used by students making working drawings of their projects.

Working drawings, like maps, are drawn to scale and a scale is shown on the drawing by which all measurements can be accurately checked. The working drawing shows all of the dimensions as well as the details of construction of the project. By studying it, the student can determine in advance what the thickness, width, and length of each part of the project should be. Also, he can decide upon a method of approach for making the project. The method used in the selection of projects and the method of instruction are presented in the following chapter.

CHAPTER IV

SELECTION OF PROJECTS AND GENERAL METHOD OF INSTRUCTION

It is very important that a student spend considerable time in choosing a good project. There are many things to consider. Among them are the students' needs, size of the project that the student is able to make, kind and cost of the wood used, finish, and the design.

Selection of Projects

Projects that were not too complicated were selected. Shea and Wenger¹ advised this when they said "it is always advisable to start on a simple type of project, something that does not involve the more complicated woodworking processes." Each student made a list of three projects that he would like to make. Projects were selected from these lists to make up the following list from which each student could choose one to construct. The group that made the working drawing, before making the project, and the group that made the project without the working drawing made their selection from this list:

1. Ship's ladder wall shelf

¹Shea, J. G., and Wenger, P. N., Woodworking for Everybody, p. 44.

2. Bookcase
3. Gun rack
4. Gun cabinet
5. Foot stool
6. Magazine holder
7. Nut bowl
8. Wall shelf
9. Shine box
10. Modern bookcase
11. Lamp
12. Flower holder
13. Book shelves
14. Turned wall shelf
15. Book ends

All students were given a choice of these projects in order to give them personal interest in their projects. It was felt that having a choice of projects would create more interest than having all students make the same project. Wilber¹ pointed out the value of having students select when he said "it has been suggested that whenever possible, students should be encouraged to choose and even design their own projects." All students were given

¹Wilber, op. cit., p. 87.

demonstrations on the use of various tools and equipment that were available to them in the shop.

General Method of Instruction

Both groups were given the same demonstrations as they started their own projects. The measuring - marking - squaring family of tools was demonstrated first. It consisted of tri-square, combination square, framing square, rules, marking gauge, bevel gauge, and compass and dividers.

All students were shown how to layout the various parts of their project on a piece of stock, so as not to waste lumber, and to estimate about how much the project would cost when finished. The value of layout planning has been clearly brought out by Feirer¹ in his statement "before you begin to work with your tools, it is wise to plan carefully the steps you will follow in making the project. This procedure is just good sense and protects you from making unnecessary mistakes." The idea in planning a project is to think exactly what materials are needed, what tools and equipment are necessary,

¹Feirer, John L., Industrial Arts Woodworking, p. 27.

what steps will be followed, and in what order they will be done to complete the project in the best way possible.

The "saw family" was demonstrated next. The parts of the family stressed the backsaw, miter saw, coping saw, compass saw, hand crosscut saw, and hand rip saw. Tests were given periodically on the proper use and safety of tools and on shop practices.

The "plane family", which included jack plane, jointer plane, and block plane, was demonstrated next. The six steps for squaring a board were demonstrated and students practiced these.

The "boring family", which included a brace, hand drill, auger bit, expansive bit, countersink bit, and an automatic push drill, was demonstrated.

The "pressure family", which included the wood hand screw, "C" clamps, and bar clamps, was presented. Shea and Wenger¹ have pointed out the importance of this family in their statement "when making articles out of wood, it is often necessary to press and hold together the different parts for a certain length of time." The gluing together of a project called for the using of clamps to hold the parts together while the glue was drying.

¹Shea and Wenger, op. cit., p. 68.

Likewise, it was often desirable to hold a board in a special manner while the work was being done. For all of these purposes, clamps were very necessary in the shop.

The "file family" was next demonstrated and was then followed by "jointing family". The common dictionary definition of the word "join" is set forth as "to set or bring together; connect; combine."¹ An article made of wood can be no stronger than the joints which hold it together. It is necessary, therefore, to secure all wood joints in the strongest possible manner. A person cannot merely put wood together and expect it to stay together. There are many different types of joints, each adapted to certain specific needs. Frequently nails are used to make joints, and sometimes screws. Other types of work call for glue, hinges, dowels, mortises, and tenons. Frequently a combination of several joints is necessary. After jointing, the projects were then prepared for finishing.

