A COMPARATIVE STUDY OF THE RESULTS OF TEACHING HIGH SCHOOL CHEMISTRY BY THE LECTURE AND BY THE GROUP-DISCUSSION METHOD

by SOC

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Science education, with the dawn of the Sputnik and new emphasis upon science, is changing in content, outlook, scope, and method. There is a scarcity of research on using the group-discussion method in teaching high school chemistry. This study, which took place at Lourdes High School, an all girls school in Chicago, Illinois, was an attempt to compare the effects of teaching chemistry by the group-discussion method and the lecture method to eleventh grade students.

I. THE PROBLEM

Statement of the problem. This study was designed to compare the scholastic achievement and critical thinking ability of two eleventh grade chemistry classes, one taught by the lecture method, the other by the group-discussion method. An attempt was made to determine the relative efficiency in achieving goals by the use of these two methods.

The null hypotheses tested were: 1.) There will be no significant difference in the scholastic achievement between students taught by the lecture method and those taught by the group-discussion method. 2.) There will be no significant difference in the critical thinking ability between students taught by the lecture method and those taught by the group-discussion method.

Importance of the Study. The objective of the present research is to test the effectiveness of small student discussion groups in secondary school chemistry with students of varying ability. The hypothesis underlying this approach is that one learns by teaching.

The rationale underlying the group-discussion method can best be described by analyzing the teaching process in relation to known principles of effective learning; or, in other words by viewing teaching as a learning experience.

In teaching one learns about his subject because he is faced with the responsibility of teaching it. Many investigators believe that getting the student to accept this type of responsibility for his own learning is the key variable in any effort to increase educational achievement (Patton, 1955; Gruber, 1965).

It was expected that participation in student-led discussion groups would increase student interest and responsibility, force active participation, require the organization and verbalization of learned material, and shift the emphasis in learning from memory and recall to understanding and application.

Much of this type of experimentation in student-led discussion groups has been done with college students. It is the purpose of this research to see if such a method will be effective in high school chemistry classes.

II. DEFINITIONS OF TERMS USED

The following is a clarification of the terms used in this study:

The Control group was comprised of the students taught by the lecture method.

The Lecture method refers to a teacher-centered situation in which the instructor gives an oral presentation of facts, concepts, or principles. Students taught by this method were required to keep personal notebooks,

memorize facts, learn definitions, read the textbook, and work out any chemical calculations or classwork assignments as individuals with little oral participation in the class.

The experimental group consisted of the students taught by the group-discussion method.

The group-discussion method is defined as that method wherein there is a free and unhampered consideration of a problem or problems by a cooperative group of persons talking together under the direction of one of its members.[1] It is mainly a pupil-centered situation in which the instructor serves as a guide. Four or five students composed a group which was selected to study and present to the class an area of chemistry designated by the teacher. The group presentation was then followed by a period of group-to-class questions, answers, and discussion. Membership of the groups was changed at the beginning of each new unit by simple rotation so that over a period of time each student might have an opportunity to work with every member of the class.

III. DELIMITATIONS OF THE STUDY

This report includes the information obtained from two classes in first year chemistry for the school year 1968-1969. The 52 students who were included in this experiment were randomly selected from one hundred and ten students who had registered for the course. These 52 girls were then randomly assigned to either the control or the experimental group. The experimental group met during the sixth period while the control group met during the eighth period daily for forty minutes.

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[1] John W. Keltner, Group Discussion Processes (New York: Longmans, Green and Company, Inc., 1957), p. 10.

CHAPTER II

REVIEW OF THE LITERATURE

Since 1920 many experimental studies and investigations have been carried out on the use of the group-discussion method of teaching in comparison to the lecture method. The basic question is whether more effective learning occurs when students work individually (though usually within the group setting of the classroom) or when two or more work together as a group on some learning task. The notion that the individual achieves different results when working in a group situation than when working individually seems to have been generally accepted at least since the experimental work of Allport[1] in the 1920's. Interest developed early in comparing group and individual performances in terms of some measure of "goodness" or "efficiency."

A review of a number of studies on group and individual work by Lorge et al.[2] points to two questions that must be resolved: 1) What about the group or the individual should be compared? For example, should one use the average group score with the average individual scores, or the best scores at each level, or some kind of summated or aggregated measure?

2) What effect does the type of problem have upon the comparison? Lorge mentioned tasks of memorization, judgment, and problem-solving, and

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[1] Floyd Allport, "The Influence of the Group Upon Association and Thought," Journal of Experiemntal Psychology, 3:162, 1920.

[2] Irwing Lorge, et al., "A Survey of Studies Contrasting the Quality of Group Performance and Individual Performance," Psychological Bulletin, 55:337-372, November, 1958.

also pointed out that each type of task could be of varying length, abstractness, or difficulty.

A pioneer in this area was Shaw,[3] who experimented with the multi-stage type of problem, requiring correct solution of each stage in order to reach the final correct answer. He found relatively more correct final answers in the group than in the individual situations and concluded that the value of the group lay in its tendency to reject extreme answers of individual members and to catch errors in reasoning at relatively early stages of the entire process.

The quality of group and individual products is examined in an early study by Allport[4] dealing with college students' responses to sets of stimulus words. He concluded that more ideas are produced in the group situation, that the group acts as a kind of stimulus activating the flow of thought, but that among the ideas so produced, those of superior quality are of relatively greater frequency in the solitary than in the group work. The more intense logical thinking of solitude gives way in the group to extensity of treatment.

