2013

The effects of implementing the cooperative learning structure, numbered heads together, in chemistry classes at a rural, low performing high school

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THE EFFECTS OF IMPLEMENTING THE COOPERATIVE LEARNING STRUCTURE, NUMBERED HEADS TOGETHER, IN CHEMISTRY CLASSES AT A RURAL, LOW PERFORMING HIGH SCHOOL

A Thesis

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Natural Sciences

in

The Interdepartmental Program in Natural Sciences

by
Daniel Paul Baker
B.S., Louisiana State University, 1998
August 2013

Acknowledgments

I would like to express my sincere appreciation and gratitude to my committee chair, Dr. E. William Wischusen, for his time, effort, and expert advice during this process. I would also like to thank my committee members Dr. Vince LiCata and Dr. Joseph Siebenaller for their time and assistance. You all were great.

I would like to thank Dr. Chris Gregg, Dr. John Hopkins, and Dr. Linda Allen also for their time and effort during LaMSTI classes over the last few years. Each of you have been a tremendous help to me in my quest to improve as a teacher.

I would also like to thank the members of my LaMSTI cohort. I enjoyed spending the last few summers with you all and I wish you the best in the future.

And finally, I would like to thank my family. Your support and love mean so much to me.

Table of Contents

Acknowledgments....................ii

List of Tables....................iv

List of Figures....................v

Abstract....................vi

Introduction....................1

Methods....................10

Results....................17

Discussion....................23

Additional Notes and Observations....................28

Conclusion....................31

Literature Cited....................32

Appendix A: Student Survey....................33

Appendix B: IRB....................34

Vita....................35

List of Tables

Table 1: Demographics of high school and Chemistry classes in this study..10

Table 2: Chemistry and AP Chemistry Spring 2013 Units of Study..11

Table 3: Daily class agendas for control and experimental units..12

Table 4: Student performance levels...13

Table 5: Normalized mean learning gains for all students in Chemistry and AP Chemistry for units taught with and without NHT...18

Table 6: Percentages of problems (that require students to show all work) on unit exams that were attempted by students..19

Table 7: A comparison of normalized mean learning gains for stronger, average, and weaker performing groups of students in Chemistry for units taught with and without NHT..20

Table 8: Normalized mean learning gains by gender for Chemistry and AP Chemistry units taught with and without NHT..21

List of Figures

Figure 1: The normalized mean learning gains for Chemistry class units taught with and without NHT.............17

Figure 2: The normalized mean learning gains for AP Chemistry class units taught with and without NHT.......17

Figure 3: Percentage of test problems attempted...19

Figure 4: Normalized mean learning gains by gender for Chemistry units taught with and without NHT............21

Figure 5: Normalized mean learning gains by gender for AP Chemistry units taught with and without NHT.....21

Figure 6: Normalized mean learning gains for quiet students..28

Abstract

Due to the positive academic results in numerous studies on cooperative learning and the need and desire to improve academic results in East Feliciana High School Chemistry classes, the implementation of a cooperative learning structure called "numbered heads together" was studied during the spring 2013 semester at this rural, low performing high school. Numbered heads together was utilized during three units of a Chemistry class with 24 students and three units of an AP Chemistry with 11 students after completion of two units taught without the use of any type of cooperative learning structure. Using pre- and post-tests, learning gain differences were analyzed using a Wilcoxon matched-pairs test to determine the effectiveness of numbered heads together versus the use of individualized learning only for whole classes, varying levels of academic performance, and gender. Results indicated the use of numbered heads together was more effective than individualized learning for boys in the Chemistry class and those students classified as "weaker performing students" in the Chemistry class. The use of numbered heads together was as effective as individual instruction for all other groups of students. Student surveys indicated more enjoyment and engagement in their Chemistry or AP Chemistry class using numbered heads together as opposed to individualized learning.

Introduction

Many high school students consider chemistry to be a difficult and boring class. Reflection on the first three years of teaching high school chemistry reveals memories of the common and consistent occurrences of students quickly losing interest during lessons. Assignments issued to students to complete individually resulted in too many students becoming frustrated, quitting, and in many cases resulting in misbehavior. While contemplating the explanations and possible solutions to these issues, it's easy to forget an important fact for most of these students. They are teenagers who naturally value and seek attention and interactions with their peers. As teachers, why not use this to our advantage? The use of cooperative learning structures the interactions and attention teenagers seek from one another into learning activities that could lead to increased student engagement, interest, and achievement in Chemistry.

Over the last 30 years, research has demonstrated that cooperative learning is an effective instructional tool that has been widely adopted at all levels of education (Johnson & Johnson, 2009; Schroeder, 2007; Kyndt, 2013). Research also suggests that the use of cooperative learning is particularly effective in both science and math (Kyndt, 2013). Cooperative learning is an instructional grouping strategy that consists of required elements to promote more effective, creative and efficient learning by students working respectfully together to achieve a common learning goal (Johnson & Johnson, 1988; Slavin, 1988). The required elements are meant to enhance the learning experience with strengthened relationships, student engagement, and academic achievement.

The success of cooperative learning is credited in part to it being based on social interdependence theory and the clear operational procedures enabling and promoting its use in the classroom (Johnson & Johnson, 2009). Social interdependence exists in a classroom setting when the success of a group of students depends on the actions and behavior of each student in the group (Johnson & Johnson, 2009). According to Johnson and Johnson, cooperative learning should include each of the following elements:

- Positive Interdependence: Students work together to achieve a learning goal. When students set a group learning goal, the success of cooperative learning is improved and the success of every student in the group becomes critical for obtaining the group's learning goal (Slavin, 1988; Kyndt, 2013). The students in a group must believe that they will succeed or fail together (Johnson & Johnson, 1988). Slavin indicates that groups working cooperatively without a group goal are less likely to participate in discussions utilizing higher order thinking (Slavin, 1988). Positive interdependence has been shown to motivate more students to work and try harder than they would when working independently and it has been shown to increase the use of higher level reasoning strategies (Johnson & Johnson, 2009). Positive interdependence has also been shown to increase student's sense of responsibility for his or her contributions to the group. It also promotes an individual student's interest in the progress and quality of other group members' assignments or tasks. He or she is more willing to assist (Johnson & Johnson, 2009). It is important that the teacher manages each group to maintain positive interdependence (Johnson & Johnson, 1988)
- Individual Accountability: Students are required to participate and their individual success and the success of their group are dependent on it (Slavin, 1988). Each student is therefore accountable to the members of his or her group in addition to the teacher for the quality of his or her performance. During cooperative learning structures, students in each group should participate equally and public performance must be required (Kagan & Kagan, 2009). The group is evaluated and results provided to the group in addition to individual evaluations by both the teacher and the students in the group. A recent analysis of cooperative learning research indicated the importance of ensuring individual accountability to achieve the most success (Kyndt, 2013).
- Promotive interaction: Positive interdependence should result in promotive interaction which is described as students encouraging each other as they work toward their common goal(s) (Johnson & Johnson, 2009). Additional evidence of promotive interaction includes students who trust one another, share information and resources, work efficiently and effectively to assist one another,

provide and accept constructive feedback from group members for improvement, and utilize higher order thinking skills when discussing and challenging ideas within the group (Johnson & Johnson, 2009).

- Appropriate use of group social skills: Members of each group must possess or learn the skills needed to familiarize themselves with each other, trust each other, communicate well, accept each other, support each other, and resolve conflicts constructively (Johnson & Johnson, 2009). Over time, developed social skills will be an asset for students as they move forward academically and professionally. (Johnson & Johnson, 2009)
- Group processing: Each member of a group must be offered time to reflect on the strengths and weaknesses of their groups processes (Bowen, 2000). Thought should be given to the actions of each group member so that steps can be taken to improve the group's effectiveness and efficiency in order to successfully achieve the group's goal(s).

