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The Implementation of Two Cooperative Learning Structures, Rally Coach and Teams-Games-Tournaments, in High School Chemistry Courses

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THE IMPLEMENTATION OF TWO COOPERATIVE LEARNING STRUCTURES, RALLY COACH AND TEAMS-GAMES-TOURNAMENTS, IN HIGH SCHOOL CHEMISTRY COURSES

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ABSTRACT

To combat the obstacles that students experience in chemistry, two cooperative learning strategies, Rally Coach and Teams-Games-Tournaments, were implemented in five chemistry courses at East Ascension High School. Rally Coach called for two students to work as a pair and peer tutor to successfully complete practice problems for each lesson. Teams-Games-Tournaments required students to work in groups of four to complete practice problems and compete for team points as a review. Every student experienced both learning strategies.

A comparison was made to see which cooperative learning strategy better helped student performance, including comparisons of effects on different student demographics and question types. To compare the strategies, normalized learning gains were calculated using pre- and post-test exams for each experimental unit. Rally Coach was found to significantly outperform Teams-Games-Tournaments in one of the units. Statistically significant differences also existed in comparisons of students with free or reduced lunch, different genders and grade levels, as well as a difference in performance on multiple choice questions. Student surveys indicated more enjoyment with Teams-Games-Tournaments but both strategies led to positive results.

INTRODUCTION

High school science courses can be inherently difficult, even for students that are academically well-equipped. The rigorous content and amount of information that a student is responsible to know and apply can be daunting. An examination of Bloom's Taxonomy can help formulate an approach to address the difficult nature of high school science curriculums. Bloom's Revised Taxonomy of Learning classifies learning into three domains: cognitive, affective and psychomotor (Anderson and Krathwohl, 2001). The cognitive domain divides into further subcategories which depict the simplest to the most complex type of learning. The order of Bloom's Taxonomy from simplest to most complex is the following; remembering, understanding, applying, analyzing, evaluating and creating.

In addition, a student must already possess concrete and abstract reasoning skills, basic math skills, good study habits, sufficient reading comprehension, and must be self-motivated. From my four years' experience of teaching chemistry, most students have trouble performing proficiently in the 1st (remembering) and 2nd (understanding) level of Bloom's Taxonomy because of the amount of information rendered in science courses. Non-instructional peer influences can also hinder a student's performance in the science classroom (Steinberg, 1988). In order to combat cognitive problems seen in high school science courses, cooperative learning strategies have been implemented in many schools (Johnson and Johnson, 1994). Cooperative learning structures are group-based instructional strategies in which students work together to assuage the negative aspects of group behavior while maintaining the benefits (Apthorp and Beesley, 2010).

Educators are continually exploring new techniques to increase the engagement and learning that takes place in the classroom. Cooperative learning has been widely used because it

is based on theory, validated by research and almost any teacher can find a cooperative learning strategy that fits his or her personal philosophy (Johnson, Johnson and Stanne, 2000). Greater achievement was seen in 61% of 67 studies comparing cooperative learning to traditionally taught high school classes (Dotson, 2001). Traditionally taught classes are defined by teacher-led lecture followed by individual student practice. Elements of effective cooperative learning structures that contribute to the success of such techniques include positive interdependence, individual accountability, promotive interaction and group processing (e.g., Aronson et at., 1978; DeVries and Edwards, 1974; Earley and Northcraft, 1989; Johnson and Johnson, 1989; Kagan, 1989,1990; Sharan, 1989; Slavin, 1977, 1981). Each skill allows the learners to strengthen their understanding of the subject through peer interactions. In a cooperative learning classroom, peer interactions take the form of tutorial exchanges, verbalizing thoughts on material, recalling textual evidence, generating images in a group, elaborating on concepts, and group discourse (Hertz-Lazaowitz and Miller, 1992).

Studies have identified important elements of cooperative learning that are necessary for successful implementation (Johnson et al., 1998). The elements of cooperative learning structures that are important in fostering effective peer interactions and learning are positive interdependence, individual accountability, promotive interaction and group processing (Johnson and Johnson, 1994).

Positive interdependence occurs when the results of any student are reciprocally intertwined with the results of the other students (Apthorp and Beesley, 2010). Groups of students realize that the success of each student is dependent on the input from every member. Reaching a goal will only happen once each person contributes–one student completing all the work cannot equal success. The strategy relies on work from each member of the group. Positive

interdependence has been shown to increase the motivation, responsibility and interest of students (Johnson and Johnson, 2009). Positive interdependence creates a caring, cooperative community and increases achievement in the process (Kagan, 2009).

Individual accountability is necessary to produce achievement gains (Slavin, 1983). To prevent high achieving students from completing all the work and unmotivated students from coasting along, each person has to be individually accountable. The strategy establishes that to receive individual credit for the group's efforts, each student must contribute to achievement of the goal (Johnson and Johnson, 1974; Kagan, 1989). Any student could be called on and needs to be prepared with the answers, making each student responsible for knowing the answers and participating.

Promotive interaction requires groups to actively encourage and engage others in their groups in dialogue as a means for questioning others' ideas (Johnson and Johnson, 1974; Apthorp and Beesley, 2010). With the questioning, any misconceptions and disagreements can be uncovered and corrected as a group. Before addressing any disequilibrium between group members, the teacher must instruct all students on how to find a group solution (Bandura, 1986). Methods for providing effective peer feedback, roles and responsibilities of the group, and how to develop an action plan must be taught for the group to successfully move past any disequilibrium that may arise (Johnson et al., 1994).

The fourth feature of the majority of cooperative learning structures is group processing, a group-level metacognition (Apthorp and Beesley, 2010). The groups should designate a time to reflect on the performance of the group as a whole and provide feedback to the group and individuals as necessary. The purpose of group processing is to determine a goal, find a way to

achieve the goal and track the group's progress towards meeting the predetermined goal (Bandura, 2000).

Strategies lacking the above features can actually inhibit the learner (Guerin, 1999; Ingham et al., 1974; Latane et al., 1979). Without positive interdependence and promotive interaction, students' individual effort can decrease (Latane et al., 1979). There is no consensus as to which features should be present for each structure but individual accountability and positive interdependence are suggested by the majority of researchers (Apthorp and Beesley, 2010). An important concern for the success of cooperative learning structures is interpersonal interactions. To ensure the strategies are working as designed, the teacher should resolve any problems that arise between students and learning objectives. The teacher will review interpersonal skills before beginning a new strategy, especially when social skills are required to achieve the group's desired outcome. If taught correctly, cooperative learning structures can transform a class to achieve higher learning gains, become more positive about school and the subject area and develop mature positive relationships with their peers (Johnson and Johnson, 1988).

Among the cooperative learning possibilities in the classroom are strategies which engage students through competition (Attle and Baker, 2007). An example is Teams-Games-Tournaments, a cooperative learning structure that was developed over thirty years ago by researchers wanting to increase academic achievement for all students (DeVries and Slavin, 1976). The strategy has since been implemented in many classrooms, including high school science courses, where it has been an effective technique for students (Hollifield and Leavey, 1980). Teams-Games-Tournaments encompasses the four features of cooperative learning and is supplemented by "positive reinforcement" and "immediate feedback" features (DeVries and

Edwards, 1972). Positive reinforcement is when a student's work is confirmed to be correct, building the confidence of the student. Immediate feedback is given from the teacher or the students in the groups, allowing the student to find their mistakes and correct them before any further misconceptions are made.

Teams-Games-Tournaments consists of teams of students who are heterogeneous based on their capabilities in the classroom as predetermined by the teacher. Every group is composed of four students, a "high"-performer, "medium-high" performer," medium-low" performer and a "low"-performer in the classroom. The teacher selects groups based on previous performance in the class. Each day after teacher-led instruction, teams work together on practice problems, implementing peer tutoring and team discussions about content. Together the students help each other learn the material in preparation for weekly tournaments. Once the unit is completed, the teacher breaks teams up into homogeneous groups based on abilities, preventing a lower-level performing student from having to compete with a higher achieving student. Once the groups are set, the tournament begins; each student competes against students academically similar to themselves for points based on content questions that must be answered accurately for points. Groups rotate students to read questions and give answers. At the end of the tournament, individual scores are converted to team scores to see which team has the highest percentage. The winning team receives an extrinsic prize – food or classroom privileges.

Teams-Games-Tournaments involves positive interdependence because each student must participate in the tournament to help the team score points. They also exhibit positive interdependence when working as a team, knowing that there is a competition at the end of the week, each student will want to help the others to make sure the team is prepared. Students are also individually accountable for answering questions during tournaments and reporting scores

back to the team. Working together accomplishes promotive interaction. They quiz each other leading up to the tournament to make sure they each know the material. After each tournament, group processing takes place where they reflect on the game and address any unknown concepts. Positive reinforcements are included because students are facing students that are similar to their achievement level so they do not feel inadequate against someone that is a high performer. After they finish their questions, they are reinforced that work was done correctly by the teacher and fellow students. Immediate feedback is given during the tournament stage - students compete and find out instantly and frequently if they won or not. This allows the student to adjust for the next set.

Another well-known cooperative learning strategy is Rally Coach. Rally Coach is a Kagan structure that has been implemented in science classrooms and shown to directly cause positive impacts on testing scores (Kagan, 2009). In addition to Rally Coach encompassing the four features of a successful cooperative learning strategy, it is supplemented by "equal participation and simultaneous interaction" (Kagan, 2009). Equal participation means that participation is not voluntary; every student is called to perform (Kagan, 2009). Simultaneous interaction increases the time students get to demonstrate their skills by providing each student with an active role.

Rally Coach requires the teacher to partner students up according to capability. Rally Coach calls for the pair of students to consist of different academic achievement levels. Students' academic capabilities were determined to be "high", "medium-high", "medium-low" or "low" by the teacher according to their previous performance in chemistry. Each partnership includes students paired with one other student within one range of their academic capability. For example, "high" learners were only paired with "medium-high" leaners" while "medium-low"

students could be paired with either a “medium-high” or “low” partner. The lesson starts with the teacher reviewing and introducing new material, and when it is time for students to practice, Rally Coach begins. Partners receive one set of problems composing of a front and back, one pencil, and one calculator if necessary. The teacher has the higher performer begin the structure, without letting students know which student is the higher or lower achiever. The first student to go begins solving the problem while their partner watches, listens, checks and coaches if needed (Kagan, 2009). Once the two students come to a consensus on the answer, the partner that coached has to sign their initials next to the answer to show agreement. Then the roles will switch, the second student flips the paper over and completes the first problem while their partner now becomes the coach. Having each student’s practice problems on different sides of the paper prevents a student from looking ahead and losing focus on the problem at hand. The one pencil and calculator also help in keeping everyone on task and from moving ahead of their partner. The partners continue to solve problems until all are complete.

