A TWO GROUP, POSTTEST ONLY, STUDY OF ATTITUDES AND CONCEPT RETENTION IN NINTH GRADE PHYSICAL SCIENCE CLASSES USING TRADITIONAL VERSUS HANDS-ON LEARNING

MASTER'S PROJECT

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Many teachers have observed that there has been a noticeable change in student attitude and behavior over the past thirty years. Students in the 1950's and early 1960's, referred to by some as the Ovaltine Generation, generally did their school work and showed respect toward elders. They tended to be other-oriented. The present generation, generally referred to as the Me Generation, is not too concerned about school work and often exhibits a lack of respect toward parents and those in charge at school. They tend to be self-oriented. The causes of this slow change in attitude are probably many, but the results, relating to teachers, are clear. Students will respond best, in today's classrooms, when they are interested in a subject and feel it is worthwhile.

Statement of the Problem

Most teachers find that students like, and do well, in subjects they are interested in. A problem that many science teachers relate is that students often seem to lose interest in science by the eighth or ninth grade. Kyle, Bonnstetter, and Gadsden (1988) reported that testing indicated that thirty five percent of the tested sixth grade students in regular science classes found science classes boring. These findings were backed by the findings of Jacobson and Doran (1986) that showed that thirty five percent of 2000 students tested found school boring most of the time. This may explain why many students have not liked science and have done poorly in science classes. It would be beneficial to determine if teachers can influence the attitude and performance of their students by the teaching methods they use.

Kyle Bonstetter, and Gadsden (1988) indicate in their published test results that boredom of students drops to thirteen percent when science classes are taught using a hands-on curriculum.

Purpose of the Project

The purpose of this project was to discover if the use of manipulatives, as compared to traditional methods of teaching, will cause students to develop a more positive attitude toward science and retain learned concepts better. This would not only give teachers a method to try, for increasing interest in science classes, but might also lead to a decrease in the number of discipline problems experienced when children are bored.

Scope of the Project

Data was gathered by administering a revised version of the standardized test, Preferences and Understanding -

Student Version, adapted by Yager and Bonnstetter (1984) from national Assessment of Educational Progress (1978) and published by Denver, CO: NAEP (Project No. 08-S-08). The project tested all the ninth grade physical science students of the researcher. The project ran for the first semester of 1989-90 and 1990-91. Testing was at the end of the two semesters. The classes were in Carrollton High School, a small rural village school in east-central Ohio.

Definition of Terms

Physical science - A science course composed of half a year of introductory chemistry and half a year of introductory physics. It was designed as a ninth grade science course. It was the only science course at Carrollton High School required for graduation.

Manipulative - Any object, used by the students, which helps the student understand a lesson. The manipulatives planned for this project are various crystals, natural and grown in class.

Hands-on learning - Any form of learning which uses some form of manipulative in order to facilitate the learning of concepts or procedures.

Process-approach - Another way of saying hands-on learning. Some researchers use one term, other researchers the other.

Traditional teaching - A general term for the method whereby students learn primarily by listening to a teacher lecture, by watching demonstrations, and by using textbooks and workbooks. Because of its structured nature, this method is probably easier for teachers to use and therefore is the most common method of teaching science in high schools and colleges.

General Hypothesis

It was hypothesized that the use of manipulatives would help students have a more positive attitude toward science class and retain concepts better than traditional teaching methods.

CHAPTER II

REVIEW OF LITERATURE

As in the Sputnik Era of the early 1960's, we are in time of great concern about education. Science seems to be an ever increasingly important part of our lives. It is widely accepted that learning about science is important. What is not so clear is what is the best method for teaching science. Apparently most introductory science courses, below the tenth grade level, are taught by traditional methods relying heavily on the use of the textbook and lecture. It would be beneficial to learn what method causes students to be interested in science and best remember what is taught.

Kyle, Bonnstetter, and Gadsden (1988) conducted a study to assess the attitudes of students and teachers toward science. Students and teachers who had completed one year of a hands-on science curriculum, called Science Curriculum Improvement Study (SCIIS), were compared to students and teachers in traditional, non-SCIIS classes. They found a "drastic" difference in attitude in favor of science in the SCIIS classes. The SCIIS were also generally able to recall scientific terms better than the non-SCIIS classes. This was the best research found by the present study. It conducted a random sampling from a large group of classes and included all the statistical information. The authors also included the Preferences and Understanding tool that was used in the study. Since their study was conducted in only one school district of Texas, they were correct when they indicated that the program could play a significant role in changing student attitudes toward science.

