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The Effect of Co-Teaching on Student Achievement in Ninth Grade Physical Science Classrooms

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Abstract

Co-teaching is a method that is increasing within schools across the US as educators strive to leave no child behind. It is a costly method, having two paid instructors in one classroom, with an average of 24 students shared between them. If it significantly increases the achievement of all students, it is well worth the costs involved. However, few studies have analyzed the effectiveness of this method on student achievement. This research follows the academic accomplishments of students in a ninth grade physical science course. Nine sections of the course "Force and Motion" were taught with a single teacher, and two additional sections were co-taught, one led by a science-certified and special educator, and another co-taught by two science certified teachers. Subgroup achievement performance was analyzed to determine whether significant differences exist between students with or without IEPs, as well as other factors such as free and reduced lunch status or gender. The results show significance with the presence of a co-teacher, while there is minimal effect size of co-teaching in this study for students with IEPs. The benefactors in these ninth grade co-taught classes were the students without IEPs, an unintended result of co-teaching.

Acknowledgements

It has been said that all teachers are good for some kids, but some teachers are good for all kids. I have been privileged to work with colleagues who are good for all kids. Thank you to my professional, caring ninth grade staff at my "school of study". I am honored to be a part of this team whose only focus is what is best for students.

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I am so proud of my children, Matt, Alyssa, and Susie for raising themselves during this Doctoral process and evolving into thoughtful, caring young adults while mom locked the door and "dissertated". Finally, my husband Jim has been mom, dad, chauffeur, cook, tutor, and counselor. He has worked harder than I throughout this process and I could not have made it without his constant unwavering support. Thank you for helping me to keep a sense of humor and bringing joy into my day to day life.

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Chapter 1: Introduction

In today's economy, people like to know if they are getting the most value for their money. If teaching science to students costs $6,500 in salary per class each semester, then that certainly sounds like a better deal than paying $13,000 per class. But what if paying $13,000 truly resulted in no child left behind? Does paying more money to provide two teachers per classroom, a system known as co-teaching, affect student achievement? Goldstein (2012) laments the lack of quantifiable data regarding teacher effectiveness and methodology. He maintains that "we do not know empirically which 'teacher moves,' actions that are decided by individual teachers in their classrooms, are most effective at getting students to learn" (p. 23). He states that some may see teaching as an art that cannot be quantified, but he insists that something must be done to marry the art of teaching with the science of student results. This study will analyze the achievement of students who were taught by science teachers teaching alone or partnered with another professional of varying certifications to see if co-teaching does indeed produce the most favorable use of funding.

The district involved in this study encompasses a diverse and large segment of a suburban area outside of a metropolitan city. The socio-economic status (SES) within one high school varies greatly, as it does across the entire district. The district, in combination with a district that provides services for all students with learning disabilities in their resident school throughout the county, currently spends thousands of dollars in co-teaching, or having two certified teachers in selected classrooms. One teacher is usually subject certified and employed within the school, and the other teacher is a special

education teacher, referencing the special education certification of the teacher who provides services to students with Individualized Education Plans (IEPs). Will there be gains in student achievement for those with identified learning disabilities and/or the non-IEP students, making co-teaching worth the extra cost of two educators? Using the concepts found in the field of testing and measurement, the researcher and author designed and implemented a study of co-teaching to determine the effect on students' science achievement.

Conceptual Framework

The author of this study is also a teacher within the school of study, thus classifying her as *teacher researcher*. Cochran-Smith and Lytle (1993) define teacher research as a "systemic and intentional inquiry carried out by teachers" (p. 7). This differs from the typical educational research in that the point of view is from the person most immersed in the teaching and learning classroom, rather than a passive observer. Christianakis (2008) maintains that teachers are best suited for the role of researcher because the educators are the ones most likely to trust the findings, knowing all of the nuances that made the data meaningful because they experienced the data for themselves. Blakemore (2012) cautions that there can be issues arising from teachers acting as researchers, namely maintaining objectivity and finding the time to balance classroom duties with analyzing data. Yet, Blakemore (2012) concurs with Christianakis' assertions that teachers are the most likely instigators of change after carefully observing their students and analyzing the data, "improving teaching at a grass-roots level" (p. 59). The

author accepted the challenge of this dual role and was prepared to meet the challenges of being a teacher researcher.

The author teaches all sciences in the high school of study, which has a population of over 1500 students. She usually teaches all freshmen courses in the fall and a mix of classes in the spring, depending on the scheduling needs. She has taught Chemistry 1 (9^{th} grade), Physics 1 (9^{th} grade), Biology 3 (10^{th} grade), Geology (11^{th}-12^{th} grade), and Astronomy and Meteorology (11^{th} and 12^{th} grade). The high school has had foundation level courses in the past for 9^{th} and 10^{th} grade classes for lower-performing students, but there are many issues with tracking students. There are no set criteria for being placed in this track other than teacher recommendation, which tends to vary from teacher to teacher, depending on their background of understanding of standardized test scores and methods of teaching in the classroom. For example, a student who is active and has difficulty staying focused in class paired with a lecture-based teacher may result in the teacher labeling the student as disinterested and unable to perform, thereby placing him or her in a lower track. Research shows that students learn more when they are integrated within the same class. Even though it may be difficult for teachers to differentiate instruction to teach in a heterogeneous classroom, "many researchers have argued that the practice of tracking is inherently unfair and that it plays a crucial role in the creation of inequalities within our society" (El-Haj & Rubin, 2009, p. 3). El-Haj and Rubin (2009) acknowledge that it is difficult for the teacher to create an environment for all students to learn at their level, but co-teaching may be able to provide the best of both worlds. Having a teacher certified in reaching students

with learning disabilities teaching alongside another professional with content expertise may ensure all students are learning to their full potential.

In some large suburban high schools, co-teaching occurs with two science teachers, rather than the traditional model of a science teacher and a special education teacher. The author of this study has personally been a part of this model and found it to be very effective in terms of professional development. One teacher was able to sit with students and give them one on one instruction, while a colleague continued a lecture with the other students. During labs, there was a twelve-to-one teacher to student ratio as each monitored half of the room. Both teachers planned together and tweaked lessons they had used in single-taught classrooms in the past, but did not seem to quite address a specific concept directly; collaborating helped identify weaknesses in lesson plans and clarify objectives. Each teacher had favorite technological teaching tools and shared her expertise with each other, effectively doubling their repertoire of techniques. One teacher imparted her knowledge of Smart Board usage and probe ware while the other demonstrated her capabilities with different student response systems. The co-teachers also used this opportunity to begin investigating whether having two instructors made a difference in student achievement. To gather preliminary data on the effects of co-teaching on students, each taught one unit alone, then taught the third and subsequent units together in a true co-teaching format. It was interesting to note that the class average on each of the summative assessments remained the same (71%), no matter which methodology of co-teaching was used. Adding to the intrigue, though, was the fact that the students reported they learned more when there were two teachers in the room. They

recounted having less frustration when their questions and other needs were met quickly. Weiss (2004) reports that “to date, science has not answered the question of whether co-teaching is an effective use of limited resources” (p. 220). If students are feeling less frustration and more success in introductory science courses, perhaps this would lead to positive feelings towards the subject matter and higher enrollment in subsequent science courses. An increased exposure to high school science has been determined to lead to increased performance in college, which should in turn lead to an increase in scientific literacy, a final goal of all science education.

Purpose of the Study

The purpose of this study was to determine the academic benefits, if any, of co-teaching in the ninth grade physical science classroom. The first part of the study attempted to determine if there were any significant differences in achievement with students in a co-taught versus a single-taught classroom. If there is a statistically significant difference within the co-taught course, then the researcher will analyze if the certification of the co-teacher made a difference as well as which group of students enhanced their performance the most, students with or without IEPs. The district involved in the study has preliminary data that achievement is higher for students with IEP’s (Individualized Education Plans to guide the recommended adaptations or modification necessary for the students to receive full benefits of education) if they are in a co-taught classroom staffed with one special educator and one certified science teacher. However, the data collected were sometimes subjective measurements contributing to a course grade, which can vary from teacher to teacher if expectations are not the same. The

researcher wanted to analyze a more objective measurement, such as a common assessment. By analyzing the pre- and post- score of a test given to every student by every teacher, the data should be a better measure of student achievement than an overall grade in the class. The author had a variety of experiences when a co-teacher was present. She previously co-taught with other science teachers, as well as special education teachers. She also taught classes alone with more than 30% students with IEP's. Many times it seemed easier and less trouble to not have another person with whom collaboration was necessary, having to teach science first to the co-teacher then again to the students. But was omitting the support staff from this situation best for the students? The researcher discussed such factors as teacher satisfaction and frustration, but the main focus was to track student achievement based on pre and post testing of common assessments given in the semester.