Rally Coach embodies positive interdependence because each student receives the same grade. One student works the problem out and the partner signs off that they agree. Individual accountability is also present because a student needs to complete their set in order for both students to get full credit. They each have to contribute to reach their goal. When students are coaching and discussing the assignment, promotive interaction is present and group processing is present throughout the practice and when the teacher gives feedback. Rally Coach also demonstrates equal participation because every student performs and the teacher could also call out questions and have partners show their answers. Finally, Rally Coach has simultaneous interaction because all students receive the opportunity to interact and work out practice problems to develop a greater comprehension of the content.

Rally Coach and Teams-Games-Tournaments help students self-reflect on their work and construct ways to improve. The techniques allow for group discussions and feedback helps guide the students. Both strategies have been tested and found to be successful in high school science classrooms, helping with problem-solving and conceptual understanding (Kagan, 2009; O' Mahony, 2006). Though many similarities between the two cooperative learning strategies, there are also differences. Rally Coach has pairs of students who are not competing but working together for the same grade. Teams-Games-Tournaments has teams of four students working together to prepare for a competition against other teams. Rally Coach splits the problem sets so that each student sees the material but actually only working half the problems and coaching the other half. Teams-Games-Tournaments has every student working every problem together. Students stay with their partners throughout Rally Coach's entirety, but Teams-Games-Tournaments has teams of students breaking up at the end of a unit for a competition.

With the widespread availability of cooperative learning reference material and the documented success rate of these strategies, teachers would benefit from a study that compares the success of these strategies against each other (Ediger, 2001). Such a comparison could help teachers decide and focus on a specific technique to best achieve positive student interactions, increased engagement and deeper conceptual understandings of the material. The purpose of this study is to determine which cooperative learning structure, Rally Coach or Teams-Games-Tournaments, produces higher learning gains for high school chemistry students. Both structures encompass the four features to make cooperative learning successful: positive interdependence, promotive interaction, individual accountability, and group processing. Each qualifies as a successful learning technique because of these features. In order to compare these two learning strategies, students completed pre- and post- tests. Students' pre- and post-assessments for

multiple units using Teams-Games-Tournaments and Rally Coach provided a comparison of learning outcomes to determine which technique is most beneficial to implement in high school chemistry courses.

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MATERIALS AND METHODS

This study implemented Teams-Games-Tournaments and Rally Coach during the 2014-15 school year in five chemistry courses offered at East Ascension High School (EAHS). EAHS is located in a rural area, and is one of four high schools in Ascension Parish. East Ascension High School follows a block schedule with four 90 minute class periods per day, five days per week. EAHS is a 5-A high school with 1,806 students. Of the student population, 47.6% qualifies for free lunch, while 5.9% of the students receive reduced lunch. East Ascension High School has been a Title I school for the past three years. A Title I school is a public school that receives extra funding because at least 40% of the student population qualifies for free or reduced meals (Heuer and Stullich, 2011). EAHS was a "B" on the New Scale provided by the Louisiana Department of Education during the 2013-14 school year (https://www.louisianabelieves.com/resources/library/performance-scores). EAHS is composed of the demographics detailed by Table 1.

The science teacher in this study was a twenty-seven year old female with four years of teaching experience. All four years, she has taught chemistry and physical science at East Ascension High School. Prior to teaching the 2014-15 school year, the teacher had no experience using Teams-Games-Tournaments and one semester experience using Rally Coach.

Three of the chemistry courses took place over eighteen weeks in the fall and the other two courses took place over eighteen weeks in the spring. The fall courses consisted of one honors chemistry class and two academic classes. Both courses in the spring semester were honors courses. Each chemistry student experienced Rally Coach and Teams-Games-Tournaments over the course of one semester. For this study, each student and their parent or guardian signed consent forms. The teacher collected these forms in compliance with the

Louisiana State University Institutional Review Board (see Appendix A). Louisiana State University Institutional Review Board granted approval for the study (IRB# 8840, Appendix B).

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

	School	Class 1 Honors Chemistry	Class 2 Academic Chemistry	Class 3 Academic Chemistry	Class 4 Honors Chemistry	Class 5 Honors Chemistry
Total Student Population	1806	27	21	19	24	32
Female	915 (51%)	12 (44%)	10 (48%)	6 (32%)	9 (37%)	20 (63%)
Male	891 (49%)	15 (56%)	11 (52%)	13 (68%)	15 (63%)	12 (37%)
African American	751 (42%)	7 (26%)	9 (43%)	13 (68%)	7 (29%)	5 (15%)
Caucasian	816 (45%)	14 (52%)	10 (48%)	4 (21%)	13 (55%)	21 (66%)
Latino/Hispanic	202 (11%)	6 (22%)	2 (9%)	2 (11%)	2 (8%)	6 (19%)
Other	37 (2%)	0	0	0	2 (8%)	0
Free/Reduced Lunch	906 (53%)	11 (41%)	11 (52%)	9 (47%)	9 (38%)	12 (38%)
Freshmen	561 (31%)	0	0	0	0	0
Sophomore	473 (26%)	14 (52%)	5 (24%)	5 (26%)	20 (83%)	29 (91%)
Juniors	401 (23%)	13 (48%)	13 (62%)	13 (69%)	4 (17%)	3 (9%)
Seniors	371 (20%)	0	3 (14%)	1 (5%)	0	0

A comparison of the normalized learning gains measured the growth of students in each of the two learning strategies. During the fall semester, students first experienced Rally Coach followed by Teams-Games-Tournaments. For the spring semester, the order reversed and Teams-Games-Tournaments came first followed by Rally Coach. Table 2 details the experimental units.

Table 2. Chemistry Units of Study

	Fall 2014 Chemistry	Spring 2015 Chemistry
Introductory Units (no cooperative learning structures used)	Units 1-6	Units 1-6
Units used with Rally Coach	Unit 7, Types of Bonds	Unit 8, Types of Reactions
Units with Teams-Games-Tournaments	Unit 8, Types of Reactions	Unit 7, Types of Bonds

Units 1-6 covered laboratory safety, atomic structure, matter, measurements, electrons in atoms, and the periodic table. The teacher made notes, practice problems and test questions using the 2002 edition of *Modern Chemistry* (Davis and Holt). Students did not need to have their own copy of the textbook, but access was available if a student wanted their own.

When designing the daily routines for each class, the only difference the teacher made between the two experimental units was the implementation of the cooperative learning strategy. Teams-Games-Tournaments and Rally Coach implementation came in the form of daily student practice during the experimental units. Table 3 details the class structure for each experimental unit.

Table 3. Daily class agendas for Rally Coach and Teams-Games-Tournaments

Rally Coach Class Agenda	Teams-Games-Tournaments Agenda
I. Bell work, completed individually II. Teacher reviews bell work, with non-volunteers and volunteers being called upon to answer III. Homework review if assigned the previous day IV. New lesson, lecture and questioning by the teacher V. Application of the new learning objective completed by students using Rally Coach VI. Practice problems picked up by teacher VII. Homework assigned.	I. Bell work, completed individually II. Teacher reviews bell work, with non-volunteers and volunteers being called upon to answer III. Homework review if assigned the previous day IV. New lesson, lecture and questioning by the teacher V. Application of the new learning objective completed by students using Teams-Games-Tournaments VI. Practice problems picked up by teacher VII. Homework assigned.

Implementation of Rally Coach

Before implementing Rally Coach in the fall, students received a pre-assessment covering Unit 7, Types of Bonds. The questions came from Davis and Holt's *Modern Chemistry* test bank and the teacher made modifications to some. Students had incentive to answer questions correctly-for every question correctly answered, students could receive bonus points that would be added to their grade at the end of the semester. Bonus points did not contribute to the experimental post-assessment to prevent skewed learning gains.

The teacher assigned student partners according to their academic capabilities. The classifications for students were "high performer", "medium-high performer", "medium-low performer" or "low performer" based on an assessment of units 1-6. Table 4 and Table 5 detail how students were classified according to their academic performance.

Table 4. Student academic performance for honors courses

Overall performance**	Classified Performer
A+ in chemistry (93-100%)	High performer
A in chemistry (85-92%)	Medium-high performer
B in chemistry (76-84%)	Medium-low performer
C in chemistry (66-75%)	Low performer

**There were no F (0-65%) students in my honors classes. If they had been present, they would have been classified as “low learner”

Table 5. Student academic performance for academic courses

Overall performance**	Classified Performer
A in chemistry (93-100%)	High performer
B in chemistry (85-92%)	Medium-high performer
C in chemistry (76-84%)	Medium-low performer
D in chemistry (66-75%)	Low performer

**There were no F (0-65%) students in my academic classes. If they had been present, they would have been classified as “low learner”

Each Rally Coach pair only consisted of learners either right above or below one another in classification. For example, “high learners” paired only with “medium-high” learners. “Medium-low” learners could be paired with either “medium-high” or “low” learners. This was to prevent frustration between students with large learning gaps. In addition to student performance in chemistry, outside factors contributed to partner assignments. Students that were friends, enemies or misbehaved learned in separate groups to prevent any conflicts that could have arisen.

Once in their assigned groups, each student received a letter, “A” or “B”. Only the teacher knew that the letter “A” stood for the student with higher academic achievement and “B” would be the lower-performing student. The teacher identified the student that should start the technique by calling a letter. A new seating chart assigned during the experimental unit allowed partners to be next to each other every day.

During the designated time, students received one piece of paper with similar questions on both sides, one pencil and one calculator. The questions came from *Modern Chemistry* review section. The student with letter “A” began to work on one side of the paper and as they completed the first problem, student “A” talked to their partner about what they were doing and why. If partner “B” found a problem, the two had a dialogue and partner “B” coached “A” to perform the correct process and get a reasonable answer. Once both students reached an agreed upon answer, student “B” initialed next to the answer approving of student “A”’s work. After student “A” had completed their problem, student “B” flipped the page and began the first problem on the other side of the paper just as partner “A” had done. The students continued to take turns between problems, flipping the page after each practice problem, until the entire sample set had been done. Students then turned in their initialed answers for the teacher to grade and provide feedback. The teacher gave papers back the following day and made copies so that each student could take their work home to review if needed.

During Rally Coach, the teacher walked around the room mediating any conflicts that may have arisen. Some students wanted the teacher to coach them before asking their partner. The teacher addressed these conflicts and helped students communicate with their partners. Other students wanted confirmation from the teacher on a problem they completed, but the partners were responsible for deciding.

Each day after picking up a Rally Coach problem set, the teacher would give the students back the previous day's problem set with feedback. If students had mistakes, the teacher encouraged them to discuss with their partner how to fix the problem. However, the teacher would answer questions if necessary. This system existed each day of Unit 7 leading up to the post-test. The post-test at the end of the Rally Coach unit continued the same questions from the pre-assessment. Comparing the pre-assessment and post-assessment provided normalized learning gains for analysis. The Unit 7 assessment consisted of several sections including: nine matching, five multiple choice, twelve classifying, six naming, six formula writing and four constructed response questions. Every type of questions was worth one point except for the constructed response. Of the four constructed response questions, two were worth one point and two were worth two points.

Implementation of Teams-Games-Tournaments

Before beginning the Teams-Games-Tournaments unit, students received a pre-assessment with questions found in *Modern Chemistry* test bank; the teacher modified some questions. Students were awarded bonus points for every question they had correct on the pretest. Bonus points did not contribute to the post-test to avoid skewed learning gains in the trial.

