THE EFFECTS OF PEER TUTORING AND COOPERATIVE LEARNING IN AN INCLUSIVE CHEMISTRY CLASSROOM

by

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ABSTRACT

This classroom research project examines the effects of targeted peer tutoring and cooperative learning strategies in the high school chemistry classes based on academic and social outcomes for students with and without disabilities. A Treatment Unit consisted of three weeks of instruction using peer tutoring and cooperative learning strategies. Students took a pre and post content assessment to measure academic gains during the Treatment Unit, which was compared to academic gains in a Non Treatment Unit. Students also took a pre and post survey on attitudes on learning styles and evaluating their preferences on peer tutoring and cooperative learning. Exit interviews were conducted with six students. Data was analyzed for two subgroups, students with disabilities (n = 6) and students without disabilities (n = 38), as well as for the entire research group (N = 44). The data suggests slight improvement in academic gains for students with disabilities in the Treatment Unit and no change for students without disabilities. Students responded positively before and after treatment to peer directed learning activities. Exit interviews demonstrated positive effects on interpersonal relationships in the classroom.

INTRODUCTION AND BACKGROUND

For the past four years, I have worked as a special education science teacher at Middleton High School (MHS). MHS offers fully inclusive classes for students with disabilities. In the science department, students with disabilities take biology, chemistry, and physics. As a special education teacher, this is what you hope for your students: access to rigorous schoolwork and the opportunity to grow and learn with their peers. As I develop in my role as a special education science teacher, it is important to me to do all I can to maintain our school's values, which center around inclusion and equity.

MHS is located in Middleton, Wisconsin, which sits as a suburb of the state capitol, Madison. The district has experienced exceptional growth in enrollment over the last decade, approximately three percent per year, as Madison's suburban areas continue to grow and develop (MCPASD Website, 2018). This flourishing area has been experiencing profound growth in population, and has been considered a destination school district by families moving into the Madison area.

In November 2017, Wisconsin Department of Public Instruction released its annual Report Card for MHS. Enrollment as of 2017 data was 2,047. The breakdown of racial demographics of MHS is 77.2% White, 7.4% Asian, 4.9% Black, and 7.0% Hispanic/Latino. Fifteen percent of students at MHS receive free or reduced lunch. Students with disabilities at MHS total 9.5% of the student population and students who are identified with Limited English Proficiency include 2.5% of the student population (MCPASD Website, 2017).

Over the past decade, Middleton has been consistently considered one of the higher achieving schools within the state. MHS offers a wide variety of classes, with almost 200 course offerings. MHS reported an average composite ACT score of 24.5, compared to a state average of 20.5 (MCPASD Website, 2017). The graduation rate of MHS is 92% (MCPASD Website, 2017). Post-graduate plans for the class of 2017 included 75% for a 4-year college, 15% 2-year or technical school, and 10% military, work, or other plans.

All students at MHS experience rigorous coursework that includes a required 24.5 credits to graduate. Three of those credits are required in science. At MHS, the progression of science classes taken is: biology as a freshman, chemistry as a sophomore, and physics or other electives as a junior or senior. Most students at MHS take the classes in this sequence, so each subject area has nearly 500 students enrolled in a given year. Biology and chemistry offer integrated honors where all students have the opportunity to earn honors as an extension of the coursework. The integrated honors options were made available in the last five years in an effort to provide high quality inclusive education that is de-tracked and provides equitable opportunity for all students. The science department at MHS has three embedded special education teachers that co-teach certain sections of these classes. Students with disabilities who need specialized instruction in the area of science as part of their Individualized Education Plan (IEP) are placed in biology, chemistry, or physics classes with special education teacher support. Further, these co-taught classes have a consult-based service delivery model for special education. This means the special education teacher is supporting two different classrooms during the same block, providing support to students in each class. During a given 90-minute class period, the special education teacher spends approximately 45 minutes in each supported classroom. The rationale for this model is to provide a setting with natural proportions of students with and without disabilities.

US News & World Report ranked Middleton High School the #1 high school in the state of Wisconsin in 2014 (MCPASD Website, 2017). In Wisconsin's Department of Instruction annual report card for the 2017 school year, Middleton received a mark of 83.1, "exceeding expectations" (2017). Despite the accolades, Middleton still has struggles and areas in need of improvement. One of those areas of need is addressing the achievement gap for minority students and students with disabilities, which has been acknowledged as a priority area by Wisconsin DPI (2017). At MHS, students of color have a lower graduation rate than students who are white by a rate of nearly 5 points (Brown & Maurice, 2017). Over the past five years, student and teacher equity coalitions have been formed at the high school to address equity-related issues for some of the most vulnerable student populations.

As a special education teacher in the science department at MHS, my primary objective is making science accessible to all levels of learners. Our diverse science classrooms include students with a variety of needs including students with learning disabilities, autism, emotional and behavioral needs and students with intellectual disabilities. Because of a range in student needs, often times an alternate or replaced curriculum is required. Other times, students require specialized supports during instructional time, such as visuals or graphic organizers in order to access the general curriculum.

One of my challenges has been finding new and unique ways to craft high school chemistry to make sense to all levels of learners. In chemistry, explaining what is happening at the unobservable level is very difficult to students who require visual or tactile supports to access the curriculum. It has often made me reflect on what new instructional practices may be helpful in delivering rigorous chemistry content. It has also made me carefully consider what the goals of my students are for a course of this nature. For many students with and without disabilities, growth in communication skills is a requisite part of development as a high schooler. Considering the nature of our science classes that utilize labs and team experiences, I have wondered how targeted peer learning or cooperative learning opportunities would benefit students with and without disabilities. On a broader scale, the school district initiatives to improve outcomes for students with disabilities and minority students has made inclusive and cooperative strategies imperative.

Upon reflection of my role as a special education science teacher and goals of our district, I seek to explore purposeful ways to engage students with disabilities in upper level science classes. The purpose of this study was to investigate the inclusive strategies of peer tutoring and cooperative learning for supporting students with disabilities in co-taught high school chemistry. My background and research lead me to the focus statement for my classroom research: in inclusive high school chemistry classes, does use of peer tutoring and cooperative learning strategies affect academic and social outcomes for students with and without disabilities?

CONCEPTUAL FRAMEWORK

For the last several decades, leading research in education has pointed towards inclusion of students with disabilities in the general education setting as best practice because of the positive academic, social and emotional outcomes for all students (Henninger & Gupta, 2014). Inclusion is not just about putting students with disabilities in classrooms with their peers, but rather involves providing meaningful instruction for all students. While the Individuals with Disabilities Education Act (IDEA) mandates inclusion through a least restrictive environment, it is also important that educators understand the genuine value and equity involved with this principle. Despite this mandate, high schools are still challenged to engage their students in inclusive practices for a variety of reasons including increased student diversity, increased expectations in learning standards, and an increased number of students with disabilities taking high stakes tests (Casole-Giannaola & Green, 2012). With the latest re-authorization of IDEA in 2007, inclusive high school science classes have become the norm for students with mild to moderate disabilities. However, inclusion through inquiry in high school chemistry classes is still a relatively new and evolving study (Mumba, Banda, Chabulengula & Dolenc, 2015).