Research suggests that most students involved in cooperative learning achieve more than students learning individually or competitively and they are more positive about school, subject areas, and other students with whom they work (Johnson & Johnson, 1988).

When compared to individual learning within a classroom, cooperative learning strategies offer additional advantages. Instead of only one student at a time responding to a question that was asked by a teacher, multiple groups discussing the same question at the same time allows for many more students to discuss the questions simultaneously and more often. It seems obvious also that when three or four students are attempting to solve a problem or answer a question together, the discussion will require students to think critically and creatively. Caution must be used, however, when using cooperative learning because if not properly structured, some students will be able to benefit from the work of the other students in the group without making a contribution themselves (Kyndt, 2013).

According to Johnson and Johnson, teachers must closely monitor how groups are functioning and progressing, intervening when necessary to help students resolve issues with learning objectives or other group issues arising from improper interpersonal skills that the teacher may need to teach (Johnson & Johnson, 1988).

Some common cooperative learning strategies that include the five components of cooperative learning are summarized below:

- Think-pair-share: The teacher poses a question, problem, or topic. Each student has a designated amount of time to think about a response. Each student then shares his or her response with his or her assigned partner. The two students discuss and formulate a final response which they share with the rest of the class. Think-pair-share fulfills the requirements of promoting positive interdependence and individual accountability because every student is required to participate and each student must work with a partner making every student accountable for individual and group success (Lindauer & Petrie, 1997). To improve student performance in cooperative learning structures such as "think-pair-share", the teacher should allow time for student's to reflect on the processes of their group.
- Inside-Outside Circle: Students stand in two concentric circles. The students in the inside circle are facing out and the students in the outside circle are facing in so that each student has a partner. After the teacher poses a question, the pairs of students discuss the question and formulate a response. The teacher calls on a group to answer the question. The inside circle then rotates to a new partner for the next question (Lindauer & Petrie, 1997). Two students working together face to face to formulate a response to a question that they will possibly be called on to answer to the class creates conditions where positive interdependence and individual accountability exist. Two students discussing a science topic to answer a mid to high-level question will have to use utilize higher order thinking skills and think critically during the discussion.

- Jigsaw: Students are assigned to groups. An assigned topic is divided up among the students according to directions from the teacher. Students are given time to read or research their part of the topic. After the individual research time, students from each group with the same portion of the topic gather together to discuss and learn their material well enough to teach it to the other members of their original group. These students become "experts" on their topic (Slavin, 1988). The next step is for all students to return to their original groups where each student teaches their portion of the topic to the rest of the students in their group. This cooperative learning structure is more complex than "think-pair-share" and "inside-outside circle" and is more demanding on students. Each student knows that he or she is solely responsible for teaching the other members of the group a part of the learning objective. Positive interdependence and individual accountability are major components of this Jigsaw. Promotive interaction is in play here because students are forced to trust each other, share information, and work together efficiently in order to be successful. Learning and teaching are occurring simultaneously between students demanding higher order and critical thinking skills.
- Numbered Heads Together (NHT): This cooperative learning structure may be a productive starting point for a teacher with little experience using cooperative learning due to its simplicity and versatility. Numbered heads together works as follows:
    - Students are assigned to heterogeneous groups of four.
    - Each student is assigned a number (1, 2, 3, or 4).
    - At various times during a lesson, the teacher poses a question and instructs the students to put their heads together.
    - Students spend an allotted amount of time discussing the question and formulating a response.
    - The teacher calls a number at random. The student with that number in the group is responsible for his or her group's response. (A volunteer with the number called may

answer, all students with the number called may answer in unison, or all students with the number called may write a solution to the question (or problem) on a dry erase board.)

NHT is relatively simple and is recommended by Kagan as a strategy especially useful for checking students' understanding of lesson objectives (Kagan & Kagan, 2009). NHT creates positive interdependence and individual accountability within groups of four students since each individual student is potentially responsible for the success of his or her group if their number is called. A successful response equals immediate success for both the group and the individual student. For effective groups, an observer will notice promotive interactions, appropriate use of group learning skills, and respectful, but honest group processing.

A study utilizing NHT in sixth grade science showed significant positive results (Maheady et al. 2006) Emphasis was placed on the importance of good questioning techniques by teachers in order to improve student achievement. The authors state that NHT is a good teaching strategy because its operational procedures support the following questioning techniques (Maheady et al. 2006):

- open- and closed-ended questions
- questions of different levels of difficulty
- time allowed for students to think of a response
- useful feedback from the teacher that is instructional in nature (Maheady et al. 2006)

In addition to careful attention paid to questioning, the purpose of their study was to measure the effects of NHT with and without behavioral incentive packages on daily quizzes, pre- and post-tests, and student response surveys (Maheady et al. 2006). The first phase in the study by Maheady et al. (2006) consisted of questions directed to all students in the class. Students could raise their hands to respond with volunteers randomly selected by the teacher (Maheady et al. 2006). Before beginning the NHT phases, each student was assigned to a small heterogeneous group consisting of at least one each high, average, and low achieving students. Students were allowed to number themselves 1, 2, 3, or 4. For groups that had only three students, students rotated being numbers 3 and 4 for a week (Maheady et al. 2006). Students would sit together in their groups. The teacher would ask a question to the whole class and instruct students to "put your heads together, come up with the best answer you can, and make sure everybody on your team knows the answer." About 30 seconds was given for groups to formulate their answers after which the teacher would say "All number (1, 2, 3, or 4 students) who know the answer, raise your hands." One student would be called on to answer. Following that student's response, the teacher would ask the other students with the same number if they agreed with that response and then she would provide feedback (Maheady et al. 2006). Students were tested with a science quiz at the end of the session (Maheady et al. 2006).

A third phase included the use of NHT with incentives for individuals and groups which included points for correct responses, public posting of team scores, and certificates for high performing groups. After completion of NHT with incentives, NHT was used without incentive for seven sessions followed by the final phase of seven additional sessions of NHT with incentives. The teacher in this study had 28 years of experience and a trained observer was present to collect data. Results of this study revealed that 83% of students had their highest mean percent accuracy on the quizzes after "NHT with incentives" was used. 13% of students had the highest mean percent accuracy on their quizzes after the use of "NHT without incentives" and 4% (only one student) had the highest mean percent accuracy after the use of "whole group question-answer" (Maheady et al. 2006). The author states that NHT or NHT with incentive "provide teachers with two relatively easy-to-implement, low cost, and effective ways to teach the essential knowledge base to support pupils' acquisition of important science concepts" (Maheady et al. 2006).

For students in a rural, low performing, high-needs, high school Chemistry class, utilization of cooperative learning strategies along with more effective and frequent questioning would seem to be effective instructional practice that might result in higher achievement on unit tests as has been shown in other studies (Johnson & Johnson, 2009; Maheady, 2006; Kyndt, 2013; Schroeder, 2007). For juniors and seniors in high school who have little experience working productively in cooperative learning groups, it seems reasonable to start simple. In the situation, where the teacher is focused on improving questioning practices, and attempting to raise the academic expectations of the students in science, a cooperative learning structure that is simple for students to understand and more manageable for a new teacher to implement could be an effective choice. It was important that the cooperative structure chosen function for conceptual questions requiring verbal responses as well as the problem solving required in high school chemistry. For a novice cooperative learning instructor, the ability and time to observe the effects of the cooperative learning structure were important. Would shy, quiet students be negatively impacted by its use? Would girls or boys – or both genders – react positively to this instructional technique? Would the academically stronger students benefit from working directly with academically weaker students, or would they become bored and be negatively impacted?