Although the above study, as well as others to follow, deal with college students rather than high school students, the author feels that the two are comparable as far as their reaction to teaching methods is concerned. This belief is held by several educators who, in recent years,

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[3] M. E. Shaw, "A Comparison of Individuals and Small Groups in the Rational Solution of Complex Problems," American Journal of Psychology, 54:491-504, 1932.

[4] Allport, op. cit., p. 173.

are encouraging the participation of high school students in college classes. One very classical example of this comes from an article in the Minnesota Journal of Education, November, 1965,[5] which reported on the Hamline University Class Plan. This plan was a three year experiment, 1960-63, in college classes for high school students. The experiment has shown that many high school students are ready for college-level work at college standards in a college classroom with college students as colleagues. Because the students employed in this study were above average intelligence in the science field, the author felt that what applied to college classes could also apply to these particular chemistry classes.

McKeachie[6] states that although there have been many studies of the lecture as compared to the group-discussion method, few have used independent measures of outcomes in the different cases. The results of the experimentations are generally in line with one another but certainly are not conclusive. For example, using tests of information, several experimenters have found no significant differences or slight differences in favor of the lecture. In one of the earliest comparisons of lecture and group-discussion, however, Bane[7] found little difference between the two methods on measures of immediate recall but a significant superiority for discussion on a measure of delayed recall.

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[5] Olaf A. Reinquist, "High School Students Attend College Classes," Minnesota Journal of Education, 46:15-18, November, 1965.

[6] William J. McKeachie, "Procedures and Techniques of Teaching: A Survey of Experimental Studies." In N. Stanford (ed.) The American College, (New York: Wiley & Sons, Inc., 1962), p. 321.

[7] C.L. Bane, "The Lecture vs. The Class-Discussion Method of College Teaching," School and Society, 21:300, 1925.

More information about the relative effectiveness of group methods of instruction comes from other sources. Evans[8] cites the works of Rasmussen and Haigh and Schmidt who compared what they called "teacher-centered" classes with others described by the first as "group-centered" and by the second as "student-centered." No significant differences were found between the amounts learned by group and other methods, but Rasmussen[9] found that those who had pursued the "student-centered" course had found it more interesting, believed they had learned more and that it would be of more practical use to them.

In a review of research relative to lecture and discussion methods of teaching by Stovall,[10] it was found that the most common standard for judging the relative effectiveness of the lecture and discussion in experimental teaching situations has been the acquisition of information. When the criterion was the ability to recall information at the close of the experimental period, the lecture and discussion were found approximately equal in effectiveness by most experimenters, although some found the lecture method to be more favorable.

Stovall reports that: 1) When the stimulation of critical thinking was used as the criterion, the group-discussion method was found to be more

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[8] K.M. Evans, "Group Methods," Educational Research, 9:48, November, 1966.

[9] G.R. Rasmussen, "An Evaluation of a Student-centered and Instructor-centered Method of Conducting a Graduate Course in Education," Journal of Educational Psychology, 47:449-61, 1956.

[10] Thomas F. Stovall, "Lecture Versus Discussion," Phi Delta Kappan, 30:255, March, 1958.

effective than the lecture method. 2) When aiding the student to attain a deeper understanding of subject matter which was reflected in the ability to make actual application of newly acquired knowledge, to interpret, and to draw inferences was the criterion, the group-discussion was found to be the more effective. 3) Group-discussion was found to have a greater effect on attitudes and also was more conducive to development of desirable inter-personal relationships in the classroom. 4) There was no reason to eliminate the lecture method from the instructional program because much depends upon the host of other factors found to be present in the teaching-learning situation.

Another interesting study was carried on by Bloom[11] at the University of Chicago where he taught both by the lecture method and the group-discussion method. From this study he concluded the following: 1) The clearest difference between the two methods was the number of persons who had an opportunity to talk. In the discussion classes almost everybody spoke while in the lecture classes only the instructor spoke. 2) The most obvious consequence was the lack of opportunity for students to speak in the lecture classes reduced them to little more than a background with all attention focused on the lecturer. In contrast, the discussion was relatively a chaotic affair, each student who spoke was recognized--not only for his contribution to the group discussion but also his manner, dress, and personal characteristics were noticed. 3) If the objective of the class was the development of

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[11] B.S. Bloom, "Thought-Processes in Lectures and Discussions," Journal of General Education, 7:160-169, April, 1953.

knowledge about a particular topic, the lecture was more effective. 4) If the objective of the class was the development of skills and abilities which were of a problem-solving nature, the group-discussion method was superior to the lecture method. Because the major objectives of our chemistry course are the development of skills and abilities which are of a problem-solving nature, it appears that learning would be more effective by the group-discussion method.

Two methods of instruction in high school biology were investigated by Taylor.[12] Again, the two methods studied were the lecture method and the small group-discussion method. Three classes of biology were involved in the study. One class was taught by individual study, lecture, and class-discussion. The other two classes were taught by the small group-discussion method. Results showed that students taught by the group-discussion method achieved more in the unit under study than did those taught by the lecture method, although the test taken at the end of the entire study showed equal gains by all three groups.

Jeep and Hollis[13] opined that group discussion is especially conducive to good learning. As a method of teaching it helps individuals grow toward independence and self-security while at the same time learning that in a society one member depends upon another.