Finishing Projects

Wood finishing is a broad subject in itself and

¹College Standard Dictionary, Funk and Wagnalls Company, p. 624.

one which requires special treatment. A project can be ruined by applying the wrong finish or by putting on the right finish carelessly. This has been clearly brought out by Feirer¹ in his statement "a good start deserves a good "finish"! If you apply a good finish, your work will carry the mark of the fine craftsman." Finishing supplies consist of turpentine, linseed oil, alcohol, benzine, waxes, steel wool, pumice, rottenstone, rubbing oil, sandpapers, oil stain, water stain, wood filler, and shellac.

In the next chapter the method of evaluating projects will be given.

¹Feirer, op. cit., p. 174.

CHAPTER V

PROJECT EVALUATION

An important part of this investigation was the evaluation of the project work of the students in order to establish which group did better work. The evaluation began at the start of the project. Frequent course marks were given until the projects were finished. Three distinct parts of the evaluation scheme were Daily Achievement Measurement, Self-evaluation, and Rating Scale.

Daily Achievement Measurement

The points used in evaluating the projects were those given by Micheels and Karnes¹ as follows:

1. Consumed an unjustifiable amount of time in the completion of the project.
2. Asked for and obtained more assistance from the instructor and from his fellow students than any other member of the group.
3. Wasted an undue amount of materials.
4. Performed inaccurate and faulty work which

¹Micheels, W., and Karnes, M., Measuring Educational Achievement, p. 399.

was concealed when the project was assembled.

5. Abused tools and equipment; failed to use them properly.
6. Persistently violated safety rules.
7. Failed to follow the general procedure as initially planned.
8. Showed no evidence of having developed an appreciation of good design and skilled workmanship.
9. Failed to learn the related information about tools, materials, and processes which was assigned as a part of his project.

As a second factor in evaluation, the students were asked to evaluate their own projects. The method of self-evaluation is given in the next section.

Self-evaluation of Projects

The idea of student rating was taken into consideration through self-evaluation by the student of his project. The importance of self-evaluation has been pointed out by Gruhn and Douglass¹ in their statement that " every pupil should be encouraged to evaluate his own progress

¹Gruhn and Douglass, op. cit., p. 319.

toward the objectives of every learning activity, every subject, and the school program as a whole." When the student brought his finished project to be evaluated, he was asked what he would do differently if he had to do it over, how he could improve the project, and what mark he thought he deserved. It was thought that by asking these questions the student would be stimulated toward recognizing his mistakes and that he could suggest ways in which the mistakes might have been avoided. Self-evaluation by the student is valuable because it contributes to more effective learning. An indispensable aid in the scheme for evaluating the projects was the rating scale.

Rating Scale for Projects

A rating scale was used to evaluate the projects to increase the objectivity of the writer's observations and to provide an accurate, detailed record of the results of these observations. The rating scale that seemed best suited to ninth grade classes, and which was used, was the comprehensive scale suggested by Micheels and Karnes¹:

¹Micheels and Karnes, op. cit., pp. 408-410.

I. Planning Stage: (Total Points____)

1. Did he obtain the basic information about tools, materials, and processes essential to intelligent planning?
0 1 2 3 4
2. To what extent did he prepare his own plan of procedure?
0 1 2 3 4
3. To what extent was his plan orderly and logical?
0 1 2 3 4
4. Did he plan in such a manner as to conserve time and materials?
0 1 2 3 4
5. Was his bill of materials adequate in terms of his plan?
0 1 2 3 4
6. To what extent did he take into consideration the time, materials, equipment, and tools available?
0 1 2 3 4

II. Execution Stage: (Total Points____)

1. To what extent did he follow the detailed steps of his plan?
0 1 2 3 4
2. To what extent did he avoid having to do work over because of failure to follow his plan?
0 1 2 3 4
3. To what extent did he refrain from spoiling materials by working accurately and carefully?
0 1 2 3 4
4. To what extent did he follow approved procedures in performing specific operations?
0 1 2 3 4
5. To what extent did he exhibit skill in the use of layout and measuring tools?
0 1 2 3 4
6. To what extent did he show improvement in the use of tools?
0 1 2 3 4
7. Did he select the proper tool for each operation?
0 1 2 3 4