Hypotheses:

The researcher's hypotheses were as follows:

1. Co-teaching will not have an effect on student achievement as measured on a pre-and post-test.
2. If co-teaching has an effect, the increase interval between pre and post test scores will be greater if the co-teacher is subject certified rather than special education certified.
3. If co-teaching has an effect, the increase interval within co-taught classes will be greater for students with an IEP as opposed to those without.

The lack of content knowledge can be a barrier to a non-subject certified teacher in a secondary level course, and the obstacles faced by the subject-matter teacher to keep

the other teacher proficient in science can be more challenging than addressing the learning disabilities of the students alone. Billingsley (2004) noted that more than 30% of incoming special education teachers do not have certification in the area of special education, let alone a specific subject matter at the secondary level, and the number has been increasing yearly since 1999. Many special educators were leaving the field due to several factors, a main one being role ambiguity, or the lack of understanding their role in the co-taught classroom. Weiss and Lloyd (2002) suggest the largest obstacle of a dual-certified team teaching approach was the lack of opportunity to plan together as well as little training of the special educator in the content area. “In addition, we saw little use of special educators’ expertise in the co-taught situation” (Weiss & Lloyd, 2002, p. 68). This may indeed be due to the increase of training for the classroom teacher due to No Child Left Behind (No Child Left Behind [NCLB], 2002). One of the mandates of this legislation is that teachers must be given access to quality professional development. The author has personally taken over 30 hours per year of district-provided workshops or college courses to enhance her understanding of students with special needs. Over a twenty-year career, she has learned much about adaptations, modifications, and behavior management. Special education teachers have received the same training as she has, and they must choose whether to augment their content knowledge on their own time, perhaps leading to a deficit in this area if time is lacking. This study is intended to contribute to the emerging literature on co-teaching.

Delimitations

Only one high school was involved in this study, and the results of only one subject, physical science, were analyzed. The course was a second semester introductory physics course entitled “Force and Motion” with all four teachers following the same curriculum guide and administering the same labs and assessments. The teachers associated with this study had already been selected to teach the courses, either as single taught, co-taught with a subject-certified, or co-taught with a special educator. The researcher is identified as Teacher A and was an instructor in a single-taught class, a co-taught section with a special education teacher, and a co-taught section with Teacher D. The students involved in this study had already been selected for their spring science course, based on a recommendation in the IEP for a co-taught class or by random selection of the computer scheduling program for students without IEP’s. Benefits of co-teaching or non-co-teaching for the teacher are discussed in part, but the main focus will be concentrated on student achievement, an area vastly ignored in the majority of current research.

Limitations

As much as the researcher strives to have consistency across common courses, there are obviously variables beyond anyone’s control. There have been five different special education teachers working as co-teachers in conjunction with this school’s science department over the past five years, so there has been little opportunity for continuity in co-teacher from year to year. There has been funding for six science teachers to be involved in co-taught classrooms in the past five years, but due to budget

constraints, only one science-certified teacher (Teacher A, the researcher) will have co-teachers. The sample size of students will be nearly 200, 1/5 of whom have a diagnosis of some kind leading to an IEP. Student motivation is always a factor and cannot be predicted. There was no common planning time, so all five ninth grade teachers had to find time and use methods such as email or texting to communicate, ensuring they were progressing at a similar speed so that all curriculum would indeed be covered in class. Time of day students took the course cannot be predicted; some had the course before lunch and some may have had it at the end of the day. The study will be limited to the experience of the five teachers at one high school enrolling more than 1500 students in a district comprised of five high schools and over 18,000 students.

Significance of Study

The significance of the study is rather large for this school and possibly the other four high schools within this district. Each department in each individual school decides how to allocate the annual staffing budget. If data show an increase, decrease, or stagnation in student achievement in the co-taught classroom, this will establish a strong indicator as to how to distribute staff members throughout the building. For example, if there is a statistically significant increase in the scores of students with IEP's, then we have some justification for paying two teachers to teach one class and will allocate funding to continue this pedagogy. The results of one building could be shared with other schools in this district, having the ability to impact the staffing for over 18,000 students. It may also have implications for other schools across the US currently using the co-taught model in science. It is possible to expand this study to other subject matters and

other grade levels. Co-teaching is discussed in professional journals as a positive experience for teachers and is usually measured qualitatively. It is important, however, to see if it impacts students as intended; that is, does co-teaching increase the achievement of all students, especially those with an IEP.

Organization and Summary

This study is organized into five chapters, references, and appendices with copies of common assessments and other necessary peripheries. Chapter 2 provides an overview of the current research on co-teaching, including co-teaching at the university level as well as other subjects. There is a noticeable lack of studies focused on student achievement. Chapter 3 outlines the design of this study and the methods used to gather and analyze the data. An analysis of the data and subsequent discussion can be found in Chapter 4. Chapter 5 summarizes the study and offers recommendations for future study.

Co-teaching may be the way of the future, or it may be another well-meaning but useless tool that does not increase student understanding of science. Analyzing the outcomes of co-taught classrooms can help retain quality teachers in science, a historically difficult field to find and retain quality personnel. Teachers want to know if their efforts are indeed affecting positive change in their students. If schools are truly going to leave no child behind, they must identify and foster programs that meet this goal. Co-teaching might possibly be the technique educators have been seeking.

Chapter 2: Literature Review

Mechanics of Co-teaching

Co-teaching took hold in the 1990's as an answer to inclusion, or placing children with various learning disabilities in the regular classroom instead of pull-out programs that isolated children in resource rooms with usually fewer than ten students. The idea was well-received, but the challenges to the classroom teacher were overwhelming. Friend, Cook, Hurley-Chamberlain, and Shamberger (2010) define co-teaching as "the partnering of a general education teacher and a special education teacher or another specialist for the purpose of jointly delivering instruction to a diverse group of students, including those with disabilities or other special needs in a general education setting and in a way that flexibly and deliberately meets their learning needs" (p. 11). Weiss (2004) suggested that learning disabled (LD) students benefit from extensive sequencing, repetition, modified assignments, using technology, group work, and modeling from the teacher. In a class of 24 students, there may be between two to eight LD children demanding more time from the classroom teacher. With another professional in the room all students get their needs met and neither professional is besieged with requests for attention.

There are several models for two educators of varying certification working together in the co-taught classroom, as outlined by Peters and Johnson (2006). One approach is the Primary/supplementary mode of delivering instruction. Students are grouped as one cohesive unit while the primary teacher (usually the content specialist)

provides the main instruction, while the supplementary teacher (typically a special educator) monitors the room for students needing additional instruction. At the first sign of a puzzled expression, the supplementary teacher immediately assists the student and brings him/her back to up to speed with the primary teacher. Another model of co-teaching is Tag-Team. In this model, teachers instruct part of the time then trade and provide supplemental support while the other continues with the lesson. This allows students to encounter a sense of equality in capabilities of both instructors. In the 50/50 approach, the class is divided in half and each teacher works with a small group rather than an entire class as would be the case if the teacher was alone in the classroom. Checking for understanding is simpler in this situation and students have less of an opportunity to hide their misconceptions or lack of understanding. Adding to this method is the 50/50 Tag Team style in which students are again placed in small groups but have the advantage of being instructed by each teacher, providing both repetition and alternative phrasing in the lesson. In the Pull-Out technique, the special educator can reinforce or remediate skills by removing a select few from the class and providing a quiet alternative setting. This allows for the greatest degree of individualized instruction, but should be used sparingly, according to the researchers, lest students fall further behind their peers while out of the classroom. This method may also have an effect on the self-esteem of the students being removed, so this method should only be used when absolutely necessary.

Weiss (2004) does illuminate the difficulties of the pedagogical technique of co-teaching, namely lack of volunteers due to personality conflicts with other teachers, a heavier burden falling on the science educator for content delivery, and a lack of common planning time. Co-teaching, however, could itself be modified to further the positive classroom experiences of teachers, lead to lower teacher attrition, and provide students with more highly-skilled and experienced instructors.