Research has demonstrated the benefits of classrooms that include all levels of learners. In 1987, researchers followed Rockville Centre School District in New York as the district went through a de-tracking reform. As the district moved from having courses separated by ability level toward inclusive classes for all students, they found the effects were staggering. Rockville saw its high school graduation rate explode from 84% to 97% for all students, and from 26% to 76% for students receiving special education services (Burris & Garrity, 2008). One of the greatest concerns about the process that the Rockville District faced before beginning de-tracking was the possibility of it having a negative effect on achievement for high-level learners. The research demonstrated that achievement was improved by teachers implementing a rigorous curriculum for all students. This included differentiation for various levels of learners, with modifications for students with special needs and access to honors and extension materials for gifted and talented students (Burris & Garrity, 2008). The findings of this case study have profound implications for instructional possibilities in high school chemistry classes that are inclusive to all students and contain integrated honors options.

With an increasing range of needs in high school chemistry classrooms, new instructional delivery methods such as team teaching have been on the rise. Middle school and high school science teachers more frequently find themselves in a co-teaching relationship with a special education teacher or English Language Learner (ELL) teacher because of students with IEPs or ELLs in the classroom (Linz, Heater & Howard, 2011). High school chemistry can present unique challenges for an inclusive classroom because of the conceptual nature of the course and the incorporation of algebraic thinking skills. A challenge many high school science teachers face is the pace at which their class moves through content. With the breadth of concepts and the high amount of vocabulary, it can be exceptionally difficult for the teacher to employ strategies that meet the needs of the honors student while meeting the needs of the student with a specific learning disability in the area of reading (Linz, Heater & Howard, 2011).

One instructional strategy that lends itself well to a high school chemistry class is peer tutoring. Peer tutoring is a learning strategy where students work as partners and tutor each other, using tools such as visual aids or vocabulary cards (Mumba, Banda, Chabulengula & Dolenc, 2015). In a study on inclusive chemistry classes, researchers compared outcomes of instruction that was teacher-directed versus instruction that was assisted through peer tutoring. They found that the use of peer tutoring had significant positive effects on student assessment scores for both students with and without disabilities compared to more teacher-directed instruction. Further, exit interviews with teachers and students showed positive support for the peer tutoring strategy in the chemistry classroom (Mumba, Banda, Chabulengula & Dolenc, 2015).

Both peer tutoring and cooperative learning present collaborative opportunities for student learning in chemistry. Similar to peer tutoring in its collaborative nature, cooperative learning can be implemented in the high school chemistry classroom. Cooperative learning involves the use of shared group and individual responsibility in order to include all members of a team. Cooperative learning contains elements such as positive interdependence, face-to-face interaction, clearly perceived individual accountability, social skills, and group processing. Research has found that cooperative learning can promote better relationships between students with and without disabilities (Johnson & Johnson, 1999). Using cooperative learning strategies could be especially effective in high school science classrooms where students are engaged in a variety of lab experiences. Some recommendations for implementing cooperative learning within the high school science classroom include using group roles to facilitate work on an assigned question for a scientific inquiry activity (Lin, 2006).

Though collaborative learning opportunities can be helpful, learning rigorous chemistry content can still be a challenge for many students. For example, many students in co-taught chemistry classes struggle with the use of mathematics. Because of this challenge, one solution may be to start the school year with more basic concepts, such as physical and chemical change, then incorporate more math-intensive units later on, allowing students to experience success with basic concepts first (Linz, 2011).

For students that struggle with reading comprehension in the science classroom, one powerful strategy can be the explicit teaching of reading comprehension strategies (Ness, 2016). Vocabulary acquisition in high school science classes is comparable to learning a foreign language (Mastropieri, Scruggs, & Graetz, 2005). Research has shown that teaching specific reading strategies to high school science students can significantly improve comprehension, such as having the science teacher model specific strategies such as comprehension monitoring, questioning, and use of graphic organizers (Ness 2016).

Although direct instruction in chemistry is helpful for math and reading skills, evolving science standards and instructional practice have placed an emphasis on an inquiry-based approach to learning science (Linz, 2011). Inquiry is the instructional practice that shifts science instruction from teacher-directed to student-directed. In inclusive chemistry classrooms, research has found teachers report student engagement, explanation through activities, and group work to benefit both special education and regular education students as the most significant benefits of using inquiry in the science classroom (Mumba, Banda, Chabulengula & Dolenc, 2015). Inquiry has proven to benefit the learner by providing them opportunities to construct their own knowledge, based on the understanding that students can acquire new information based on past experiences applied in new situations (National Education Council, 2000). Based on this information, inquiry can provide an overall approach to science instruction that involves investigations where students work collaboratively.

In conclusion, research has demonstrated numerous approaches to the inclusive chemistry classroom. Collaborative practices and teacher-directed instruction have benefits on learning outcomes. In the inclusive high school chemistry classroom, there are students of a variety of backgrounds and needs. Students with disabilities and students who are gifted and talented can and should work together towards common and individual goals. Though there can be challenges to inclusion in high school chemistry, collaborative strategies such as peer-tutoring and cooperative learning can be implemented in purposeful ways to improve academic and social learning for all students.

METHODOLOGY

The classroom research project was designed to measure the academic and social outcomes for students with and without disabilities when cooperative learning and peer tutoring strategies were used consistently, as a focus for instruction, over the course of a unit. Prior to the treatment, data was collected during a non-treatment unit to be used to compare the effects of cooperative learning and peer tutoring. The details of data collection will be discussed in the next section.

Treatment

The treatment group consisted of two sophomore chemistry classes (*N* =44). The treatment period took place during our Bonding unit, which totaled seven class periods. MHS is on a block schedule that alternates A/B days, so the treatment lasted a total of three weeks. A peer tutoring or cooperative learning strategy was used in each day of the unit (Table 1). The peer tutoring and cooperative learning strategies each followed a similar protocol.

Table 1
Peer Tutoring and Cooperative Learning Activities by Lesson

Lesson	Peer Tutoring	Cooperative Learning
1. Intro and Lewis Dot Lab	X	
2. Molecular Geometry		X
3. Intermolecular Forces		X
4. Bonding Lab		X
5. Properties of Ionic and Covalent	X	
6. Vocabulary Partner Activity	X	
7. Tell a Molecular Story	X	
8. Team Task Activity		X

Note. X indicates the instructional strategy used during the lesson.

For peer tutoring, students were given a partner throughout the unit. Each time the class engaged in a peer tutoring activity, students met with the same partner. Partners were determined by scores on the non-treatment post-test. The highest score was paired with the lowest score, second highest score was paired with the second lowest, and so-on. The rationale behind this was to use the information gathered during the non-treatment period to pair students who had a strong understanding with a student who had a weak understanding. These partnerships also paired a student with a disability to a student without a disability. The activities that partnerships engaged in during peer tutoring included: think-pair-share questions, shared reading, peer editing, and taking turns teaching and quizzing each other on content.

