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Increasing student achievement with cooperative learning, curriculum changes, and portfolio assessment

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INCREASING STUDENT ACHIEVEMENT WITH COOPERATIVE LEARNING, CURRICULUM CHANGES AND PORTFOLIO ASSESSMENT

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ABSTRACT

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Increasing Student Achievement with
Cooperative Learning and
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Professor Richard Meagher
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The purpose of this project was to determine if student achievement could be approved by curriculum changes within a cooperative learning framework and the use of portfolio assessment. Students in two classes were involved in the study. Both classes received the same instruction, worksheet and quizzes. In addition one class worked individually to complete the worksheets to prepare for weekly quizzes. The other class used the cooperative learning technique - Student Teams Achievement Divisions. The cooperative learning students worked in groups of four to complete the worksheets to prepare for the weekly quizzes. The goal was to have everyone in the group learn the material to have the highest team average score on the quiz and to gain improvement points. Improvement points were awarded each week and a record of the results posted for each team.

. A statistical analysis of the second marking test scores of the classes showed a significant difference in their level of achievement. It was established that the noncooperative learning class demonstrated a higher academic level of achievement. Students were given a pre test and a post test before and after the unit to measure cognitive gains. The results of the analysis of the pre test and post test results represent a

reduction in the gap between the two classes. Further time is needed to determine the impact of keeping a portfolio on the achievement of the less motivated chemistry student.

MINI-ABSTRACT

Lois S. Allen
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The purpose of this project was to determine the effect of curriculum changes within a cooperative framework on student achievement. Students worked in groups to complete activities and labs from the food unit of Chemistry in the Community. Another class completed the same activities with teacher lecture and individual work. The results show a narrowing in a gap between the achievement of the two classes. Further study is needed to determine the effect of cooperative learning when the teacher and student are more proficient in the use of this technique.

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CHAPTER I

INTRODUCTION

Current practices in science teaching encourage reducing the content and aiming for greater understanding of depth of study. Science should be taught through discovery or inquiry-based activities. A course that meets these requirements needs to provide the opportunity for success and positive experiences for the less motivated student. These students can become productive by building their confidence. In dealing with the at-risk or lower level students, it is not just what one teaches, but how one teaches. These students need to see that learning is a cycle of effort, assessment, and revision. There is a need to increase student responsibility, active learning and accountability.

Everyone should study chemistry because chemistry is everywhere. Even if people are not planning careers in science, they need to be productive citizens in this technological world. More than that, chemistry's major contribution to their education and their personal needs is the development of rational thinking. All students will eventually be required, as citizens, to make decisions on a variety of issues that involve some understanding of chemistry. The study of chemistry should make students aware of the quality of modern life and help them understand their responsibilities to society. It is also an excellent training to assist students in developing their problem solving skills. To ignore the issues so pertinent to modern life is to insult the students. Therefore, more societal issues must be included in current chemistry courses. A revised curriculum developed around topics related to students everyday life will be more meaningful to them.

The highly motivated students in chemistry classes are capable of understanding the chemistry course designed for those planning a career in a science related field. The less motivated student has difficulty with in-depth study of chemical concepts. These students seems to lack study skills and social skills necessary to be successful in school. Cooperative learning situations will help them develop the skills to work in groups. Positive experiences might raise their attitudes towards their own abilities in science and school in general. The goal is to keep students productive by building confidence and studying topics with relevance to them.

The question arises: will using the cooperative learning strategy Student Teams Achievement Divisions (STAD) improve student achievement? Will keeping a portfolio to develop goals and monitor individual achievement assist students in becoming more responsible for their own success? The cooperative learning strategy and portfolio development will be examined in this paper during a unit concerning a topic more relevant to the students personal lives - food.

CHAPTER II

Literature Research

James Watson, who won a Nobel Prize as the codiscoverer of the double helix, stated, "Nothing new that is really interesting comes without collaboration" (Johnson and Johnson, 1992). For many years schools have been structured as mass manufacturing organizations. Teachers work alone, in their own rooms, with their own students, and with their own set of curriculum materials. Schools need to change from a mass-manufacturing competitive, individualistic, organizational structure to a "high performance" cooperative team-based organizational structure. Cooperative learning is used to increase student achievement, create more positive relationships among students, and generally improve student psychological well-being (Johnson and Johnson, 1989). Research has shown that cooperative learning can be an advantageous learning strategy for the sciences, including chemistry at the secondary and postsecondary level (Kerns, 1996). The advice of all the major science education publications over the last twenty-some years is to teach less, but teach it better and create cooperative relationships in the classroom that encourage discussion and include everyone. When students work cooperatively, they learn more science, like it better, and want to take more in the future (Johnson, 1991).

Cooperative learning is an old idea. The Roman philosopher, Seneca, advocated cooperative learning through such statements as, "Qui Docet Discet: (when you teach, you learn twice). Johann Amos Comenius (1592-1679) believed students would benefit both by teaching and being taught by other students. In the last three decades of the 19th

Century, Colonel Francis Parker's fame and success rested on his power to create a classroom atmosphere that was truly cooperative and democratic. Following Parker, John Dewey promoted the use of cooperative learning groups as part of his famous project method in instruction (Johnson and Johnson, 1992).

Student motivation for learning is a major concern for the teacher of low-achieving or "at-risk" students. In today's classroom, motivational inequality prevails. Some students persist and work on their own for their own intrinsic reasons. Others work because of necessity and do not believe their actions result in success or failure. If a student consistently fails a science test, he/she can believe that he/she is not a good science student. This type of student perceives himself as helpless to prevent future failure and achieve success. The helpless student expends less effort after failure, while a more motivated student increases effort and looks for better strategies (Alderman, 1990).

The teacher needs to help students break the failure/low expectation helpless cycle. Student attributions determine their future expectations and actions. The reasons students assign for their successes or failures include not having the ability; not expending enough effort; and luck (Alderman, 1990). These attributions can become stable and internalized.

Teacher expectation of student achievement can greatly influence student performance (Alderman, 1990). Teachers must be realistic, confident, and determined. They must look for ways to overcome the learning problems and let students know that they can achieve. Students need to know that they will be taught the skills or learning strategies necessary to achieve. Students must perceive a link between their performance and the outcome.