Co-teaching is not a skill inherent to all teachers. It must be cultivated and practiced, as any teaching skill must be. Conderman (2011) determined that "effective co-teaching depends, in part, on each teacher's interpersonal skills, willingness and ability to work collaboratively, and skills in successfully handling conflict" (p. 222). If each teacher is to make a positive contribution to the learning of all students, then Conderman (2011) suggests following six proactive strategies: 1. Co-teachers should begin the relationship by defining their teaching styles and educational philosophies. If one teacher believes in the constructivist viewpoint and allows students to discover concepts while the other believes independent rote learning is best, there is certainly going to be some conflict within that classroom. Teachers need to be honest about their preferred methods and techniques and come to an agreement as to when each style is most appropriate. 2. Co-teachers need to set ground rules on addressing conflict. Both adults should agree to never correct each other in front of the students. However, they will need to be comfortable in how to disagree. Is it better to meet over coffee, break news gently, or come right out and handle it immediately after class? It is important to

know the preference of the co-teacher and to respect his or her views on conflict resolution. 3. Co-teachers should put lesson plans to paper and include the responsibilities of each professional. It is also a useful reflection tool; after class, the teachers can write on each segment and determine the effective and ineffective activities. 4. Issues and conflict should be managed in a timely manner. Person to person is the best method, so a short phone call or face to face meeting can help eliminate minor events that can fester and become large issues. Written exchanges should be avoided; “lol” or emoticons in email exchanges are a weak substitute for body language and tone. 5. Effective communication is a must between co-teachers. All exchanges should be done calmly and succinctly. Paraphrasing and sticking with “I” phrases are valuable skills and should be utilized by both professionals. 6. Finally, co-teachers should be forgiving of each other. Humility and grace are as necessary with each other as they are when dealing with students.

Murawski and Dieker (2008) add their own advice when embarking on the co-teaching venture. In addition to citing multiple sources of research, they also include their own personal experience as well as questions to ask of administration, students, and each other in “Fifty Ways to Keep Your Co-Teacher”. Murawski and Dieker (2008) surmise “Inclusive education is not going away. Schools increasingly require that teachers collaborate, many by some form of co-teaching, because of the changes in the Individuals with Disabilities Education Improvement Act (IDEA) of 2004 and changes related to the highly qualified component of No Child Left Behind” (p. 40). If teachers are to pool their

talents to create the synergetic classroom, it is important for teachers to receive adequate training in workshops and read a plethora of articles on inclusion and differentiation. Co-educators must also be willing to relinquish control and be open to new methods and styles of teaching. The classroom percentages recommended by Murawski and Dieker (2008) mirror the natural proportions in the real world, which is about twenty percent. If a class must have as many as 30% of students with IEP's, then the disabilities should be varied and not comprised of all learning disabled or behavior disabled students. Sharing responsibilities and classroom equipment equitably sends the message to the students that neither teacher is the dominant one and both contribute proportionally to the learning experience, even if the special educator is not a content expert. Murawski and Dieker (2008) also recommend that paraprofessionals or special educators not hover over one or two students, but meander throughout the room, making themselves accessible to all students. In an earlier work, Murawski (2005) cautioned on the danger of using the co-teaching time to catch up on grading, making copies, or writing IEP's. Both teachers must be committed to the learning of all students at all times.

Roy (2006) adds his own tactics specific to co-teaching in a science classroom. Teachers and students are entitled to a safe laboratory experience, and students with disabilities provide challenges that must be overcome by the school. Aides must be provided in situations, such as sight impaired children in a chemistry lab and lower eye wash stations for students in wheel chairs. The special educator teachers in a co-taught classroom must have access to the same safety training as the science certified teachers as

they are just as liable for general classroom safety. However, the science certified teacher has an unequal burden of specific chemical and equipment safety. “In issues dealing with specific safety situations for science laboratory operations, the shared liability would not be considered equal.” (Roy, 2006, p 65).

Co-teaching in Universities

Co-teaching is not just reserved for the K-12 classrooms. This relatively new methodology is now beginning in the undergraduate teacher education programs. In order to have high-achieving science students, it is imperative that each classroom has a highly trained skilled professional at the helm. The quest for filling science classrooms with the most highly qualified teachers begins in science classrooms at the college level, according to Mervis (2007). At the University of Texas, Austin, a program dubbed “UTeach” requires science majors to visit classrooms in their freshman year to see if there is any interest in becoming a teacher. They take two tuition-free courses that place them in local schools for interactions and observations while learning pedagogy at the university, thereby creating a co-teaching situation at the very beginning of one’s journey of becoming a teacher. Jeff Kodosky, the program’s benefactor, thought it was an obvious move to recruit science teachers from those who decided to major in the field. “It was clear we weren’t producing many science and math teachers. And having an education major decide to teach science always seemed backwards to me: Why not start with someone who loves science?” (Mervis, 2007, p. 1278). In 1996, only five graduates

were certified as science teachers. As a direct result of UTeach, in 2006 the University of Texas graduated 34 certified science teachers, an almost 600% increase in the field.

The University of Colorado, Boulder (CU-B), has a similar plan to increase the number of STEM (science, technology, engineering, and mathematics) teachers. Top-performing undergraduate students are invited to become “Learning Assistants”, or LA’s. They earn $1,500 assisting professors during lectures and holding review sessions with students outside of class. The LA’s learn teaching methods while watching professors use clickers (hand-held student response systems) and noting the level of interest of the students. Founder Richard McCray of CU-B credited the success of the program with the fact that “you could get seven undergraduates for the price of one grad student. And when I found out that the LA experience was extremely powerful for these students, and that it got them interested in teaching, I thought, let’s exploit that” (Otero, Pollock, & Finkelstein, 2010, p. 1278). Otero et al. (2010) tracked the effectiveness of the LA program and reported that in 2004-2005, there were two physics majors and zero biology majors enrolled in the science teacher certification programs at CU-B. When the LA program began in 2005-2006, that number increased to seven and four, respectively. An unintended, but positive, outcome has also been the impact on the college professors themselves. They report an increased attention to collaborating and focusing on how their own students learn. Identifying the best and brightest at the college level seems to be the first step towards having the best and brightest in the classroom. Co-teaching at this level

seems to have many positives outcomes and should be expanded and explored within all levels of education.

At Auburn University in Auburn, Alabama, students learn to teach science through co-teaching in their methods course. Eick, Ware, and Jones (2004) noted that preservice students tend to still view themselves as academicians, rather than adapting to the role of teacher in the classroom. To help these students find their teaching style, Auburn has adopted a model of placing two methods students with a local middle or high school science teacher. The two students spend two half days in a classroom for twelve weeks. The preservice teachers spend the first few weeks observing and learning the day to day routine. After two weeks, students take the lead in the second class of the day, mimicking what the cooperating teacher taught in the first class. The classroom teacher becomes the equal co-teacher rather than a passive observer or peripheral participant. After a full month of this model, trading responsibilities for co-teaching between the three adults, the two college students become the co-teachers of the class. They plan with the classroom teacher and evaluate the effectiveness of the lesson together. In order for this model to be successful, Eick et al. (2004) have made a list of do's and don'ts during this experience, similar to those suggested by Conderman (2011). Methods students are advised to get highly involved in the cooperating teacher's classroom, and learn the names of students as soon as possible. Classroom policies and procedures, including student management techniques, should be familiar to the preservice teachers before the co-teaching experience. This can be accomplished through a series of lunch meetings so

that the three participants can get to know each other on both a professional and personal level. The college participants may find carpooling to be a convenient way to continue collaboration after a session of teaching. During the co-teaching experience, “do’s” include active assistance from the peripheral teachers and clearly articulating individual duties in the detailed lesson plan. Meeting together as a group of three is imperative and must take priority both before and after teaching a lesson. Being comfortable and up to date with the content and having clear rules about when and how to interject are also important skills to have for a successful co-teaching experience. With careful and purposeful planning, Eick et al. (2004) determined that the co-teaching model of a methods course eases the transition from student to teacher in a more supportive manner than traditional models of college coursework in which students remain on campus and learn to instruct by reading or listening about teaching.