The study by Jacobson and Doran (1986) seemed to support the contention that most students were using traditional methods for learning science and that many of them were bored. They based their conclusions on opinionnaires given to 2000 students involved in the Second International Science Study. Their research indicated that students had a generally positive outlook toward science and school in general. Several responses were singled out as possible problems in science education. Over one third stated they were bored most of the time. Two-thirds stated they used textbooks for science lessons. Only two percent wanted to become a science teacher. A problem with this paper was that although 2000 samples were used, there was no way to know if they were randomized. No information on controls was given and no information on statistics was given, so there was no way to confirm the validity of the study. The only data given were the questions and the percent of each type of response. On the positive side, the study was a survey and the conclusions of the authors were of a general, suggestive nature, rather than statements of fact.

In the study by Trueblood (1986), the use of manipulatives was accepted as a preferred method for teaching. The main points that the study made were that teachers will not use manipulatives in the classroom unless they are trained in their use and are shown that students can make the change from their use to abstract thinking. How they arrived at these two concepts is not indicated in the paper. The paper outlined how to get teachers started in the use of manipulatives, but there was no way to check the validity of these two underlying ideas. This work should be considered a program guide. It contained ideas relevant to this project, but they were not corroborated by research evidence.

Koballa (1986) investigated the variables that influence the use of hands-on teaching by a teacher. As in the study by Trueblood (1986, p. 48), hands-on teaching was assumed to be desirable teaching strategy. His findings were that measuring teachers attitudes toward science will not allow prediction of teaching behavior. He found that the more specific the measured attitude was, the greater the ability to predict became. The study used convenience sampling of a University class. Randomization was not indicated, but was implied. This weakened the study because it could not be checked to confirm that the variables were controlled. The size and scope of the sample were small. He correctly stated his conclusions in the form of suggestions rather than facts. The weakest part of this study was its design description, which was unacceptable.

Riley (1979) conducted a study relating the influence of hands-on science process training to beginning teachers' acquisition of process skills, attitude toward science, and science teaching. He found that hands-on science process training improved beginning teachers' ability to incorporate process skills but had no affect on attitude or teaching ability. The sample was clearly explained and was shown to be a random selection yielding 90 subjects. The design was also very clearly stated and explained. Statistics, calculations, charts, and graphs were provided so that each step of the experiment could be followed. The sample was a convenience sampling, using all the students enrolled in the course. In keeping with the narrow scope of the sampling, the implications were correctly stated in general terms using terms such as "results suggest", "may be required", and "while it appears" (p. 383).

Shymansky, Kyle, and Alport (1983) did a study using the multi-trait, multi-method technique, that synthesized the results of 105 experimental studies involving over 45,000 students. In this study they concentrated on eighteen areas of student performance. They wanted to show if new science curricula, developed since 1955, increased student performance in the eighteen chosen performance areas. They were comparing the new science curricula, which stressed hands-on classroom work, to traditional textbook oriented curricula. They found that student performance went up in seventeen of the eighteen performance areas. Their conclusion was that new science curricula increased student performance, but recent public calls for "back to basics" was threatening the use and development of new science curricula.

This study was important because it reinforced the hypothesis that hands-on curricula will yield better student performance. The validity of this study was helped by the fact that this study used such a large sample. Tables showing the mean, minimum, and maximum change in performance, as well as the standard deviation for each, allowed readers to cross-check conclusions with the test data. The synthesized data was also presented in an easy to read bar graph which was very effective. Finally, the summary posed possible errors that may have caused variations in data observed by the researchers. This seemed a very appropriate conclusion to a well done study and provided much useful information.

In their synthesis of pre-college science curricula from the past twenty years, Weinstein, Boulanger, and Walberg (1982) investigated a claim made by other researchers that new curricula always seemed to yield positive results because traditional curricula were tested by traditional measuring tests and innovative curricula were measured by innovative measuring tests. Only studies comparing traditional to innovative curricula were used. Thirty three studies, involving over 19,000 students from three countries, were used. The results of this synthesis were that innovative curricula, no matter what the bias of the testing, increased student performance more than traditional curricula. A weak point in this study was that no mention was made of this study being based on a randomized sample, but their results are valid because they state that the results suggest, rather than prove, their conclusion. This study was especially strong in its definition of important terms. These terms were clearly defined and left nothing for the reader to guess at. Especially helpful was a listing of variables the authors felt were potential threats to the validity of the study. This study also provided the statistical formula and weighting procedure used in the study, as well as the usual charts of data. The study was clear, well documented, and appeared valid. The results of this study were very relevant to this project.