The teacher assigned students to teams of four students based on differentiated learning capabilities. Groups included one "low", one "medium-low", one "medium-high" and one "high" leveled student, with capabilities determined by achievement on units 1-6. Reference Table 4 and Table 5 to see student divisions based on academic performance. Other factors contributing to determining groups was behavior, gender and student conflicts. A new seating chart kept groups together throughout the unit.

Each day during the Teams-Games-Tournaments, students worked in their groups of four during student practice. Every team was aware that there would be a competition at the end of the unit to gain points for their team. Together the groups completed daily assignments and insured that each member knew the material in preparation for the competition. At the end of each day's practice session, the teacher randomly picked up one of each of the group's problem sets to grade and provide feedback. The following day, the teacher provided corrections and the group members were responsible for making corrections on their own papers.

At the end of the unit, the teacher divided students into homogeneous groups based on their academic levels. This was to prevent "lower" performing students from feeling discouraged when competing against "higher" performing students. Students competed in tournaments to earn points for their original team of four. Students competed by taking turns answering review questions from the previous week. For competition day, the teacher arranged the desks in groups of four with a white board and dry erase marker in the middle of the group in order to keep score. The students kept the score board in the middle to prevent cheating when counting points. There was a stack of review questions numerically ordered and a stack of answer cards also numerically ordered according to their respective question.

To begin, one student, randomly chosen by the teacher, read the first question card to the student on their right. The student answering the question gave the answer or worked the problem out to find the answer. If the answer matched the answer card, the student earned the correct amount of points (points were valued according to the question's difficulty). Definitions and recall questions were worth one point, while application questions that require more work were worth two points. If the student could not answer the question or answered incorrectly, the other two students in the group could to write down their answer and show the questioner. If the

students got the question right, they earned the points. Both students could get points as long as they both had the correct answer. If only one student got the right answer, only that student earned points. If no one was correct, then no one received points. Students received immediate feedback by reading answer cards.

After each round ended, the questioner passed the stack of questions and answers to his or her right and a new round started. There was a timer in the middle with thirty seconds to one and a half minutes allotted for answering, depending on the question. Recall questions received thirty seconds while application questions received one and half minutes to answer. The competition continued until either time ended or the group(s) had gone through all cards.

Each student recorded their individual points that they achieved and reported it back to their original groups to tally total points for posting in the classroom. The winning group chose their prize, most chose food while others chose “skip a homework pass”. At the end of the unit, students received post-tests that were identical to the pre-test for an analysis of normalized learning gains. The Unit 8 test consisted of nine matching, six multiple choice, thirteen classifying, thirteen predicting, thirteen balancing and four constructed response questions. The constructed response questions were worth six points, two questions were one point value and two questions had a two point value, all other questions were one point.

For fall classes, Unit 7 went with Rally Coach and Unit 8 went with Teams-Games-Tournaments. For spring classes, Team-Games-Tournaments went first with Unit 7 and Rally Coach went with Unit 8. At the end of each unit post-test, students received an anonymous survey to answer about the learning technique they had just experienced leading up to that test. After students had experienced both techniques and a week had passed since the last post-test,

students received a survey comparing Rally Coach to Teams-Games-Tournaments. The teacher analyzed the results.

Data Analysis

Grades for students' pre- and post-assessments were given according to the number of correct answers. To compare Rally Coach and Teams-Games-Tournaments, normalized learning gains for each individual used the formula (Hake, 2002):

$$\text{Normalized learning gain} = \frac{(\text{Posttest Percentage} - \text{Pretest Percentage})}{(100\% - \text{Pretest Percentage})}$$

Normalized learning gains were examined to assess the learning that took place in between the pre- and post-assessments. Normalized learning gains are valid and reliable measures of students' learning gains (Meltzer, 2002). Each student had a normalized learning gain for the Rally Coach unit and the Teams-Games-Tournaments unit. In addition, the types of questions assessed on the exams were broken down and normalized learning gains were calculated for each type of question. Every student in this study experienced an increase in their composite score from pre to post-test. However, when analyzing the learning gains of specific question types, some student exhibited decreased scores or no net difference in score from pre to post-test. If a student did not show any improvement from the pre to the post-test, precedent in similar studies is to input the normalized learning gain as the minimum on the scale, which is zero (Weber, 2009; Bao, 2007). If a student scored a 100% of a certain type of question for the pre-test, then to find their normalized learning gain, the 100% in the formula decreases to a 99% to prevent a denominator of zero.

Normalized learning gains for these two techniques also provided a comparison of students of different socioeconomic backgrounds (free or reduced lunch vs. paid lunch), grade levels, and honors vs. academic chemistry courses. Means, standard errors of the mean and

statistical tests were calculated using GrahPad InStat, version 3.1 for Windows and values were graphed in GraphPad Prism version 6.05 for Windows. The power of comparisons which were not statistically different were calculated using GraphPad StatMate version 2.0 for Windows. Survey questions were evaluated with a Chi-square test on GraphPad Prism 6.07 for Windows.

RESULTS

To determine whether one of the two cooperative learning structures, Rally Coach or Teams-Games-Tournaments, is better for students when implemented in a chemistry classroom, normalized learning gains for similar units were compared. Every student experienced an increase from their pre-test to their post-test for both Units 7 and 8 (Figure 1).

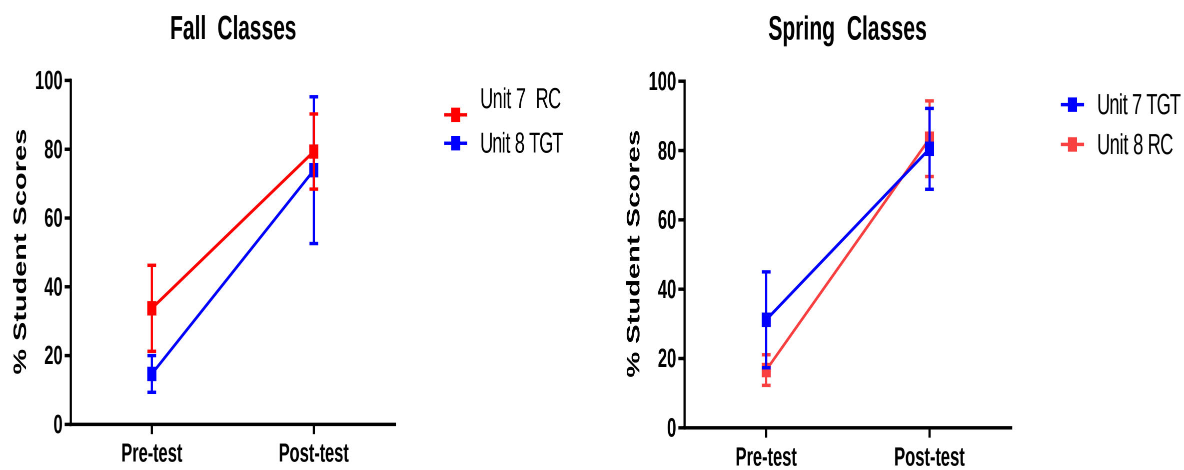

Figure 1. Average pre- and post-test scores ± standard error (SEM) of the mean for both fall and spring semester chemistry course students taught using Rally Coach (RC) and Teams-Game-Tournaments (TGT).

The students in the fall that used Rally Coach for Unit 7, Types of Bonds were compared with the students in the spring that implemented Teams-Games-Tournaments with Unit 7. For Unit 8, Types of Reactions, students in the fall that used Teams-Games-Tournaments and were compared to students in the spring that used Rally Coach. A comparison of a single semester's learning gains for each learning structure was not performed due to concern that significant results might be attributed to the differences in the difficulty of units as opposed to the effectiveness of the learning strategy.

Learning Constructs

In the tested chemistry courses, there was no significant difference in normalized learning gains between Unit 7, Types of Bonds taught with either Rally Coach or Teams-Games-Tournaments (Figure 2). However, with Unit 8, Types of Reactions, significant differences in normalized learning gains were found when comparing Rally Coach to Teams-Games-Tournaments (Figure 3).

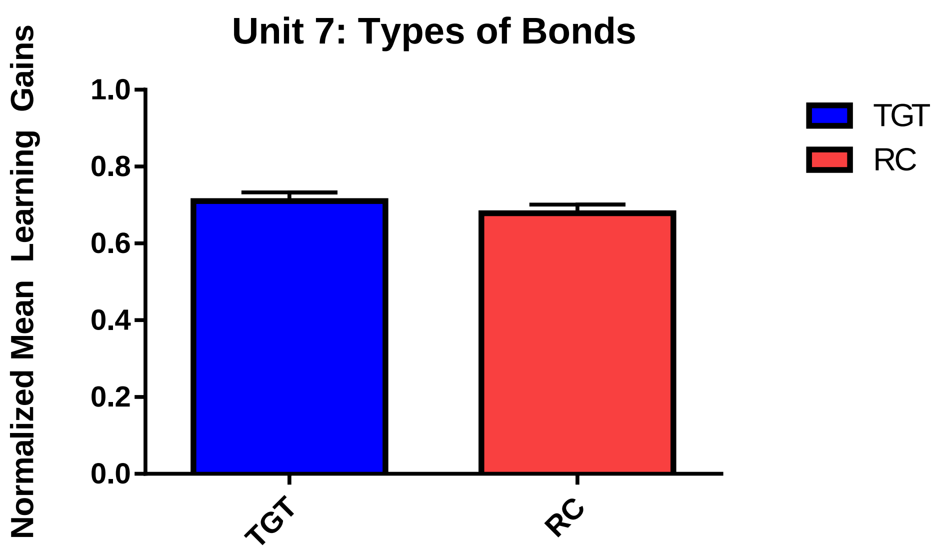

Figure 2. The normalized mean learning gains ± standard error for Unit 7, Types of Bonds for Rally Coach, RC, (n=67) and Teams-Games-Tournaments, TGT, (n=56).

For Unit 7 the mean normalized learning gain for Teams-Games-Tournaments was 0.71 ± 0.02 and did not differ from the Rally Coach mean of 0.68 ± 0.02 (unpaired t-test, P = 0.33, Figure 2).

For Unit 8, the mean normalized learning gains for Teams-Games-Tournaments (0.70 ± 0.03) differed from the mean for Rally Coach (0.80 ± 0.02; t-test, P = 0.004, Figure 3).