Drawing on research on motivation and learning strategies, Alderman has developed "Links" for helping the "at-risk" student become successful. M. Kay Alderman's Links-to-Success model provides teachers and students with a frame work for beginning the cycle of progress that fosters self-responsibility for learning. When teachers help students take responsibility for learning, they take a giant step in promoting motivational equality in the classroom.

Link one is to establish proximal goals. The goals play an important role in the cultivation of self-motivation by establishing a target or standards by which the student can evaluate or monitor his/her performance. They provide the mechanism for self-assessment. To be effective the goal must be proximal rather than long-term. These "at-risk" students are inefficient learners who fail to apply a learning strategy that will be beneficial. In link two students learn to identify the correct learning strategy to achieve their goal. Strategies including summarization, question asking, clarification, and prediction can improve reading comprehension (Alderman, 1990).

A learning goal rather than a performance goal is the key to success. The focus in a learning goal is on the progress made, not on the ability of the student. The student measures his or her success using the proximal goal and his/her personal effort to the successful outcome in the third link. In link four the teacher helps the student make the appropriate attribution. The teach can ask, "What did you do when you prepared for the test?" Examples of student effort might be completing all homework, correcting errors, doing extra practice, redoing an assignment, and/or going to a review lesson. When failure occurs, students will attribute the failure to not using the proper strategy. This student will be more likely to try again as compared to the student who attributes his/her failure to lack of intelligence or ability (Alderman, 1990).

This model then goes full circle. Students who have succeeded and attributed the success to their effort or ability (not to task ease or luck) have concrete performance feedback that in turn will lead to increased self-efficacy. This increased self-efficacy leads to increased confidence about goal accomplishments. To foster the highest motivation, the classroom must emphasize learning and progress over performance and ability. Errors are viewed as a natural and important part of the learning process, not as an indication that one lacks ability. Students are given opportunities to relearn concepts and correct errors (Alderman, 1990).

Marlene Katz (1996) describes the four criteria for developing student independence and responsibility. These criteria are student ownership, student-active learning, student accountability, and student control. Student directed learning (SDL) meets the four criteria for developing student independence and responsibility. The goal of SDL is to keep students in the productive cycle by building confidence. After changing to SDL in her organic chemistry classes, the average exam scores improved and, more importantly, the bottom half of the class scored higher. In a few years no one using the SDL method had to repeat the course. Students reported that they were working harder and learning how to study. One student stated "Even if I do not remember anything in twenty years about your class, I will always carry with me the maturity and responsibility I have acquired while trying to keep my head above the water."

Charles R. Adamchik, Jr. Of Blairsville High School in Blairsville, Pennsylvania, has developed some materials to help students address the portfolio in his chemistry class

(Adamchik, 1996). This portfolio design could be used to help students link their efforts to their successes. His students' portfolios contain these items: a goal record sheet, a grade record form, a test self-evaluation form, a chapter summary and four work samples.

On the goals record form the student is expected to set positive, realistic goals on the top and at the end of the semester evaluate his achievement or lack thereof on the bottom of the form. The grade record form makes the student aware of his/her grades and therefore his/her achievement and growth. The test self-evaluation form is an attempt to get the student to reflect on what he has done and how his performance might be improved. The chapter summary form allows the student to reflect on what he has learned and how he has grown as a chemistry student and as a learner (Adamchik, 1996).

The portfolio should not be just a collection of forms. Adamchik has his students include samples of their work - two good samples and two that need improvement. These assignments can be any work done during the marking period. This allows the teacher to see the range of the students' work.

To assess the portfolio, Adamchik uses a combination of assessment and conferencing. Students are given assessment guides and asked to use their portfolio to show how they addressed the areas of goal setting, growth and achievement, and reflection and self-assessment. A rubric is distributed to the student so they know what is expected of them. At the conference each area is discussed and a score of one to four is given for each of the three areas. Adamchik has found that he and the student would often agree on the scores to be given. All in all, Adamchik has found this assessment technique to be very positive (1996).

Another paper describes the implementation of portfolio assessment in a rural high school in a midwestern state. The portfolio is described as an organized collection of evidence used by teacher and student to monitor growth of knowledge, skill and attitude. The development of the portfolio allowed the student to review and improve their work as opposed to the one-shot atmosphere on the paper and pencil exam. Since assessment continued over a relatively long time learning continued throughout the assessment process (Phelps, LaPorte, and Mahood, 1997).

Johnson and Johnson (1991) identify five basic elements of cooperative learning: positive interdependence, face-to-face promotive interaction, individual accountability, interpersonal and small group skills, and group processing. Positive interdependence is the idea that students perceive the need for one another for the completion of the task at hand. Teachers need to structure learning tasks so that students come to believe that they "sink or swim" together. Their access to rewards is as a member of an academic team wherein all members receive a reward or no member does (Stahl, 1994). Face-to-face promotive interaction is the concept that students assist each other by helping, sharing, and encouraging each others efforts to learn and complete the task. Individual accountability is the idea that the student has ultimate responsibility for his or her own learning, even though the group will help the student. Interpersonal and small group skills are necessary for the group to function effectively. Finally, it is important that the group synthesize the information it has and decide where to go with that information through group processing (Kerns, 1996).

Johnson and Johnson (1991) have classified cooperative learning groups into three basic types: formal learning groups, informal learning groups, and base groups. Formal learning groups are structured groups which are formed and maintained until the completion of a task, such as a project for the marking period. Informal groups are less structured, short-term groups, such as two or three students checking each other's understanding of material in class. Base groups are long-term groups whose function is peer support and long-term accountability (Kerns, 1996).

Research in cooperative learning has been done in all areas of secondary school science. Lazarowitz et al. (1994) studied a population of 120 11th and 12th grade earth science students. They found a greater difference in pre/post test scores in students in the cooperative learning groups. The results of the test on affective outcomes (self-esteem, number of friends, involvement, classroom cohesiveness, cooperative, competition, and attitudes towards earth science) showed that the students engaging in cooperation had higher scores than the students engaging in individualized learning.