Research is mixed on differences between genders when learning math and science (Halpern, 2007). Although boys are traditionally considered to have advantages over girls when learning math and science, girls earn higher grades in math and science demonstrating they can and usually do outperform boys in math and science classes (Halpern, 2007; Gurian, 2011). The level of achievement for any particular student, however, is affected by a student's belief in his or her ability to achieve success and in the value he or she places on the subject (Leaper, 2011). For these two qualities, boys usually score higher than girls (Leaper, 2011). Girls, however, can be further motivated to achieve more in math and science when they observe that their peers place more value, including interest, in these subjects (Leaper, 2011). Leaper's study concluded that "peer support may be especially important for adolescent girls" (Leaper, 2011).

A different study on peer relationships and gender considerations when using collaboration in a classroom yielded "no significant interaction between friendship and gender on problem-solving performance", meaning there were no differences between friends and non-friends or girls and boys when collaborating for problem-solving (Swenson, 2008). However, on a scientific reasoning task, students who perceived conflict within their group during interactions scored lower than others on the "justification" portion of their group task. Even if they answered the question correctly, they were more likely unable to explain the reasoning for the correct response. Swenson states that "conflict may have been disruptive such that students did not effectively use their time and lost focus on the task" (Swenson, 2008). If implementing a cooperative learning structure in a classroom for the first time in an environment of common student misbehavior, perhaps additional consideration should be made to assign students into groups with the intention to create as much harmony as possible.

Partnering high achieving students with low achieving students presents possible issues such as a high achieving student dominating the group discussion and/or the lower achieving student accepting his or her own low academic ability resulting in non-participation. This can be countered with the use of structured cooperative learning that creates the components of positive interdependence and individual accountability (Kagan & Kagan, 2009). If structured, all students in a group, regardless of achievement level, become invested in the success of each other. Additionally, a study showed that when groups consisted of different levels of academic achievers, the use of learning goals improved the "quality of learning" as opposed to when working together without a learning goal (Gabriele & Montecinos, 2001). They conclude that the use of learning goals may not increase the verbal participation of low achieving students, but it did influence "cognitive processing of the verbal information presented" during group discussions (Gabriele & Montecinos, 2001). A simple to learn cooperative learning structure used by heterogeneous groups of students with a mutual learning goal is the instructional technique that was investigated in this study.

The purpose of this study was to determine the effects of implementing the cooperative learning structure "numbered heads together" (NHT) on chemistry test achievement in a learning environment similar to those described here. This simple to learn cooperative learning structure used by heterogeneous groups of students with a mutual learning goal is the instructional technique that was taught and examined in this study. Students' test scores were examined based on whole-class, gender, and prior academic performance in order to determine the potential future use of NHT or any adjustments necessary to improve its use in the future.

Methods

The numbered heads together approach was implemented during the spring 2013 semester in the only two chemistry courses offered during that semester at East Feliciana High School. East Feliciana High School is located in a rural area, serving as the only public high school in a parish of approximately 10,600 residents. The school operated on a block schedule with four 106 minute class periods per day, four days per week (Tuesday-Friday). Each course was completed in one semester.

East Feliciana High School is a “Title I” school meaning it has a high percentage of students from low income families (Table 1). Title I schools receive extra federal funding in order to help low income and minority students close the achievement gap. East Feliciana was most recently rated as a “D” school by the state of Louisiana during the 2011-2012 school year (Louisiana Department of Education, 2012). The school has experienced an almost continuous change in leadership. During the 2012-2013 school year, four individuals served as principal or as “lead administrator” at the school. The school will have a new principal to begin the 2013-2014 academic year. Behavioral issues, lack of discipline, and academic dishonesty were issues commonly faced and discussed by teachers. The last PTO/open house meeting had fewer than 20 parents in attendance. Two parents of chemistry students attended the PTO/open house meeting held during the 2013 spring semester.

Table 1. Demographics of high school and chemistry classes in this study

	School	3rd Block Chemistry	4th Block AP Chemistry
Total Student Population	380	24	11
Female	202	15	9
Male	178	9	2
Black	354	22	11
White	26	2	0
Juniors	88	21	11
Seniors	65	3	0
Free/Reduced Lunch	>95%		

The Chemistry and AP Chemistry teacher in this study was a 42 year old male with four years of teaching experience. He has three years of experience teaching chemistry – all at this high school. This was his first semester teaching AP Chemistry. Prior to the spring 2013 semester, the teacher had limited experience using NHT, having attempted it briefly during the previous two semesters. NHT was not fully utilized due to classroom management issues.

Prerequisites for Chemistry included Physical Science in 9th grade, Biology in 10th grade, Algebra I, and completion of or enrollment in Algebra II at the time Chemistry was scheduled. The prerequisites for AP Chemistry included the same courses (preferably honors) required for Chemistry in addition to a high grade point average and recommendation by the school guidance counselor. This was the first semester AP Chemistry was offered at the school and the first time AP Chemistry was taught by this teacher.

Because of the small number of students participating in this study and the differences between the regular Chemistry and AP Chemistry curriculum, each student served as their own control by measuring and comparing their test performances on two control units without NHT to three experimental units using NHT. The two control units occurred before the three experimental units and did not use cooperative learning structures of any type (Table 2). Due to numerous interruptions during the last few weeks of school, the results for the last unit in each class were not included in this study.

Table 2. Chemistry and AP Chemistry Spring 2013 Units of Study

	Chemistry	AP Chemistry
Introductory Units (no cooperative learning structures used)	Units 1-3	Units 1-2
Control Units (without NHT or any other cooperative learning structure)	Unit 4: Compounds and Molecules Unit 5: Stoichiometry and Chemical Reactions	Unit 3: Stoichiometry and Chemical Reactions Unit 4: Reactions in Aqueous Solutions
Experimental Units (utilizing NHT)	Unit 6: Reactions in Aqueous Solutions Unit 7: Gases Unit 8: Electrons and Periodic Trends	Unit 5: Thermochemistry Unit 6: Gases Unit 7: Electrons and Periodic Trends
Additional Unit (utilizing NHT)	Unit 9: Chemical Bonding	Unit 8: Chemical Bonding

The daily class agendas for each class were planned so that during the experimental units NHT would be the only change (Table 3). During the experimental units, NHT was used as an option in place of individuals called on without the time given for students to confer as groups. NHT was used at least once a day during either the warm-up review, homework review, or during assignments following the lesson on new objectives.

Table 3. Daily class agendas for control and experimental units.

Class Agenda during Control Units	**Class Agenda during Experimental Units**
I. Warm-up question or problem Completed individually.	I. Warm-up question or problem Completed individually.
II. Warm-up review Individuals called on to respond. Individual volunteers responded.	II. Warm-up review Individuals called on to respond. Individual volunteers responded. OR use of **numbered heads together**.
III. Homework review Individuals called on to respond. Individual volunteers responded.	III. Homework review Individuals called on to respond. Individual volunteers responded. OR use of **numbered heads together**.
IV. New learning objectives lesson Questions directed to and answered by individual students.	IV. New learning objectives lesson Questions directed to and answered by individual students.
V. Application of new learning objectives Completed individually. Individuals called on to respond. Individual volunteers responded.	V. Application of new learning objectives Completed individually or NHT groups. Individuals called on to respond. Individual volunteers responded. OR use of **numbered heads together**.
VI. Lesson exit slip Completed individually.	VI. Lesson exit slip Completed individually.
VII. Homework issued	VII. Homework issued

Implementation of Numbered Heads Together

Students were assigned to groups of 3 or 4. Each group was assigned a number. Each student in the group was also assigned a number between 1 and 4. A new seating chart was devised so that students could sit together throughout the class. The groups were chosen so that each group had a stronger performing student, two average performing students, and one weaker performing student based on grades and quality of submitted work prior to the beginning of the first control unit (Table 4).