8. Did he use all tools properly?
0 1 2 3 4
9. To what extent did he exhibit initiative in revising his plan as required by changing conditions?
0 1 2 3 4
10. Did he practice difficult operations to minimize material spoilage and poor workmanship?
0 1 2 3 4
11. To what extent did he keep profitably employed? Busy?
0 1 2 3 4
12. To what extent did he maintain a fair balance between quality of work performed and time consumed?
0 1 2 3 4
13. To what extent was he able to do his own work without assistance from instructor or other students?
0 1 2 3 4

III. Completed Project: (Total Points_____)

1. To what extent is finished product an embodiment of original plan?
0 1 2 3 4
2. Does the general appearance of the project reflect neat, orderly work?
0 1 2 3 4
3. Are the dimensions of the actual project the same as those on the drawing, within reasonable tolerances?
0 1 2 3 4
4. How do angular measurements check with those specified?
0 1 2 3 4
5. Of what quality is the finish?
0 1 2 3 4
6. To what extent were materials used to best advantage?
0 1 2 3 4
7. Do all joints fit properly?
0 1 2 3 4
8. Are all margins uniform, curved and irregular lined properly executed, etc?
0 1 2 3 4

Each completed project was inspected carefully in every detail. In addition to the Micheels and Karnes rating scale, the list of factors and specific points given earlier in this chapter were considered in grading the particular project. Measuring instruments, such as rules, squares, and straightedges were used to determine the accuracy of the work. These evaluations appear in the following section.

Project Achievement Results of the Two Groups

A comparison of the projects of the two groups showed that the group that drew the projects before constructing them did better work. Table 3 shows the types of projects that were made and the marks that were given. The projects of individuals of the experimental group were not compared with those of individuals of the control group because in equating the groups individuals were not matched. Only group comparisons were made to assure that the range of mechanical ability was about the same for the two groups. Likewise, in evaluating achievement by project marks only group comparisons were made.

TABLE 3. DISTRIBUTION OF PROJECT MARKS OF EXPERIMENTAL AND CONTROL GROUPS*

Name of Project	Control Group					Experimental Group				
	A	B	C	D	AV.**	A	B	C	D	AV.**
Ship's ladder wall shelf		1	1	1	2.0	1	1			3.5
Bookcase			1		2.0			2		2.0
Gun rack			3	1	1.7		2	3		2.4
Gun cabinet		1			3.0	1				4.0
Foot stool		1			3.0		1	2		2.3
Magazine holder		1			3.0		2			3.0
Nut bowl			1	1	1.5			2		2.0
Wall shelf			1		2.0		1		1	2.0
Shine box				1	1.0					
Modern bookcase	1		1		3.0	2	1			3.7
Lamp		1	1		2.5		1			3.0
Flower holder										
Book shelves	1	2			3.3			1		2.0
Turned wall shelf										
Book ends			2		2.0				1	1.0
Total					2.3					2.6

*Project marks of 24 students in control group and 25 students in experimental group.

**Average computed from scale A-4, B-3, C-2, D-1.

The writer believes that there was no relation between types of projects made and marks received by the individual student. The student was marked on his workmanship and probably would have received the same mark on any project that he made.

A comparison of both groups on the rating scale results shows that the group that drew its projects was rated higher on most minor points.¹ There was very little difference between the two groups in some points such as the quality of finish on the projects, the extent of improvement shown in the use of tools, abuse of tools and equipment, and violation of safety rules. The three major divisions of the rating scale are planning, execution, and completion scale. The greatest difference in total points between the two groups was in the execution stage. Table 4 shows the total average points for both groups on the rating scale for each of the major divisions.

A summary of the findings of this investigation are given in Chapter VI.

¹Rating scale points are to be found in Chapter V, p. 24. Only major divisions of the scale are reported in Table 4.