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[12]Harold O. Taylor, "A Comparison of the Effectiveness of a Lecture Method and a Small Group Discussion Method of Teaching High School Biology," Science Education, 43:442-446, December, 1959.

[13]H.A. Jeep and J. W. Hollis, "Group Dynamics in Action," The Clearing House, 41:209, December, 1966.

Many educators (Beach, 1966; Bloom, 1953, Flanders, 1965) feel that group discussion enables students to release their feelings and aggressions and thus increase their chances for individual and social adjustment.

In the group discussion method the student actually becomes a teacher. In teaching one learns about his subject because he is faced with the responsibility of teaching it. Many investigators believe that getting the student to accept this type of responsibility for his own learning is the key variable in any effort to increase educational achievement (Patton[14] and Gruber[15]). In a review of studies on teaching, McKeachie[16] summarizes this belief: "It may be the more we teach the less our students learn!"

Carpenter[17] observed from his experience with the Pyramid Plan at Penn State that any serious efforts to improve student achievement must of necessity deal with the problem of improving relevant student motivations. When students are faced with the task of explaining their own position to another, as in the case of teaching, motivation should be enhanced. An

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[14] J.A. Patton, A Study of the Effects of Student Acceptance of Responsibility and Motivation on Course Behavior. Unpublished doctoral dissertation, University of Michigan, 1955.

[15] H.E. Gruber, "The Future of Self-Directed Study." In Hatch, W.R. (Ed.), Approach to Independent Study. New Dimensions in Higher Education, U.S. Department of Health, Education, and Welfare, 13:1-10, 1965.

[16] W.J. McKeachie, op. cit., p. 312-365.

[17] C.R. Carpenter, "What are the Most Effective Methods of Improving Instruction, with Special Reference to Work Programs?" In G.K. Smith (Ed.), Current Issues in Higher Education. (Washington: Association for Higher Education, 1959), p. 187-196.

additional motivational source in the discussion method pointed out by Craig[18] is the uncertainty in not having the answers neatly packaged by the teacher.

In the group discussion process one is an active learner. Krumboltz and Weisman[19] found that active responding (written responses) to programmed instruction produced better retention after a two week interval, while Ripple[20] concluded that active involvement contributed to increased learning of programmed materials, but reinforcement alone did not. Bloom[21] in his study on thought processes during lectures and discussions, showed more active thinking was stimulated by discussion than lecture. In a study on opinion change, Watts[22] found that active participation (writing an argument) resulted in superior recall and greater personal involvement than did passive participation (reading an argument).

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[18] R.C. Craig. "Discovery, Task Completion, and the Assignment as Factors in Motivation," American Educational Research Journal, 2:217-22, 1965.

[19] J. Krumboltz, & R. Weisman. "The Effect of Overt Versus Covert Responding to Programmed Instruction on Immediate and Delayed Retention." Journal of Educational Psychology, 53:89-92, 1962.

[20] R.E. Ripple. "Comparison of the Effectiveness of a Programmed Text with Three Other Methods of Presentation." Psychological Reports, 12:227-237, 1963.

[21] B. S. Bloom, op. cit., p. 160-169.

[22] William A. Watts. "Relative Persistence of Opinion Change Induced by Active Compared to Passive Participation." Journal of Personality and Social Psychology, 5:4-15, 1967.

Teaching also involves the practice and verbalization of learned materials. In discussions students have the opportunity to practice and to verbalize the concepts they have learned. Especially if students are to achieve application, critical thinking or other higher cognitive outcomes, it is reasonable to assume they should have an opportunity to practice them (McKeachie[23]).

In brief, student discussion groups attempt to make use of some important principles of learning: increased student responsibility, motivation, active learning, practice, and verbalization.

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[23]W.J. McKeachie. Research in Teaching: The Gap Between Theory and Practice. Paper read at American Council on Education, 1966, New Orleans.

CHAPTER III

PROCEDURES IN THE COLLECTION AND TREATMENT OF DATA

I. SELECTION OF GROUPS

The fifty-two subjects of this study were randomly selected from the 110 students enrolled in 11th grade chemistry at Lourdes High School during the 1968-69 school year. Chemistry is an elective course for those students who had received an 85 percent or above average in 10th grade biology. These subjects were randomly assigned to experimental and control groups. The experimental group met during the sixth period and was taught by the group-discussion method whereas the lecture method was used with the control group which met during the eighth period.

All the chemistry classes met for thirty-six weeks, Monday through Friday, for a forty minute period with a double period twice a week for laboratory.

II. TEACHING PROCEDURE

An illustration of the plan that was used is outlined below.

EXPERIMENTAL GROUP	CONTROL GROUP
Monday	Monday
Review previous test. Group discussion. Group questions. Discussion on new materials.	Review previous test. Lecture by teacher on new materials.
Tuesday (Double period)	Tuesday
Lab experiment in groups of two in laboratory on new materials	Continue lecture on new materials. Individual problem solving.

Wednesday	Wednesday (Double period)
Continue group discussion. Problem solving in groups. Pupil-to-pupil question and answer.	Lab experiment in groups of two in laboratory on new materials.
Thursday (Double period)	Thursday
Lab experiment in groups of two. Discussion of lab results. Review of materials by pupil-pupil questions.	Lecture and review by teacher-pupil question and answer period.
Friday	Friday (Double period)
Test on materials taught during this week.	Lab experiment. Test on materials taught during this week.