For cooperative learning, students worked with others in groups of four students. These four students had their desks pushed together, termed a "pod." The pods were intentionally mixed with students of varying ability. During the intro day to the unit, each pod put together a team binder for them to keep in the classroom. The team binder held lab activities from throughout the unit that the pod could share. Students kept their own notes and reference sheets in each of their personal binders. Each cooperative learning activity included positive interdependence through shared resources and assigned tasks or roles. Examples of the roles used in the cooperative learning activities included: Recorder, Direction Reader, Materials Manager, and Project Manager. The roles of the group were rotated between activities, so each student was responsible for a new aspect of the team goal. These cooperative strategies were designed to promote individual and group accountability, as well as time for the group to process and engage in communication.

Data Collection

Data collection took place between mid-November to the end of January and over the course of two units in chemistry. One unit was a non-treatment unit, and the other was the treatment unit for both classes. Prior to the treatment, data was collected in the non-treatment unit for both classes in order to measure and assess student learning. This data was then compared to that of the treatment. During the non-treatment period, normal classroom routines and procedures were followed without peer tutoring or cooperative learning strategies. For the non-treatment unit, students took the Pre/Post-Test on Atomic Structure (Appendix A) at the beginning and end of the unit on the atom and periodic table. Students' scores on the Pre and Post Test were analyzed using normalized gains. In addition, students completed two Exit Ticket (Appendix B) Google Form responses during the non-treatment unit. These response forms asked students to summarize their learning for the day and identify what specific learning activities were helpful for them. Student responses were analyzed for trends and patterns, in order to assess the complexity of their learning. It was also analyzed to determine which students found teacher directed, self-directed, or peer-directed activities to be the most helpful for their learning.

Following the non-treatment period, the two Chemistry classes were then given the Pre/Post-Test on Bonding (Appendix C) for the treatment unit at the beginning and end of the unit. Student scores for the Pre/Post-Test on Bonding were analyzed using normalized gains for the entire treatment group (*N=25)*. In addition, students took the Peer Tutoring and Cooperative Learning Survey (Appendix D) at the beginning and end of the treatment unit. Results from the survey were analyzed using a Wilcoxon Sign Ranked test.

Further, results from the Pre/Post-Test on Bonding and the Peer Tutoring and Cooperative Learning Survey were analyzed within two sub-groups. Subgroup one included students who have an Individualized Education Plan (IEP) (*n*=6). Subgroup two included students who do not have an IEP (*n*=38). Normalized gains were analyzed for each subgroup for the Pre/Post-Test.

During the course of the treatment unit, two formative assessments were collected as exit tickets following a class period where peer tutoring or cooperative learning was implemented. The Exit Tickets, Peer Tutor (Appendix E) and Cooperative Learning (Appendix F), were both used following a lesson where a peer directed learning strategy was implemented. Student responses for these two exit tickets were analyzed for patterns and themes overall, as well as for each subgroup.

Following the treatment unit, six students were selected to respond to the Exit Interview Questions (Appendix G). Three students were selected from subgroup one (students with IEPs) and three students were selected from subgroup two (students without IEPs). Student responses were analyzed for patterns and themes.

Finally, qualitative classroom observations were made during class times and recorded in a journal. Observations and entries in the journal were focused on student-to-student interaction, including interpersonal communication and overall engagement in the activities. These observations, along with the data collection tools listed above, were used to collect evidence to for both research questions (Table 2).

Table 2
Data Triangulation Matrix

Research Question	1	2	3
1. Does use of peer tutoring and cooperative learning strategies affect academic outcomes for students with disabilities and students without disabilities?	Bonding Pre/Post Test	Cooperative Learning and Peer Tutoring Exit Tickets	Exit Interview Questions
2. Does use of peer tutoring and cooperative learning affect social outcomes?	Peer Tutoring and Cooperative Learning Survey	Exit Tickets	Exit Interview Questions

DATA ANALYSIS

Non-Treatment Unit

Students in two chemistry sections were given the Pre and Post-Test on Content for the Atom/Periodic Table Unit (Appendix A) and a Takeaway Exit Survey (Appendix B) (*N*=44). Both these data collection instruments were used during the Non-Treatment Unit and were compared to data from the Treatment Unit.

The Pre/Post-Test on Content consisted of ten multiple choice questions based on content from the Atom and Periodic Table Unit. Prior to the unit, students in both chemistry sections took the Pre-Test. On the Pre-Test, the mean score was 32.5% while the mode score was 40% (Figure 1). At the end of the Non-Treatment Unit, students were given the same ten question content assessment for the Post-Test. The mean score on the Post-Test was 71.8% while the mode score was 90%. The scores for the Pre-Test and Post-Test were analyzed for Normalized Gains. Overall, the entire study group had a normalized gain value of 0.6, demonstrating significant growth in their understanding of the topic. Further, gains were analyzed for each Subgroup. Subgroup One (students with IEPs) demonstrated a normalized gain value of 0.11, while Subgroup Two (students without IEPs) had a normalized gain value of 0.66.

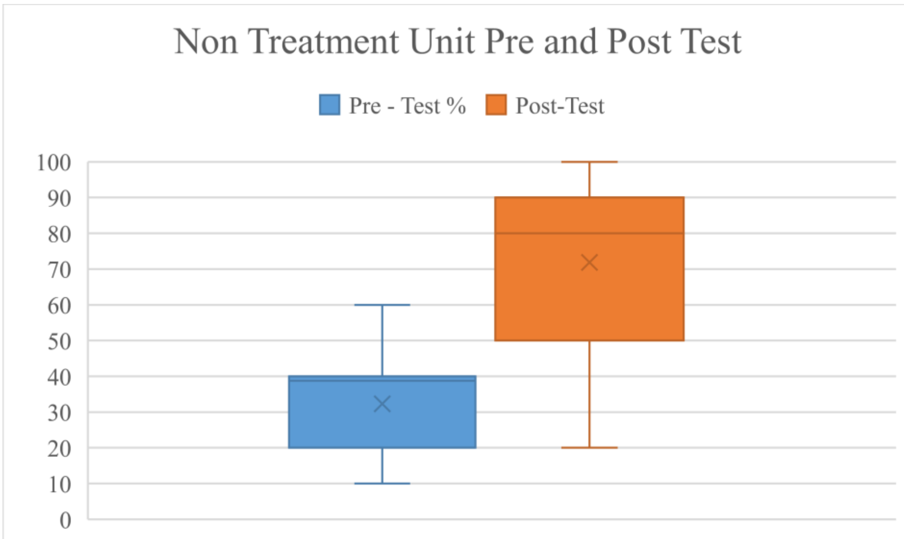

Figure 1: Non-treatment unit pre and posttest box and whisker plot, (*N*=44).

Following a class period during the Atom and Periodic Table Unit, students responded to the Takeaway Exit Survey. The survey asked two questions: in one sentence, summarize what you learned in chemistry today, and what activity was helpful for your learning today? These responses were analyzed for patterns and themes.