Most people would agree that when people enjoy or like what they do, they do better than when they dislike what they are doing. Student feelings about school classes and teachers may be an indicator of the success or failure of school programs. Yager and Bonnstetter (1984) decided, in 1982, to rerun a test given in the 1977 National Assessment of Educational Progress. They found that the feelings and attitudes of students and young adults were almost identical in 1977 and 1982. One interesting finding was that elementary teachers seem to like science less than high school teachers, but are more successful in making science exciting for their students. The longer a student had been in school, the less fun and exciting science was for them.

The longer a student was in school, the more uncomfortable and unsuccessful they felt in science. These findings were disturbing and indicated that methods needed to be found to stop the decline in interest and enjoyment of science in secondary school science classes. The testing included 700 students selected at random in Iowa school districts willing to cooperate in the study. This large test sample and the fact that selection was randomized lent a lot of strength to this study. The fact that this study was a follow-up to a previous study, and that the results were almost identical, makes this study even more powerful. A glaring omission in the study was the absence of a key to the data chart comparing the results of the individual questions in 1977 and 1982. Apparently the figures were the percent of each type of response to the questions, but this was not indicated. Other than that key omission, this was a solid study which gave this researcher guidance in the present study.

Some researchers and educators have felt that activity-based education programs may promote process learning at the expense of content learning. Bredderman (1983) conducted a study, using meta-analysis techniques, to investigate three activity-based science programs used in 900 classrooms by over 13,000 students. Variation among classrooms was considerable, especially for process outcomes, according to Bredderman (1983). The study showed that tests not biased in favor of activity-based programs resulted in positive but lower effects than tests favoring activity-based programs.

They also found evidence that indicated that when students from activity-based programs took part in traditional programs, the gains made in the activity-based programs disappeared. This researcher felt that the Bredderman (1983) study was well done and of great value. The study sample was very large. The sample was not randomized, but the conclusions were properly made, using general terms. Another valuable facet to that study was the publication of statistical information. The study stated that comparisons were considered statistically significant at at least the .05 level. The mean, median, and standard error of the mean were also published. The proper use of headings made the study one of the most readable papers read by this researcher.

Moore (1973) outlined the process of developing attitude scales by determining what attitudes to assess, selecting the five best attitude statements representing each selected attitude, selecting the best attitude statements, and field testing the scale. The best attitude and statements were selected by a panel composed of teachers and other experts. The field was a group of teachers involved in a science curriculum project. Moore (1973) used a pre-pretest, pretest, and a posttest, predicting no significant difference between the pre-pretest and pretest, but a significant difference between the pretest and the posttest. The results came out as predicted. This researcher felt that the weakest part of this study by Moore (1973) was the small size of the sample and the fact that it was drawn from such a narrow set of circumstances. The fact that all thirty one teachers were taking part in the same science curriculum program may have had an influence in the test results being predictable. Statistical information was provided. The mean and the standard deviation were provided for the questions and the generalized test outcomes. Total test scores were considered significant beyond the .01 level. I believe this gave the study a high degree of validity. The proper use of headings made this paper easy to read and mentally organize.

The chapter on the Theory of Meaningful Verbal Learning, by David Ansubel, in the book by Joyce and Weil (1972) was a theory of traditional teaching taken to extremes. The teacher was an oral presenter of ideas and facts. The student was a receiver, processer, and storer of these facts and information. This seemed to make the student just a living computer. Oral presentation of material was stressed because any other type of presentation took too much time. The teacher was in complete control of the lesson, the student was a passive receiver of information. Deductive reasoning, rather than inductive, was stressed because it was felt that the large abstract ideas would set the stage for the more detailed information. Perhaps, because this was a theory, it was felt there was no need to confirm the idea with experimentation. This researcher did not agree. For an idea to be valid, it must be tested in a controlled experiment of some kind. The theory was not presented in an organized fashion. Headings were not used, and it was easy to get lost and have to go back and reread whole sections in order to see how they fit together. No researcher should make statements that are not backed up by valid testing. This theory made interesting reading but could not be taken seriously.