TABLE 4. EXPERIMENTAL AND CONTROL GROUPS TOTAL POINTS
ON RATING SCALE

Stage	Total Possible Points	Average Points	
		Control Group	Experimental Group
Planning	24	14	18
Execution	52	30	36
Completed Project	32	18	22
Total	108	62	76

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This experimental study was conducted with two classes of about the same size and with tested mechanical ability about the same for both groups. One group made working drawings of the projects before starting actual construction, while the other group constructed the woodworking projects without making working drawings. Both groups met every day, five days a week, one hour a day, for eighteen weeks and were given identical lesson demonstrations, visual aids, and tests. A list made of fifteen projects was selected by the students. Each student chose one of these for his project. Every project had fundamental skills and was not too hard or too expensive, so that the student would have an interest in his project, and at the same time it would be practical and useful to the student. The simplicity of the project that the student made was taken into consideration because, as Feirer¹ has pointed out, "there is a tendency for beginners to want to make something too big, too

¹Feirer, op. cit., p. 13.

complicated, or too difficult." Notes¹ were taken on each student's project and were used in evaluating the results and in comparing the two groups. In addition to the observation and evaluation of his behavior, the construction results of the student's efforts, final design, the plan formulated, and the finished project were checked and evaluated.

Conclusions

The following conclusions have been based on the notes taken, the rating scale, and final marks on the projects. This information showed that a student who first made a working drawing of his project helped the student avoid costly mistakes. He made his mistakes on paper, and then corrected his mistakes before working on his woodworking project. This helped save material and time for the student. When the student was drawing his project he had more interest in his work than if he had been drawing a problem in mechanical drawing.

Every completed project was inspected carefully in every detail. A rating scale for each project was used and a list of factors and specific points were considered in marking that particular project. The group

¹Notes were taken from points listed by Micheels and Karnes in Chapter V, pp. 22-23.

of students that drew their projects first did a better job, as a group, on their projects according to the rating scale. The errors on dimension were less, and the construction was better as shown by marks. The students of the experimental group also showed a more comprehensive knowledge of assembling the projects.

The group that drew its projects needed less help and asked fewer questions about the project while constructing it. Wilber¹ points out how working drawings help a student by the statement "the making of a working drawing or sketch gives the student an opportunity to think through the problem of construction. He must decide just how much material to allow for each piece, and how it is to go together."

The group of students that drew its projects took from five to seven hour periods to complete the working drawings. The two groups completed their projects at approximately the same time. Therefore, the actual construction time for the group that drew its projects was much less than for the other group.

In summarizing, there is definite evidence that students who made working drawings of their projects before starting construction made fewer mistakes, needed

¹Wilber, op. cit., p. 173.

less help, and did better work on their projects. The conclusions reached in this study led to the following recommendations.

Recommendations

The study has brought out that the integration of drawing in the woodworking class is beneficial. The drawing of the project seemed to the writer to give the student a more personal interest in his work than if he had to draw a separate problem in mechanical drawing. It helped him in understanding how the project would look after it was constructed. Smith¹ has stated that working drawings "help to develop in each pupil an understanding of drawings and the ability to express ideas by means of drawing." When the student's interest has been developed in his project through drawing the project, it means more to him. Struck has brought this out in his statement:

A project then becomes more than a doing job; it becomes an educational job--one involving reasoning plus habit formation, managerial plus operative ability and sustained interest because the work is largely projected by the pupil instead of the teacher.²

¹Smith, op. cit., p. 57.

²Struck, Theodore F., Methods and Teaching Problems in Industrial Education, p. 51.

The working drawing, as well as the construction of the project, is an important part of the individual student's learning process. Students should not just "make something" for the project is not an end but rather a means of developing certain desirable habits, skills attitudes, and appreciation. Micheels and Karnes have given support to this idea by their statement:

The project should be considered as a means to an end. It is a means employed by the teacher to develop certain desirable habits, skills, knowledges, and appreciations. The project serves as a vehicle of instruction. It becomes a problem which tends to aid students in organizing and integrating their experiences as they direct their efforts toward its solution. As contrasted with the exercise, the project, when carefully selected and planned, can be effectively employed to develop and sustain a high degree of interest.¹

¹Micheels and Karnes, op. cit., p. 398.

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