In response to the first survey question, 86% of answers used at least one of the unit vocabulary words. However, most of these responses just identified the word, but did not provide a definition or connection. For example, a common response was “I learned about electronegativity and ionization energy.” This response provides the unit vocabulary, but does not show the student understands what that word means or makes a connection. An example of a better response that made a connection was “Today I learned that ionization energy decreases as you go down the periodic table due to decreasing attraction between the nucleus and the outer electrons." This response demonstrates both a definition and connection. However, responses like this were much less frequent. Eight percent of student responses included a definition or connection. Responses from these Takeaway Surveys were used as comparison to the Treatment Unit.

In the second survey question, students identified what activity was most helpful for their learning. The lesson from this class period included a teacher directed activity, an individual directed activity, and a peer learning activity. Students indicated what they found to be most beneficial to their learning and a reason why. Overall, 54% of responses indicated a preference for the peer directed activity, followed by 34% preferring the teacher directed activity, and 12% favoring the individual directed activity (Figure 2). These responses indicate that most students found the peer activity to be most beneficial to their learning.

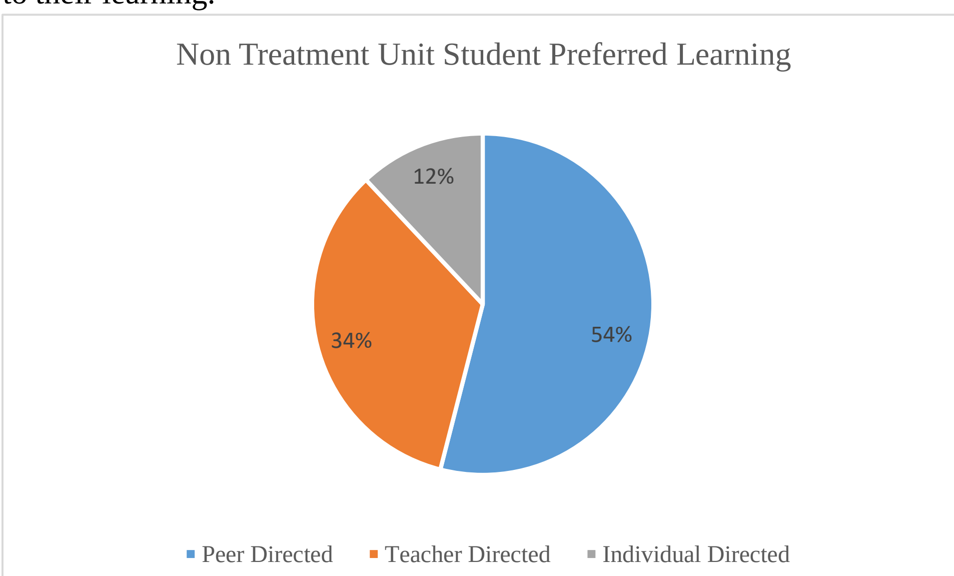

Figure 2: Student takeaway responses indicating preferred learning activity, (*N*=44).

Students who responded in favor of a peer directed activity identified reasons for it being the preferred activity including “working with a partner helped my understanding” and “it was helpful to see the graphs with my group.” The responses that were in favor of individual or teacher directed activities did not provide a justification for that being the preferred learning method, just saying “I liked taking notes” or “working alone on the worksheet.” Overall, this indicated that in the Non-Treatment Unit, students had a preference for peer directed learning and were able to identify reasons why this was their preferred style.

Treatment Unit

During the Treatment Unit, students took a Pre and Post Test on content knowledge (Appendix C). The test consisted of 10 multiple choice questions on content knowledge of the chemistry bonding unit. Students scored an average of 30.1% on the Pre-Test with a mode score of 30%. On the Post-Test, the mean score improved to 70.7% with a mode score of a 90% (Figure 3). Pre and Post Test scores were further analyzed using normalized gains. Overall, the study group had a normalized gain value of 0.61, demonstrating significant improvement in their content knowledge. Further, Subgroup One (students with IEPs) had a normalized gains value of 0.34, while Subgroup Two (students without IEPs) had normalized gains value of 0.65.

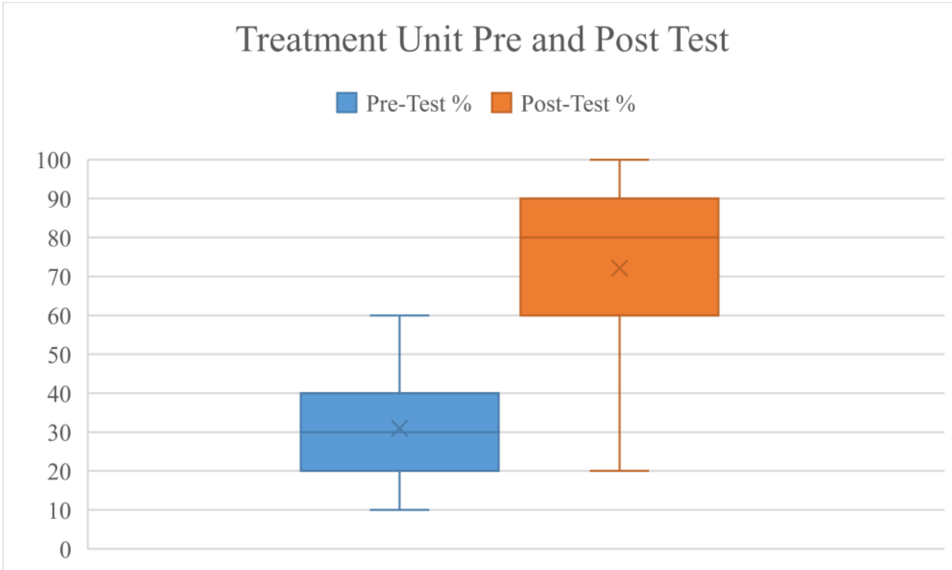

Figure 3: Treatment unit pre and posttest box and whisker plot, (*N*=44).

Students also took a Pre-Treatment Survey on Peer Tutoring and Cooperative Learning (Appendix D). The survey consisted of questions asking about preferred learning styles and attitudes towards peer tutoring and cooperative learning activities. In the Pre-Treatment Survey, the first question asked students in general how they feel they learn best, to which 48% of responses indicated they learn best when working with the teacher, while 31% learn best when working with peers, and 20% learn best when working independently. Eight questions were statements that asked the students to respond on a Likert scale from strongly disagree to strongly agree. The survey also had an open ended question for students to leave comments. Responses to the Pre and Post Surveys can be seen in Figure 4 and Figure 5 respectively. For all of these survey questions, more students responded Agree or Strongly Agree than those who responded Disagree or Strongly Disagree in both the Pre Survey and Post Survey.