Approximately one chapter in chemistry was completed in one week. This time limit was not strictly adhered to, because certain areas of study were more difficult than others. However, each class was allotted the same time for study in the same areas of learning.

The experimental group was taught in the following manner: A concept in chemistry was selected by the teacher. One of the groups was selected to prepare an oral presentation on the particular topic. The topic was then broken down into an equal number of sub-divisions or areas, with each member of the group assuming the responsibility for presenting an area. After a period of time allotted for preparation and study, the various areas were presented orally to the class. Each member of the experimental group read the content being studied as preparation for the question and answer interaction between the group and the class. It was the teacher's duty to clarify and elaborate the more difficult material. Such clarification

may be instigated either by the teacher or by a student request. When one topic was completed, another group was selected and the process was repeated for the study of the next topic. When an entire unit was taught, a test was given and new groupings were made. This cycle was repeated throughout the entire year.

III. SELECTION OF TESTS AND TREATMENT OF DATA

As a measurement of scholastic achievement, the Anderson-Fisk Chemistry Achievement Test, Form E,[1] published by the Harcourt, Brace, and World Company, was administered at the beginning of the school year and again at its termination in June. This test measures the extent to which important educational objectives have been attained by students in typical high school chemistry courses. Three major cognitive categories--knowledge, comprehension, and application--were considered by the author to be broad enough in scope to encompass the important measurable objectives commonly found in high school chemistry. A summary of basic content distributions in Form E of the test follows:[2]

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[1] Kenneth Anderson and F. Fisk, Anderson-Fisk Chemistry Achievement Test (New York: Harcourt, Brace & World, Inc., 1966).

[2] Kenneth Anderson and F. Fisk, Anderson-Fisk Chemistry Achievement Test, Manual of Directions (New York: Harcourt, Brace & World Inc., 1966), p. 5.

TABLE I

SUMMARY OF BASIC CONTENT DISTRIBUTION IN FORM E
OF THE ANDERSON--FISK CHEMISTRY ACHIEVEMENT TEST

Basic Content	FORM E	
	Number of items	Percent of items
Stoichiometry, Redox, Electrolytic Cells	12	22
Nuclear-Molecular Structure & Bonding	12	22
Equilibrium, Rates of Reaction, Kinetic Energy	8	14
Emperical Laws Formulas, Equations	8	14
Acids, Bases, Salts Solutions	6	11
Periodic Table	6	11
Chemical Properties, Uses	3	6
Total Test	55	100

The Watson-Glaser Critical Thinking Appraisal[3] Form YM, consists of five subtests designed to measure different factors related to the total concept of critical thinking. The subtests include:

Test 1. Inference. Designed to sample ability to discriminate among degrees of truth or falsity or probability of certain inferences drawn from given facts or data.

[3]Goodwin Watson and E.M. Glaser, Watson-Glaser Critical Thinking Appraisal (New York: Harcourt, Brace & World Inc., 1963).

Test 2. Recognition of Assumptions. Designed to sample ability to recognize unstated assumptions in given assertions or propositions.

Test 3. Deduction. Designed to sample ability to reason deductively from given premises; to recognize the relation of implication between propositions; to determine whether what seems an implication or necessary inference between one proposition and another is indeed such.

Test 4. Interpretation. Designed to sample ability to weigh evidence and to distinguish between unwarranted generalizations and probable inferences which, though not conclusive or necessary, are warranted beyond a reasonable doubt.

Test 5. Evaluation of Arguments. Designed to sample ability to distinguish between arguments which are strong and important to the question at issue and those which are weak and unimportant or irrelevant.[4]

Whenever a new instructional procedure is introduced, the questions asked by the potential users are: How good is it? How does it compare with methods currently used? Will the students suffer in the attainment of course objectives from using the new method?

In an effort to provide answers to some of these questions a comparative study was carried out. The study was designed to test the effectiveness of the group-discussion method when pitted against the lecture method. The typical research design employed randomly selected groups of students of comparable ability who were taught using experimental (group-discussion) and control (lecture) treatments. The relative success of the methods was evaluated by means of test results.

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[4] Goodwin Watson and E.M. Glaser, Watson-Glaser Critical Thinking Appraisal, Manual of Directions (New York: Harcourt, Brace & World Inc., 1963), p. 1.

In order to carry out this evaluation the Anderson-Fisk Chemistry Achievement Test, Form E and the Watson-Glaser Critical Thinking-Appraisal Test, Form YM were administered to both the control and experimental groups in September, 1968, as a pre test, and again in June, 1969 as a post test, and the results were compared statistically. The t-test was employed to determine statistical significance of difference between the intelligence quotient, the Chemistry achievement, and the critical thinking appraisal test of both groups involved in the experiment. Formulas used to make the necessary calculations can be found in the Appendix.

CHAPTER IV

RESULTS OF THE EXPERIMENT

Interpretation of Data

The primary purpose of this study was to ascertain whether, and to what extent the group discussion method of teaching chemistry to secondary school students can be used effectively. Fifty two eleventh-grade students from Lourdes High School in Chicago were randomly selected from a group of one hundred and ten students taking chemistry as subjects for this study.

The t-test was employed to determine statistical significance of difference between the intelligence quotient, the critical thinking ability, and the scholastic achievement in chemistry of both groups involved in the experiment.