The study by Odubunmi and Balogun (1991) assessed cognitive achievement of eighth grade science students. The control group was taught using only lectures and chalkboard notes. The experimental group was taught by a laboratory-based method that incorporated experimenting, manipulating, collecting data, and drawing conclusions. The hypothesis was that the experimental group would test higher than the control group. The results supported the hypothesis but the sex of the student was found to be important. In the control group, females outperformed the males. In the experimental group, males outperformed the females. Males and females from the experimental group outperformed their counterparts from the control group.

This was a well written and well organized study. The testing instrument was clearly described and extensive statistics were provided. The one weakness of the study was in the statistics. The test instrument contained 60 questions but the means varied from only 14.44 to 23.60. Two charts, showing achievement scores, were numbered to only 30. Other than this one area of confusion, this was a very useful study.

CHAPTER III

DESIGN

Type of Design

The researcher used only the students in his physical science classes. Since randomization was not feasible with this type of sample, a quasi-experimental posttest only design was employed. The control and experimental groups were matched according to grade level. The test design was a two-group posttest only.

Participants

The participants in this study were the students in the researchers' ninth grade science classes. The control group was taught using traditional, textbook-oriented methods. It was composed of six physical science classes totaling 156 students, 121 of which were present on the testing day and became part of the statistics in the project. The experimental group was taught using a hands-on approach based on the use of mineral crystals and other manipulatives. Due to unforeseen administrative scheduling problems, the experimental group consisted of two physical science classes totaling 55 students, 41 of which were present on testing day.

The formation of the classes, in the two groups, was under different guidelines. The control group, formed in the 1989-90 school year, was composed of students randomly assigned from the ninth grade class. Physical science was a required course for all ninth grade students. In the 1990-91 school year, physical science became a required elective. All students were required to take the course to graduate but they weren't required to take it during ninth grade. Only 55 students enrolled in physical science for the 1990-91 school year and they became my experimental group, using hands-on techniques in their learning. There was concern that the two groups were not similar enough to be compared. A study of the first semester physical science grades of the two groups indicated that the two groups were very similar in ability, with the traditional group achieving moderately higher grades than the control group (see Appendix A). The following two tables give the summary of letter grades earned by students from both groups at the end of the first semester and a synthesis of the grades composed by grouping A, B, and C grades and C, D, and F grades.

TABLE 1

Summary of First Semester Letter Grades

Letter Grade Percentages for Control and Experimental Groups

Grade	Control Group (1989-90 Traditional)	Experimental Group (1990-91 Hands-On)
A	14.1%	16.4%
B	21.8%	12.7%
C	27.6%	30.9%
D	26.3%	27.3%
F	10.3%	12.7%

TABLE 2

Synthesis of First Semester Letter Grades

Synthesis of Letter Grades

Grade	Control Group (1989-90 Traditional)	Experimental Group (1990-91 Hands-On)
A B C	63.5%	60.0%
C D F	64.2%	70.9%

Table 1 shows that the ability of the control group was very similar to the ability of the experimental group, with only the letter grade of B showing a difference of more than 3.5%. Table 2 indicates that the two groups were similar when comparing the upper and lower grade groupings. The control group was moderately superior with 3.5% more grades in the A, B, C range and 6.7% fewer grades in the C, D, F range. The differences between classes within the two groups were sometimes larger than the differences between the two groups (see Appendix A). The tables indicate the two groups are similar enough for comparison, but the differences were important later in this study.

Apparatus

The posttest only design was used for this study. The same two instruments were used to test the control and the experimental groups (see Appendices B and C). The instruments were modifications of the Preferences and Understandings - Student Version used by Kyle, Bonnstetter, and Gadsden (1988). The Preferences and Understandings standardized test consisted of 32 attitudinal items and eight scientific items. Several modifications were made for the present study. The scientific questions were separated from the attitudinal questions to form two instruments. The scientific questions were increased to ten questions and revised to deal with physical science terms and ideas studied during the first semester (see Appendix B). The students answered the questions by circling the letter of the answer they believed to be correct. The 32 attitudinal items were modified to refer to physical science rather than life science (see Appendix C). The attitudinal instrument had an answer sheet which provided for four fill-in answers and a space to check off the answers as "Yes", "No", or "I don't know" for the remainder of the items (see Appendix D). These were the same responses provided in the original test. All of the changes were reviewed by the four science teachers in the building to insure that the items were assessing what was intended to be assessed.