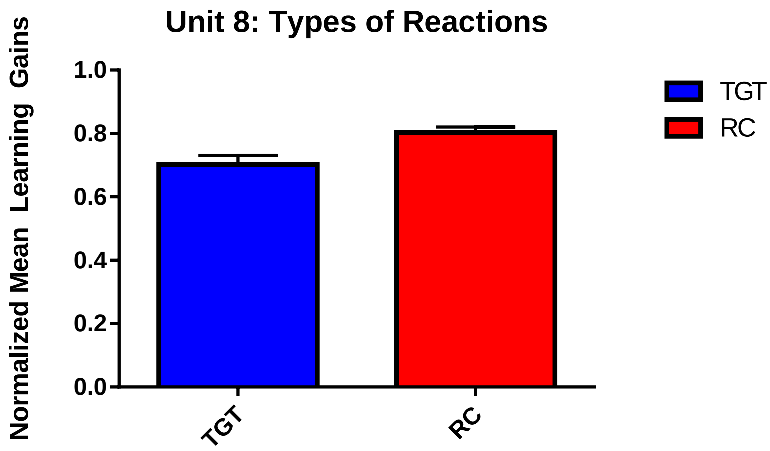

Figure 3. The normalized mean learning gains ± standard errors for Unit 8, Types of Reactions for Rally Coach, RC, (n=56) and Teams-Games-Tournaments, TGT (n=67).

Normalized learning gains for specific question types were also compared between similar units. Unit 7, Types of Bonds included nine matching, five multiple choice, twelve classifying, six formulas, six naming and four constructed response questions. Each question had a value of one point, except for two of the constructed response questions which were worth two points. Figure 4 shows averaged normalized learning gains for the types of questions in Unit 7. The effects of Rally Coach and Teams-Games-Tournaments on normalized learning gains for Unit 7 broken down by question type were compared. Students showed a greater increase in mean normalized learning gains for multiple choice questions (ANOVA, Tukey a posterior comparison, $P<0.01$) when taught using Team-Games-Tournaments. In contrast, for the other types of questions no differences were present. A power test was performed on the non-significant comparison for naming type questions using the GraphPad StatMate model (Figure 5). Given the sample sizes and standard deviations of the classes, to detect a difference in mean normalized learning gains with 80% power, the difference (delta) would have to be 0.13. The observed delta was 0.011 (30% power).

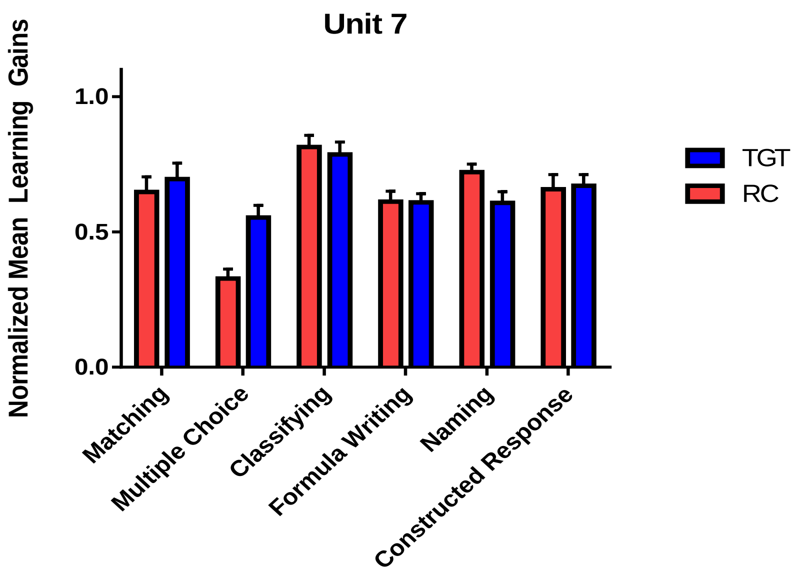

Figure 4. Normalized mean learning gains ± standard errors compared for Rally Coach (RC) and Teams-Games-Tournaments (TGT) broken down by types of questions in Unit 7, Types of Bonds.

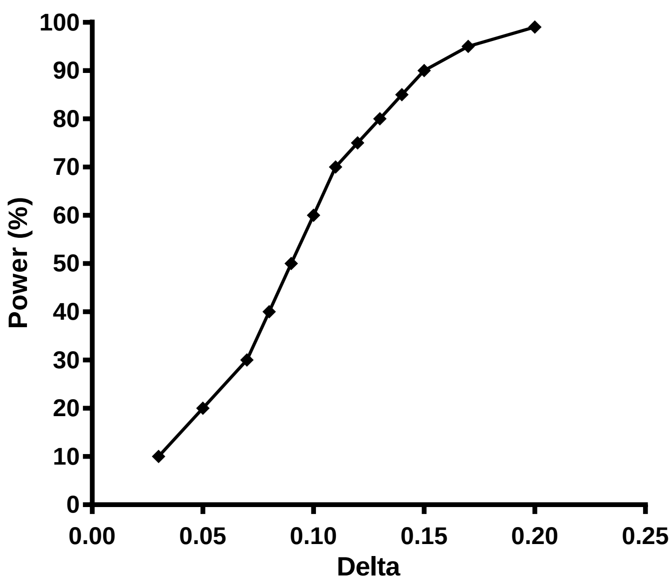

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Figure 5. Power calculation for comparisons of student populations for naming questions in Unit 7. Delta is the difference between mean normalized learning gains. The power was calculated using GraphPad StatMate to determine if the comparison in the completed experiment missed a small effect due to small sample size. The curve shows the computed power of a test to detect various hypothetical differences (delta) using the class sample sizes and standard deviations. To detect a difference with 80% the delta would have to be 0.13. The observed difference in mean learning gains was 0.011 (30% power).

For Unit 8, Types of Reactions, there were nine matching, six multiple choice, thirteen classifying, thirteen predicting, thirteen balancing and four constructed response questions. Each question was worth one point, except for two constructed response questions which were worth two points. Figure 6 shows the normalized learning gains for types of questions comparing Rally Coach and Teams-Games-Tournaments. Students showed significantly greater normalized learning gains with Teams-Games-Tournaments on Unit 8 multiple choice questions (ANOVA, Tukey a posterior comparison, $P<0.01$).

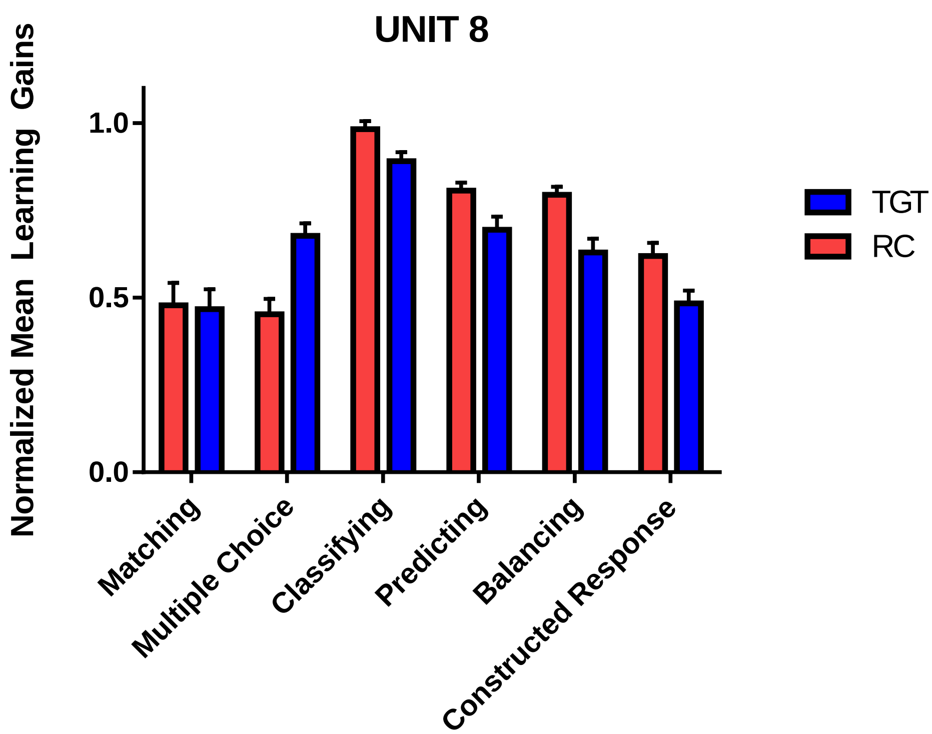

Figure 6. The normalized mean learning gains ± standard errors broken down by types of questions in Unit 8 using Rally Coach (RC) and Teams-Games-Tournaments (TGT).

Using the GraphPad StatMate model, the power for the non-significant comparisons of classifying, predicting, balancing, and constructed response questions was determined (Figure 7).

Sample sizes and standard deviation for the classes were used to detect a difference in average normalized learning gains with 80% power.

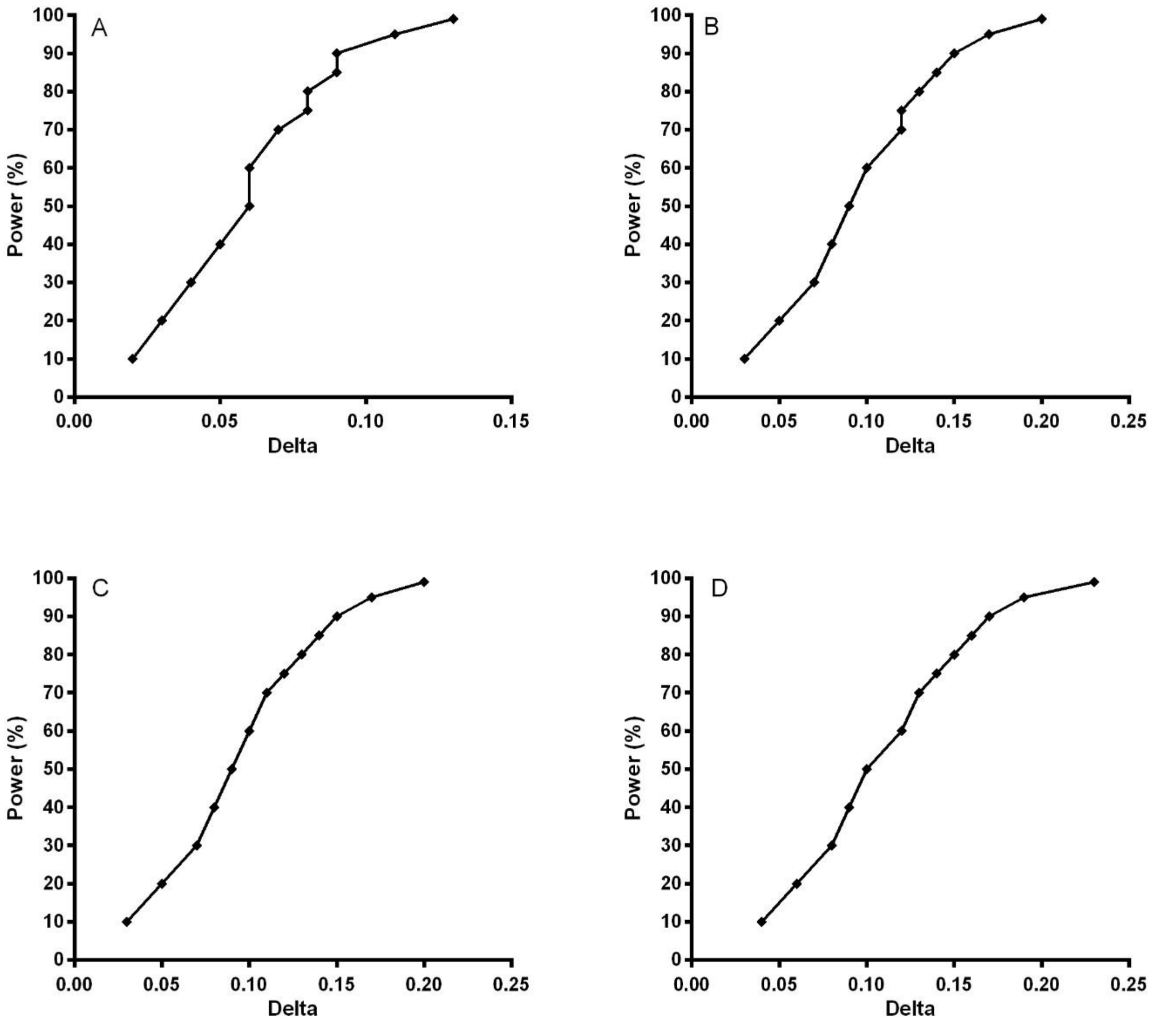

Figure 7. Power calculations for comparisons of student populations for classifying, predicting, balancing, and constructed response questions in Unit 8. Delta is the difference between mean normalized learning gains. The power was calculated using GraphPad StatMate to determine if the comparison in a completed experiment missed a small effect due to small sample size. The curve shows the computed power of a test to detect various hypothetical differences (delta) using the class sample sizes and standard deviations. A. Classifying. B. Predicting. C. Balancing. D. Constructed Response.