CUNY researcher Tobin and University of Victoria’s Roth developed a model of co-teaching in an urban setting. Tobin and Roth (2005) noted that “when teachers and students do not interact successfully, contradictions occur. Negative forms of emotional energy can build up and manifest themselves as disappointment, disinterest, dissatisfaction, and frustration and catalyze resistance and anger” (p. 313). This negativity leads to higher teacher turnover than schools in a suburban or rural setting. Tobin and Roth’s (2005) answer to this lack of positive teaching environment is co-teaching, but set it up in a way that is different from previous models. One of the main differences is having a team of 6-8 teachers involved in a single classroom. The teachers

include 2-4 methods teachers from a university, the methods professor, the classroom teacher, and the researchers themselves. All members of this team were involved in planning and executing the lessons within the classroom, assuring the urban students of a 3 to 1 teacher/student ratio. The second part of Tobin and Roth's model included "cogenerative dialoguing" (2005, p. 315). Cogenerative dialoguing is a method in which students take part in an after school discussion with the 6-8 members of the co-teaching team to debrief on the day's lesson. A video would play back the footage of the classroom experience, and teachers and students alike would comment on the effectiveness of the lesson's delivery and implementation. Empowering the students to comment on their role in the learning process helps them to take ownership of their success or failure in a school setting At times, reassignment of university preservice teachers was necessary when issues of respect and trust arose; classroom teachers must be able to demonstrate a desire and ability to connect with students and create an atmosphere conducive to learning. When this obviously was not the case, preservice students would be assigned to another cooperating teacher. Also, the researchers intervened when co-teaching became a division of labor, rather than a collaboration and collective responsibility. Synergy is the outcome when all adults in the class are truly co-teaching, whereas team teaching simply leads to less work for the teacher, rather than a focus on more learning for the student. The most interesting part of Tobin and Roth's (2005) model was having two new, uncertified teachers co-teach in a classroom without a certified mentor present. Expecting a disaster, researchers were pleasantly surprised with

positive outcomes from the students, including students spending less time sleeping in class, more relevant discussion among students, fewer absences, and student claims of learning more from two teachers rather than the traditional one. But the lack of quantifiable data relating to student achievement makes one skeptical of the results presented by Tobin and Roth (2005).

Milne, Scantlebury, Blonstein, and Gleason (2011) also studied the effectiveness of co-teaching in a college education course. They raise the following questions:

> How can co-teaching support the identification of disturbances [discord or unsettledness] associated with the activity system of teaching/learning to become science teachers? and, How can an identification of disturbances associated with the activity system of science methods courses help professors support the learning of interns to become science teachers? (p. 415)

Milne et al. (2011) clearly distinguish co-teaching from "tag teaching," (p. 416), a system by which professors take turns daily or weekly in the teaching duties, noting that true co-teaching is to benefit the students, not ease the duties of the teacher. Cultural Historical Activity Theory, or CHAT is used to analyze the benefits of co-teaching, namely to identify and attend to the disturbances that arise in the science class. If teaching is to equip students with tools necessary to solve problems, then it stands to reason that co-teaching offers a wider variety of tools from varying viewpoints and allows students to choose the presented tool best suited for their learning style. Milne et al. (2011) also references Tobin and Roth's 2005 proposal of using cogenerative dialogues, or cogens,

within the methods course. Preservice teachers and methods professors would meet to discuss the methods of teaching the methods course. This allows all participants to share power and establish a voice, critical components in the teaching and learning process.

Using the framework of CHAT to explain possible relationships between disturbances and deeper contradictions, Milne et al. (2011) analyzed the lesson episodes within two university methods classroom by first transcribing the dialogue. They noted nuances in conversation, such as long pauses or excited interruptions. It became apparent to the methods professors through both experiencing the class and reading the transcripts that the first hint of disturbance generated from allowing interns to self-evaluate and self-grade. Self-grading was a challenge for the college students as they would have to first identify the skills they should possess when teaching a science course, then determine their level of proficiency with this skill. Students were frustrated with this concept, noting their grade for the course would come from a single reflection paper at the end of the semester. A cogen at the beginning of the subsequent semester allowed students to vent frustrations and listen to the defense of the university co-teachers. It was agreed that several artifacts would be used throughout the semester, both to give feedback to the interns from the professors as well as to guide students in their final self-evaluation.

Cogens are not the only benefit to co-teaching a university methods course. Typically, the co-teachers are an experienced science teacher from a local high school coupled with a pedagogical expert from the university. In a case at Urban University, the science teacher was demonstrating a can crush activity to explain air pressure. The

disturbance arose in conversation as to the difference between education and entertainment, and the value of each. The content teacher was focused on observing the science of what happened, but the professor helped guide the interns towards a connection between a story and true learning. The pedagogy is necessary to make transitions between observed events, explanation, and communicating scientific concepts to demonstrate understanding. Had only one teacher been present, only half of the disturbance would have been addressed.

Not all preservice teacher experiences revolve around co-teaching with other subject certified interns or teachers. Arndt and Liles (2010) of St. John Fischer College completed a qualitative study of social studies interns co-teaching with special educators. The legislation of No Child Left Behind (NCLB, 2002) dictates that all children will meet state standards regardless of learning disabilities. Teachers are expected to reach all students, requiring them to collaborate with special educators or risk leaving children behind. Co-teaching requires both educators to seamlessly teach together in a classroom, blurring the student's perception as to who the primary teacher may be. The reality noted by the researchers, however, is that co-teaching between these two different realms of education remained separate spheres in the classroom. Arndt and Liles (2010) lament this finding, noting that:

> traditional teacher-training programs that separate instruction for special education from content instruction exemplify the belief that special education is so different from typical instruction that is warrants and needs to be taught in

> isolation….Teacher education needs to transmit the ideal that teaching includes having the attitude, knowledge, and skills to teach students with and without disability labels. (p. 17)

The qualitative study conducted by Arndt and Liles (2010) consisted of two classes of preservice education teachers, one of which comprised secondary social studies teachers and the other consisting of elementary special educators. Eleven of the twelve special educators were women, and fourteen of the seventeen social studies teachers were men. The collected data included written reflective lessons from the social studies teachers, a reflective paper written by the special educators on their role in the co-teaching process, and two focus groups conducted at the end of the semester. The findings that emerged from this study were the shared anxiety of all of the teachers of not being prepared to meet the challenges of the classroom. The special educators had notable concern about content knowledge; they did not feel as if their teacher training at the university prepared them to know the content well enough to adapt it for other learning styles. The content teachers felt they did not have enough training on differentiating or the process of co-teaching. One social studies student noted that "we really only learned about disabilities, not how to teach students with disabilities" (Arndt & Liles, 2010, p. 20). When these two realms of education came together in a co-teaching situation, more often than not students viewed the special educator as a teaching assistant, not a true equal partner in the delivery of material. This viewpoint was especially persistent at the secondary level, where content is increasingly more prevalent.

Arndt and Liles (2010) acknowledge the power of teacher preparation courses and conclude that the university is the place to initiate change in traditional teaching styles. They note that the goals of methods courses are generally achieved and students adopt the practices presented in the college classroom. What they greatly underestimated, however, is the deep and powerful influence of the hidden curriculum. Schools themselves are generally not receptive to the idea of co-teaching to achieve successful inclusion. Arndt and Liles (2010) also noted limitations within their own field study, the most obvious one being elementary special educators placed with secondary content teachers. The elementary interns would never need to know the depth of content presented at a high school level, and pairing these groups together most likely caused most of the anxiety noted in the transcripts. However, Arndt and Liles (2010) did summarize some real implications for teacher preparation programs. They concluded special educators did need to be competent in their area of content, implying dual certification would best accomplish this deed. A co-teaching relationship would be difficult to establish and maintain if both educators were not confident in their subject knowledge. Secondly, they noted all teachers should feel confident of their ability to differentiate instruction, no matter what their area of certification. This can best be done through intensive collaboration during both pre- and post-service teaching, working with students of all abilities and disabilities. Differentiation pertains to both reaching children who struggle as well as enriching the experience of those who excel. Partnering with as many educators as possible will give teachers the tools to expand their repertoire of teaching

techniques. Finally, teachers need to be comfortable addressing the hidden agenda. It is very easy to become the experienced educator who taught one year then repeated his/her actions for 30 more, never reflecting or making changes to teaching methods to better serve the students. Newly trained teachers must feel confident in the ability and mission and challenge the status quo when the status quo meets the needs of teachers before students.