Peter Okebukola (1985) examined the effect of cooperative and competitive interaction techniques on student performance by eighth-grade Nigerian science students. Mean gains on the pre/post test scores were higher for the cooperation groups than the competitive group on the Science Achievement Test. In another study, Okebukola (1986) reported that students in his ninth-grade biology class had a more favorable attitude towards laboratory work than did the students in the control group.

Peter Okebukola and Meshach Ogunniyi (1984) studied the effects of cooperative, competitive, and individualistic learning on ninth-grade students' achievement and acquisition of practical skills in secondary chemistry. Students in the cooperative groups scored better on the achievement test than the students in the competitive and the individualistic groups. The low-ability and medium-ability students in the heterogeneous cooperative groups scored higher than those same students in the competitive groups.

Patricia Heler, Ronald Keith, and Scott Anderson (1992) studied the problem solving skills of college physics students (n=209) involved in cooperative groups and individual problem solving. They found that solutions formed by groups collectively were significantly better than those produced individually by the best students in the groups, and that the students in cooperative groups displayed more expert-like problem solving.

Mario Caprio uses cooperative learning as a motivational technique in his biology program. He reports that students who classify themselves as science-anxious usually report their study-group affiliation to be a major stress reducer (Kerns, 1996).

Cooperative learning situations on the college level can also lower the withdrawal rate. Harry Pence combined cooperative learning and multimedia in a general chemistry class. Every 15 to 20 minutes the lecture would be interrupted and students would work in pairs at a multimedia station. Pence found the students to be most actively involved in the process, and the class became more concept-oriented and less math-oriented (Kerns, 1996).

Melanie Cooper (1995) uses cooperative learning in a general chemistry class. The students (n=190) formed self-selected informal groups and were given group work, either a discussion question or a group quiz. Group quizzes were given about midway through the class to serve two purposes: to break up the lecture portion of the classes and to allow the instructor the ability to discuss questions that originated in the group discussions. Another technique used was to begin the lecture with a question or organizer related to the previous lecture. The groups would then discuss them knowing one of the students would be randomly called upon to summarize the group's response.

Jim Bier (1993) used a technique similar to Cooper's in his organic chemistry classes. In his classes he used about half the time for guided cooperative problem solving. He does not give group quizzes. To build group camaraderie and teamwork, he takes his classes through six stations of the college's low-ropes challenge course during the first week of classes. Bier indicates that this approach takes the same amount of time as the traditional approaches.

In the undergraduate laboratory, use of cooperative learning has been developed and studied. Smith, Hinckley, and Volt (1991) used the Jigsaw technique in an introductory non-majors' chemistry course. The students were given a special topic that they were to master and take back to the group and teach. Students in the cooperative groups worked in groups of three and the work for the laboratory procedures were divided specifically into three parts. The traditional students worked alone and completed the laboratory based on the procedure handed them from the instructor. The students in the cooperative group showed a higher achievement on the examination than did the control group. Also notable was that the low-achievement students in the cooperative learning laboratories scored significantly higher than did those in the traditional laboratory.

Cooper (1995) also studied a cooperative learning laboratory setting versus a traditional setting. She studied the effect of cooperative learning, project-based, guided-inquiry laboratories versus traditional cookbook labs in a freshman chemistry (n=1300) at Clemson University. Half the students were randomly assigned to a laboratory setting in which they worked in heterogeneous groups. Instead of following a set of directions as did the other half, they worked on three open-ended projects over the semester. Differences in achievement, attitude, and dropout rate were monitored in the two groups. Cooper found that students in the cooperative laboratory had a more positive attitude towards science and the laboratory format. She also found that students in the cooperative setting felt they had improved their oral communication, writing, and problem-solving skills. In achievement on the common lecture exams, there was no significant differences in males' scores, but the females in the cooperative laboratory performed slightly better (eight points) on the lecture exams than the females in the traditional format.

Lorie Juhl of Easter Idaho Technical College (EITC) used an applied and cooperative approach when faced with the challenge of developing a general chemistry course. The course would teach basic chemical principles and skills required in the work setting (1996). She developed a "junk and tools" lab. Students in groups of three to five built a device with equipment brought in from home. Another project was to develop a solution to an environmental waste problem. Juhl found that projects provided valuable experience with creative thinking, conflict resolution, delegation, compromise, and communication. Most students agreed that group projects mimic "real world" problem solving in terms of interpersonal skills necessary to complete the task.

Teachers need to master the essential elements of cooperation which include positive interdependence, face-to-face promotive interaction, individual accountability, social skills, and group processing. Positive interdependence must be established with every cooperative lesson with mutual learning goals. Bonus points, divided resources, and complementary roles may be used. Students must interact to help each other accomplish the task at hand. Students are expected to discuss what they are learning, explain to each other how to solve the assigned problems, and provide each other with help, assistance, support, and encouragement. Promoting each other's success results in both higher achievement and development of social skills. Cooperative learning makes each student a stronger individual in his or her right. To ensure each member is strengthened, students are held individually accountable to do their share of the work. The performances of each individual is assessed and the results given back to the group and the individual. Contributing to the success of a cooperative effort requires interpersonal and small group skills. Leadership, decision-making, trust-building, communication, and conflict management skills have to be taught just as purposefully and precisely as academic skills (Blosser, 1993).

In group processing, the group members discuss how well they are achieving their goals and maintaining effective working relationships. Groups must describe which member actions are helpful and which are not helpful. Such processing gives members feedback and reminds the students to practice collaborative skills consistently. Sufficient time must be devoted to processing, and students must have clear expectations as to the purpose of processing. The processing must be specific rather than vague. (Johnson and Johnson, 1992).

Teachers have to do cooperative learning for some time before they begin to gain real expertise. This requires support, encouragement and assistance from colleagues. In order for teachers to use cooperative learning the majority of the time, they must identify course routines and generic lessons that repeat over and over. Some examples of repetitive cooperative lessons include checking homework, preparing for and reviewing for a test, drilling-review of facts and events, reading of textbooks and reference materials, writing reports and essays, giving presentations, learning vocabulary, learning concepts. Each of the instructional activities may be done cooperatively and once planned and conducted several times, will become automatic activities in the classroom (Johnson and Johnson, 1992).