For classification questions (Figure 7, A), the detection of a difference with 80% power, requires a delta of at least 0.08. The observed difference in mean learning gains was 0.091 (85%

power). Nonetheless, no statistically significant difference was found. Detection of a difference with 80% power for predicting and balancing questions requires a delta of 0.13. The observed difference in mean learning gains for predicting (Figure 7, B) and balancing questions (Figure 7, C) was 0.1124 (65% power) and 0.1644 (92% power), respectively. The statistical power of the test of balancing questions suggests that if there were real difference between the two cooperative learning techniques it should have been detected. Constructed response questions (Figure 7, D) using the 80% power model would need to have a difference of 0.15 to be detected. The actual difference measured was 0.1355 (75% power).

Lunch Status

East Ascension High School has a student population with over half of the students qualifying for free or reduced lunch. A comparison of the techniques might provide insight to help know which strategy is better for different subsets of students. Figure 8 shows the learning gains of students with free or reduced lunch compared to paid lunch students for Unit 7 and Unit 8.

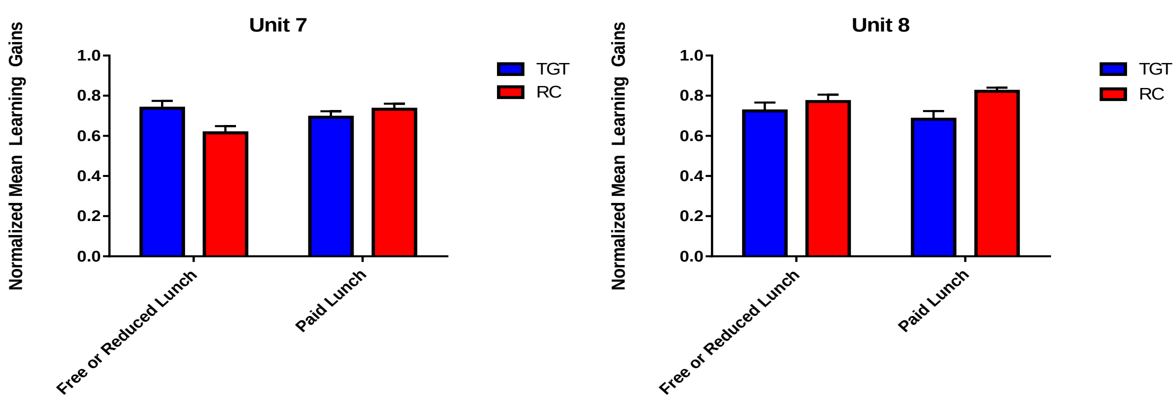

Figure 8. Normalized mean learning gains ± standard error of students with free or reduced lunch compared to paid lunch students using Rally Coach (RC) and Teams-Games-Tournaments (TGT). Left panel: Unit 7. Right panel: Unit 8.

When using Rally Coach, students who qualified for free or reduced lunch (n=31) performed significantly lower on Unit 7 than students with paid lunch (n=36) (unpaired t-test, P=0.008). The normalized mean learning gain for free or reduced lunch students using Rally Coach was 0.62 ± 0.19 while students that pay for their lunch had a normalized mean learning gain of 0.73 ± 0.17. Other comparisons within Unit 7 were not significant.

In Unit 8, students that pay for their lunch performed significantly better using Rally Coach when compared to students that pay for their lunch and used Teams-Games-Tournaments (P=0.003). For Rally Coach, the average normalized learning gain was 0.82 ± 0.02 and for Teams-Games-Tournaments the normalized mean was 0.68 ± 0.04. There were no other significant results within the Unit 8 lunch status.

Gender

In addition to comparing students' socioeconomic status, gender comparisons were made between the learning strategies (Figure 9).

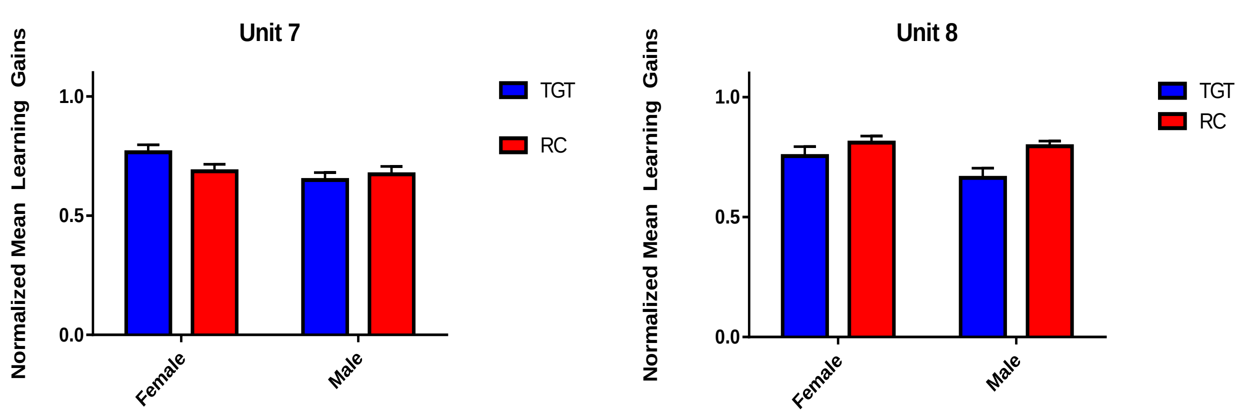

Figure 9. Average normalized learning gains ± standard error for female and male students for Teams-Games-Tournaments (TGT) and Rally Coach (RC). Left panel: Unit 7. Right panel: Unit 8

For Unit 7, females (n=29) outperformed males (n=27) when using Teams-Games-Tournaments (unpaired t-test, P=0.0095) (Figure 9). For Unit 8, males using Rally Coach (n=27) performed better than the males using Teams-Games-Tournaments (n=38) (unpaired t-test, P=0.0126, Figure 9).

Grade Levels

The student population was broken down into grade levels and the normalized learning gains were compared with Unit 7, Types of Bonds and Unit 8, Types of Reactions (Figure 10). There were only four senior students in the fall semester so twelfth grade was not included for either unit because there were no students in the spring semester to compare. Figure 10 shows the Unit 7 comparisons. There were no differences in normalized learning gains by grade levels within Unit 7. For Unit 8 (Figure 10) 10th grade students using Rally Coach (n=49) did better than 11th graders using Teams-Games-Tournaments (n=39). There were no differences among the other grade subsets. The normalized mean learning gain ± standard error of the mean for the 11th grade Teams-Games-Tournament students was 0.67 ± 0.25 and 0.83 ± 0.11 for the 10th grade Rally Coach students.

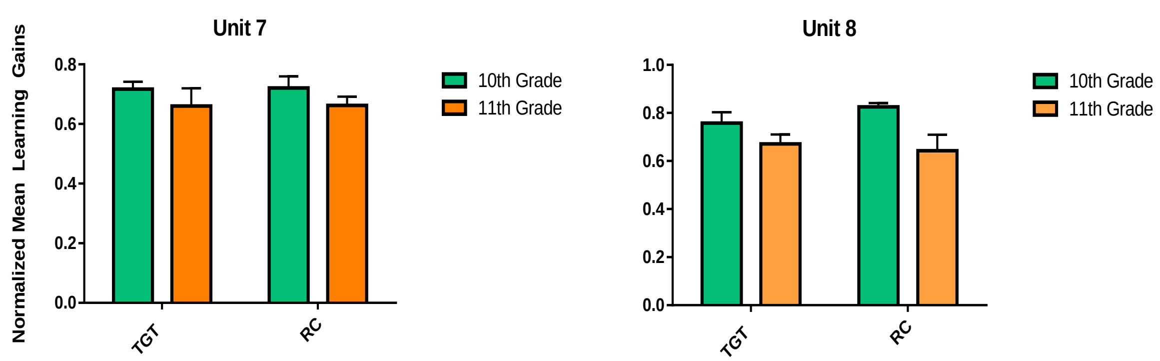

Figure 10. Normalized mean learning gains ± standard error for sophomore and junior students for Rally Coach and Teams-Games-Tournaments. Left panel: Unit 7. Right panel: Unit 8.

Honors and Academic Courses

Of the five sections of chemistry courses in the study, three were honors classes while the other two were academic chemistry courses. In the spring semester, both courses were honors. Thus, a comparison for academic students was not done. Unit 7 and Unit 8 were compared for honors classes. For Unit 7, there was no difference in normalized learning gains for the honors students using either cooperative learning strategy (Figure 10). The average normalized learning gain (± SEM) for Rally Coach was 0.76 ± 0.03 and the average normalized learning gain (± SEM) for Teams-Games-Tournaments was 0.71 ± 0.02. For Unit 8 honors students, there were no differences in normalized learning gains between the two cooperative learning strategies (Figure 11). The average normalized learning gain ± the standard error of the mean for Rally Coach and Teams-Games-Tournaments was 0.80 ± 0.02 and 0.76 ± 0.04, respectively.