Procedure

The subjects for this project were a convenience sample consisting of all the students in the author's physical science classes during the 1989-90 and 1990-91 school years. The control group was composed of six physical science classes held during the first year of the program. They were taught by traditional instruction methods. The main focus was on the textbook and lectures. The basic teaching mode was reading assignments from the text, lectures and written assignments from the text, written chapter reviews from the text, and finally a chapter test. There were some demonstrations and video tapes, but these played a minor role in the instructional plan. The experimental group was composed of two physical science classes held during the second year of the program. They were taught with a balanced emphasis on textbook assignments, lectures, and the use of manipulatives. The major manipulative was mineral crystals. One or more days of lecture and text work was normally followed by a day using manipulatives. An example was the study of physical and chemical characteristics of matter. After a day of lecture and a textbook assignment, quartz crystals were handed out to the students and they discussed and listed the physical and chemical characteristics of the crystals. A lesson that involved a higher degree of difficulty involved several days of lecture and textbook assignments involving chemical formulas. The students, in groups of three, then followed directions in using chemicals and balances to grow crystals. The growth of the crystals, and the crystals themselves were used to develop answers to the following questions. Are molecules, of the same compound, all the same? Does the environment of formation affect a compound? Why are differences between crystals seen if they are grown following the same directions? A third lesson involved using formulas of crystals to compute the number and kinds of atoms present in a compound and to compute the atomic mass of the compounds used and grown in class.

Measurement, for this project, consisted of the revised Preferences and Understandings - Student Version used by Kyle, Bonnstetter, and Gadsden (1988). The scale for the attitude portion of the testing was a nonparametric, ordinal scale that ranked the subjects by percentage. The scale for the test of the scientific items was a parametric, ratio scale involving the mean and the standard deviation for each group.

Statistically, the project was descriptive since a random sample of a large population was not taken. The sampling method caused the conclusion to be narrow but some valuable inferences were able to be made.

The alpha internal consistency reliability coefficient for the student questionnaire was calculated as 0.82 by Kyle, Bonnstetter, and Gadsden (1988). The researcher maintained high internal validity by controlling secondary variables. In order to control proactive history, all participants had passed eighth grade science in Carrollton. Retroactive history was controlled by giving the test on a day when the school has nothing unusual planned. The test was given on approximately the same date each year. Anyone visibly upset or ill was excused. Maturation was avoided by giving the test as soon,after the end of the chemistry semester,as possible. I administered and graded the tests myself. External variables were well controlled. Selection bias was not present because I used a convenience sample consisting of all the students in all my classes. The Hawthorne Effect and demand characteristics were minimized by not informing the students that this particular test was part of a masters' project.

All ethical considerations mandated by the University of Dayton were incorporated into this project. Permission to do this project was granted by the researchers' superiors (see Appendix E). Informed consent was obtained from the students (see Appendix F). Students were free to decline or drop out at any time. Confidentiality was maintained since no names were put on the test instruments. A debriefing will be made available to all participants after evaluation of the study.

Operationally Defined Hypothesis

Hands-on learning with crystals will be measurably more effective than traditional learning as measured by scores on the revised Preferences and Understanding - Student Version.

CHAPTER IV

RESULTS

Science Information Test

The results of the science information test are shown in table 3. The standard deviation is 22.21 for the control group and 13.32 for the experimental group. The mean is 60.08 for the control group and 66.10 for the experimental group.

TABLE 3

PERCENTAGE GRADE DISTRIBUTION FOR SCIENCE INFORMATION TEST

Grade (%)	Control Group (1989-90) Traditional	Experimental Group (1990-91) Hands-On
100	6	3
90	14	5
80	14	7
70	19	7
60	17	8
50	15	4
40	18	4
30	12	1
20	5	2
10	1	0

Attitudinal Questionnaire

The attitudinal questionnaire consists of 32 questions, but only 10 of the questions are relevant to this study. The other 20 questions are of a general nature and are used to mask the relevant questions. Table 4 gives the results of the attitudinal questionnaire.