Table 4. Student performance levels

	Students grade at the conclusion of the introductory units	Corresponding Letter Grades (based on District Grading Scale)
Stronger Performing Students	85-100%	A and B
Average Performing Students	67-84%	C and D
Weaker Performing Students	0-66%	F

Other factors considered when assigning groups included gender, behavior, and/or specific student issues. Close friends, enemies, and students dating each other were all assigned to different groups.

At various times during class (noted in the daily agenda for experimental units above), questions were posed to students as "numbered heads together" questions. The teacher would announce the question as a NHT question worth a predetermined number of points.   For a specified period of time, students would confer with fellow group members to discuss the question and formulate a response. Students were expected to be able to provide reasoning for their responses. Students were able to refer to notes and the periodic table as needed. The teacher circulated through the classroom to keep students and groups on task, encourage students who were not participating, and monitor group discussions as evaluation.

To help maintain order in the classroom, only one student from one group was chosen at a time to answer a question. Using two sets of numbered index cards, the teacher would draw a group number and a student number to determine which student would answer the question. After each question, the cards were placed back into their stack and shuffled so that any student from any group could potentially be drawn for any question. This was done in view of students so they could be certain that the drawings were indeed random. The student was required to answer the question for the group. If the student refused to answer or answered incorrectly, each member of the group received a zero for the question. Correct responses earned full credit. At times, partial credit was awarded. For problems such as balancing chemical equations, stoichiometry, concentrations, or gas laws, only a student number was drawn. All students with that number would work the problem on their designated dry erase board on the wall. The teacher would then determine (based on the results) which student would first explain their work and answer follow up questions. For problems written on the dry erase boards, partial credit could be earned.

Using NHT during warm-ups and homework reviews allowed individual students time to answer questions or solve problems alone before working with their group. Students were then able to present their answer or solution to the question or problem to their group. For NHT questions or problems during the lesson, the teacher announced the amount of time available before a number would be drawn. The group would then discuss and decide on a final response or solution before one student's number was drawn by the teacher to represent their group. It is worth noting that although NHT was used in class at least once per day, it wasn't always used to answer questions or practice working chemistry problems related to the new learning objectives for a given day. It is possible that some learning objectives were not reviewed, discussed, or practiced by students utilizing NHT.

The questions used during the control units (whole-group question and answer) and the experimental units (whole-group question and answer and NHT) were determined before class. Questions used in all units throughout the course were taken from various sources. The AP Chemistry student textbook (Brown, 2012) was a main source, specifically using "Go Figure" questions, "Give It Some Thought" questions, "Sample Exercises", and "Practice Exercises". The "Go Figure" questions were usually accompanied by images that were projected onto the Smart Board during the question and discussion time. For Chemistry, some of the supplemental materials provided by the textbook publisher were used as resources for questions (Chemistry: Matter and Change, 2012). Follow up or clarifying questions were added during class and were based on students' initial answers to questions. During units utilizing NHT, points were awarded for correct responses to NHT questions to provide incentive for all students and to promote individual student accountability. Effort was made to ask questions that were open ended and the teacher demanded that all students demonstrate proper respect to those answering questions (or lose points for everyone in their group).

To measure the effectiveness of NHT, students completed a pre-test and a post-test for each of the two control units and three experimental units – just as they did for the introductory units. Questions for the tests were taken from the textbook publisher's version of "ExamView." Question types included multiple-choice and problems (which required students to show all work for credit). Each question or problem counted as one point. Pre-test questions and post-test questions for each unit were identical. Calculators were provided for all tests. Pre-tests, and post-tests were different for Chemistry and AP Chemistry students (except for the unit "Electrons and Periodic Trends").

Students were awarded points for making a genuine effort on the pre-tests. In addition to those points that counted as a regular assignment, bonus points were awarded for each question they answered correctly on the pre-test. All questions and problems that were not multiple choice had to be answered 100% correct in order to be counted as a correct response. For example, when calculating the temperature of a gas using the ideal gas law, the student would have to show the equation(s) used, substitutions, and the correct answer with correct units in order to earn credit for that problem. Students who were absent for pre-tests or post-tests were allowed to make them up when they returned.   Units completed before the control units were not included in order to allow time for students to adjust to the teacher, pacing, and expectations of the class. Since the number of questions on tests varied from unit to unit, raw scores were converted percentages. The pre-test and post-test percentages for each unit were used to calculate the normalized learning gains for each student and for each class as follows:

$$\text{Normalized learning gain} = \frac{\text{posttest (\%)} - \text{pretest (\%)}}{100 - \text{pretest (\%)}} \qquad \text{(Coletta \& Phillips, 2005)}$$

For example, if a student scores a 10% on the pre-test, the highest possible increase would be 90 if the student earned a perfect score on the post-test. Then normalized gain in this case would be 1. Normalized gains range from 0 to 1. In the case of a student scoring a 100% on the pre-test, the pre-test score would be adjusted to 99% to prevent dividing by zero when calculating normalized learning gain. The normalized learning gains for units taught with and without NHT were then compared using a Wilcoxon matched-pairs test using GraphPad Prism for Windows Version 6.02.

Also examined were the number of unit exam problems left blank. Perhaps the use of NHT, which was used extensively for practice problems and problem solving strategies, would impact the number of questions which the students attempted to solve. These problems involved calculations and/or multiple steps and students were required to show all of their work in order to earn full credit. At East Feliciana High School, it is common for students to leave the problems blank that require them to show all of their work. Based on pre-assessments given on the first day of class each semester, most students were beginning the course with relatively weak math and problem solving skills which is why time was reserved for review. However, students continued to struggle through the semester. A major stumbling block student's face when solving chemistry problems is deciding how to start. Based on feedback from previous classes, students who could not determine how to start a problem, would give up and leave it blank.

At the conclusion of the experimental unit, each student was invited to complete an anonymous online survey using the surveymonkey.com website. Each question included a section for comments. The only instructions given were to "please be honest so that the results would be useful." Participation was voluntary and those who elected to complete it were not tracked. Survey questions and possible responses are shown in Appendix A.

Results

<u>The effects of using NHT on unit test performances by class</u>

In Chemistry, there were no significant differences in normalized mean learning gains between units taught with or without using NHT (Figure 1). Likewise, in AP Chemistry, there were no significant differences in normalized mean learning gains between the NHT units and the units without NHT (Figure 2).

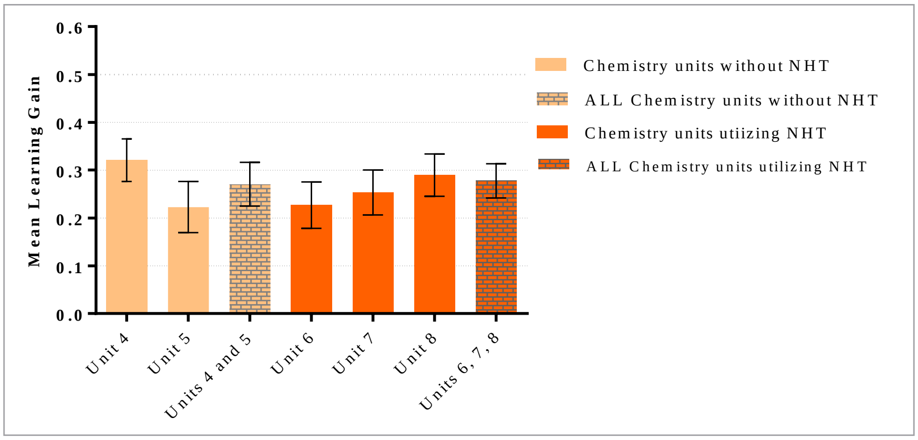

Figure 1. The normalized mean learning gains for Chemistry class units taught with and without NHT.