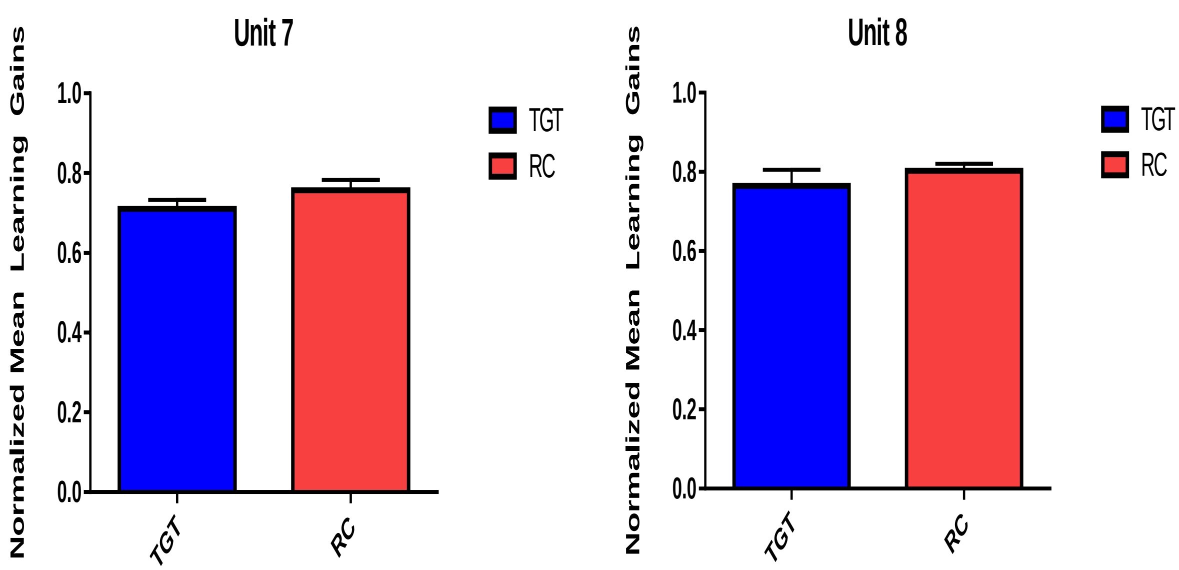

Figure 11. The average normalized learning gains (± SEM) for honors students using Teams-Games-Tournaments (TGT) and Rally Coach (RC). Left panel: Unit 7. Right panel: Unit 8

Student Attitudes

Success in science courses can be affected by a student's attitude (Trujillo and Tanner, 2014). Students' attitudes about engagement, motivation and their personal success was measured using a five-point Likert scale with ordinal values. A Chi-square test was used to measure whether students' attitudes towards each learning strategy differed among the classes. There were ten questions on the survey. The questions dealt with working in a group or partnership (Figure 12), student engagement (Figure 13) and whether the students would want to continue use of these group activities in the future (Figure 14). Surveys were given after the post-test for each unit. Students were not aware of their performance on the post-test when answering survey questions. There were five questions assessing students' opinions about working in a group or with a partner. Three of the questions were made to measure students' attitudes on how engaging Rally Coach and Teams-Games-Tournaments were in the chemistry classroom. The last two of the ten questions were meant to see if students would like to use the technique again in the future and their confidence in their performance on the post-test they had just taken. The survey given for Rally Coach can be found in Appendix C and the survey for Teams-Games-Tournaments is found in Appendix D.

Figure 12 shows the students' attitudes about working with a partner or group. Question one under the group questions, measured students attitudes about their learning when working with a group or partner in class Students in the different classes had different attitudes about question one (Chi-square, $P < 0.05$). Questions two, three, four and five were found to not be different.

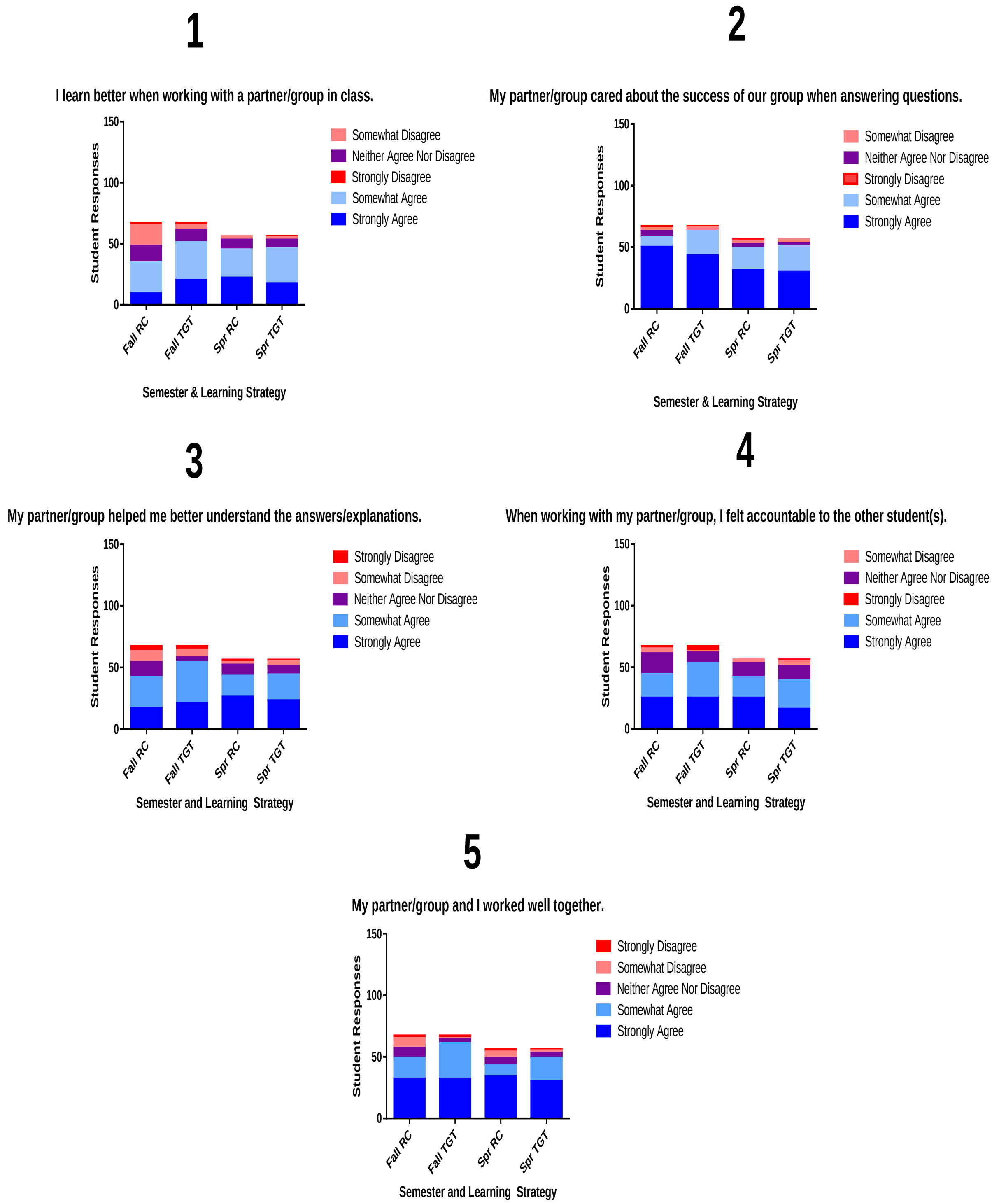

Figure 12. Five questions measuring students' attitudes about group and partner work when using Rally Coach (RC) or Teams-Games-Tournaments (TGT) on a Likert scale. The number of students responding in each category is shown.

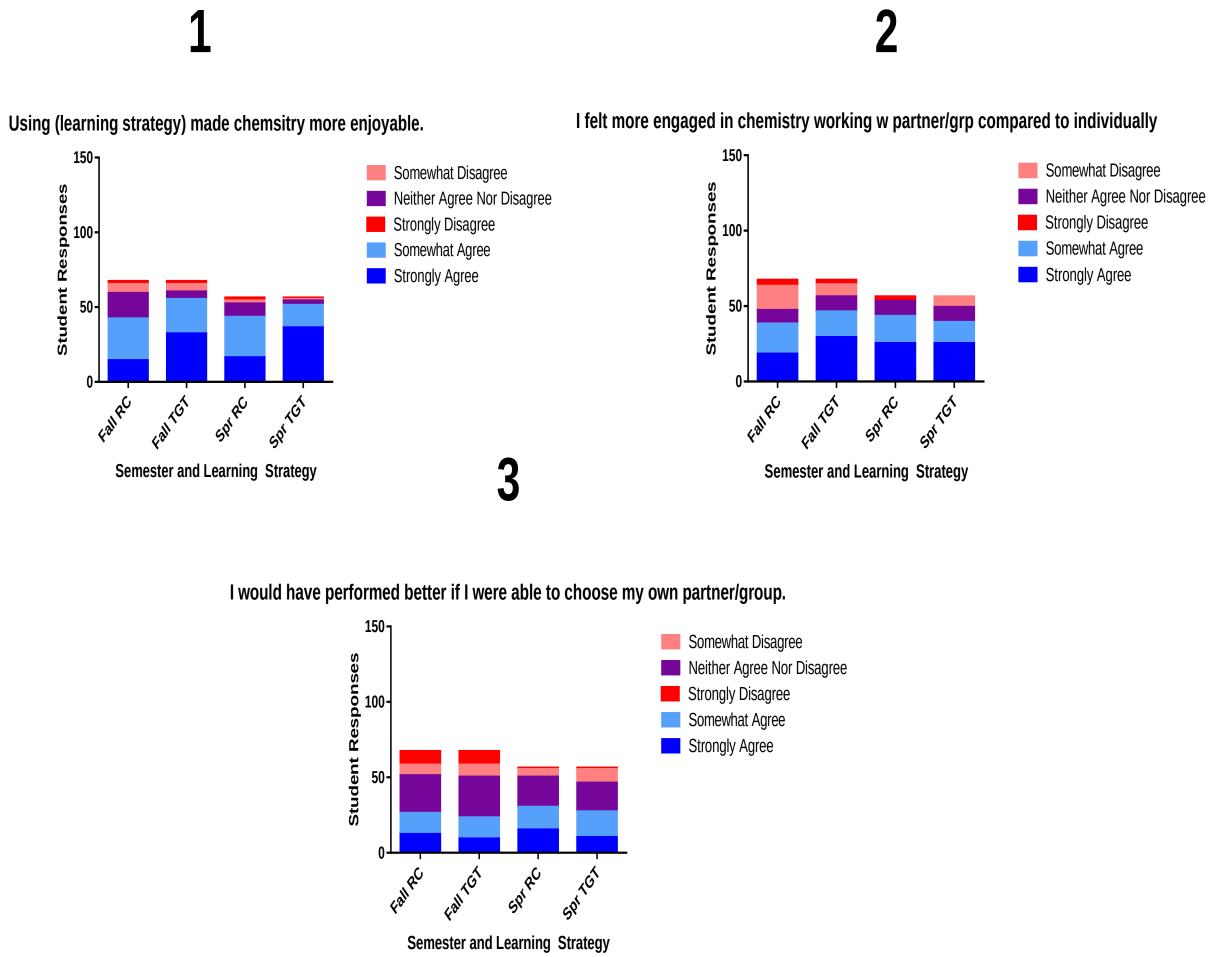

Figure 13. Three questions, using a Likert scale, measured students' attitudes about engagement of Rally Coach (RC) and Teams-Games-Tournaments (TGT). The number of students responding in each category is shown.