The experiment was designed to test the hypotheses that there will be no significant difference in the scholastic achievement and critical thinking ability between students taught by the lecture method and those taught by the group-discussion method. An appropriate t-test was used to test these hypotheses. The students were randomly assigned to two groups, twenty-six in each group. Table II reveals the mean I.Q. of the experimental and control group to be similar.

TABLE II

Significance of Difference Between Means of Intelligence Quotient of Experimental and Control Groups

	Experimental Group	Control Group	σ_{D_M}	t-ratio
Mean I.Q.	118.73	118.81	1.27	.060

The .08 difference between the mean I.Q. of the two groups was found to be statistically insignificant therefore, it can be concluded that no measurable differences in intelligence were present.

A statistical analysis of the Watson-Glaser Critical Thinking-Appraisal scores as shown in Table III indicates that no significant initial differences existed. However, both groups gained during the nine-month experimental period. In fact, the 2.35 t-ratio certainly permits the assertion that the gain is significant.

TABLE III

Significance of Difference Between Means of Initial and Final Watson-Glaser Critical Appraisal Test Scores of Experimental and Control Groups

	Experimental	Control	σ_{D_M}	t-ratio
Initial	70.00	70.86	1.88	.511
Final	74.15	70.50	1.55	2.35*

*Significant at the.05 Level of Confidence

No significant differences between the two groups were indicated in the initial Anderson-Fisk Achievement Test scores as is shown in Table IV. At the end of the experiment, however, the 4.71 t-ratio indicates a significant difference in achievement favoring the experimental group.

TABLE IV

Significance of Difference Between Means of Initial and Final Anderson-Fisk Achievement Test Scores of Experimental and Control Groups

	Experimental	Control	σ_{D_M}	t-ratio
Initial	13.15	13.46	1.15	.267
Final	46.54	41.31	1.11	4.71*

*Significant at the .01 Level of Confidence

These results permit the rejection of the hypotheses that there will be no significant difference in the scholastic achievement and in critical thinking ability between students taught by the lecture method and those taught by the group-discussion method. It can be concluded therefore that the experiment supports the assumption that teaching chemistry to secondary school students by the group discussion method is effective in the improvement in both critical thinking and in scholastic achievement in chemistry.

EVALUATION of GROUP-DISCUSSION METHOD by STUDENTS

To supplement the statistical data a questionnaire was designed to obtain the students' evaluation of the group-discussion method of teaching. The format of the questionnaire can be found in the Appendix.

The results of the questionnaire indicated that eighty-seven percent of the students were enthusiastic and interested in the group-discussion method of teaching. They evaluated the instruction as interesting and more profitable than the lecture method.

The principle results which emerged from a tabulation of the questionnaire responses agreed with by at least seventy percent of the students were: 1) The discussion method generally made the students prepare more thoroughly than if they were attending a lecture class. Ninety seven percent agreed to this. 2) The discussion forced the students to think and organize their ideas. 3) As a result of the discussion method the students were more actively involved in their own learning. 4) The students own ideas were clarified in the process of discussing with others. The students agreed to this one hundred percent.

In an attempt to find more specifically just what in the group discussion method appealed to the students most, the following question was asked: "What is your candid opinion about the effectiveness of the discussion period as compared with the usual lecture method of instruction? Main Advantages:" Some responses were as follows:

> I liked the responsibility and challenge of learning more on my own. I didn't rely on the teacher as much.
>
> I liked working in a small group. I got to know my fellow students better.
>
> I found that learning can be fun. I enjoyed the research involved in learning certain topics more thoroughly.
>
> I soon realized that I could not teach nor discuss what I myself did not know or understand. It wasn't a matter of just memorizing things. I really had to 'buckel down' and learn them.

Some responses from the Main Disadvantages were:

> Some material was too difficult to learn. No matter how hard I tried by myself I just couldn't learn it.
>
> I learned well what I was responsible for in the discussion but sometimes neglected to study what other students were responsible for.

Not all of my classmates were good at presenting new material. Some just read from a paper and didn't teach me anything at all.

Sometimes lack of a definite direction left me unsure of what I was doing or what I was expected to learn about a particular topic. I couldn't always pick out the major or most important facts to learn.

CHAPTER V

SUMMARY AND CONCLUSIONS

A major trend in contemporary education is the extension of independent study beyond the usual emphasis on superior students to include students representing a wider range of abilities. One way to achieve this extension is through the rise of the group-discussion method of teaching within the regular course system.

The objective of the study was to test the effectiveness of the group-discussion method in a secondary school chemistry course with eleventh grade students of varying ability. It was expected that participation in group discussions would increase student interest and responsibility, force active participation, require the organization and verbalization of learned material, and shift the emphasis in learning from memory and recall to understanding and application. Specifically, the purpose of this study was an attempt to evaluate experimentally the relative effectiveness of the group-discussion method of teaching Chemistry as compared with the lecture method.

A plan of procedures was developed, tested, evaluated, and compared. The results of the Watson-Glaser Critical Thinking Appraisal Test and the Anderson-Fisk Chemistry Achievement Test indicated no significant differences between initial scores of the experimental and control groups. In the comparison between the mean final scores, the experimental group was found to be superior to the control group in both tests, as indicated by the t-ratios of 2.35 and 4.71 respectively.