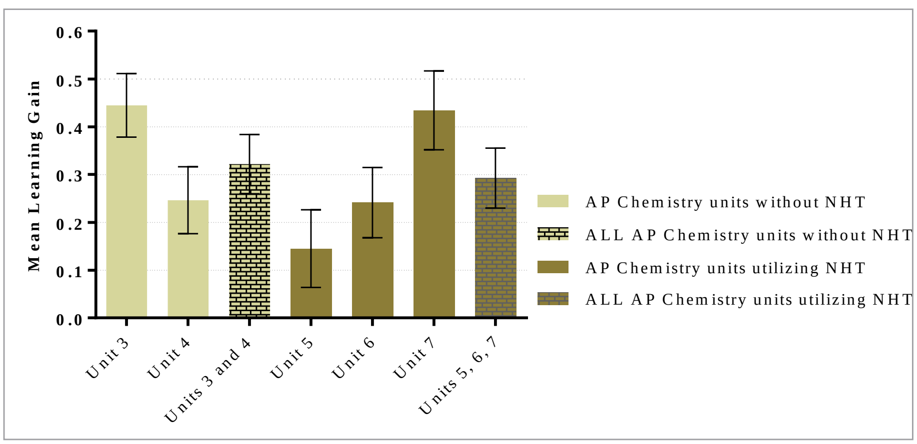

Figure 2. The normalized mean learning gains for AP Chemistry class units taught with and without NHT.

For Chemistry, there were a total of 30 questions on the two tests for the two units taught without NHT. The average percent correct on the pre-tests was 15.4% and the average percent correct on the post-tests was 38.1%. Calculation of the raw gain (as a percentage) for Chemistry students on the two units without NHT was 22.6%. The normalized mean learning gain for the Chemistry students in units taught without NHT was 0.270 ± 0.046 (Table 5). For the three units taught with NHT in Chemistry, there was a total of 55 questions on the three tests. The average percent correct on the pre-tests was 18.2% and the average percent correct on the post-tests was 40.7%. Calculation of the raw gain (as a percentage) for Chemistry students on the three units using NHT was 22.5%. The normalized mean learning gain for Chemistry students using NHT was 0.278 ± 0.036. A Wilcoxon matched pairs test, with $p < 0.05$ indicative of a significant difference, was used to determine no significant difference (P = 0.8238) in normalized mean learning gains when NHT is used. To summarize, based on the normalized mean learning gain, NHT was as effective as individual learning in the Chemistry class.

Table 5. Normalized mean learning gains for all students in Chemistry and AP Chemistry for units taught with and without NHT.

	Chemistry	AP Chemistry
Normalized Mean Learning Gain for all Units without NHT	0.270 ± 0.046	0.322 ± 0.062
Normalized Mean Learning Gain for all Units with NHT	0.278 ± 0.036	0.292 ± 0.063
Wilcoxon matched-pairs test	P = 0.7898	P = 0.4131

For AP Chemistry, there were a total of 36 questions on the two tests for the two units taught without NHT. The average percent correct on the pre-tests was 15.9% and the average percent correct on the post-tests was 38.6%. Calculation of the raw gain (as a percentage) for AP Chemistry students on the two units without NHT was 22.7%. The normalized mean learning gain for the AP Chemistry students in units without NHT was 0.322 ± 0.062. For the three units using NHT in AP Chemistry, there were a total of 61 questions on the three tests. The average percent correct on the pre-tests was 21.0% and the average percent correct on the post-tests was 43.5%. Calculation of the raw gain (as a percentage) for AP Chemistry students on the three units using NHT was 22.5%. The normalized mean learning gain for AP Chemistry students using NHT was 0.292 ± 0.063. Comparison of the normalized mean learning gains from the two units taught without NHT and the three units taught with NHT indicates NHT was as effective as individual learning (Wilcoxon matched-pairs test, P = 0.4131).

How did the use of NHT affect the number of written problems attempted on unit exams?

Chemistry students attempted 25% more of their post-test problems for the NHT units (Table 6) when compared to units taught without NHT (Figure 3). Of the two control units in Chemistry, only the unit on stoichiometry had problems that required students to show their work. On average, students attempted to work 43% of those problems. The two NHT units in Chemistry with problems to work on the post-test were "Reactions in Aqueous Solutions" and "Gases". Students attempted 71% and 63% of those problems, respectively.

AP Chemistry students attempted 23% less of their post-test problems for the units when NHT was used. In AP Chemistry, over 90% of the problems on the stoichiometry unit test were attempted. NHT was not used during the stoichiometry unit (unit 4). However, the number of test problems attempted in the other unit that did not use NHT ("Reactions in Aqueous Solutions"), fell to 57%. For AP Chemistry, 51% of post-test problems were attempted for the units taught utilizing NHT ("Thermochemistry" and "Gases") (Figure 3).

Table 6. Percentages of problems (that require students to show all work) on unit exams that were attempted by students.

	Total number of unit test chemistry problems in units taught without NHT.	Percent of unit test chemistry problems attempted by students in units taught without NHT.	Total number of unit test chemistry problems in units taught utilizing NHT.	Percent of unit test chemistry problems attempted by students in units taught utilizing NHT.
Chemistry	10	43%	13	68%
AP Chemistry	18	74%	15	51%

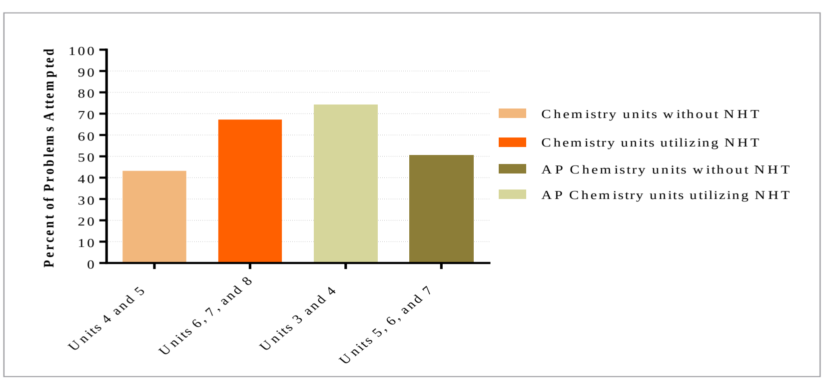

Figure 3. Percentage of test problems attempted.

How did the use of NHT affect students who were performing at different levels prior to this study?

In Chemistry, the use of NHT resulted in a significant increase (Wilcoxon matched-pairs test, P = 0.0039) in normalized mean learning gains for the weaker performing students (Table 7). The use of NHT was a more effective instructional tool for weaker performing students than individual learning and questioning. Normalized mean learning gain comparisons indicate the use of NHT was just as effective as individual learning for average performing students (Wilcoxon matched-pairs test, P = 0.2061) (Table 7). Owing to the small sample size (four) of stronger performing students, it is not possible to determine a meaningful P value.

Table 7. A comparison of normalized mean learning gains for stronger, average, and weaker performing groups of students in Chemistry for units taught with and without NHT.

Chemistry	Stronger Performing Students (n = 4)	Average Performing Students (n = 11)	Weaker Performing Students (n = 9)
Normalized learning gain for units without NHT	0.670 ± 0.017	0.291 ± 0.032	0.068 ± 0.019
Normalized mean learning gain for units with NHT	0.562 ± 0.076	0.236 ± 0.039	0.202 ± 0.033
Wilcoxon matched-pairs test	P = 0.2500	P = 0.2061	P = 0.0039

For the 11 student AP Chemistry class, statistically analyzing groups based on performance levels was not performed due to the very small sample sizes. There were only two stronger performing students, five average performing students, and four weaker performing students.