Goor, Schwenn, Eldridge, Mallein, and Stauffer (1996) in their article for the Council for Exceptional Children suggest using strategy cards to assist students to appropriately seek clarification on the expectations of the assignment and to focus on the group activity. They developed preprinted 3 X 5 index cards and an accompanying script. Students reported they better understood what was expected of them. Teachers using this procedure reported observing increased participation and more on task comments. Students were better able to explain the main idea of the lesson.

Teachers need to gain experience in an incremental step-by-step manner. Teachers need to do the following to progressively refine their competencies in using cooperative learning: plan and teach a cooperative lesson, assess the strengths and weaknesses of the lesson, reflect on how to better teach the next lesson, plan and teach a second cooperative lesson with the modifications determined from teaching the first lesson, assess the strengths and weaknesses of the second lesson, and reflect on how to teach the next lesson better. This process is repeated continually until the person retires from teaching (Johnson and Johnson, 1992).

A support system is needed to encourage and assist teachers in their long-term effort to improve their competence in using cooperative learning. Teachers may need 20 to 30 hours of instruction in the theory of a moderately difficult teaching strategy, 15 to

20 demonstrations using it with different students and subjects, and an additional 10 to 15 coaching sessions to attain higher-level skills. For cooperative learning, a more difficult strategy, several years of training and support may be needed to ensure that teachers master it (Johnson and Johnson, 1992).

Some issues can prevent instructors from using cooperative learning. Three of these are: covering the material, the instructor's lack of control, and the "hitchhiker" problem. Not covering all of the material is the most frequently heard excuse in content-specific courses such as science and engineering. Covering all the material is something that is impossible. What is possible is to promote independent thinking skills so that students can process information they encounter (Cooper, 1995). Dinan and Frydrychowski actually reported covering two additional chapters when they used a team learning approach as opposed to lecture in their organic chemistry course (1995). The "hitchhiker" problem is one that is always an issue with those who are new to cooperative learning. Newcomers fear that the higher-aptitude students will do all the work, and they will dislike working with students of lower aptitude. Cooper has not encountered this problem in her four years of using this method. Since she does not grade on a curve, it is possible for everyone to make an A in the course (Cooper, 1995).

Students' response to group work has been overwhelmingly positive. In an end-of-term survey, they indicated they were better able to synthesize the information in an group because each member could contribute, and one might remember something that the other did not (Dinan and Frydrychowski, 1995).

The purpose of a study by J. Tingle and R. Good (1990) was to determine the effect that cooperative groups, heterogeneously based proportional reasoning ability, have on stoichiometric problem solving in a high school chemistry. Students (n=178) were assessed as successful or unsuccessful problem solver based on videotape analyses, their written work, through class observation, and a pre/post-test. The results of the statistical analysis indicate that students experienced similar success on the post test regardless of whether they were in a regular or honors class or whether they solved problems individually or in groups. Students of varying proportional reasoning abilities also experienced similar success on the chemistry post test. Results of this study also suggest that the cooperative grouping strategy was comparable to individualized problem solving based upon similar chemistry post test means.

Cooperative grouping offers another means for teaching chemistry problem solving. It also provides an active environment for students to practice solving problems rather than through seatwork or reception of learning. Neither of these strategies proved adequate stimulation for the development of formal reasoning skills (Tingle and Good, 1990). For most students the prescriptive method provided a strategy to link what they know and what they were being asked to find. For many students extracting the given data, identifying the unknown, writing a balanced equation, and sketching a picture of the mole quantity in question enabled them to visualize the problem, rethink it without the extraneous words, and thus make a plausible prediction. In some cases, the prediction and mathematical solution were identical.

The outcome of the cooperative grouping strategy was twofold. Besides cooperative grouping serving as an alternative problem-solving strategy, it served as a means for teaching interaction skills. Most students did not know how to work effectively with other students. Evidence of this was the poor interaction between student pairs who had been problem solving on an individual basis. Most students participating in cooperative grouping cited enjoyment and interest as positive interpersonal relationships as found in the research by Johnson and Johnson (1987) and Kurtz and Karplus (1979). Students were encouraged to work together by requiring a group product as well as bonus points dependent upon a minimum score by each group member on the test. Most students working in groups learned to share their expertise, with the more capable students accepting responsibility for the other group members' learning.

Interaction among group members was characterized by students using questions to involve other group members and to check strategies. In many groups it was difficult to identify a group leader in that students shared responsibility equally. In one of the successful groups, they were well organized, working in steps and labeling all their work. Each student seemed to have specific assigned tasks such as inputting the initial data into the calculator, checking the result, and retrieving the atomic mass from the periodic table. They were characterized by persistence and confidence. If a group arrived at a mathematical solution that did not agree with their prediction, the students would work diligently to expose the incongruency. During this process group interaction was at its peak (Tingle and Good, 1990).

William Sumrall (1991) suggests using a cooperative and investigative approach to learn chemistry. Students gather and synthesize the information given, analyze the results, and draw conclusions. After solving more traditional stoichiometric problems from their textbook, students are provided with more relevant problems using the metal silver. The article includes three problems and their solutions. The fact that students have to research, speculate price settings, and use their chemistry knowledge makes this a practical and relevant learning experience.

Richard Felder (1996) taught an introductory engineering course to a class of 123 students at North Carolina State University. This class became the experimental cohort in an ongoing longitudinal study. Those who remained in sequence in the chemical engineering curriculum took four more courses from Felder. The purpose of his study was not to test novel instructional methods: the effectiveness was already well supported by both theory and prior research (Felder, 1996). The goal was rather to show that repeated use of these methods in a curriculum would have significant positive effect on students' performance and retention, attitudes toward chemical engineering as a career choice, and levels of self-confidence.