CONCLUSIONS

Certain implications of educational significance seem to flow from these results and their interpretations as presented in this study.

1. The hypotheses that there will be no significant difference in the scholastic achievement and critical thinking ability between students taught by the lecture method and those taught by the group-discussion method must be rejected.

2. The tests used in this study point to the greater effectiveness of the group-discussion method of teaching chemistry to secondary school students as compared with the lecture method.

3. Students in the eleventh grade are in general mentally capable of acquiring the necessary understanding of chemistry by the group-discussion method of teaching.

4. An effective way of helping eleventh grade students to acquire the necessary working knowledge of the principles of general chemistry is through the use of the group-discussion method.

IMPLICATIONS

The following implications were suggested by the results of the study:

1. In relation to other methods, the discussion method placed more emphasis on comprehension and understanding and less on memorization.

2. As a result of the discussion students were more actively involved in their own learning.

3. The discussions generally forced more thorough preparation than regular class meetings.

4. The discussions forced students to think and organize their ideas.

5. The students own ideas were clarified in the process of discussing with others.

6. There were definitely improved communications between students and the teacher when the group discussion method was used.

7. In the group discussion classes, the teacher spends more time listening to the students and interacting with them.

8. In the group discussion classes, the teacher becomes less directive and gives more freedom and responsibility to the students.

9. The group discussion method of teaching creates a more congenial atmosphere in the classroom.

10. The teacher has more time to spend on specific problems of extreme difficulty to the students.

This process also entails some disadvantages. A few of these are listed below:

1. Absentees present a problem when they occur on the same day that the group discussion is to be given. This creates a disruption of the plan, and the teacher must substitute for the absentee.

2. Certain areas of chemistry are too difficult for some of the students to understand. Consequently, they resort to reading a report which is not comprehensible even to the reader.

3. Some of the students cannot present the material effectively.

4. Unless everyone in the group is prepared, little is gained from the discussions.

5. When one or two members are prepared and the others are not, the prepared members become discouraged and lose interest.

SUGGESTIONS FOR FURTHER RESEARCH

The investigator feels that this is a little used process having considerable possibility. One of the main tasks of the teacher is to motivate his students to the full level of their capacity. The observations made by the researcher and the attitudes expressed by the students have indicated that this method is at least a partial answer to the question of motivation.

However, since this is one of the first experiments of this sort in the teaching of chemistry, it is recommended that more investigations of this type be conducted in order to determine its value.

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APPENDIX

I. Q. TEST RESULTS

No.	EXP X	CON. Y	Diff. X-Y	Diff^2
1	119	125	-6	36
2	129	129	0	0
3	119	118	+1	1
4	109	109	0	0
5	118	121	-3	9
6	112	113	-1	1
7	120	120	0	0
8	119	120	-1	1
9	123	123	0	0
10	112	123	-11	121
11	123	123	0	0
12	99	99	0	0
13	136	138	-2	4
14	122	122	0	0
15	115	116	-1	1
16	119	118	+1	1
17	108	109	-1	1
18	112	120	-8	64
19	110	106	+4	16
20	116	116	0	0
21	134	137	-3	9
22	125	127	-2	4
23	124	122	+2	4
24	121	121	0	0
25	125	97	+28	784
26	118	117	+1	1
Σ	3087	3089	-2	1058

Solution:

Experimental $\Sigma X = 3087$, $M = 118.73$

Control $\Sigma Y = 3089$, $M = 118.81$

$\Sigma D^{(+)} = 37$

$\Sigma D^{(-)} = 39$

$\Sigma D = -2$

$\Sigma D^2 = 1058$

$M_D = \frac{2}{26} = .077$

$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$

$= \sqrt{\frac{1058}{26} - (.077)^2}$

$= 6.37$

$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}} = \frac{6.37}{5} = 1.27$

$\boxed{+} = \frac{\text{Diff}}{\sigma_{M_D}} = \frac{.077}{1.27} = \boxed{.060}$

PRE-TEST RESULTS (WATSON-GLASER)

No.	EXP X	CON Y	DIFF X-Y	DIFF^2
1	67	80	-13	169
2	59	78	-19	361
3	74	89	-15	225
4	66	58	+8	64
5	71	75	-4	16
6	75	64	+11	121
7	74	87	-13	169
8	62	62	0	0
9	70	58	+12	144
10	62	68	-6	36
11	69	64	+5	25
12	55	60	-5	25
13	83	83	0	0
14	75	75	0	0
15	65	63	+2	4
16	66	76	-10	100
17	60	68	-8	64
18	74	70	+4	16
19	67	70	-3	9
20	62	73	-11	121
21	86	75	+11	121
22	75	70	+5	25
23	82	76	+6	36
24	77	67	+10	100
25	77	60	+17	289
26	67	76	-9	81
	1820	1845	-25	2325

Solution:

Experimental	**Control**
$\Sigma X = 1820$	$\Sigma Y = 1845$
$M = 70.00$	$M = 70.86$

$\Sigma D^{(+)} = 91$

$\Sigma D^{(-)} = 115$

$\Sigma D = -25$

$\Sigma D^2 = 2325$

$M_D = \frac{25}{26} = .961$

$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$

$= \sqrt{\frac{2325}{26} - (.961)^2}$

$= 9.407$

$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}} = \frac{9.407}{5} = 1.881$