Co-teaching in or Across Other Disciplines

Co-teaching is not limited to education classes at the university level. Rehling and Lindeman (2010) discuss the benefits of co-teaching a college writing course at San Francisco State University. Rehling and Lindeman (2010) indicate that they are more opposite than alike, adding a yin and yang feel to the course. In developing the course, they both realized one had a talent not possessed by the other and their joined efforts resulted in a more enhanced course than either could have accomplished alone. The term *synergy* was used to describe their collective endeavors. Although students were sometimes confused on the first night of class to see two professors, Rehling and Lindeman (2010) immediately established the equality of the relationship. Each professor taught an equal part of daily class, and papers were graded and annotated by both. Each took turns leading small groups, trading places to ensure both teachers heard from every student. The biggest benefit to team teaching, however, was the joy of preparing and grading when the tasks are shared by a colleague who has mutual passion for the subject.

Mathematics is another subject in which students may benefit from co-teaching. Sileo and van Garderen (2010) summarize the methodology of Thomas, a math instructor, and Merced, a special educator. With 5-8% of students in the classroom having disabilities in the areas of math, the general and special educator were obligated to work together to meet the needs of all students in the classroom. In fact, "the greatest promise of co-teaching is the teachers' ability to provide academic and behavioral support for all students" (Sileo & van Garderen, 2010, p. 15). In using the structure similar to Peters and Johnson's (2006) Structure of Co-Teaching, Sileo and van Garderen (2010) describe the One Teach, One Observe method in the math classroom as an essential process of observation in which one teacher determined which students needed extra attention and support during whole class instruction and discussion led by the other instructor. This method allowed teachers to gather data on students and use this information to provide support or even modifications to Individualized Education Plans (IEP's). By having one teacher engaged in the lesson and one solely monitoring student interaction and participation, gaps in understanding were quickly identified and plans were put in place to address these gaps.

Team Teaching was also utilized in this math course. This method involves both teachers equally contributing to the planning and implementing instruction. The teachers noted misconceptions of students when solving word problems, then one teacher researched strategies to help address these misconceptions. Both teachers supported each

other in the design of a new way to approach word problems and reinforce mathematical concepts.

Sileo and van Gardener (2010) also discussed Alternative Teaching, in which one teacher taught the majority of the class while the other worked in a small group of more mathematically challenged students. This method is similar to Parallel Teaching in which both teachers work with half of the number students, teaching the same lesson to the smaller group, allowing for more individualized instruction. Station Teaching, with students rotating from table to table to practice multiplication, was set up to improve retention of basic arithmetic and was utilized two to three times per week. One Teach One Drift was also put in place so Merced could seamlessly move next to students needing a quick repetition or rephrasing while Thomas taught the class as a whole.

The benefit to these methods, according to Sileo and van Gardener (2010), was the ability of students to be placed in a more inclusive setting and not have to be in a resource room for instruction. “This approach allowed Ms. Merced the opportunity to increase the level and intensity of services she afforded students in a general education setting” (p. 19). Whether this increase in intensity resulted in an increase in learning is yet to be seen; there is no documentation within this article as to whether these efforts affected the learning of any student within this co-taught math classroom.

Honigsfeld and Dove (2008) discuss co-teaching in core classes with English as a Second Language (ESL) certified teachers acting as support staff. The definition of co-teaching has been expanded to include other support specialists, namely remedial math

teachers, reading specialists, teachers of the gifted and talented, and ESL staff. Since co-planning time is usually limited, the researchers recommend that teachers adopt the “One Teach, One Assist” or “Parallel Teaching” methods. These styles of co-teaching allow the ESL teacher to mimic or rephrase the content teacher, minimizing the teacher’s need to prepare a full lesson in an unfamiliar content. The ESL teacher also helps the content teacher learn strategies to help ESL students meet the state’s content standards, usually in the area of communicating proficiently in English in the particular content area. Honigsfeld and Dove (2008) are confident that educators will acknowledge the wisdom of Woodrow Wilson who once said, “I not only use all of the brains I have, but all I can borrow” (p. 11). Co-teaching is borrowing the brains and talents of colleagues to share their wisdom and help ESL students integrate into a new culture and country.

Zigmond (2006) had a rather different view of co-teaching in her study on reading and writing in co-taught secondary school social studies classrooms. She explored eight pairs of co-teachers in a high school social studies class and followed whether this method of pairing a special educator with a classroom teacher affected reading ability of language impaired students. Zigmond (2006) chose history because it is traditionally a class filled with reading, answering comprehension questions, and discussing the text. Students with any disability in reading and writing will usually display their difficulty with literacy in this subject matter as it is so laden with texts and written responses.

Zigmond (2006) was dismayed to find out that since co-taught classrooms have a higher percentage of students who struggle with reading, that the teachers assigned fewer text-reliant assignments. Rather than have the special educator teach skills, such as

concept mapping a unit or how to scaffold notes, the decision was made to have class time comprised of discussion or copying the teacher's notes from the board. Zigmond (2006) found many issues with this surrendering to a child's area of weakness. Her main concern was that all material was filtered by the classroom teacher, limiting the exposure to students of the complex but necessary task of wrestling with reading and strengthening one's skills to learn from texts. This places a limit on a student's ability to become self-directed learners, as most knowledge is gathered from written material.

In Zigmond's eyes, having all material come from the classroom teacher "perpetuates a vicious cycle" (2006, p. 19) by having the teacher promote the deficiency of reading by requiring less of it from her students. This in turn causes additional lessening of literacy skills, so the teacher must continue to provide the notes and content to the students in an auditory format. Instead of having special educators meander through the class simply to keep children awake or help them copy notes from the board, these co-teachers would better serve the students by helping them with their deficiencies and lessen the gap between students with literacy disabilities and those with none.

Co-teaching in Science

Collaboration and co-teaching are also found in interdisciplinary units in the science classroom at the K-12 level. "Beyond the Bird Unit," is a series of co-taught lessons on animal classification by Robins (2005). In this method of co-teaching, the two teachers are never in the same classroom, yet the collaboration through the internet is key to the success of this unit. Robins (2005) developed a lesson that would utilize problem-based lessons (in which students are either given or design a problem to solve), project-

based learning (in which outcomes are measured by a final project) and collaborative inquiry with faculty at Central Missouri State University. The work completed by the students would be synchronized by the classroom teacher who was daily collaborating with the university professors. The professors of Central Missouri State University planned with the classroom teacher to ensure he/she was confident in the content knowledge necessary for the success of the lesson. They also served a role in teaching the students about spiders, a specialty area usually unfamiliar to elementary education teachers.

The first part of this unit is comprised of a quote from a famous piece of literature such as Charlotte's Web. In the third chapter of this famous fictional story, there is a description of Charlotte, the spider, and a list of insects she enjoys eating. Using this information of her adaptations as clues, students are directed to use books or the internet and determine the species of this arachnid. They are then to sketch her, based on the information they have uncovered (Robins, 2005).

This lesson is inquiry in nature because students are allowed to use whatever means they are comfortable with to find information. It is collaborative, because students are encouraged to share the information as they locate different pieces of information. It is inclusive, because students draw Charlotte based on their findings, allowing students who struggle with vocabulary or writing to fully participate. Finally, it engages students and teachers in the research of university scientists by having students visit websites or to email araneologists (scientists who study spiders) at Central State University for

additional information. Learning through interactive discovery will allow students to remember the meaning of adaptation much longer than had they merely been told this information by a teacher speaking to them from in front of a classroom. The teachers benefit from the expertise of university researchers, illustrating that co-teaching can be virtual yet effective for the instructors.

Smith, Edwards, and Raschke (2006) shared their expertise in the areas of geography, history, and science to develop an interdisciplinary co-taught unit on the Columbia River Watershed area. They take the multidisciplinary areas of map making and the water cycle and use technology to help students construct a meaningful picture which integrates these concepts. Incorporated into this picture is the impact of humans on the area, taking note of the region before and after the construction of a dam and factories along the shore. Using Bloom's Taxonomy as a guide, students use the internet and free software such as Geographic Information System (GIS) to achieve goals ranging from simply locating the Columbia River to constructing a map of the area today and 100 years ago. Students acquire data sets online from the Columbia River Basin Environmental Research Project (CERP) provided by local scientists dedicated to virtual co-teaching in science classrooms. Students analyze these data to demonstrate their understanding of complex interactions of humans and the environment. Water cycle processes are more evident, due to the fact that this area is a classical ocean-mountain water cycle system, much more easily understood when it is discovered through plotting the amounts of water on the mountain and valley, rather than read about the phenomenon in a textbook.