Figure 13 summarizes the students' views on engagement of the two cooperative learning techniques. Students mostly believed that the two cooperative learnings strategies made chemistry more enjoyable and engaging. Questions two and three found that students in different classes had different opinions about the engagement and enjoyment (Chi-square, P<0.05). The

majority of students felt neutral when asked about whether their performance would have been better had they chosen their own partner or group.

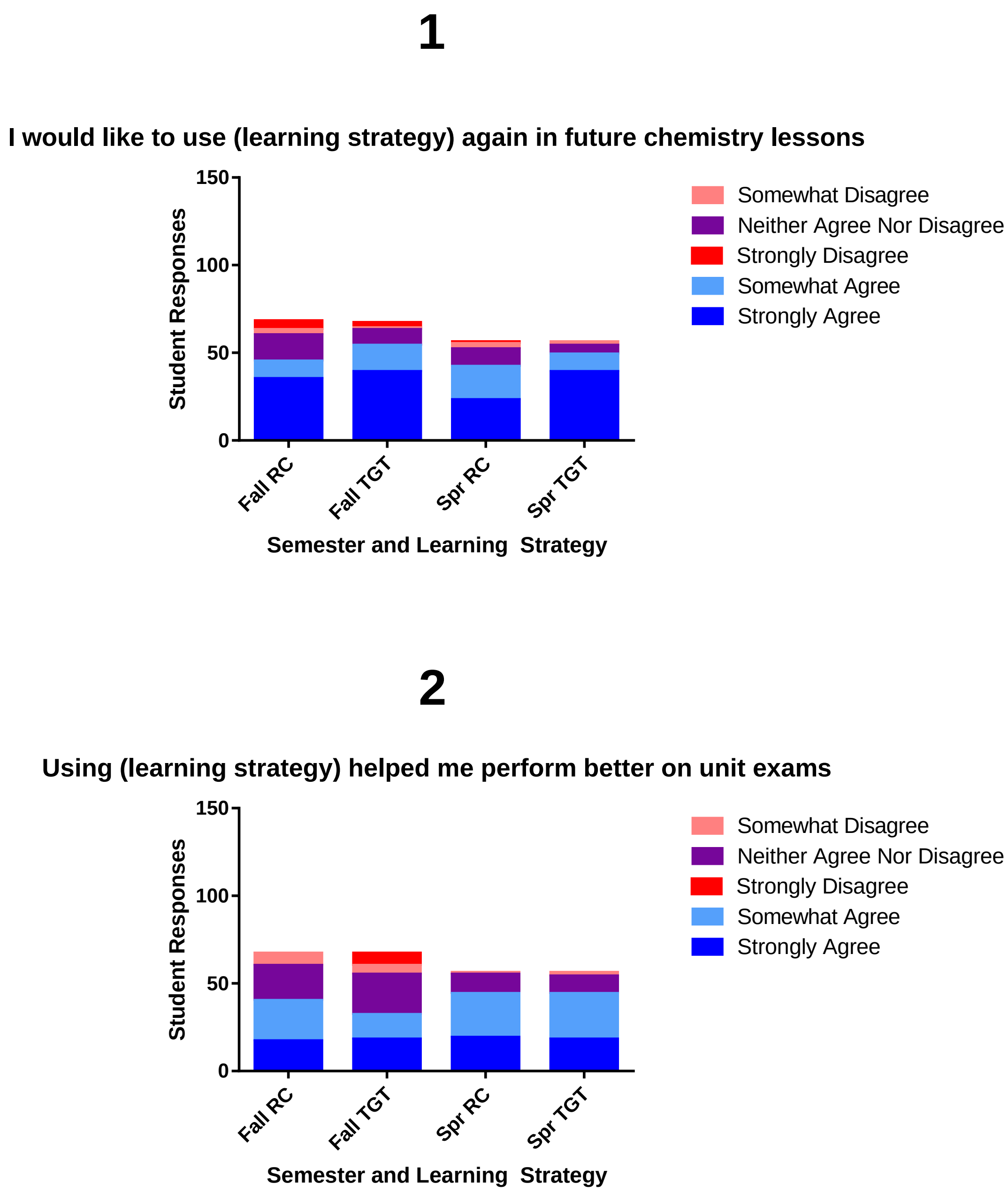

Figure 14. The attitudes of students about using Rally Coach (RC) or Teams-Games-Tournaments (TGT) in the future and their performance on their post-test were measured using a Likert scale. The number of student responses in each category are shown.

Figure 14 shows the interest of the students in using these cooperative learning techniques in future course work and whether they felt that these techniques improved their performance on the unit exams. Students enjoyed both learning strategies and most wanted to use them in future classes. As far as their perception on doing better on exams because of the learning structures (question two, Figure 14), students in different classes had different attitudes (Chi-square, $P<0.05$).

After students experienced both techniques and received time for reflection, a comparison survey of Teams-Games-Tournaments vs. Rally Coach was given to everyone (n=123). Results are shown in Figure 15.

Figure 15. Students were asked to identify which method they preferred in response to the questions shown in the panels above, Teams-Games-Tournaments (TGT) and Rally Coach (RC).

Students knew their scores on their post-test when completing the comparison survey (Appendix E). Most students thought that both strategies were helpful with learning the material, helping perform better on exams and wanted to use both techniques in the future. Teams-Games-Tournaments is the strategy students found most engaging and enjoyable. The number of responses for Rally Coach, Teams-Games-Tournaments and Both Strategies were similar for whether the strategy helps understand the content, however, the option ‘both’ had the most votes.

DISCUSSION

This study was designed to compare the effectiveness of two cooperative learning structures, Rally Coach and Teams-Games-Tournaments, in high school chemistry classes. The two strategies are similar in that they share four common characteristics of effective cooperative learning strategies: positive interdependence, individual accountability, promotive interaction and group processing. The strategies differ in that Teams-Games-Tournaments includes positive reinforcement and immediate feedback (DeVries and Edwards, 1972). Students received feedback right away and have their work confirmed as correct or not by their group. Rally Coach involved equal participation, peer tutoring and simultaneous interactions (Kagan, 2009). Equal participation requires each partner to be involved while simultaneous interaction increases time students get to demonstrate their skills by having an active role. Peer tutoring is the main idea behind Rally Coach allowing students to teach, help and coach each other to master the content. Efficacy of these approaches was determined by comparing normalized learning gains of classes of students who used these two cooperative learning structures.

Every student achieved positive learning gains for both Unit 7, Types of Bonds, (Figure 2) and Unit 8, Types of Reactions (Figure 3). When comparing Rally Coach vs. Teams-Games-Tournaments with Unit 7, there was no difference in the normalized learning gains of students. However, for Unit 8 covering chemical reactions, Rally Coach was the more effective learning technique. The students that utilized Rally Coach for Unit 8 were two honors chemistry classes from the spring semester and Teams-Games-Tournaments was implemented in the fall with two academic and one honors class.

From experience prior to the onset of this study, the teacher had an impression that the material covered in Unit 7, Types of Bonding, is typically easier than Unit 8, Types of Reactions,

for high school chemistry students. Foundation for bonding is taught in sixth grade science (https://www.louisianabelieves.com/docs/academic-standards/science-grade-6.pdf?sfvrsn=2) and tenth grade physical science classes. Fall Rally Coach was used by two academic classes and one honors class. That the two academic classes exhibited learning gains similar to the Spring Teams-Games-Tournaments group (consisting of two honors classes) might result from the foundation created in previous science classes for lower performing students. Unit 8, Types of Reactions, is a new topic and the first time students have to predict products. This topic requires absolute understanding of the material and any extra individualized tutoring can help students master the content. Rally Coach allowed for two students to communicate and assist each other in doing just this, leading to greater learning gains than Teams-Games-Tournaments (Figure 3). Teams-Games-Tournaments does allow for peer tutoring, but it is not a required aspect of the learning structure. Rally Coach's peer tutoring is referred to as elaborative interrogation, where students explain their performance and reasoning for their answer (Dunlosky et al., 2013). Groups that utilize elaborative interrogation have a significant effect when learning new facts about familiar material as opposed to a weaker or nonexistent effect when learning unfamiliar content (Dunlosky et al., 2013). Beginning a unit with prior knowledge increases learning and reasoning for why facts are true, without a foundation or prior knowledge, individualized tutoring can help achievement gains. Rally Coach allowed students to tutor, reason and justify their answers daily, whereas Teams-Games-Tournaments had opportunities for elaborative interrogation, but it was not a requirement for the structure. Rally Coach may also be easier to teach new material with a coaching environment instead of a competitive environment. Students may be more receptive to being coached when they are unsure as opposed to competing.

Competition may be better for solidifying understanding, but only after a student is comfortable with being challenged on the new material.

Females using Teams-Games-Tournaments in Unit 7 scored higher than their male counterparts using the same strategy (Figure 9). Teams-Games-Tournaments is a competitive yet cooperative strategy, creating a learning environment that encourages social engagement and cooperative learning for females (Notter, 2010). Young females enjoy friendly competition and have shown more interest in STEM education using such strategies (Notter, 2010). For Unit 8, the males using Rally Coach outperformed the males using Teams-Games-Tournaments. The significance can be attributed to elaborative interrogation that Rally Coach provides. However, the males using Rally Coach consisted of all honors students while 15 of the 38 males using Teams-Games-Tournaments were honors. Honors students are found to be more open to new ideas, more intelligent and more academically confident compared to non-honors students (Akkerman, et al., 2011).

Another difference found in Unit 8 was between 10th grade students using Rally Coach compared to 11th grade students using Teams-Games-Tournaments (Figure 10). The tenth grade students had higher learning gains than their older peers. While elaborative interrogation can be used to justify the differences, it should be noted that all of the tenth grade students were honors and of the 39 juniors, only 13 were honor students. As in the case in the comparison of males using Rally Coach and males using Teams-Games-Tournaments, honors students may be the reason for the higher scores. With new material in unit 8, the sophomores may have been more motivated to learn and study the concepts than the majority of the juniors.

Of the Unit 7 Rally Coach group, students that received free or reduced lunch performed lower than students that pay for their lunch (Figure 8). Typically, lower socioeconomic students

do not outperform higher socioeconomic students (Blazer, 2009; Lin et. al, 2015). In Unit 8, those students that paid for their lunch performed better with Rally Coach. These students are of higher socioeconomic status, enrolled in honors chemistry and had daily elaborative interrogation. All of these aspects are consistent with higher scores.

In both experimental units, students achieved higher learning gains on multiple choice questions when instruction was accompanied by Teams-Games-Tournaments. The Unit 7 Teams-Games-Tournaments students consisted of two spring honors class and the Unit 8 Teams-Games-Tournaments students were two academic chemistry courses and one honors.

Students demonstrated positive thoughts about the two learning strategies implemented in chemistry. There was an optional section for comments on all three surveys and many students expressed Teams-Games-Tournaments was the more enjoyable technique and they one they would like to use again. Rally Coach was effective, but some students did not like working with only one other student. All comments can be found in Appendix F.