$\boxed{+} = \frac{\text{Diff}}{\sigma_{M_D}} = \frac{.961}{1.88} = \boxed{.511}$

POST TEST RESULTS (WATSON-GLASER)

No.	EXP X	CON Y	DIFF X-Y	DIFF^2
1	74	75	-1	1
2	68	81	-13	169
3	74	88	-14	196
4	72	60	+2	4
5	79	80	-1	1
6	75	67	+8	64
7	79	85	-6	36
8	65	59	+6	36
9	68	62	+6	36
10	66	66	0	0
11	80	67	+13	169
12	65	60	+5	25
13	88	79	+9	81
14	84	73	+11	121
15	72	60	+12	144
16	72	71	+1	1
17	67	60	+7	49
18	76	70	+6	36
19	67	74	-7	49
20	70	76	-6	36
21	84	70	+16	196
22	79	71	+8	64
23	79	78	+1	1
24	80	70	+10	100
25	78	64	+14	196
26	77	67	+10	100
Σ	1928	1833	+95	1911

Solution

Experimental $\Sigma X = 1928$, $M = 74.15$

Control $\Sigma Y = 1833$, $M = 70.50$

$\Sigma D^{(+)} = 143$

$\Sigma D^{(-)} = 48$

$\Sigma D = +95$

$\Sigma D^2 = 1911$

$$M_D = \frac{95}{26} = 3.65$$

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{\frac{1911}{26} - (3.65)^2}$$

$$= \sqrt{60.21} = 7.76$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}} = \frac{7.76}{5} = 1.55$$

$$\boxed{+} = \frac{\text{Diff}}{\sigma_{M_D}} = \frac{3.65}{1.55} = \boxed{2.35}$$

Significant at .05 level

PRE-TEST RESULTS (ANDERSON-FISK)

No	EXP X	CON Y	DIFF X-Y	DIFF^2
1	18	20	-2	4
2	3	15	-12	144
3	12	10	+2	4
4	9	12	-3	9
5	17	14	+3	9
6	20	13	+7	49
7	14	11	+3	9
8	17	12	+5	25
9	11	15	-4	116
10	4	21	-17	289
11	16	11	+5	25
12	11	13	-2	4
13	16	11	+5	25
14	14	10	+4	16
15	12	10	+2	4
16	15	11	+4	16
17	15	10	+5	25
18	8	14	-6	36
19	8	16	-8	64
20	20	23	-3	9
21	12	13	-1	1
22	6	11	-5	25
23	19	13	+6	36
24	12	13	-1	1
25	14	10	+4	16
26	19	18	+1	1
Σ	342	350	-8	862

Solution

Experimental $\Sigma X = 342$, $M = 13.15$ **Control** $\Sigma Y = 350$, $M = 13.46$

$\Sigma D^{(+)} = 56$

$\Sigma D^{(-)} = -64$

$\Sigma D = -8$

$\Sigma D^2 = 862$

$$M_D = \frac{8}{26} = .308$$

$$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$$

$$= \sqrt{\frac{862}{26} - (.308)^2}$$

$$= \sqrt{33.06} = 5.75$$

$$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}} = \frac{5.75}{5} = 1.15$$

$$\boxed{+} = \frac{\text{Diff}}{\sigma_{M_D}} = \frac{.308}{1.15} = \boxed{.267}$$

POST TEST RESULTS (ANDERSON-FISK)

No.	EXP X	CON Y	DIFF X-Y	DIFF^2
1	48	47	+1	1
2	45	51	-6	36
3	50	48	+2	4
4	44	37	+7	49
5	47	47	0	0
6	48	45	+3	9
7	46	45	+1	1
8	43	37	+6	36
9	40	38	+2	4
10	44	49	-5	25
11	49	35	+14	196
12	45	32	+13	169
13	46	38	+8	64
14	48	32	+16	256
15	41	36	+5	25
16	46	39	+7	49
17	44	37	+7	49
18	46	45	+1	1
19	46	40	+6	36
20	51	49	+2	4
21	49	42	+7	49
22	50	46	+4	16
23	53	40	+13	169
24	44	37	+7	49
25	50	35	+15	225
26	47	47	0	0
	1210	1074	+136	1522

Solution

Experimental $\Sigma X = 1210$, $M = 46.54$ **Control** $\Sigma Y = 1074$, $M = 41.31$

$\Sigma D^{(+)} = 147$

$\Sigma D^{(-)} = 11$

$\Sigma D = +136$

$\Sigma D^2 = 1522$

$M_D = \frac{136}{26} = 5.23$

$\sigma_D = \sqrt{\frac{\Sigma D^2}{N} - (M_D)^2}$

$= \sqrt{\frac{1522}{26} - (5.23)^2}$

$= \sqrt{58.5 - 27.35} = 5.58$

$\sigma_{M_D} = \frac{\sigma_D}{\sqrt{N-1}} = \frac{5.58}{5} = 1.11$

$\boxed{+} = \frac{\text{Diff}}{\sigma_{M_D}} = \frac{5.23}{1.11} = \boxed{4.71}$

Significant at the .01 level

STUDENT QUESTIONNAIRE

INSTRUCTIONS

Your response to the questions on this form will provide me with valuable information regarding student opinion about the group-discussion periods. I am particularly interested in gathering your evaluations of the learning experience in using this method.