Students also have internet access to current fish populations around the region, as well as elevations of landscapes, population of other fauna, and land usage by humans, all compliments of the US Geological Survey. With this information at their fingertips, students are able to construct meaningful conclusions about the area and make recommendations regarding maintaining the ecosystem. Textbooks become an antiquated resource in this unit; these lessons place multidisciplinary skills and knowledge in the forefront and demand that students apply current research from a variety of arenas to solve real problems.

Scientists can also be a real presence in the co-taught classroom, as indicated by Owens' (2000) study of Scientists and Engineers in the Middle School Classroom. Owens (2000) espouses the benefits of having real scientists in the classroom because:

> they are trained problem-solvers whose work involves posing questions, collecting data, and hypothesizing solutions to scientific problems; they have an accurate concept of the nature of science; and they have cutting-edge knowledge of current advancements in science to share with students and teachers. (p. 1)

There are several lessons involving co-teaching developed by teachers and scientists in the Pascagoula, Mississippi region. One lesson involves a chemist helping students test theories on which gas changes the colors of a chemical reaction, while another involves an engineer assisting students with designing an inexpensive yet navigable floatation device. The scientist teaches a weekly one-hour lesson with the assistance of the classroom teacher. At the end of six weeks, students take a field trip to

the scientists' laboratory or research facility to see the day to day undertakings of their co-teacher. Students report a positive view of the program, noting they now see firsthand why they need to learn the curriculum and how it will be useful in a career. Teachers feel validated as professionals when scientists comment on how difficult it is to write meaningful lessons that reach all learners. The scientists view it as a positive way to recruit students, especially females, into the research profession. Although no measurement of student achievement was mentioned in the study, Owens (2000) concluded that "the results of the study suggest that students' acquisition of problem-solving skills, their perception of scientists, and their science-related attitudes may be enhanced when scientists teach in the classroom" (p. 4).

Team teaching can also involve multiple science teachers in a single class. Kusnick (2008) discusses the benefits of lesson study, a form of professional development that began in Japan and has spread to the United States. The focus of a lesson study is the lesson itself, designed by five to six teachers collaborating and working in the same classroom. Although only one teacher is officially instructing, the other four to five teachers are actively observing student engagement and recording their data. The team then discusses the pros and cons of the lesson, being careful to assess the activity itself and not the delivery of the instructor. The team makes necessary changes then disseminates the lesson to other science teachers. Teachers who have used this method of co-teaching contend it is a very satisfying way to teach and enjoy the camaraderie of working together for the benefit of the students.

Another method of co-teaching in the science classroom is a partnership of teaching between the classroom teacher and a student. Emdin (2008) describes the apathy of urban science classrooms and wondered what could be done to spur on excitement for a field under-represented with minorities. He developed a method of 3 C's for Urban Science Education, namely Cogenerative Dialogue (or "cogens"), Co-teaching between students and teacher, and Cosmopolitanism. Cogens are open discussions between students and teachers regarding the current experience in the class and creating action plans to improve the teaching and learning within the classroom. All members have an equal voice and respect and cooperation is emphasized within this shared time. Co-teaching is an integral part of improving urban science education in that it provides a sense of shared responsibility. Each student takes a turn developing and teaching a lesson alongside the classroom teacher. Video-taping lessons and discussing methods of instruction help both the classroom teacher and current student co-teacher to improve instruction and develop ways to address student misconceptions. The feeling of responsibility for teaching and learning directly channeled into the sense of cosmopolitanism, the last of the three C's. This philosophical idea is what expands success in one classroom to success within the school and then community. Emdin (2008) describes cosmopolitanism as "understanding can be shared across communities when similar conversations surrounding the ways to teach and learn science are shared with students from similar backgrounds" (p. 775). Co-teaching, therefore, has larger implications than the professional development of the teacher It can be used as a catalyst

to spark engagement in a population who traditionally felt excluded from the science world.

McDuffie, Mastropieri, and Scruggs (2009) completed an extensive study involving peer tutoring in the science classroom. As part of the study, they followed the achievements of students in four co-taught science classes as well as in four single-taught classes. The main focus was whether peer- tutoring, or pairing students with another of similar ability to review simple concepts as a warm-up activity, improved student achievement. As a side study, the researchers hypothesized that if peer tutoring improved learning, and co-teaching improved learning, then the combination of the two practices would significantly improve student understanding. The main conditions studied by McDuffie et al. (2009), therefore, "1. Co-taught classes with peer tutoring, 2. Co-taught classes without peer tutoring, 3. Single-taught classes with peer tutoring, and 4. Single-taught class without peer tutoring" (p. 496). The peer tutoring segment of each class comprised the first ten minutes of the period. Students in the upper half of the class were paired with each other as were those in the lower half. They spent the first ten minutes of each class drilling each other on vocabulary or other science concepts before beginning the classroom activity for the day. The co-teaching segment of this study was not a research-developed or research- implemented intervention, but rather another variable thought to affect learning. In other words, the researchers did not follow the methods of co-teaching to see that they were similar across the classrooms, but simply gathered the data from the various assessments, unknowing if the teaching methods from one co-

taught classroom to another varied or not. The results revealed that unit tests were higher for students involved in peer tutoring, but the cumulative posttest was higher for the students not engaged in peer tutoring. Students in the co-taught classes outperformed those in the single-taught classrooms on both levels of assessments. The researchers noted that students in the co-taught classroom outperformed students in the single-taught classroom on lower-level questions of factual recall, but they did not outperform their single-taught counterparts on higher-level questions of application and evaluation. Interestingly enough, though, there "were no statistically significant interactions between the peer-tutoring intervention and the co-teaching setting" (McDuffie et al., 2009, p. 504). This was surprising to the researchers, as they had hypothesized if each treatment individually improved achievement, then the combination should magnify the results. However, since the methods used in the co-taught classrooms were not purposefully controlled, it is difficult to know if other variables within the co-taught classrooms led to these results.

Implications for Study

Why is there such a need for two teachers sharing responsibilities of one classroom? Loiacono and Valenti (2010) answer this query in their study of the increasing number of autistic children in the general education setting, stating "educators continue to be challenged to learn disability-specific teaching skills to address meeting the learning needs of a statistically higher number of children with autism within the public school systems" (p. 25). According to the New York State Department, local

educational agencies (LEA's) have reported increases of autistic children enrolled in public school to average a 100% increase from 2003-2007. Yet in the 135 general educators who responded to Loiacono and Valenti's (2010) study, only five had taken a course dealing with the educational needs of autistic children. The researchers concluded that educators in this study were clearly not prepared to teach autistic children, but did not indicate exactly how co-teaching would remedy this situation. They have identified the need for helping general educators, but have not helped to forage a solution to meeting the needs of the increasing number of students with learning challenges.

Co-teaching may or may not be just a passing fad. This pedagogy asks teachers to do what professionals around the world are doing on a daily basis: work in teams for the benefit of the all. Gunawardena, Weber, and Agosto (2010) address the benefits of co-teaching from a different standpoint, that of a library and information scientist. In today's world, scientists do not work in isolation. Jones, Wuchty, and Uzzi (2008) state that in science and engineering, including the social sciences, scientists are working together even more, with the proportion of single author work dropping by half from 1975 to 2005. Gunawardena et al. (2010) also emphasize the importance of collaboration in science, noting that the National Science Foundation awards more grants to those initiatives that are interdisciplinary in nature. If science is becoming an increasingly collaborative field, drawing on the knowledge and skills of many disciplines, it is only logical that teachers should be trained in a way to expect and educate students on the benefits and techniques of collaboration. If teachers are to expect this from their students,

then it is imperative that educators themselves learn to work collaboratively in the classroom. Gunawardena et al. (2010) comment on the difficulty and stress involved in collaborating if responsibilities of all involved parties are vague and unspecified. Another obstacle in co-teaching is an impulse to divide work and split the tasks, rather than forge a seamless teaching environment of shared duties. Teachers will need to relinquish the traditional autonomy and surrender the individualistic approach to teaching and learning. By modeling collaboration in the classroom, students will also learn to bring their strengths to the assignments and prepare them "to work in an increasingly collaborative work world" (Gunawardena et al., 2010, p. 218).