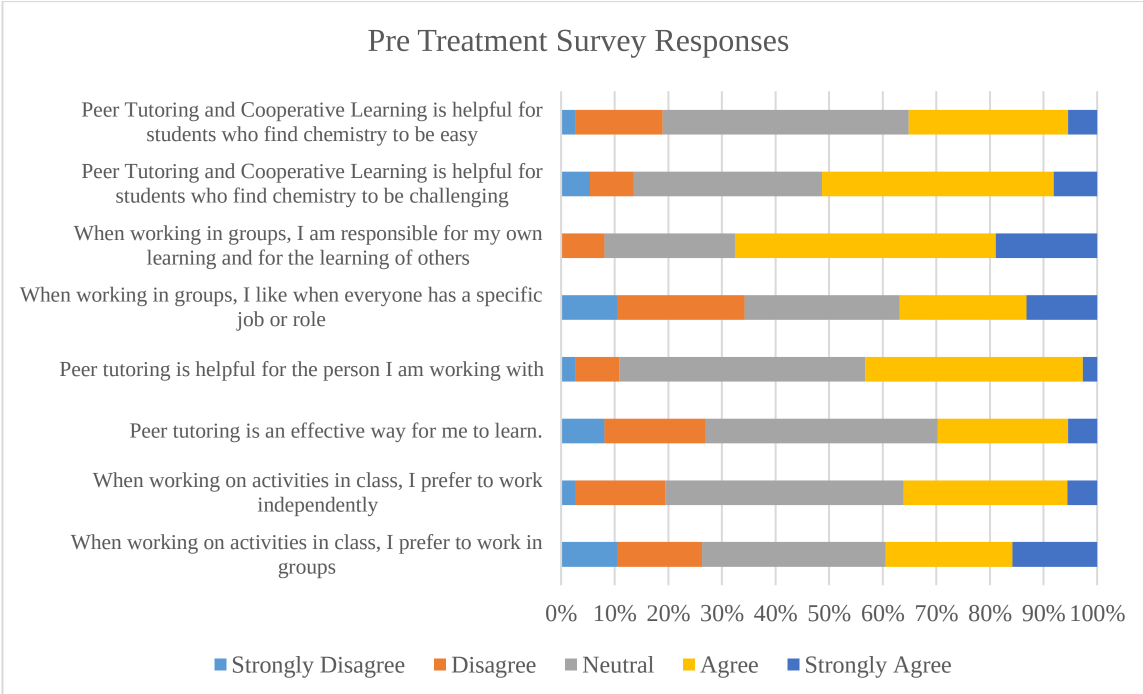

Figure 4: Pre-treatment cooperative learning and peer tutoring survey responses, (*N*=44).

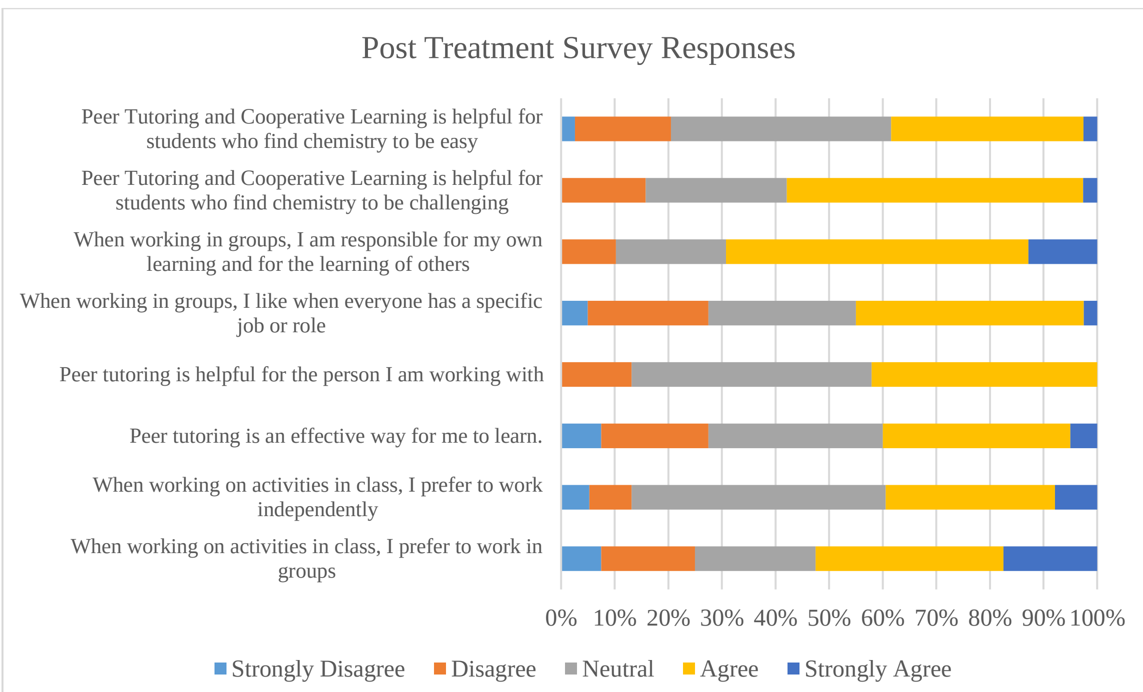

Figure 5: Post-treatment cooperative learning and peer tutoring survey responses, (*N*=44).

Results from the Pre and Post Survey were further analyzed using a Wilcoxon Sign Rank Test. For this test, response items were assigned values from 1 to 5, where 1 represented Strongly Disagree and 5 represented Strongly Agree. Upon analysis, none of the questions showed significant change with p-values all greater than 0.05. The survey question with the lowest p-value of 0.11 was "When working on activities in class, I prefer to work independently" with a slight shift of more students responding in agreement to the statement. Overall, student opinions from the survey questions did not represent significant change.

Some students also included comments to their survey responses. In the Pre Survey, students that responded indicated that they favored teacher directed learning over peer directed learning. One comment stated, "I prefer to learn in a lecture format, where the teacher explains the topic up front and students take notes, instead of doing group work before we fully understand the topic." Another student commented, "I feel like I would understand a lot more when I was with three or four people and the teacher was with us explaining the lesson." Both these responses indicated a preference for teacher directed instruction.

Many comments in the Post Survey indicated a preference for group activities, but only when they could select which other students they would be working with. One individual commented, "It is nice working in groups when the groups actually work. There are times when you could be in a group with people that don't work and that leaves you doing all the work, which could benefit you, but it's also difficult and doesn't help anybody else." Another student remarked, "I think that Peer Tutoring is only helpful with a specific group/type of people."

Students also had the opportunity to provide feedback throughout the Treatment Unit during two Exit Tickets, one for peer tutoring and the other for cooperative learning. These Exit Tickets followed a lesson where a peer tutoring or cooperative learning strategy was employed (Appendices E & F). Following a lesson where peer tutoring was used, students responded to two statements: "Peer Tutoring helped my learning today" and "Peer Tutoring helped my partner's learning today." Students responded on a scale from one to five, with one being Strongly Disagree and five being Strongly Agree. In total, 73.3% of students agreed or strongly agreed it was helpful for their own learning, and 70% indicated it was helpful for their partner's learning (Figure 6). In response to the open ended question "In one sentence describe what you learned in chemistry today," 50% of responses included at least one vocabulary word from the lesson. In addition, several students included how the partner activity was involved in their learning. For example, one student said "Today I learned more about covalent and ionic bonds. I learned the characteristics and ways to determine between to two. I enjoyed working with a partner because I was able to ask questions and get a direct response." Another student stated, "I didn't learn anything new, but I did reinforce old concepts with my partner so that I could understand them better."