How did the use of NHT affect students according to gender on unit exam performances?

For girls in Chemistry (n = 15), the use of NHT was just as effective as individual instruction (Wilcoxon matched-pairs test, P = 0.4212) (Table 8). For boys in Chemistry (n = 9), normalized mean learning gains increased significantly when units were taught utilizing NHT (Wilcoxon matched-pairs test, P = 0.0273) (Figure 4).

For girls in AP Chemistry (n = 9), the use of NHT was just as effective as individual instruction (Wilcoxon matched-pairs test, P = 0.1289) (Figure 5). Because there were only two boys in AP Chemistry, their results were not analyzed statistically.

Table 8. Normalized mean learning gains by gender for Chemistry and AP Chemistry units taught with and without NHT.

By Gender	Chemistry Girls (n = 15)	Chemistry Boys (n = 9)	AP Chemistry Girls (n = 9)
Normalized mean learning gain for units without NHT	0.305 ± 0.061	0.212 ± 0.069	0.348 ± 0.071
Normalized mean learning gain for units with NHT	0.264 ± 0.045	0.300 ± 0.061	0.277 ± 0.077
Wilcoxon matched-pairs test	p = 0.4212	p = 0.0273	p = 0.1289

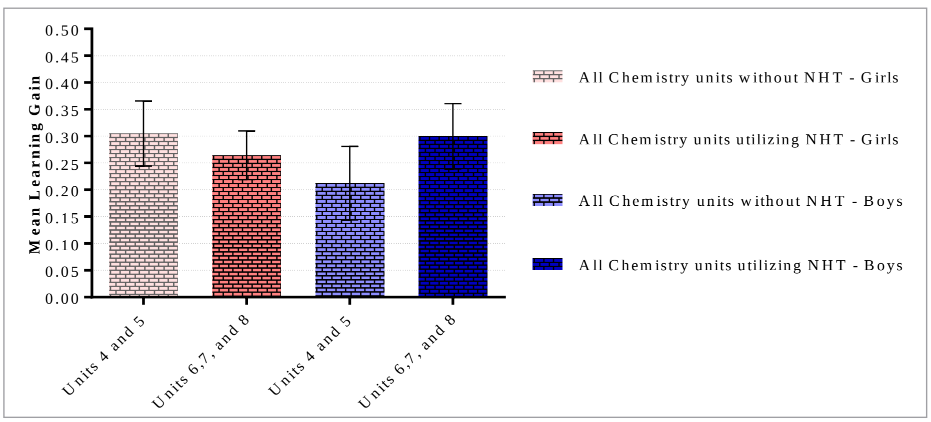

Figure 4. Normalized mean learning gains by gender for Chemistry units taught with and without NHT.

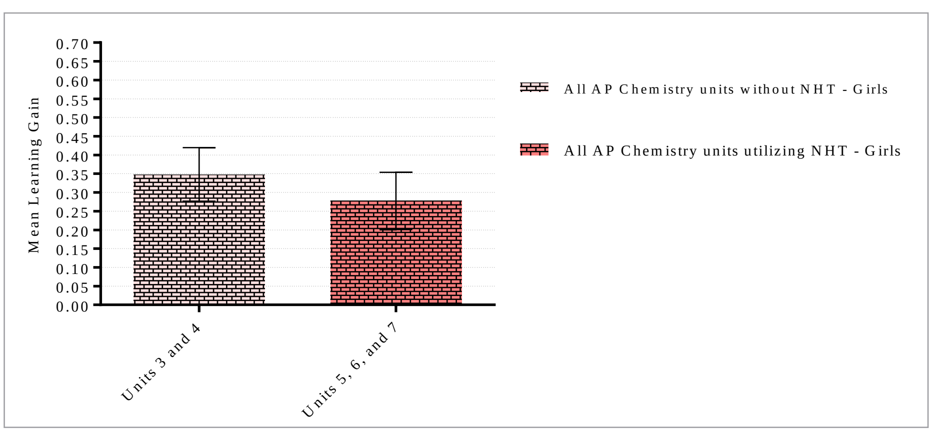

Figure 5. Normalized mean learning gains by gender for AP Chemistry units taught with and without NHT.

Student Feedback on NHT

66% of Chemistry and AP Chemistry students completed the survey. All students indicated at least some experience working in small groups that required participation and shared success, but most students indicated no experience using NHT.

For survey questions related to the appeal of NHT to students:

- 78% of respondents slightly agreed or strongly agreed that they felt more engaged in class when using NHT and the use of NHT made class more enjoyable. 17% of respondents had no opinion and on this question while 4% slightly disagreed.

For survey questions related to positive interdependence and individual accountability:

- 69% of respondents either slightly agreed or strongly agreed that they felt accountable to the other students in their group, 17% were neutral, and 13% either slightly disagreed or strongly disagreed.
- 83% of respondents either slightly agreed or strongly agreed that the other students in their group helped them to better understand answers to NHT questions while 17% slightly or strongly disagreed.
- 78% of respondents felt that all other students in their group cared about the group succeeding during NHT. 22% either had no opinion or disagreed.

70% of respondents agreed that the use of NHT helped them to perform better on unit tests. 22% neither agreed nor disagreed and 9% strongly disagreed that NHT helped them perform better on unit tests.

Discussion

When compared to the traditional, lecture format for high school chemistry lessons with assignments and questions designed and directed to students working individually, the use of numbered heads together produced positive and useful results. The use of numbered heads together during lessons was a more effective learning technique for low performing students in Chemistry as opposed to assigning them to work and learn individually. Direct observation of these students during the course revealed additional participation in class during the times reserved for group discussions. Prior to working in cooperative groups, most of the low performing students never participated in whole-class discussion, volunteered to answer questions or work problems on the board. They completed a low percentage of written assignments such as homework. The combination of positive interdependence and individual accountability within cooperative learning groups provides reasoning for these results. When discussing questions used during numbered heads together, stronger performing students were frequently observed assisting the lower performing students in groups. Average performing students were also observed assisting the stronger performing student with explanations. At other times, average performing students received help from the stronger performing student. For cooperative learning to occur, positive interdependence must be present which means students in a group have to believe the success of the individual relies on the success of all members of the group (Johnson & Johnson, 1988) (Slavin, 1988) (Johnson & Johnson, 2009). For most groups, there appeared to be some degree of buy in to this idea since stronger students took the lead within the groups by focusing attention on the student or students who needed the most help. However, the amount of verbal input or response by lower performing students did not necessarily increase much, but their learning gain improvements demonstrate that what they heard from the members of their groups was helpful. These results are consistent to those found by Gabriele & Montecinos, (2001). Individual accountability is one factor that may have provided additional motivation that lower performing students did not have prior to using NHT. If lower performing students felt accountable to their peers – pressure to not adversely affect them – then they may have been more focused to learn responses to questions and problems during the use of NHT. During NHT, they were accountable to their peers only if their specific number was called by the teacher (Kagan & Kagan, 2009). The use of NHT was shown to be just as effective as individual learning for stronger and average performing students. Further evidence of the presence of positive interdependence and individual accountability was found using the results of student surveys.

The use of numbered heads together during lessons was a more effective learning technique for boys in Chemistry as opposed to learning individually. Of the nine boys enrolled in Chemistry, seven of them were the only boy in their group. Of note, four of the nine boys were also considered "weaker performing" students in addition to five of the fifteen girls enrolled in Chemistry who were considered "weaker performing students". Individual accountability during NHT was most likely the additional motivating factor that helped boys in this class significantly improve their normalized learning gains. The use of NHT was shown to be just as effective as individual learning for girls in both Chemistry and AP Chemistry.