On the first day of class, students were assured that when they eventually went to work in industry they would have to work in teams so they might as well start learning how to do it now. For each assignment the teams designated a coordinator, whose job was to make sure that all team members know their responsibilities and understood all problem solutions, a recorder to write out the final solutions, and one or two checkers to check the solutions for accuracy before they were submitted. The roles rotated for each assignment. The cover page of the assignment was to list all participating team members and their designated roles. Homework assignments periodically included questions calling on groups to assess themselves, stating what they were doing well as a team, what they thought they could do better, and what they planned to do differently on the next assignment (Felder, 1996).

If students ran into problems working together such as students doing more or less than their fair share of the work, the students were instructed to discuss these problems and figure out how to solve them. If the problems persisted, the groups were to meet with Felder. If all else failed, students could be fired by unanimous consent of the rest of their team. A student who consistently had to do most of the work could quit the team. A student who quit or was fired had to find another team of three to let him/her join the group. Those who quit could easily find another group, but it was nearly impossible for those who were fired. These last-resort options were rarely exercised; the teams usually managed to work their problems out by themselves. In class, exercises were done by students working in groups of two to four. At any time during a class period Felder would ask a question or pose a problem, give the students five minutes or so to come up with responses and call randomly on individuals to share their responses. He would vary the structural format. Sometimes a recorder would write down the team's response or problem solution with only the recorder allowed to write. At other times students would work individually and then pair up to compare their solution and synthesize a better one. Felder would wander around the classroom making comments or suggestions to the groups. He would remind recorders to keep writing and answer any questions. After a certain time period he would call randomly on students to present their team's responses or call on teams and let them designate their own spokesperson. At the end of an occasional period, he would call on individuals or pair of students to write "one-minute papers" to list the main points in the material or list the muddiest point (Felder, 1996).

Felder was convinced this class performed at a higher level than any traditionally taught chemical engineering class, and the experimental instructional methods had substantial effect on both the quality of learning and the intellectual growth of the students. He observed a remarkable sense of community among these students by the time they were juniors. The students' proficiency at formatting problems and answering questions that called for a measure of creativity was greater by the time they were juniors. Student comments on evaluations included persistence in finding solutions, increased understanding when they explained to others, and less tendency to skip an assignment to not let the group down. Industrial recruiters showed an unusually high level of interest in the students in the group due to their experience in team work. An unusually high percentage of the students went to graduate school. In the final analysis, Felder was convinced that the cooperative approach was more effective than the traditional individual/competitive approach to education.

Jon E. Pedersen from the University of Arkansas in Fayetteville (1992) investigated the effects of cooperative framework, focusing on Science, Technology, and Society (STS) issues, an achievement and anxiety toward science. A cooperative framework with STS issues was compared to an individualistic approach studying STS issues. The classes involved in a 4-week instructional cycle using a role playing scenario developed by the Social Science Education Consortium of Boulder, Colorado. Working in groups of four, students were to write a consensus paper representing the groups view of the issue.

Analysis of variance (ANOVA) was chosen as the method by which the data would be analyzed. Each group was given the State-Trait Anxiety Inventory, pre test and post test, and the teacher-made achievement test, pre test, post test, and delayed post test. The results indicated that there were significant differences between the treatment and the control for anxiety, and no significant difference between the treatment and control group on achievement.

The author states that the nature of the material studied itself may lead to the reduction in students' anxiety toward science. Current trends in science education point toward students studying what is relevant to them personally. By presenting science in this manner, students see the intrinsic value of studying science. Because science is of value to them, the content itself may seem less threatening.

The research indicates that using cooperative learning and studying more relevant topics may increase student interest and achievement. The less motivated chemistry student may benefit from preparing a portfolio that establishes goals and evaluates achievement based on these goals. Working in groups students will improve their interpersonal skills and become better problem solvers. Hopefully students will learn how to study and become lifelong learners.

CHAPTER III

DESIGN OF THE STUDY

Rationale:

Everyone needs to have some knowledge of chemistry in this technological era. However, what should the curriculum include for the less motivated and nonscience major student? The idea is to teach the less motivated students topics that are related to their everyday lives. Using cooperative learning techniques the students will receive the support they need, be encouraged to develop their social skills and become more responsible for their learning. The hope is to see improvement in student interest and achievement with these instructional changes. Accepting responsibility for their learning is necessary to improve student achievement. Establishing goals, working in groups, and studying relevant topics will improve student achievement in chemistry.

Hypothesis:

Students who are taught more meaningful topics in a cooperative learning setting will achieve more and demonstrate increased interest in science. These students will find that their cooperative groups are valuable in their achievement. The grades of the students working in cooperative groups will demonstrate increased improvement from the pre test to the post test. The grades of the students in the class studying the new material in a traditional setting will show less improvement from the pre test to the post test. Students working in cooperative groups, setting goals and monitoring their progress towards these goals will achieve higher post test scores than students not placed in these groups.

Method:

Students will be given an evaluation form (see appendix, part C) before and after the unit is completed. The survey will allow the students to express their views of chemistry and the course. It will also evaluate the student's opinion of his own ability, interest, and effort in chemistry. The same evaluation will be given after completion of the food unit to determine any changes in student comments.

To evaluate the success of the STAD cooperative strategy, pre and post tests will be administered before and after the unit. The pre test is composed of thirty questions - 16 multiple choices and 14 true/false questions. These questions are about organic compounds, nutrients, vitamins, and minerals. The post test will be administered upon completion of the food unit. Copies of both tests and the answers are in appendix parts B and C.

Students will be required to keep a portfolio with a goal setting sheet, grade record sheet, and test evaluation sheets. In addition students will be required to include examples of their best work including a lab report, a corrected test, a classwork assignment, and a quiz. Using the portfolio students will be asked to show how their work exemplifies the three elements of the portfolio - goal setting, self-assessment, and growth/achievement.

Having just completed a unit on chemical bonding and formula writing, students will apply what they learned to study the composition of the nutrients necessary in their diets. This four week unit includes the study of organic chemistry to introduce students to basic structural formulas of hydrocarbons and functional groups of substituted hydrocarbons. Next, the chemical composition of nutrients and their role as energy providers and builder molecules will be explored.