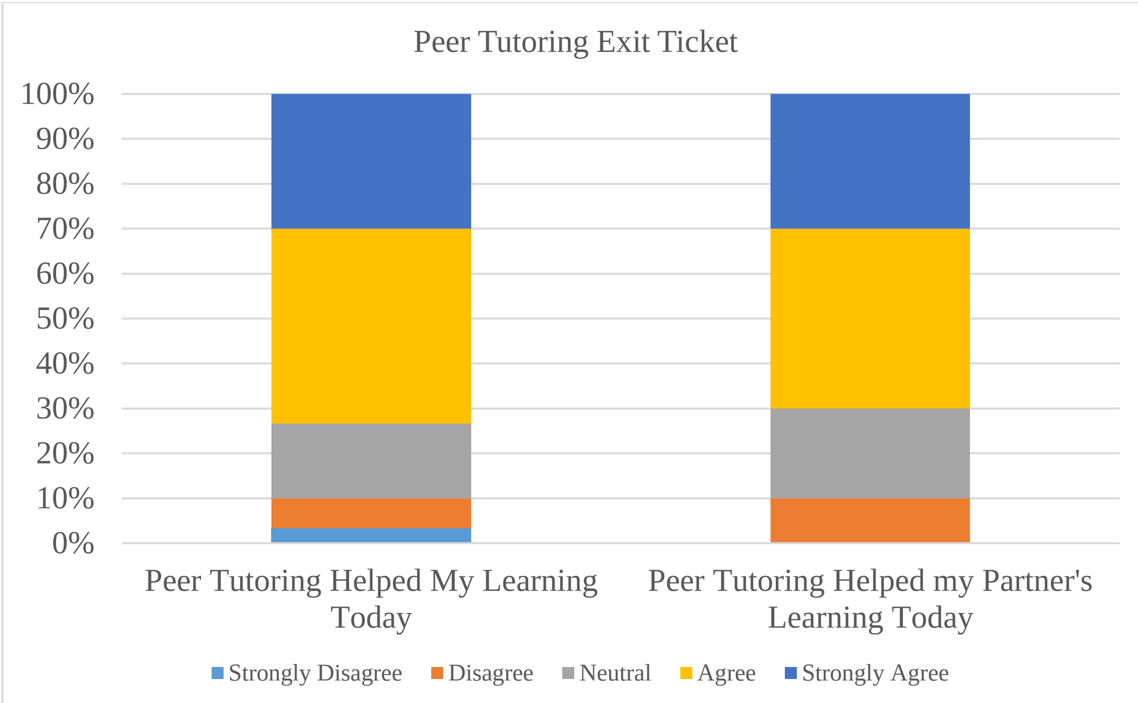

Figure 6: Peer tutoring exit ticket responses, (*N*=44).

The Exit Ticket following a lesson that used cooperative learning also indicated a positive learning experience. Due to an unexpected drill at school during this particular day, the Exit Ticket was given to only one chemistry class, thus representing a smaller sample of the study population (*n*=20). In response to two statements, "Group work was helpful for my learning today" and "Group work was helpful for other members of my group," 73% agreed or strongly agreed group work benefited their own learning, while 75% agreed or strongly agreed that it was helpful for other members of their group.

Following the Treatment Unit, six students were selected randomly to answer the Exit Interview Questions (Appendix G). Three students were from Subgroup One, and the other three were from Subgroup two.

Students from Subgroup One shared several positive comments about aspects of peer tutoring and cooperative learning they found helpful. When asked about what they liked and didn’t like about peer tutoring, one student shared, “There were some parts of the unit that were confusing, but it was good working with a partner because each person has strengths and weaknesses.” This student also shared comments on cooperative learning saying “I liked when we went in the labs and everyone has a specific job or role because that’s kind of helpful. Some people it helped a lot. Some were confused.” Another student from subgroup one enjoyed the aspects of teamwork involved in peer tutoring and cooperative learning. When asked about what they liked about peer tutoring, this student said, “I liked that we got to work with others that we don't get to work with as much. With certain people, you can carry your own weight not as much instead of them telling you all the answers. It was a chill activity.” When asked if these methods of learning were helpful for their peers, the student responded, “Yeah because not many people talk to each other, so we got to bond more and talk to each other.” The third student from Subgroup One did not share much during the exit interview, but noted “I usually don’t like working with others, but some of it was actually helpful.”

Students in Subgroup Two had more of a mixed bag of comments. When asked about peer tutoring one student noted, “I liked that we got to work with someone because I usually need help.” Another student commented, “I’m not sure if it was helpful. I may have been better off on my own.” On the topic of cooperative learning, this student also noted, “I don’t know if it helped my group members. They didn’t really talk that much.” The third student in Subgroup Two added that they felt indifferent about the structure, saying, “It was fine. Sometimes it was challenging. I sometimes like the peer learning and sometimes I don't.”

During the Treatment Period, a journal was kept recording qualitative observations of student-to-student interactions. In the lessons using peer tutoring strategies, students were overall observed as engaged in the learning with their partner. During the first lesson, students switched roles with one person drawing out Lewis dot structures with the other partner explaining how to do it. Students were observed to be engaged and 95% completed the entire activity and homework with their partner. During another lesson where a peer tutoring strategy was used, students switched roles telling the story of a molecule to a partner where they explained its structure and properties. Students were observed sharing resources and having positive peer to peer interactions. Four students were on their cell phones during the activity.

Observations of the lessons of the cooperative learning lessons also reflected positive student-to-student interactions, although slightly less engagement. During a lesson that involved cooperative learning, where groups of four each had a role to complete one aspect of the activity, students were observed helping each other get caught up when another group member got behind. There were three students in one classroom observed not engaged with their group and on their phone during the activity. In another activity, students completed a lab where they each had a role holding them accountable for a certain aspect of the pre and post lab questions. Groups also had shared resources. Students were observed asking each other clarifying questions, and holding each other accountable for their sets of questions. Students worked well in their groups and both students with and without IEPs were observed carrying out their assigned job.

INTERPRETATION AND CONCLUSION

The objective of this action research project was to implement inclusive practices in high school chemistry classrooms in order to improve academic achievement for students with and without disabilities. Another objective was to improve student sense of agency as an individual learner and in a community of learners through the use of inclusive strategies. This project seeks to understand how peers with a diverse range of abilities support each other in the process of learning.

In both the Non Treatment and Treatment Unit, students demonstrated exceptional growth in their chemistry content knowledge. Overall, the study group had a normalized gain value of 0.60 for the Non Treatment Unit. This indicates that on average, students gained 60% of what they had potential to learn from pre-test to post-test. Hake (1998) indicates a normalized gain value above 0.3 represents significant growth. The same test for the Treatment Unit indicated a normalized gain value of 0.61, or 61% of knowledge gained. For the class as a whole, both the Non Treatment Unit and Treatment Unit were effective in significantly increasing student content knowledge. There is not a significant difference between the overall effectiveness of each unit. Running a paired T-test, we return a p value of 0.97, indicating the null hypothesis can be accepted with a high level of confidence.