If positive interdependence and individual accountability were not present among girls within groups, then learning cooperatively would not have occurred because most groups consisted of 75% girls. Students at East Feliciana High School were no different than most students elsewhere around the U.S. in terms of achievement by gender in science (Halpern, 2007) (Gurian, 2011) - of the stronger performing students, all but one were girls. These were the students who led their groups during NHT questions and problems. There was not a significant difference between the normalized mean learning gains of boys and girls. Again, student surveys provided additional evidence for the presence of the required components of cooperative learning – positive interdependence and individual accountability.

Student surveys also revealed overwhelming student preference for using NHT versus working and learning individually. Because NHT proved to be just as effective as whole-group questioning, and students preferred NHT (indicated by most students feeling more engaged in class and finding Chemistry more enjoyable), NHT should be chosen as an instructional technique and used more often than whole-class questioning and individualized learning.

Comparing the results of this study to those of Maheady et al. (2006) indicates some agreement on the effectiveness of NHT. Since the students in Maheady's study were quizzed over material immediately after the lesson and students in this study were tested only at the conclusion of 2 – 3 week long units, individual Chemistry and AP Chemistry student test scores were not expected to be comparable to the sixth graders quiz scores.

For both Chemistry and AP Chemistry classes, normalized mean learning gains trended upward for each successive unit utilizing NHT (Figures 1 and 2). Beginning with a normalized mean learning gain of 0.227 ± 0.048 in Unit 6, students improved to a normalized mean learning gain of 0.253 ± 0.047 in Unit 7 and further improved to a normalized mean learning gain of 0.290 ± 0.044 in Unit 8. In AP Chemistry, normalized mean learning gains trended upward for each successive unit utilizing NHT, from 0.145 ± 0.081 in Unit 5, to 0.241 ± 0.073 in Unit 6 to 0.434 ± 0.082 in Unit 7. One might conclude that as students became more familiar with using NHT and with their group members, increases in learning gains resulted. In comparison, Maheady et al. (2006) indicated a general downward trend in mean percent accuracy over time attributing it to possible "novelty effects." Their study lasted for 34 "sessions" measured using 34 ten-item quizzes (Maheady et al. 2006). Future uses of NHT in high school Chemistry over a longer time span would determine whether or not normalized mean learning gains would become statistically significant due to extended use and practice of NHT. With longer use of NHT, students and groups could have "group processing" time which may help them focus more on the success of the group rather than the specific cooperative learning structure used. Perhaps this could delay any "novelty effects" that might occur with long term use of NHT. For students at East Feliciana High School, the introduction of additional incentives, recognition, competition, and additional cooperative learning structures with the use of NHT can be further studied to determine ways of preventing or delaying students from becoming bored with the use of NHT during the length of a course. Once students are familiar and comfortable using NHT and if learning gains increase significantly over time, a teacher may further challenge students by preventing the use of notes during group discussions or increasing the difficulty of questions or problems.

Another positive result for students in Chemistry was the 25% increase in the number of problems attempted on unit tests for units taught using NHT versus the two control units. The use of NHT during the math and problem solving review lessons at the beginning of the course may be beneficial in the future. Student discussion during NHT and explanation of thought processes to the class and the teacher may provide the classroom structure needed to increase the number of good problem solvers if this strategy is used over the length of the course. The decrease in the number of problems attempted in AP Chemistry can be attributed to two factors. First, the initial NHT unit was “Thermochemistry.” Almost all students struggled with this unit as was evident by the low percentage of homework completed, low quiz grades, NHT groups failing to formulate responses, the lowest unit test average of the course, and the smallest mean learning gain. On average, only 45% of the 7 problems on the Thermochemistry unit test were attempted. Second, two AP Chemistry students each submitted one NHT unit test after filling in only random multiple-choice answers, leaving the problems blank. Not only was Thermochemistry the toughest unit for students to learn, it was the first NHT unit. In hindsight, NHT should have been introduced and practiced in a relatively simpler unit.
It is worth noting that although NHT was used in class at least once per day, it wasn’t always used to answer questions or practice working chemistry problems related to the new learning objectives for a given day. On some days, NHT was used only during the warm-up review or during homework review. It is possible that some learning objectives were not reviewed, discussed, or practiced by students utilizing NHT.

Additional improvements for future use of NHT would include additional focus on improving social skills used within groups. Teaching good social skills needed to work cooperatively will have to be taught and modeled for some students over time due to the lack of previous experience. As suggested by Swenson (2008), reducing conflict within groups is an important skill (promotive interaction) needed for successful cooperative learning to occur (Johnson & Johnson, 1988). When NHT was introduced to students during the first experimental units, most students were not able to answer most questions of any difficulty level without referring to their notes. Initially, students were expected to develop a response to a question by putting their “heads together”, however, due to too many students struggling to participate in group discussions and too many students unable to answer NHT questions and follow up questions, the decision was made to allow students to use their notes during discussions. Students at East Feliciana High School can be challenged to tackle more numbered heads together questions without using notes after enough time has passed for groups to learn NHT and exhibit better group social skills.

When implementing cooperative learning structures for the length of a course in the future, additional time will have to be reserved for students to reflect on their group functions, provide feedback to one another, and develop a plan to improve as a group. This process will have to be carefully taught and closely monitored by the teacher to ensure positive outcomes.

In this study, the goal for each group was to earn the points available by correctly answering a question or solving and explaining a problem presented by the teacher. In this case, the incentive – points – was an immediate reward. When using cooperative learning structures such as NHT for an entire course, testing the effects of long term learning goals and performance goals for groups may be useful. Slavin (1988) stressed the importance of group goals that are important to the members of the group when describing successful cooperative learning. These results show promise and provide direction to further improve the learning environment in Chemistry classrooms in the future.

A limitation of this study is the use of small sample sizes due to the number of Chemistry classes offered and the number of students enrolled.

Additional Notes and Observations

The following notes and observations were made by the teacher during the use of NHT:

- Some students were naturally shy and reserved. As their teacher, I was aware of this fact before beginning the units on NHT and I was concerned about their reactions to being forced to work with a group of students. I identified four students from Chemistry and two students from AP Chemistry who were not only very quiet and timid in class, but appeared quiet and shy in social settings within school – in the cafeteria, between classes in the hallway, and before school. Comparing the normalized mean learning gains for this small group of six students using a paired t test indicated the difference in learning gains in units utilizing NHT was insignificant ($p = 0.4280$) (Figure 6). However, two of the six students were obviously very uncomfortable working in their groups and did not like to have their numbers drawn. In fact, there were a few instances when one of their numbers was drawn and I immediately put the number back in the stack and drew another number because I knew that student would not be able to answer and I didn't want to embarrass him or her. I spoke with these students and both indicated they were ok, so I took no further action. For these students, the specific persons they were grouped with may have affected whether or not they were comfortable functioning in group activities.

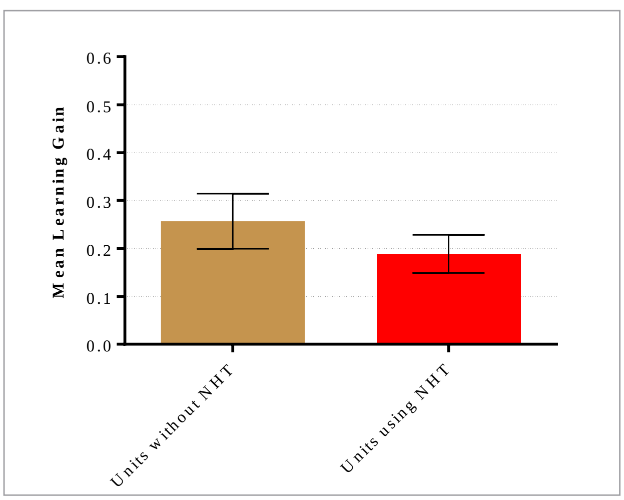

Figure 6. Normalized mean learning gains for quiet students.