Student Teams Achievement Divisions (STAD) is an effective approach to mastery of basic facts and information. Students will be placed in groups of four which will work together for the entire unit. Improvement points used in the scoring system provide high motivation for students across the range of ability levels. The five components of STAD are teacher presentations, teams, quizzes, individual improvement scores, and team recognition. The teacher presents material in a lecture-discussion method and uses audio-visual aids where appropriate. Students realize they must listen carefully to do well on quizzes which determine their scores and the team scores.

Teams of four students will be established by the teacher to represent a cross-section of students in academic performance. The major function of the team is to prepare students to do well on the quizzes. After presentations, the teams meet to study worksheets or other material. Study takes the form of students quizzing each other back and forth to be sure they understand the content or work problems together. Emphasis is placed on team members doing their best for the team and on the team doing its best to help its members. After one period of teacher presentation and student practice, the students take individual quizzes. In addition to the quiz score, students receive an improvement score each week indicating how well they are performing compared to their usual level of performance.

The first quiz taken will establish a base score for each student. After each additional quiz, students receive three improvements points if their quiz score is ten or more points above the base score. Two improvement points are given for five to nine points above the base score. If the score is one to four points above the base score, one improvement point is given. Scores below the base score receive no improvement points.

A score of 95 to 99 never receives less than two improvement points and a 100 always receives three improvement points. After two weeks the base score is recomputed. Each week teams receive recognition for the sum of the improvement scores of the team members and incentives such as no homework passes.

Students will use the jigsaw cooperative learning structure to learn material on proteins, carbohydrates, fats, vitamins and minerals. In the jigsaw approach each student on the team specializes in one aspect of the learning unit. One student concentrates on the study of proteins, another carbohydrates, another fats, and the fourth member of the group will study vitamins and minerals. They meet with other students from the other groups assigned the same topic to master the material in an expert group. Upon mastering the material, they return to their group to teach their teammates and complete teacher made worksheets. A quiz will be taken individually after the presentation of material by the expert on each topic and completion of the review worksheet.

As a culminating activity, student teams will research a favorite recipe and present their findings to the class. The assignment includes researching the ingredients of the recipe stating the nutrients and vitamins supplied by the food and the energy (calories) available.

Labs that will be completed include the following topics: calculating the energy in a peanut, physical and chemical properties of milk and testing for iron in food from the student lab manual - Chemical Activities by Christie Borgford and Lee Summerlin. These labs will be completed with a lab partner from the group of four and conclusions completed with the other pair in the group. After each lab, a quiz will be taken to assess student comprehension.

The class not using cooperative learning groups will cover the same material. They will work in pairs for laboratory assignments and write up their own labs. They will be given the same teacher presentations and work on the worksheets alone. Studying for the quizzes will be done individually in class. They will not compile a portfolio or set individual goals.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Introduction:

This purpose of this study was the determination of the effect of cooperative learning groups and the structure of Student Teams Achievement Divisions on student achievement. This study involved two lab chemistry classes. Up until now this course has been geared more toward students planning careers in science or science related fields. The period 9/10 class is composed of 25 students and is the noncooperative learning group. The period 12 class has 20 students which will be placed in the cooperative learning groups. Although these classes are the same level, student achievement in period 9/10 is above that of period 12. Note the comparison of the test averages for the second marking period in both classes(table IV). Period 9/10 had a mean of 83.8 and period 12 had a mean of 69.3. Period 12 is not as academically successful although students appear to be equally motivated. They perceive themselves as being less capable then the other class. Period 12 will use the cooperative learning technique hoping to improve their achievement.

As stated before period 9/10 will be presented the same material through teacher lecture and given the same quizzes without using cooperative learning groups and STAD. The period 9/10 class consisted of 25 students. Twenty-four of these students were college bound sophomores and one was a junior. Period 12 consisted of 19 college bound sophomores and one junior. Second marking period test averages (refer to Table I) show there is a significant difference in academic achievement between the two classes. Period

9/10 had a mean score of 83.8. Period 12 had a mean score of 69.8 which is 14 points lower than period 9/10. Using *t* test to determine the significance of the means, *t* was found to be equal to 3.58 with a *p* value of 0.0009. These results indicate a significance difference in achievement of period 9/10 and period 12(table IV).

Each class was administered a pre test before beginning the unit. Period 9/10 had a mean score of 62.76. The mean score for the pre test for period 12 was 54.50 which is 8.26 points lower than period 9/10. The *t* value was determined to be 2.90 with the *p* value of 0.0058 (table V). These values still show a significant difference between the two classes.

Period 12 students were placed into groups of four students. Each class received the same instruction on formula writing, organic chemistry, and chemical composition of the nutrients - carbohydrates, fats, proteins, and vitamins and minerals. Both classes were given the same study worksheets to complete. Period 12 worked on the worksheets in their groups knowing that they would all take a quiz. Improvement points were awarded as the unit progressed. The improvement points were posted and recognition given to the all the groups with special congratulations to the group with the highest improvements points. At the end of the unit a post test was administered. The mean score for period 9/10 was 73.6 while period 12 had a mean score of 66.7 only 6.9 points lower. The individual difference between pre and post test scores for each student was computed. The mean score for these differences showed an average increase of 10.9 points for period 9/10 and an average increase of 12.2 points for period 12. Period 12 showed slightly higher improvement than period 9/10. The results of the t tests of these means (table VI) show no significant difference between the two classes.