When looking specifically at the gains students with IEPs (Subgroup One), it appears the Treatment Unit was more effective in increasing student content knowledge than the Non Treatment Unit. Students with IEPs had an average gain of 0.34 in the Treatment Unit, compared to an average gain of 0.11 in the Non Treatment Unit. The value of 0.34 is above the minimum considered to be a significant gain in knowledge. When comparing the gains of students with IEPs in the Non Treatment and Treatment Unit using a paired t test, we get a p value of 0.18. This p value does not meet the 0.05 level needed to be considered significant. This is likely due to the small size of the subgroup ($n = 6$). With a larger subgroup and more data, we could more conclusively state whether or not the treatment was effective in improving content knowledge acquisition for student with IEPs. However, with the data at hand, it does appear that the treatment may have been at least somewhat effective in improving academic outcomes for students with IEPs.

Turning from academic to social outcomes, it is clear that students have an overall positive view of peer directed learning. Prior to the treatment, a majority of students selected peer directed activities (54%) as preferred method of learning over teacher directed or individually directed. In the Pre Survey on Cooperative Learning and Peer Tutoring, students also had overall more responses of agree or strongly agree that peer tutoring and cooperative learning were effective methods of learning than students who disagreed or strongly disagreed. From results in the post survey, there were slight increases in student agreement with the statements: “I learn best when in a group,” “Peer Tutoring is an effective way for me to learn,” “Peer tutoring is effective for my partner’s learning,” “When working in group’s I like when everyone has a specific job or role” and “Peer Tutoring and Cooperative Learning are helpful for students who find chemistry to be easy.” Though there was an overall increase in the number of students who responded with agree or strongly agree to many of the survey statements, there is not enough change to be considered significant when running a Wilcoxon Sign Rank Test. The question in the survey that had the highest level of agreement in both the Pre and Post Survey was "When working in groups, I am responsible for my own learning and the learning of others." At the core, this statement is a good representation of what peer tutoring and cooperative learning strive to be. In the Pre Survey, 69.2% of students agreed with this statement, and in the Post Survey 70.7% agreed, which demonstrates students feeling a strong sense of responsibility for their own learning and the learning of others. Even prior to engaging in activities that were structured for individual and group accountability, students already were recognizing the value of ownership over their learning and how they could lift up others as well.

The Exit Interviews also support the idea that students take pride in their own individual responsibility as a learner as well as their role in a classroom of learners. One student with an IEP made several remarks about the value he found in cooperative learning, saying, "it makes you carry your own weight instead of someone else telling you the answers." This statement is powerful, coming from a student with a learning disability. He recognizes the value of everyone doing their part to help each other for the good of the whole, instead of a few doing all the work while others are just told the answers. The statement encompasses a sense of worth in a learning community, and a positive view of peer tutoring which is consistent with exit interview data collected in research by Mumba, Banda, Chabulengula & Dolenc (2015).

Similarly, another student with an IEP remarked, "There were some parts of the unit that were confusing, but it was good working with a partner because each person has strengths and weaknesses." The remark from this student demonstrates evidence for positive social effects of peer tutoring and cooperative learning activities, and is consistent with research on positive interpersonal outcomes. As Johnson and Johnson state in their analysis of over 180 studies on cooperative learning, "The data indicates that cooperative learning promotes greater interpersonal attraction than do competitive or individualistic ones. Cooperative learning promotes the development and caring and committed relationships for every student" (1999).

VALUE

The outcomes of this action research project provide insight to the effects of Peer Tutoring and Cooperative Learning strategies in high school chemistry classrooms that are fully inclusive to students with disabilities. Students identify the importance of having a role in their learning and in the learning of others. Beyond the results, I found an exceptional amount of value in the process of observing what was happening in the classroom, and the professional collaboration that ensued with my colleagues.

During the Treatment Units, I kept a journal of things I noticed in class. The journal helped me reflect on what I observed during a class period, but it also helped make me more aware of the conversations that were happening in the class. I had increased perception for pieces of evidence that told me whether or not the lesson was working. Because my action research project was about student-to-student interactions, I became in-tune to indicators that I could record in my journal. I think this awareness overall has been a benefit to my practice as an educator.

When planning a lesson, likely one of the first considerations made is the teacher-to-student interactions. What will the teacher say? What responses will the students give to the teacher's questions? I think it becomes more difficult to start planning for how student-to-student interactions should look. What will students say to other students? How will students help each other persevere through challenges? The planning I did for this action research project helped me think about answering those questions. Ultimately, a classroom does not become inclusive just by the teacher welcoming diverse students into the classroom. It happens when the teacher establishes a complete classroom environment where all voices invite others. My teaching practice was benefited by being more aware of the conversations happening in the classroom and planning for student-to-student interaction.

Another valuable outcome from this project was the collaboration I have experienced with my fellow teachers. My coworkers who also teach chemistry knew about the research I was doing, and they had genuine interest in how it was progressing. There were occasions where I would plan a chemistry lab to be a cooperative learning activity for the A day lesson, and another teacher would ask me how it went and if they could use the activity with their B day classes. Likewise, in the planning phases of my project, I used cooperative learning strategies I had seen other teachers use earlier in the year for my own instruction. In many ways, the collaboration I experienced on a daily basis with my coworkers models the peer learning strategies I set out to implement. Learning from each other, individual and group accountability, and collaboration, are all strong facets of the instructional strategies. These are also vital 21st century skills that are essential components of well-functioning teams.

Since the study ended, my colleagues and I have used more cooperative learning and peer tutoring strategies in the classroom. I have continued to use group worksheets and resources, utilized roles in the lab setting and structured peer learning opportunities. Many of my colleagues have done the same. Because of a continued use of these instructional strategies, it has made me wonder – in hindsight, should I have expanded the study to more chemistry classrooms and for a longer treatment period? It is easy to look back and answer yes, of course, to that question. However, in my planning process, I never really considered how the work would continue after the project was officially over, and perhaps that's one of the greatest outcomes of all. Classroom action research is a cycle involving planning, implementation, and data analysis, which leads to new planning. I find myself now in the next phase. Having learned about new peer learning strategies and implemented them with some success, my professional practice has been moved improved. My hope is that this action research project can be of benefit to others in my school. Going forward, I plan to share my findings with my colleagues in the special education department and science department at MHS during the 2019-20 school year. Next school year, I will continue to implement peer tutoring and cooperative learning strategies in chemistry, and also biology classrooms, and monitor the academic and social outcomes for students with disabilities.