RECOMMENDATIONS

Upon completing the study, my recommendation is to implement cooperative learning structures with daily chemistry lessons. Specifically, Rally Coach and Teams-Games-Tournaments are positive additions in the classroom for both students and teacher. Rally Coach had more positive impact when comparing the two structures, but students communicated enjoyment of Teams-Games-Tournaments both in the classroom and also on their surveys. The study raises some questions about how the two learning strategies affect student performance on various types of questions. The analysis would benefit from a replicate study in the future to see if the differences hold true. Implementing Rally Coach and Teams-Games-Tournaments in more units would be useful for a comparison of results.

For an educator, Teams-Games-Tournaments is easier to implement daily because students are part of larger groups and have more assistance. The competition day takes dedication, clear directions and planning, but once everything is set up, the cards can be used in future semesters. When grading daily practice, Teams-Games-Tournaments cut down grading by 75% because the teacher only picks up one paper per group. Rally Coach cuts down on grading by 50% because the teacher only collects one paper per partnership. This makes feedback easy and the teacher has more time to be detailed and informative.

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APPENDIX A – STUDENT AND PARENT CONSENT FORMS

Child Assent Form

I, ____, agree to be in a study that will help Ms. Miketinas find ways to help educate students at East Ascension High School by using Cooperative Learning Strategies. Ms. Miketinas will provide methods to aid my knowledge of scientific content. I understand that I will have to work to the best of my abilities while in this study. I will devote my time towards this study by participating in all learning instruction, classroom and at home activities, and assessments all while observing classroom rules at all times. I am fully aware that I can decide to stop being in the study at any time without getting in trouble or affecting my grade.

Student's Signature_______________________________Age________Date________________

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall Baton Rouge, LA 70803
P: 225.578.8692 F:225.578.5983
irb@lsu.edu I lsu.edu/irb

Parental Permission

PROJECT TITLE: Effects of Implementing Cooperative Learning Strategies, Rally Coach and Teams-Groups-Tournaments on Student Learning Gains in the Science Classroom

PERFORMANCE SITE: East Ascension High School
612 E. Worthey Street
Gonzales, Louisiana 70737

INVESTIGATIONS: The following investigators are available for questions about this study,

Monday – Friday 9:00 am – 3:00 p.m.
Ms. JoAnna Miketinas 225-621-2400
Dr. Joseph F. Siebenaller 225-578-1746

PURPOSE OF THIS STUDY: The purpose of this study is to determine whether there are greater learning gains in the science classroom at East Ascension High School when implementing cooperative learning strategies, Rally Coach or Teams-Games-Tournaments.

INCLUSION CRITERIA: Students in science classes taught by Ms. JoAnna Miketinas

DESCRIPTION OF STUDY: Over the course of the 2014-2015 school year, the investigator will introduce students to cooperative learning structures, Rally Coach or Teams-Games-Tournaments. The teacher will implement the strategies to enhance student achievement in the science classroom over numerous units. The teacher will provide feedback and instruction on how to successfully use the strategies. The instructor will help students reflect and improve their learning using the cooperative learning techniques. At the end of each unit, students will take a post-test and student survey.

BENEFITS: It is anticipated that all subjects will notice improved academic performance pertaining to students' abilities to grasp content knowledge and students' abilities to retain content presented. This study will also enhance behavior patterns within students, social capacity with teachers and peers, and an overall confidence of scientific knowledge by participating in this study.

RISKS: There are no risks associated with participation within this study.

RIGHT TO REFUSE: While participation in this study is highly suggested and recommended, it is not mandatory that a student subject chose to participate. At any time, either the subject may withdraw from the study of the subject's parent may withdraw the subject from the study. Non-participation in this study will leave no impact on the student's final grades or assessments throughout the duration of the school year.

PRIVACY: The records of participants in this study include, but are not limited to test scores and attendance, which may be reviewed by investigators. Also, results of the study may be published, but no names or other identifying information will be disclosed in publication. All subjects' identities will be kept confidential unless otherwise advised by law.

FINANCIAL INFORMATION: There is no cost for participation in this study, nor is there any compensation to the student subjects and/or their representatives for participation.

SIGNATURES: This study has been discussed with me and all of my questions have been answered. I may direct any additional questions regarding study specifics to the primary and/or co-investigator. If I have any questions about subjects' rights or other concerns I can contact Dr. Dennis Landin, Chairman of the Institutional Review Board at 225-578-8692, irb@lsu,edu I lsu.edu/irb. I will allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Parent Signature____Date___________

IF APPLICABLE: The parent/guardian has indicated to me that he/she is non-English speaking/reading, or unable to read. I certify that I have read and/or translated this consent form to the parent/guardian and explained that by completing the signature above, he/she has given permission for the child to participate in the study.

Signature Reader____Date

APPENDIX B – LOUISIANA STATE UNIVERSITY IRB APPROVAL

ACTION ON EXEMPTION APPROVAL REQUEST

LSU

Institutional Review Board
Dr. Dennis Landin, Chair
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TO: Joseph Siebenaller
Biological Sciences

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: July 1, 2014

RE: **IRB#** E8840

TITLE: Will Implementing Cooperative Learning Strategies, Rally Coach or Teams-Groups-Tournaments, Have a Greater Impact on Student Learning Gains in a Science Classroom?

New Protocol/Modification/Continuation: New Protocol

Review Date: 7/1/2014

Approved X **Disapproved** ____

Approval Date: 7/1/2014 **Approval Expiration Date:** 6/30/2017

Exemption Category/Paragraph: 1

Signed Consent Waived?: No

Re-review frequency: (three years unless otherwise stated)

LSU Proposal Number (if applicable): ____

Protocol Matches Scope of Work in Grant proposal: (if applicable) ____

By: Dennis Landin, Chairman DLandin

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING – Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. SPECIAL NOTE:

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

APPENDIX C – RALLY COACH SURVEY

This is an anonymous survey. Please circle one answer per question.

1. Not including chemistry, how many of your high school courses require you to work in partners whose grade depended on the participation and success of all members of the pair?
   4+ 3 2 1 0
2. Other than this chemistry class, have you ever participated in a class that uses Rally Coach?
   Yes No Which one(s)?
3. I learn better when I work with one other student during class.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

4. My partner and I cared about the success of our group when answering questions from Ms. Miketinas.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

5. My partner helped me better understand the answers to the questions and the explanations for our answers.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

6. When working with my partner, I felt accountable to the other student in my group.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

7. Using Rally Coach made chemistry more enjoyable.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

8. I felt more engaged in chemistry class when working with my partner compared to working individually.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

9. Using Rally Coach helped me to perform better on unit exams

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

10. I would have performed better if I were able to choose my own partner for Rally Coach.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

11. My partner and I worked well as a pair.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

12. I would like to use Rally Coach again in future chemistry lessons.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

APPENDIX D – TEAMS-GAMES-TOURNAMENTS SURVEY

This is an anonymous survey. Please circle one answer per question.

1. Not including chemistry, how many of your high school courses require you to work in partners whose grade depended on the participation and success of all members of the group?
   4+ 3 2 1 0
2. Other than this chemistry class, have you ever participated in a class that uses Teams-Games-Tournaments?
   Yes No Which one(s)?
3. I learn better when I work with a group of students during class.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

4. My group and I cared about the success of our group when answering questions from Ms. Miketinas

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

5. My group helped me better understand the answers to the questions and the explanations for our answers.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

6. When working with my group, I felt accountable to the other student in my group.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

7. Using Teams-Games-Tournaments made chemistry more enjoyable.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

8. I felt more engaged in chemistry class when working with my group compared to working individually.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

9. Using Teams-Games-Tournaments helped me to perform better on unit exams

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

10. I would have performed better if I were able to choose my own group for Teams-Games-Tournaments.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

11. My group and I worked well as a pair.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

12. I would like to use Teams-Games-Tournaments again in future chemistry lessons.

Strongly Agree Somewhat Agree Neither Agree nor Disagree Somewhat Disagree Strongly Disagree

APPENDIX E – RALLY COACH VS. TEAMS-GAMES-TOURNAMENTS COMPARISON SURVEY

This is an anonymous survey. Please select one answer per question.

1. Choose the learning strategy that helped you learn the material the best.

Rally Coach Teams-Games-Tournaments Both were beneficial No difference between the two

2. Choose the learning strategy that you enjoyed the most.

Rally Coach Teams-Games-Tournaments Both were beneficial No difference between the two

3. Choose the learning strategy that helped you better understand the answers to the questions and the explanations for the answers.

Rally Coach Teams-Games-Tournaments Both were beneficial No difference between the two

4. Choose the learning strategy that made chemistry more engaging.

Rally Coach Teams-Games-Tournaments Both were beneficial No difference between the two

5. Choose the learning strategy that helped you perform better on unit exams.

Rally Coach Teams-Games-Tournaments Both were beneficial No difference between the two

6. Choose the learning strategy that you would like to use again.

Rally Coach Teams-Games-Tournaments Both were beneficial No difference between the two

APPENDIX F – STUDENT COMMENTS

Comments from Teams-Games-Tournaments Survey

1. Adding competition to any class makes it easier for me to learn the content
2. I like working in groups!
3. I would just hope for better group members… not people who don't work then cheat from me, and clown around all class period
4. I miss school during this lesson and my group helped catch me up a lot and the games helped me remember what we were learning very well
5. Pretty Cool!
6. For #10 I didn't know what to put because I wouldn't know if would have done better with a group I chose. So it could have been bad or good.
7. It was fun and interesting
8. I enjoyed Chemistry
9. Games were enjoyable, made class more fun.
10. Team Games Tournament made chemistry fun and allowed the fun of competition to come out in the class
11. I had so much fun! And with that game I was able to understand some things so much more and class was so much fun! I definitely think we should do that again.
12. The game before the test really helped me a lot!
13. I would like to get a better chance to answer the question and not be against time.
14. I feel like in my group we got off topic a lot more.
15. I like to work individually but sometimes when I can just ask my group for help and they do.

Comments from Rally Coach Survey

1. It was really good, I just had a lazy partner
2. The partners help, because if you have trouble figuring out a problem, then they can help you out.
3. My partner doesn't talk. I talk to him, he doesn't respond…
4. I had the partner I wanted, and we worked well together
5. When you are assigned random partners, it can make working incredibly difficult/awkward. Please let us pick our own partners.

Comments from Comparison Survey

1. The group/partner activities helps me study and challenge myself in the classroom
2. I really liked the TGT
3. Working with my friends really helped

VITA

JoAnna Miketinas Stewart was born in Meridian, Mississippi, the daughter of Robert and Lisa Miketinas and the oldest sibling to Jessica, Bobby and Michael Miketinas. She received her Bachelor of Biological Sciences in 2011 from Louisiana State University in Baton Rouge, Louisiana. In 2013, she entered Louisiana State University's Graduate School as a candidate for a Masters in Natural Sciences. She is married to Matthew Wilson Stewart and currently teaches high school science at East Ascension High School in Gonzales, Louisiana.