Kohler-Evans (2006) espouses the detriments of teaching students with learning disabilities in separate classrooms, declaring "time has taught us that students pulled from general education classes and taught in a resource setting do not benefit from the instruction of content area teachers" (p. 260). Yet, she admits that research is inconclusive as to whether co-teaching is an effective way of meeting the needs of these students in the inclusive classroom. Although she declares co-teaching to be espoused by teachers as a wonderful method for them professionally, Kohler-Evans (2006) does acknowledge that "more study is needed to determine the exact effects on student achievement in variety of subjects and classrooms, and to examine the effects on students with significant needs" (p. 264). With so much positive research on the benefits for teachers who co-teach, it is imperative than one take a longer look at the benefits to

students and determine if this methodology is worth the thousands of dollars it takes to staff a single classroom with two professionals rather than one.

Classroom teachers seem to feel the need for two educators in the classroom. What has not been quantified, however, is the intended benefit of co-teaching, namely increasing student achievement. This study tracked student achievement in eleven sections of a ninth grade physical science classroom: nine traditional single-taught, one co-taught with a content specialist and a special educator, and one co-taught with two content specialists.

Chapter 3: Methodology

Introduction

Teachers devote their entire careers to assessing students' understandings of various concepts. Their occupation involves creating lessons that clearly explain a state-mandated concept, such as density or separating mixtures. They must then measure whether a student has indeed grasped the concept. But are the teaching methods the catalyst that lead to comprehension, and if so, which part of the implementation can be credited for sparking understanding? It is imperative to learn as a profession to not only measure students' gains, but measure the means that achieved them.

The purpose of this study was to determine if co-teaching affected the achievement of students in a ninth grade physical science course. Co-teaching may include a subject certified teacher coupled with a special education teacher, or it may include two subject-certified teachers working together within the same classroom. Because the goal of the district involved is to increase achievement for all, some co-taught classes are AP level courses consisting of students who may not have normally taken this level of difficulty but felt compelled to enroll, knowing there was an additional teacher in the course for support. During this time of budget cuts in nearly all educational settings, however, it is important for the district to ascertain if two teachers affect the learning outcomes of a classroom. If it is determined that co-teaching does indeed increase achievement, then are there particular groups who seem to benefit most from this method, or is there a general increase in all students? The study was designed to measure

the science course level with the highest rate of failure: the ninth grade physical science course. With budget cuts looming for the next academic year, it was important to determine if co-teaching is an effective method of increasing student achievement. If it was indeed effective, then one must look to see if students without IEPs benefit as well as the students with IEPs for educators cannot neglect one group in favor of a method that benefits another.

Research Design

The research design was a quantitative study of student achievement within two co-taught and nine traditional classrooms. The treated group was composed of students in a co-taught class with two teachers, at least one of whom is a certified science teacher. There were five teachers involved in the study. Teacher A, the researcher, is a female, age 43 with 22 years of science teaching experience at the time of the study. She is certified in General Science, Biology, Chemistry, Earth Science 7-12, as well as being a National Board Certified Teacher in Early Adolescent Science. She taught middle school for 17 years and has taught the Force and Motion class since moving to high school five years ago. For this study, she taught three sections of Force and Motion: one co-taught with Teacher E (a special education teacher), one single-taught, and one co-taught with Teacher D (a science-certified teacher).

Teacher B is a female, age 55 at the time of the study. She was retired one year from teaching after 33 years, but came back to work part time (2 Force and Motion classes). She is certified in Biology, Chemistry, Physics, and General Science 7-12, and is a National Board Certified Teacher in Adolescent Physics. She taught two sections of

Force and Motion that met on “B” days only, so she was present in the building every-other day. She co-planned via email or by coming in early on the days she taught. Communication with the other teachers was frequent, averaging five emails per week to share lessons and compare assessments as well as pacing.

Teacher C is a male, age 52, and in his final year of teaching prior to retiring at the time of the study. He is certified in PE 9-12, Biology 9-12, and general science 7-9. He taught five sections of Force and Motion, each section as a single-taught course.

Teacher D is a thirty-five year old female in her fourth year of teaching at the time of the study and was a new member of the department. She is certified in Biology and Physics, 9-12. She had always taught ninth grade in her four years in education, but the year of the study she also taught three sections of senior-level physics. She taught a single section of Force and Motion and co-taught with Teacher A in another section of this course.

Teacher E is a fifty-one year old female, certified as an Elementary teacher, as well as special education. Her certification area in special education is behavior disordered (BD, now called Educational Disordered, or ED) and Learning Disabled (LD). She has experience in co-teaching English 2, Algebra 1 and 2, Geometry, World History, and Physical Science- Chemistry. This was her first semester co-teaching the physical science course Force and Motion.

The study was controlled by having the same teacher (Teacher A, the researcher) instruct one course alone and the same course with a co-teacher certified in science (Teacher D), as well as a second section co-taught with a co-teacher certified as a special

education instructor (Teacher E). The other nine sections were taught by four different science teachers, but they employed nearly identical labs, activities, and chapter assessments. Identical pre- and post-tests were administered in each section of the course and the instructional strategies and curriculum were the same. This method was chosen in order to compare student achievement with as much emphasis as possible on only one main independent variable present: the presence of a co-teacher. If it was determined that students in co-taught classes did in fact achieve more than students in a single-taught classroom, the study would be augmented to include the certification of the co-teacher as well as the subgroup of the students who benefitted as additional independent variables. The methodology employed by the co-teachers, whether special education or science certified, was controlled as much as possible in an attempt to ascertain if it was the co-teaching model itself rather than the methods of co-teaching that produced the change. The dependent variable was the change of score on a common assessment given to all students at the beginning and end of every science course.

In the co-taught section involving a special educator, the main method of co-teaching was concentrated around One Teach, One Assist, and Pull-Out, with the subject matter teacher instructing over 95% of the time. This was an unavoidable necessity, due to the discomfort of the special education teacher with presenting or clarifying a science lesson. The duties of the special education teacher centered on walking the room to improve the students' task completion and ability to remain focused on the labs and lessons. She conducted small pull-out sessions in the back of the classroom to re-teach to

small groups or work with individuals. She reminded the students to write down homework, assisted in assessing homework if given an answer key, kept students on task with verbal prompts, and made phone calls to parents when student achievement was in or near the failure range. She also provided valuable feedback to the content teacher on the clarity of the lesson as well as necessity for repetition or proceeding with the lesson. Lesson design, lab prep, and evaluations of higher-level assessments were left to the science teacher, per the wishes of the special educator. The classroom teacher also modified all assignments, again due to the special educator's discomfort with high school science content. The special educator's contribution to the success of the students, however, should not be diminished. The purpose of this study is to determine if content can be delivered more effectively with two teachers present and actively attuned to the success of each child; it is not to ascertain nor judge which instructor is the most effective piece of the puzzle for they each have a potentially critical role in student success.

The same co- teaching methods were used in the other class where both teachers were science certified instructors, with the difference being both acting interchangeably as the primary teacher. The One Teach/One Assist as well as Pull-Out models were again utilized, but since both teachers are comfortable teaching the main idea as well as monitoring for student understanding and re-teaching as needed, the One Teach alternated between the two instructors. Pull-outs were sparse in both co-taught classes and mainly limited to test review days. Working with small groups in the back of the room or in another room was sometimes necessary due to the high number of students on the autistic spectrum who needed some one-on-one time from a subject certified

instructor. In spite of having two science teachers alternate the lead teaching position in the dual science-certified co-taught (CT) class, the researcher noted that activities and explanations were virtually the same every day in the three classes she taught, no matter if the class was single-taught or co-taught. The explanations of the other science teacher mirrored her own explanation, so in her perception, the teaching from class to class was identical and seamless. Interestingly, Teacher D noted the same similarities in her survey, commenting on being relieved that her instruction closely resembled that of Teacher A.

Population and Sample

The district involved is a large suburban school district outside a major metropolitan city. This district at the time of the study had a total enrollment of 17, 456 students spread over 18 Elementary Schools, 5 Middle Schools, 4 High Schools, 1 non-traditional high school and 1 early childhood center. The population of Asians during the time of study made up a total of 11% of the district; Hispanics; 3%, Blacks; 15%, Indians; 0.2%, and Whites 68 %. The free/reduced population of the entire district was 19.8% (see Table 1). The individual school involved in the study had a total enrollment of 1511 students, with Asians comprising 9%; Blacks, 28%; Hispanics, 2.3%; Indians, 0.3%, and Whites, 57.2% (see Table 1). The graduation rate for this school was 96.5%.