Table I

Second Marking Test Scores Averages

Section 9/10	Section 12
79	55
83	64
76	81
81	58
58	77
72	77
86	84
92	83
93	72
107	65
87	54
81	74
85	71
111	72
72	75
75	67
86	75
73	82
108	50
93	61
97	
99	
82	
72	
47	

Table II

Pre Test Scores

Section 9/10	Section 12
63	70
53	57
57	53
53	47
53	47
57	63
77	77
83	50
63	47
80	43
57	47
53	47
57	70
77	53
63	60
50	53
70	43
60	63
70	50
60	50
53	
63	
70	
67	
60	

Table III

Post Test Scores

Period 9/10	Period 12
63	77
77	60
63	60
60	53
63	57
67	80
83	83
67	80
83	57
87	57
80	73
77	70
93	67
83	63
67	87
60	77
77	43
53	70
97	83
73	57
80	
70	
47	

Table IV

Analysis of Second Marking Period Test Scores

The mean value for period 9/10 was 83.8. The mean for period 12 was 69.9. When those scores were compared using a t test the t value is 3.58 with a p value of 0.0009 showing a significant difference in the test averages of these two classes

T TEST

Second Marking Period Scores

	N	MEAN	STDEV	SE MEAN
9/10	25	83.8	14.8	3.0
12	20	69.8	10.2	2.3

95 PCT CI FOR MEAN 9/10 -MEAN 12: (6.1, 21.8)

TTEST Mean 9/10 = Mean 12 (VS NE) T = 3.58 P = 0.0009 DF = 43

Table V

T TEST

Analysis of PreTest Scores

The mean value for period 9/10 was 62.76. The mean for period 12 was 54.50 Using T Test analysis with a T value of 2.90 and P equal to 0.0058 there still appears to be a significant difference between the two classes.

Pre Test Scores

	N	MEAN	STDEV	SE MEAN
9/10	25	62.76	9.32	1.9
12	20	54.50	9.68	2.2

95 PCT CI FOR MEAN 9/10 -MEAN 12: (2.5, 14.0)

TTEST Mean 9/10 = Mean 12 (VS NE) T = 2.90 P = 0.0058 DF = 43

Table VI

T TEST

Analysis of Post Test Scores

The mean value for period 9/10 was 73.6. This was a net gain of 10.84 points over the mean value of the Pre Test scores. The mean for period 12 was 66.7. This was a net gain of 12.20 points over the mean value in the Pre Test scores. The T Test analysis of the post test scores has a T value of 1.87 and a P equal to 0.069 which means we fail to reject the null hypothesis that the two classes are equal.

Post Test Scores

	N	MEAN	STDEV	SE MEAN
9/10	25	73.6	12.5	2.5
12	20	66.7	12.3	2.7

95 PCT CI FOR MEAN 9/10 -MEAN 12: (-0.6, 14.4)

TTEST Mean 9/10 = Mean 12 (VS NE) T = 1.87 P = 0.069 DF = 43

Analysis of Individual Gain Scores

	N	MEAN	STDEV	SE MEAN
9/10	25	10.9	12.0	2.4
12	20	12.2	12.6	2.8

95 PCT CI FOR MEAN 9/10 -MEAN 12: (-8.7, 6.1)

TTEST Mean of gains 9/10 = Mean of gains 12 (VS NE) T = -0.36 P = 0.72

DF = 43

Chapter V

Summary

This project was an attempt to determine if students working in cooperative groups would improve their level of achievement. The overall atmosphere in the classroom during the project was one of enthusiasm and student interest was high. Each week the students in period 12 were eager to compute the improvement points for their team. During the completion of the unit there was considerable interruption. The preparation of the musical, practice testing for the HSPT, and the illnesses common to the third marking period each year. Another factor affecting the results of the study was the proficiency of the teacher in the method of cooperative learning. The teacher was new to this method of instruction. The students were also new to this style of learning. Results may have been different if teacher and students were more familiar with the technique of cooperative learning. An attempt was made to have students keep a portfolio to evaluate their achievement. To determine the impact of this effort on the students achievement a longer time interval than one marking period would be needed.

The results of the statistical analysis does represent a narrowing in the difference in achievement levels of the two classes. It indicates that further study of the use of this technique is worthwhile in the teaching of chemistry to the “less-motivated” high school student.

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APPENDIX

PART A

Pre Test

The following is the sample of the pre test that was given to both sections of lab chemistry class. The answer key follows.

Pre Test Formula writing/foods unit Name ________________

Choose the word, formula, or phrase that best completes the following examples. Put the letter of your answer on the scantron.

1. All of the following are organic compounds except:
   a. C_2H_2 b. H_2O c. CH_3CH_3 d. $CH_3CH_2CH_3$
2. Ethane, ethene, and ethyne are all similar in that they are:
   a. Hydrocarbons b. All unsaturated c. All saturated
   d. Aromatic
3. The general formula for an alcohol is
   a. R-H b. R-OH c. R-COOH d. R-COOR'
4. An example of an organic acid is
   a. CH_3OH b. $CH_3CH_2CH_2OH$ c. CH_3COOCH_3
   d. $C_5H_{11}COOH$
5. All of the following are animal protein sources except:
   a. Soybeans b. Cottage cheese c. Steak d. Skim milk
6. Our food supply depends on all of the following except:
   a. Green plants b. Sunlight c. Minerals d. Animals
7. All of the following are nutrients except:
   a. Protein b. Vegetables c. Fats d. Minerals
8. All of the following are carbohydrates except:
   a. Cellulose b. Meat c. Starch d. Sugar
9. Foods can be preserved in all of the following ways except:
   a. Soaking in warm water b. Refrigeration c. Cooking
   d. Salting
10. When food is burned in our body cells, all of the following are produced except

a. Heat b. Carbon dioxide c. Water d. Carbon monoxide

11. All of the following foods are rich in iron except
    a. Eggs b. Kale c. Lima beans d. Butter

12. The form of iron used best in your body is
    a. Fe b. Fe^{2+} c. Fe^{3+} d. All are equal

13. Iron is considered to be a
    a. Protein b. Carbohydrate c. Mineral d. Vitamin

14. The first step in protein digestion is
    a. Decomposition to peptones b. Decomposition to amino acids
    c. Decomposition of peptones to amino acids d. Coagulation

15. Proteins are coagulated by all of the following except
    a. Heat b. Acids c. Sugar d. Enzymes

16. All of the following are examples of protein coagulation except
    a. Sour milk b. Melting butter C. Boiling eggs d. Clotting blood

Decide if each of the following statements are true or false. Put your response on the scantron.

17. $C_n(H2O)_n$ is the general formula for a fat.