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APPENDICES

APPENDIX A

ATOM AND PERIODIC TABLE PRE/POST TEST

Name: ________________________ **Atom and Periodic Table Pre-Test**

1. How many protons does Oxygen have?
   a. 7
   b. 8
   c. 15
   d. 16

2. What is a cation
   a. An atom with a neutral charge
   b. An atom with a positive charge
   c. An atom with a negative charge
   d. A molecule that is polar

3. A common Isotope of Sodium is Na - 23. What does the number 23 represent?
   a. The number of protons
   b. The number of electrons
   c. The number of protons + neutrons
   d. The number of protons + neutrons + electrons

4. What happens during alpha decay?
   a. An atom loses 2 protons
   b. An atom loses 2 neutrons and 2 protons
   c. An atom loses 2 neutrons
   d. An atom gains an alpha particle

5. How to purple wavelengths and red wavelengths compare on the electromagnetic spectrum?
   a. Purple wavelengths are shorter
   b. Red wavelengths are shorter
   c. Purple wavelengths are faster
   d. Red wavelengths are faster

6. In order for a neutral atom to become an ion with a -2 charge, it would have to:
   a. Lose 2 neutrons
   b. Lose 2 electrons
   c. Gain 2 electrons
   d. Attract more protons

7. As you go across a row on the periodic table…
    a. Atomic radius decreases
    b. Atomic radius increases
    c. Atomic radius stays the same
    d. There is no pattern related to atomic radius

8. Electronegativity is defined as:
    a. The inverse of atomic radius
    b. An atom's total number of electrons
    c. How difficult it is to take an electron from an atom
    d. An atom's ability to attract a bonded pair of electrons
9. How many electrons fit in the 2nd orbital
    a. 2
    b. 4
    c. 6
    d. 8
10. Which element has the highest ionization energy?
    a. F
    b. P
    c. Ca
    d. Fr

APPENDIX B

EXIT TICKET

Today's takeaways

1. **In one sentence, what did you learn in chemistry today:**

2. **What activities or types of learning were helpful for you today?**

APPENDIX C

BONDING PRE/POST TEST

Bonding Pre-Assessment Name____________________________
______/20

1.) What is the name given to the electrons in the highest occupied energy level of an atom?
   a.) orbital electrons b.) anions
   c.) valence electrons d.)cations
2.) How does calcium obey the octet rule when reacting to form compounds?
   a.) It gains electrons. b.) It gives up electrons.
   c.) It does not change its number of electrons. d.) Calcium does not obey the octet rule.
3.) Which of the following occurs in an ionic bond?
   a.) Oppositely charged ions attract
   b.) Two atoms share two electrons.
   c.) Two atoms share more than two electrons.
   d.) Like-charged ions attract.
4.) Which of the following pairs of elements is most likely to form an ionic compound?
   a.) magnesium and fluorine
   b.) oxygen and chlorine
   c.) nitrogen and sulfur
   d.) sodium and aluminum
5.) Which of these elements does not exist as a diatomic molecule?
   a.) Ne b.) H
   c.) F d.) I
6.) How do atoms achieve noble-gas electron configurations in single covalent bonds?
   a.) One atom completely loses two electrons to the other atom in the bond.
   b.) Two atoms share two pairs of electrons.
   c.) Two atoms share two electrons.
   d.) Two atoms share one electron.
7.) Why do atoms share electrons in covalent bonds?
   a.) to become ions and attract each other
   b.) to attain a noble-gas electron configuration
   c.) to become more polar
   d.) to increase their atomic numbers
8.) Which of the following elements can form diatomic molecules held together by triple covalent bonds?
   a.) carbon b.) fluorine
   c.) oxygen d.)nitrogen
9.) Which of the following is the name given to the pairs of valence electrons that do not participate in bonding in diatomic oxygen molecules?

a.) unvalenced pair
b.) inner pair
c.) outer pair
d.) unshared pair

10.) A molecule that contains double covalent bond is ____.
a.) CO_2 b.) HCN
c.) Cl_2 d.) N_2

11.) Which of the following covalent bonds is the most polar?
a.) H—F b.) H—H
c.) H—C d.) H—N

12.) What causes hydrogen bonding?
a.) attraction between ions
b.) Attraction of two non-polar molecules
c.) sharing of electron pairs
d.) Attraction of a covalently bonded hydrogen atom with an unshared electron pair

Draw the Bohr model for nitrogen and answer the questions to the right.

Bohr model of nitrogen	1. How many valence electrons does nitrogen have? (1 pt) 2. How many bonds would you expect nitrogen to form? (1 pt) 3. Explain your answer to #2 in <u>two sentences or less</u>. (2 pt)

APPENDIX D

PEER TUTORING AND COOPERATIVE LEARNING SURVEY

Peer Tutoring and Cooperative Learning Survey

* Required

1. **Overall, I learn best when:** *
   Mark only one oval.
   - I work with my teacher
   - I work with my peers
   - I work independently

2. **When working on activities in class, I prefer to work in groups** *
   Mark only one oval.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

3. **When working on activities in class, I prefer to work independently** *
   Mark only one oval.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly agree

4. **Peer tutoring is an effective way for me to learn.** *
   Mark only one oval.
   - Strongly Disagree
   - Disagree
   - Neutral
   - Agree
   - Strongly Agree

5. **Peer tutoring is helpful for the person I am working with** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

6. **When working in groups, I like when everyone has a specific job or role** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

7. **When working in groups, I am responsible for my own learning and for the learning of others** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

8. **On a scale from 1-10, I find chemistry to be:** *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Very Easy	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Very Challenging

9. **Peer Tutoring and Cooperative Learning is helpful for students who find chemistry to be challenging** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

10. **Peer Tutoring and Cooperative Learning is helpful for students who find chemistry to be easy** *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

11. **Anything else you want me to know related to this topic?**

____

____

____

____

____

APPENDIX E

PEER TUTOR EXIT SLIP

Peer Tutor Exit Slip

1. **In one sentence, what did you learn in chemistry today:**

____
____
____
____
____

2. **Peer Tutoring helped my learning today**
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

3. **Peer Tutoring helped my partner's learning today**
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

4. **Anything else you want me to know?**

____
____
____
____
____

APPENDIX F

COOPERATIVE LEARNING EXIT SLIP

Cooperative Learning Exit Slip

1. **In one sentence, what did you learn in chemistry today:**

2. **Group work helped my learning today**
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

3. **Group work was helpful for other members of my group**
   Mark only one oval.

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

4. **Anything else you want me to know?**

APPENDIX G

EXIT INTERVIEW QUESTIONS

Exit Interview Questions

1. What were your favorite activities from this unit?

2. What was helpful for your learning in this unit?

3. What did you like a peer tutoring?

4. What did you not like about peer tutoring?

5. What did you like about cooperative learning?

6. What did you not like about cooperative learning?

7. Do you think peer tutoring/cooperative learning helped your learning? Why/Why not?

8. Do you think it was helpful for your peers? Why or why not?

APPENDIX H

IRB EXEMPTION

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Leo Olson and Kathryn Solberg

FROM: Mark Quinn, Chair *Mark Quinn CJ*

DATE: December 4, 2018

RE: *"The Effects of Peer Tutoring and Cooperative Learning in an Inclusive High School Chemistry Classroom" [LO120418-EX]*

The above research, described in your submission of December 3, 2018, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.