TABLE 4

RESULTS OF THE ATTITUDINAL QUESTIONNAIRE

Question #	Science is:	Control Group (Traditional)			Experimental Group (Hands-On)		
1	(Favorite)	23.1%			24.4%		
	(2nd Favorite)	29.8%			26.8%		
	(least favorite)	16.5%			9.8%		
	(not mentioned)	30.6%			39.0%		
		% Yes	% No	% I don't know	% Yes	% No	% I don't know
3	(fun)	52.1	19.8	28.1	58.5	26.8	14.6
4	(interesting)	71.9	11.6	15.7	80.5	12.2	7.3
5	(exciting)	42.8	33.1	24.0	39.0	31.7	29.3
6	(boring)	23.1	58.7	18.2	22.0	53.7	24.4
7	(successful)	19.8	45.5	34.7	29.3	53.7	17.1
8	(uncomfortable)	9.9	74.4	15.7	12.2	70.7	17.1
9	(curious)	63.6	18.2	18.2	78.0	14.6	7.3
21	(teacher likes)	66.1	0.8	33.1	87.8	2.4	9.8
22	(teacher exciting)	38.0	36.4	26.4	48.8	26.8	24.4

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Summary

Students, as well as the general public, have become self-oriented. The result is that students respond best when they are interested in a subject and feel good about it. Some studies indicate that 35 percent of the students find science boring. This may explain why many students don't like science and don't do well in science. In 1989-90, students studied physical science using traditional, textbook oriented methods. In 1990-91, students studied physical science using hands-on oriented methods. Each year, at the conclusion of the first semester, the students were tested on science information retention and their attitudes toward science. The results are, in almost every instance, at least a five percent difference in favor of hands-on learning, in spite of the apparent greater ability of the traditional learning group. The science information test shows a 6.02 percent increase in the mean score of the hands-on group. In the attitudinal questionnaire, question one shows a similar percent in each group naming science as their favorite or second favorite subject but 6.7 percent fewer of the hands-on group name science as their least favorite subject. The third question shows 6.4 percent more of the hands-on group indicating that science is fun. Question four shows that 8.6 percent more of the hands-on group find science interesting. Question five indicates only a small difference between the two groups on the question of science being exciting. In question six, both groups show about the same percentage indicating science is boring. In question seven, 9.5 percent more of the hands-on group feel successful, but question eight shows that both groups feel uncomfortable about science. In question nine, 14.4 percent more of the hands-on group feel curious about science. In question 21, 21.7 percent more of the hands-on group think the teacher likes science. Question 22 shows that 10.8 percent more of the hands-on group thinks the teacher makes science more interesting.

Conclusions

Although demonstrating lesser ability, the hands-on experimental group did better on the science information test and consistently indicated a more positive attitude toward science than the traditional learning control group. Hands-on teaching strategies seem to have very positive affects on students. Both groups have about the same percentage of students that feel uncomfortable in science, but that number is low (about 10 percent).

A little puzzling is the fact that about the same percentage of both groups feel that science is boring but all other indicators point to the idea that the hands-on group has a greater percentage of students that feel good about science. This puzzling discrepancy involving the hands-on group might be explained by the idea that, for a certain percentage of students, it is the "in thing" to say school (any subject) is boring.

Recommendations

Based on the evidence of this study, this researcher recommends that hands-on learning should be incorporated in secondary school science. This researcher also recommends a further study under the following conditions:

1) All the students will be enrolled using the same school policy.
2) The control and experimental groups will be about the same size.
3) Hand-on learning will be used about 50 percent of the time.
4) The sample groups will be randomized.
5) Statistical significance of the science information test results will be computed.

Appendix A

First Semester Letter Grades, by Class

1989-90 Control Group (Traditional)

Grade	A	B	C	D	F
Class					
Period 1	2	9	6	8	2
Period 2	6	6	6	7	2
Period 3	2	1	12	8	2
Period 6	5	7	6	4	1
Period 7	3	5	5	8	6
Period 8	4	6	8	6	3
Total	22	34	43	41	16
%	14.1%	21.8%	27.6%	26.3%	10.3%

1990-91 Experimental Group (Hands-On)

Grade	A	B	C	D	F
Class					
Period 1	6	4	11	6	1
Period 2	3	3	6	9	6
Total	9	7	17	15	7
%	16.4%	12.7%	30.9%	27.3%	12.7%