1. What is your candid opinion about the effectiveness of the discussion period as compared with the usual lecture method of instruction?

   a. Main Advantages

   b. Main Disadvantages

2. Circle the letter in front of those statements which describe the majority of discussions in which you were a participant. Circle the A in front of statements with which you agree, and the D where you disagree and the ? if you are unable to decide.

A ? D The discussions generally made me prepare more thoroughly than if I were attending a regular class meeting.

A ? D In relation to other methods, the discussion periods placed more emphasis on comprehension and understanding than on memorization.

A ? D In the process of discussing the materials with other students, my own ideas were often clarified.

A ? D Because of the discussions I was more actively involved in the learning.

A ? D In the discussion the students often misled one another.

A ? D The discussions have led to a greater interest in the subject matter.

A ? D A lecture period would be more valuable than a discussion period.

A ? D The discussions force you to think and organize ideas.

A ? D One disadvantage in the discussions is arriving at incorrect conclusions.

A ? D One advantage of the discussions is in the interaction with other students you get other points of view.

A ? D Because of the discussions I understood better subsequent class meetings and readings.

A ? D The discussions were helpful in preparing for the tests in the course.

A ? D As a result of the discussions I was better able to relate course knowledge to everyday experience.

A ? D The course probably would have been just as successful without the discussions.

A ? D A general problem in discussing with other students is discovering what parts of the material are most important.

Comment here on any of the above statements: _____

_____

_____

A COMPARATIVE STUDY OF THE RESULTS OF TEACHING HIGH SCHOOL CHEMISTRY BY THE LECTURE AND BY THE GROUP-DISCUSSION METHOD

BY

SISTER MARY JOANNE, GRIB

B. S., De Paul University, 1967

AN ABSTRACT OF A MASTER'S REPORT

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KANSAS STATE UNIVERSITY
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1969

PROBLEM.—This study, which took place at Lourdes High School, an all girls school in Chicago, Illinois, was an attempt to compare the effects of teaching chemistry by the group-discussion method and the lecture method to eleventh grade students.

The null hypotheses tested were: 1.) There will be no significant difference in the scholastic achievement between students taught by the lecture method and those taught by the group-discussion method. 2.) There will be no significant difference in the critical thinking ability between students taught by the lecture method and those taught by the group-discussion method.

The objective of the present research is to test the effectiveness of small student discussion groups in secondary school Chemistry with students of varying ability.

It was expected that participation in student-led discussion groups would increase student interest and responsibility, force active participation, require the organization and verbalization of learned material, and shift the emphasis in learning from memory and recall to understanding and application.

PROCEDURE.—The fifty-two subjects of this study were randomly selected from the 110 students enrolled in 11th grade chemistry at Lourdes High School during the 1968-69 school year. These subjects were randomly assigned to experimental and control groups. The experimental group met during the sixth period and was taught by the group-discussion method whereas the lecture method was used with the control group which met during the eighth period.

All the chemistry classes met for thirty-six weeks, Monday through Friday, for a forty minute period with a double period twice a week for laboratory.

The experimental group was taught in the following manner: A concept in chemistry was selected by the teacher. One of the groups was selected to prepare an oral presentation on the particular topic. The topic was then broken down into an equal number of sub-divisions or areas, with each member of the group assuming the responsibility for presenting an area. After a period of time allotted for preparation and study, the various areas were presented orally to the class. Each member of the experimental group read the content being studied as preparation for the question and answer interaction between the group and the class. It was the teacher's duty to clarify and elaborate the more difficult material. When one topic was completed, another group was selected and the process was repeated for the study of the next topic. When an entire unit was taught, a test was given and new groupings were made. This cycle was repeated throughout the entire year.

The relative success of the methods used was evaluated by means of test results. In order to carry out this evaluation the Anderson-Fisk Chemistry Achievement Test, Form E and the Watson-Glaser Critical Thinking-Appraisal Test, Form YM were administered to both the control and experimental groups in September, 1968, as a pre test, and again in June, 1969, as a post test. The t-test was employed to determine statistical significance of difference between the intelligence quotient, the Chemistry achievement, and the critical thinking appraisal tests of both groups involved in the experiment.

FINDINGS.---The experiment was based on the hypothesis that the group-discussion method would be an effective method of teaching Chemistry to eleventh grade students. The testing program involved was used to test the hypotheses.

In the analysis of the results of the pre-test of the Anderson-Fisk Chemistry Achievement Test and the Watson-Glaser Critical Thinking Appraisal Test, as well as of the Intelligence Quotient, the difference between the experimental and the control groups was found to be statistically insignificant. The results of the final test, however, indicated that an assertion could be made of the superiority of the experimental group over the control group at the 1% level of confidence for the Anderson-Fisk Chemistry Achievement Test and at the 5% level of confidence for the Watson-Glaser Critical Thinking Appraisal Test. Since the specially designed program was the only apparent variable in this study, the experimenter felt justified in concluding that it was the group-discussion method of instruction which produced the desired growth in pupil achievement.

CONCLUSIONS.--Certain implications of educational significance seem to flow from these results and their interpretations as presented in this study:

1. The hypothesis that there will be no significant difference in the scholastic achievement or in the critical thinking ability between students taught by the lecture method and those taught by the group-discussion method must be rejected.
2. The tests used in this study point to the greater effectiveness of the group-discussion method of teaching Chemistry to secondary school students as compared with the lecture method.