18. Vitamin C is found in oranges and prevents scurvy.

19. Vitamin B has not been proven to be essential to human life.

20. Cooked foods are easier to digest because the fats are coagulated by heat.

21. Pentanol is a five-carbon alcohol.

22. The functional group for hexanoic acid is the hydroxyl group.

23. The carboxyl group is responsible for the properties of an organic acid.

24. Molecular formulas always give the simplest whole number ratio of atoms in a molecular substance.

25. Energy in food is expressed in Calories. One Calorie is equal to 1000 calories.

26. Saturated fats have only single bonds.

27. Fats contain more calories per gram than carbohydrates.

28. All proteins can be stored in your body until needed.

29. Vegetable proteins do not provide all the essential amino acids.

30. Vitamin A is essential to life but an overdose is poisonous.

Answers Pre test

1. b
2. a
3. b
4. d
5. a
6. c
7. b
8. b
9. a
10. d
11. d
12. b
13. c
14. d
15. c
16. b
17. b
18. a
19. b
20. b
21. a
22. b
23. a
24. b
25. a
26. a
27. a
28. b
29. a
30. a

APPENDIX

PART B

Post Test

The following is the sample of the post test that was given to both sections of the lab chemistry classes. The answer key follows.

Post test - formula writing/food unit Name ____________

Choose the word, formula, or phrase that best completes the following examples. Put the letter of your answer on the scantron.

1. All of the following are organic compounds except:
   a. C_2H_2 b. H_2O c. CH_3CH_3 d. $CH_3CH_2CH_3$

2. Ethane, ethene, and ethyne are all similar in that they are:
   a. Hydrocarbons b. All unsaturated c. All saturated
   d. Aromatic

3. The general formula for an alcohol is
   a. R-H b. R-OH c. R-COOH d. R-COOR'

4. An example of an organic acid is
   a. CH_3OH b. $CH_3CH_2CH_2OH$ c. CH_3COOCH_3
   d. $C_5H_{11}COOH$

5. All of the following are binary compounds except:
   a. nitrate b. Iron sulfide c. ammonia d. Carbon disulfide

6. The correct name for P_2O_5 is
   a. Potassium II oxide b. Phosphorus II oxide c. Diphosphorus pentoxide
   d. phosphate

7. All of the following are nutrients except:
   a. Protein b. Vegetables c. Fats d. Minerals

8. All of the following are carbohydrates except:
   a. Cellulose b. Meat c. Starch d. Sugar

9. The ester methyl salicylate (wintergreen) is composed of
   a. Alcohol and organic acid b. Alcohol and aldehyde c. Organic acid and ketone d. Alcohol and ketone

10. When food is burned in our body cells, all of the following are produced except
    a. Heat b. Carbon dioxide c. Water d. Carbon monoxide

11. All of the following foods are rich in iron except
    a. Eggs b. Kale c. Lima beans d. Butter

12. The form of iron used best in your body is
    a. Fe b. Fe^{2+} c. Fe^{3+} d. All are equal

13. Iron is considered to be a
    a. Protein b. Carbohydrate c. Mineral d. Vitamin

14. The first step in protein digestion is
    a. Decomposition to peptones b. Decomposition to amino acids
    c. Decomposition of peptones to amino acids d. Coagulation

15. Proteins are coagulated by all of the following except
    a. Heat b. Acids c. Sugar d. Enzymes

16. All of the following are examples of protein coagulation except
    a. Sour milk b. Melting butter C. Boiling eggs d. Clotting blood

Decide if each of the following statements are true or false. Put your response on the scantron.

17. $C_n(H2O)_n$ is the general formula for a fat.

18. Vitamin C is found in oranges and prevents scurvy.

19. Iron II sulfate is the correct name for $Fe_2(SO4)_3$.

20. Cooked foods are easier to digest because the fats are coagulated by heat.

21. Pentanol is a five-carbon alcohol.

22. The functional group for hexanoic acid is the hydroxyl group.

23. The carboxyl group is responsible for the properties of an organic acid.

24. Molecular formulas always give the simplest whole number ratio of atoms in a molecular substance.

25. Energy in food is expressed in Calories. One Calorie is equal to 1000 calories.

26. Saturated fats have only single bonds.

27. Fats contain more calories per gram than carbohydrates.

28. All proteins can be stored in your body until needed.

29. Vegetable proteins do not provide all the essential amino acids.

30. Vitamin A is essential to life but an overdose is poisonous.

Post Test Answers

1. b
2. a
3. b
4. d
5. a
6. c
7. b
8. b
9. a
10. d
11. d
12. b
13. c
14. d
15. c.
16. b
17. b
18. a
19. b
20. b
21. a
22. b
23. a
24. b
25. a
26. a
27. a
28. b
29. a
30. a

APPENDIX C
EVALUATION FORM

PLEASE PROVIDE THE FOLLOWING INFORMATION

Name ______________________________ Also put your name on the Scantron answer sheet. Responses to surveys will be confidential.
Considering experiences you have had, respond to each statement using the following scale:
A Strongly agree B Agree C neutral D Disagree E Strongly disagree

1. Science is best done working alone.
2. Chemistry is very difficult for me to understand.
3. Lab work is helpful in learning key concepts and processes in chemistry.
4. I prefer to work alone on lab projects.
5. Working with others helps in learning chemistry.
6. Preparing lab reports is best done working alone.
7. I effectively communicate my understanding of chemistry.
8. Explaining concepts in chemistry to others helps me better understand the concepts.
9. In the real world, scientists do most of their important work working alone.
10. I find working with others in labs distracting and confusing.
11. In general, I learn better of I work alone.
12. In general, I learn better if I work with others.
13. Other students in my classes are generally helpful.
14. I like studying about issues in chemistry.
15. I can help my family better understand these issues.
16. I talk about what we are learning in class with my friends.
17. I talk about what we are learning in class with my family.
18. The information that I am learning in class will be useful to me in the future.

Using the scale which follows, how would you rate yourself on each of the items below.
A Very high B High C Moderate D Low E Very low

19. Interest in science
20 Interest in chemistry
21 Liking to work with others
22. Ability to communicate scientific ideas
23. Effort in learning chemistry
24. Capability in science
25. Capability in chemistry

Overall, how would you describe your attitude toward the study of chemistry.