- Awarding points to groups for correct responses during NHT served as motivation and incentive to participate for many students – similar to the results of the sixth grade NHT science study by Maheady et al. (2006). I base this conclusion partly on students who regularly checked with me to ensure their points from NHT were entered into the online gradebook. In the future, additional recognition for positive group behavior and successful results may include certificates, pictures on a special bulletin board, or prizes for groups who perform best on unit exams.
- There are specific Kagan structures which can be added to NHT to improve the impact. Quiz-quiz-trade is a cooperative learning structure that could be relatively simple and useful for such activities as reviewing vocabulary, naming chemical compounds, or providing formulas for molecules (Kagan & Kagan, 2009). For quiz-quiz-trade, the teacher (or students) make up index cards with questions that students can use in pairs for practice and review. In Chemistry, index cards with chemical formulas can be used for naming and classifying ionic compounds and molecules. For this particular school, a cooperative structure that involves students interacting with other groups may be chosen. An example that seems to fit nicely with NHT is called "One Stray" (Kagan & Kagan, 2009). Using the same number assignments used for NHT, the teacher calls a number. The student in each group with that number in each group stands and moves in a specified direction to a different group in order to gain additional perspective or assistance or offer help to that group if needed. After the allotted time has passed, the "stray" students return to their regular groups to share what they have learned.
- The classroom and school learning environment were not always conducive for productive cooperative learning. Far too often, events that recently occurred at the school (such as fights or other negative incidents) and local gossip quickly overshadow the NHT question or problem because students want to communicate with each other about these types of incidents. Time during NHT discussion was used to discuss the events of the day. As the teacher, my job during NHT was usually moving from group to group to redirect their attention back to the NHT question. There were days when NHT was

ineffective due to student behavior (overall school discipline was an on-going issue) or less effective classroom management by the teacher.

- Far too many students were routinely being called out of class on a daily basis by administrators, counselors, or the health center. NHT was interrupted on multiple occasions by intercom announcements calling ten or more individual student names at a time to be released from classes in the school. These types of interruptions during NHT distracted students due to the length of the announcement. Students who were called out of class would later return causing additional delay and interruption in the class schedule in order for them to catch up. These types of interruptions definitely affected the functioning and results of NHT. It is important for school administrators to realize how interruptions like these impact all phases of student learning and the teacher's ability to keep students engaged – such as during the use of NHT in Chemistry or AP Chemistry class.

Conclusion

Fostering positive interdependence among groups of students and individual accountability within each student, the cooperative learning structure, numbered heads together, was a more effective learning tool for weaker performing students and boys in Chemistry and proved just as effective for the majority of other students in comparison to learning chemistry individually. Student responses indicated NHT was helpful and made Chemistry or AP Chemistry more engaging and enjoyable. Students also indicated the presence of the cooperative learning components positive interdependence and individual accountability during NHT. Adding additional incentives, focusing on improving social skills within groups, and introducing competition between groups could be investigated during future use of NHT and/or other cooperative learning structures.

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Appendix A. Student Survey

Number	Question	Possible Responses
1	Not including Chemistry, how many of your high school courses required you to work in a small group (2-5 students) whose grade depended on the participation and success of ALL members of the group?	4 or more courses 3 courses 2 courses 1 course 0 courses
2	Other than this Chemistry class, have you ever participated in a class that used “numbered heads together”?	Yes No If so, what course(s)?
3	I learn better when I work with other students in small groups (2-5 students) during class.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
4	All students in my Chemistry class group participated when discussing questions or problems asked by Mr. Baker.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
5	All students in my group cared about the success of our group when answering questions from Mr. Baker.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
6	When Mr. Baker asked questions, the students in my group helped me to better understand the questions, the answers to the questions, and the explanation(s) for our answers.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
7	When working with my Chemistry class group, I felt accountable to the other students in my group.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
8	Using “numbered heads together” made Chemistry class more enjoyable.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
9	I felt more engaged in Chemistry class when we worked in groups compared to when we did not work in groups.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree
10	Using “numbered heads together” helped me to perform better on unit exams.	Strongly disagree Somewhat disagree Neither agree nor disagree Somewhat agree Strongly agree

Appendix B. IRB

Application for Exemption from Institutional Oversight

Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.6792
irb@lsu.edu
lsu.edu/irb

Unless qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/ projects using living humans as subjects, or samples, or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

– Applicant,Please fill out the application in its entirety and include the completed application as well as parts A-E, listed below, when submitting to the IRB. Once the application is completed, please submit two copies of the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at http://www.lsu.edu/screeningmembers.shtml

– A Complete Application Includes All of the Following:

- **(A)** Two copies of this completed form and two copies of part B thru E.
- **(B)** A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
- **(C)** Copies of all instruments to be used.
  - *If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
- **(D)** The consent form that you will use in the study (see part 3 for more information.)
- **(E)** Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (http://phrp.nihtaining.com/users/login.php.)
- **(F)** IRB Security of Data Agreement: (http://www.lsu.edu/irb/IRB%20Security%20of%20Data.pdf)

1) Principal Investigator: E. William Wischusen **Rank:** Professor

Dept: Biological Sciences **Ph:** 225-578-8239 **E-mail:** ewischu@lsu.edu

IRB# E6005 LSU Proposal #____

✓ Complete Application

✓ Human Subjects Training

2) Co Investigator(s): please include department, rank, phone and e-mail for each

Daniel Baker
Graduate Student
dbkr89@gmail.com
Biological Sciences
225-788-6115

3) Project Title: Cooperative Learning Strategy - "Numbered Heads Together", impact of this strategy on student's knowledge and application of Chemistry in a rural, high-needs high school.

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
203 B-1 David Boyd Hall
225-578-8692 | www.lsu.edu/irb
Exemption Expires: 6/24/2015

4) Proposal? (yes or no) No **If Yes, LSU Proposal Number** ____

Also, if YES, either ◯ **This application completely matches the scope of work in the grant**

OR ◯ **More IRB Applications will be filed later**

5) Subject pool (e.g. Psychology students) 11th and 12th grade Chemistry Students

*Circle any **"vulnerable populations" to be used**: (children <18; the mentally impaired, pregnant women, the ages, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature [signature] **Date** 4 Jun, 2012 (no per signatures)

**** I certify my responses are accurate and complete.** If the project scope or design is later changes, I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted. I also understand that it is my responsibility to maintain copies of all consent forms at LSU for three years after completion of the study. If I leave LSU before that time the consent forms should be preserved in the Departmental Office.

Screening Committee Action: Exempted ✓ Not Exempted ____ Category/Paragraph 1

Reviewer Mathews **Signature** [signature] **Date** 6/25/12

Vita

Daniel P. Baker was born in Anaheim, California, in February 1971. He attended many elementary and middle schools in Louisiana, Utah, Nevada, and Texas. He graduated from Edgewater High School in Orlando, FL in May 1989. He began his college career at Louisiana State University Agricultural and Mechanical College in Baton Rouge in August 1989. After many years of full time and part-time enrollment, and time off for work, he earned his degree in Biochemistry from LSU in May 1998. He entered the Graduate School at LSU in May 2011 and is a candidate for a Master of Natural Sciences. He has taught Chemistry, Physics, Biology 2, and Advanced Math during his four years in East Feliciana Parish at Clinton High School, in Clinton, LA and East Feliciana High School in Jackson, LA.