Appendix B

SCIENCE QUESTIONS

1. Energy	a) the ability to move b) the ability to do work	c) a measure of heat d) a measure of strength
2. Mass	a) a measure of matter b) a measure of weight	c) a measure of gravity d) a measure of size
3. Balance	a) measures volume b) measures weight	c) measures size d) measures mass
4. Density	a) compares mass to weight b) compares mass to volume	c) compares volume to weight d) compares weight to size
5. Covalent Bond	a) involves sharing protons b) involves transfer of protons	c) involves sharing electrons d) involves transfer of electrons
6. Fission	a) a type of radiation b) a type of radioactivity	c) a type of nuclear reaction d) a type of chemical reaction
7. Electron	a) has mass and - charge b) has mass and no charge	c) has no mass and + charge d) has no mass and - charge
8. Group on the Periodic Table	a) identical elements b) horizontal row of elements	c) vertical column of elements d) Diagonal staircase of elements
9. Element	a) a simple compound b) a single kind of atom	c) a simple reaction d) a single phase of matter
10. Phase	a) a form of matter b) a form of energy	c) a part of the Periodic Table d) a part of an element

Appendix C

QUESTIONS ABOUT SCIENCE AND SCHOOL

1. Which is your favorite required academic subject? Language Arts, Foreign Language, Mathematics, Science, or Social Studies.

2. What is the most important aspect of science?

   a) knowing about your world
   b) thinking through problems
   c) being curious and exploring
   d) explaining things you observe
   e) testing your ideas

ANSWER QUESTIONS 3-30 with Yes, No, or I don't know.

3. Science is fun.
4. Science is interesting.
5. Science is exciting.
6. Science is boring.
7. Science makes me feel successful.
8. Science makes me feel uncomfortable.
9. Science makes me feel curious.
10. Are you taking science now?
11. Are you going to take more science courses?
12. Do you wish there was more time for science?
13. Do you wish there were more kinds of science courses?
14. Do you like physical science better than life science or earth science?
15. Is the science you learned in physical science useful in your daily life?
16. Knowing a lot about science will be useful in the future.
17. Is the science you study generally useful?
18. Does your science teacher ask you questions about science?
19. Does your science teacher let you ask questions about science?
20. Does your science teacher let you give your own answer?
21. Does your science teacher really like science?
22. Does your science teacher make studying science exciting?
23. Does your science teacher know a lot about science?
24. Does your science teacher admit to not knowing answers to questions?
25. Being a scientist would be fun.
26. Being a scientist would make me rich.
27. Being a scientist would be a lot of work.
28. Being a scientist would be boring.
29. Being a scientist would make me feel important.
30. Being a scientist makes me feel lonely.

Appendix D

SCIENCE QUESTIONS ANSWER SHEET

Class Period

1. Favorite subject

Second favorite subject

Least favorite subject

2. ________________

Answer questions 3-30 with an "X" in either the "yes", "no", or "I don't know block".

	YES	NO	I DON'T KNOW
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
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23.			
24.			
25.			
26.			
27.			
28.			
29.			
30.			

APPENDIX E

PROJECT PERMISSION LETTER

Carrollton Exempted Village Schools
80 THIRD STREET, N.E. CARROLLTON, OHIO 44615

January 5, 1990

To Whom It May Concern:

This is to inform you that I have read Randy Gifford's master project, "A Two Group, Posttest Only, Study of Attitudes and Concepts Retention in Ninth Grade Physical Science Classes Using Traditional Versus Hands-On Learning." I fully understand and support his implementation of the project using both the control and experimental groups. I am pleased and excited that Mr. Gifford has done research in this area. Hopefully in the future he will take a leadership role in training other teachers in this concept.

If I may be of any further help, please let me know.

Kathleen Carney

Kathleen Carney, Principal
Carrollton High School

KC/dw

APPENDIX F

STUDENT PERMISSION FORM

Dear Student,

As part of a Master's Project, I am researching ninth grade physical science classes. I hope that all the students in my ninth grade physical science classes will take part in this project. No extra training will be required and only one class period will be used for the project. Participation is voluntary and you may decide to withdraw at any time. No names will be used in the project, only groups of scores. At the end of the project the results will be made available to all the students who took part in the project.

If you are willing to participate, please sign below and include your phone number.

Thank You,

John Gifford

John Gifford

Signature-------------------------------

Phone Number----------------------------

Date------------------------------------

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