Within the course studied, there were 201 Force and Motion students (1 section of co-taught with 2 science certified teachers, 1 section co-taught with 1 science certified teacher and 1 special education teacher, and 9 sections of single teacher). Even though the total population of the course was 201 students, only 174 students took both the pre-

and post-test. Table 1 summarizes the population of the district and the school involved in the study. Table 2 illustrates the individual breakdown of each section of the course.

Table 1:
Whole population of District and School of Study

	Total Population (as of 2011)	%White	%Black	%Asian	%Hispanic	%Other	% IEP	%Free/ Reduced Lunch
District	17,456	68	15	11	3	0.2	17.1	20.6
School of Study	1,511	57.2	28	9	2.3	0.3	16	25.5

Table 2
Demographics of Force and Motion Classes

Total Population	Hr & Teacher	% White	% Black	% Asian	% Hispanic	% Other	% IEP	%Free/ Reduced Lunch
16	7, B	50	44	0	0	6	13	38
21	8, B	48	29	10	10	5	5	43
21	2, A&E*	69	15	15	0	0	42	5
20	7, A	35	45	5	10	5	20	30
21	8, A&D**	57	33	0	5	5	29	33
21	1, C	62	24	10	4	0	24	29
12	3, C	33	33	17	17	0	25	8
18	4, C	61	33	0	0	6	28	22
18	5,C	44	33	11	11	0	17	28
15	7, C	67	27	7	0	0	20	33
18	5, D	56	22	6	0	17	11	44

indicates CT section with 1 science teacher and 1 Special education teacher, and **indicates CT section with 2 science certified teachers

Sampling Procedure

The sampling procedure used for this study was purposive sampling. According to Weiss and Sosulsky (2003), "Purposive sampling is a sampling method in which elements are chosen based on purpose of the study. Purposive sampling may involve studying the entire population of some limited group" (p. 1). This may include students in co-taught or non-co-taught sections of different science courses. The purpose of the study was to compare the achievement of students in co-taught and single-taught science classes, so a completely random sample would not suffice in this case; the students being studied must have been enrolled in a co-taught or single-taught section of the course. Students with IEP's are purposefully placed in co-taught classes, but the general education students are selected randomly to complete the class of 18-24 students. Students with IEP's typically make up 25-30% of the co-taught class, but can range as high as 70% or more. In single-taught classrooms, this subgroup usually makes up 10% or less of a single-taught classroom, but some courses have had one teacher with over 50% IEP students. The CT class with the special education teacher has an IEP population of 42%, well over the school's average of 16%. It was interesting to see the results of this class with such a high population of students with difficulty learning in the traditional manner.

Instrumentation

The instrumentation used to measure achievement in this course was a district-approved common assessment for Force and Motion. Common assessments are used to

measure the guaranteed and viable curriculum within the district, a local term assuring parents that no matter which school their child attends within the district, he or she will be taught the skills on these assessments. These tests were developed in 2007 and piloted in 2008. They have been in place since that time and utilized to achieve a baseline of student knowledge before and after delivery of instruction. (See Appendix A for the assessment.)

The researcher also conducted oral interviews with teachers involved in the co-taught classroom. This qualitative information, combined with the quantitative data regarding student achievement, was helpful in analyzing and interpreting results. For example, it was important to note if co-teachers chose this method of delivery or had reluctantly accepted the assigned position. The researcher asked for attitudes towards co-teaching before, during, and after the semester to see if perceptions changed or if convictions were strengthened or weakened by the experience. (See Appendix B for the interview questions.)

Data Collection

At the beginning of each course, the classroom teachers administered the common assessment within the first week of class. Students are not expected to know the material on the test but simply answer to the best of their ability. Assessments were scored by the researcher, using a district-approved rubric to ensure reliability of scores. In the last week of the course, the same assessment was again administered, providing teachers with a

measurement of material mastered within the course. The scores of each pre and post-test were entered into a spreadsheet and imported into the statistical application "SPSS" for data analysis.

Data Analysis

Regression analysis is used to evaluate the relationship of two variables, the predictor variable normally found on the x axis, and the criterion variable, normally found on the y axis. When researchers want to know if there is a pattern or relationship between two variables, such as presence of a co-teacher, they can create a scatter plot to compare the data. The researcher collected information from a purposive population sample, making sure to include information on race, ethnicity, gender, GPA's, and IEP's so that one could determine if the percentage of these different categories was close to the school's actual population; this would be necessary if generalizations found in the study could be applied to the school population as a whole. The data for each pre- and post-test was entered into Microsoft Excel for the purpose of calculating the equation of that line and creating an R value (Pearson Correlation) to see how closely the two variables correlate. If there is a positive correlation, then that indicates that the presence of a co-teacher relates to a larger interval between the pre- and post-test. If there is no correlation, then these two variables have no effect on the other. If there is a negative correlation, this would indicate that the presence of a co-teacher negatively affects the outcome of student achievement. The researcher wanted to see if there is indeed a

correlation between variables. If on a scatter plot there is an obvious clustering of data creating a positive slope between co-teaching and the improvement of student common assessment scores, the researcher can review the r value or Pearson Correlation to see how closely the two are related. An r value can be between -1 and 1, with 0 indicating no relationship. The closer the r value is to 1, the more highly the two variables are related. It is important to note that one does not cause the other; it is merely an indication of relationship and must be investigated further if one is indeed present. A test for significance was done using ANOVA to determine if there is a significant relationship between the two variables and also measured the effects of other variables, such as whether students receive free or reduced lunches or is a resident of the district. A Repeated Measures ANOVA with multiple covariates was helpful in determining which, if any, other variables were related to student achievement.

Meier (2008), as well as McFall and McDonel (1986), suggest that ANOVA falls short of explaining person-environment interactions. They also maintain that investigators can easily manipulate the experiment and that there is no scale to make meaning of chunks of the person-situation process. Salkind (2008) cautions researchers to not negate the importance of effect size, even when significance is present. In his words, "the $64,000 question is not only whether that difference is (statistically) significant, but also whether it is *meaningful*" (p. 196). Salkind (2008) discusses the measurement of the magnitude of the treatment and the importance of taking this into consideration when advising others to continue with or abandon the treatment. In other words, the presence of

statistical significance is not enough to warrant funding of a program if the effect size is minimal. The researcher worked closely with the school's statistician to ensure the selected statistical models provided meaningful data. The school involved in the study is a data-driven school, and the conclusions are only as good as the methods used to gather and interpret the numbers.

Limitations

The limitations of this study included the lack of continuity of the same co-teacher from year to year in each classroom. Teacher E (the special education certified co-teacher) did not have experience with co-teaching in the course "Force and Motion, and Teacher D (the science-certified co-teacher) had never co-taught in any situation. To minimize this limitation, the content teacher met with the special education co-teacher at least once per week to review content being covered in the class. Both science co-teachers also met on a different day to decide on preferred methods of co-teaching that corresponded with the daily lessons. Other limitations included lack of identical instruction from teacher to teacher. When the same teacher instructs several sections of co- and single-taught sections, this can be better controlled. When comparing a single-taught section of Force and Motion from one teacher to another, however, there may be differences simply because of the teaching style and depth of the instruction. Common assessments were put in place by this district to encourage continuity of instruction between teachers across the district. Hopefully this continuity is happening and any significant gains or losses by students over a semester can be attributed to the number of teachers in the classroom.

Chapter 4: Findings

As stated in Chapter 1, the purpose of this study was to determine if co-teaching resulted in higher gains of student learning as measured on a pre and post-test in a ninth grade science course. Although the study was controlled as tightly as possible and all aspects of student demographics were tracked and recorded, the results indicate there is much to be learned about the benefits of co-teaching and how it affects achievement.

The hypotheses were as follows:

1. Co-teaching will not have an effect on student achievement as measured on a pre-and post-test.
2. If co-teaching has an effect, the increase interval between pre and post test scores will be greater if the co-teacher is subject certified rather than special education certified.
3. If co-teaching has an effect, the increase interval within co-taught classes will be greater for students with an IEP as opposed to those without.

To begin the data analysis, pre and post-test scores were used as factors in an SPSS generated general linear model to determine if the starting point of students was similar, thereby eliminating the “Regression to the Mean” factor, or the fact that student groups who start significantly below other groups in pre-tests are bound to increase just by sheer chance. Figure 1 illustrates the results of this initial analysis.

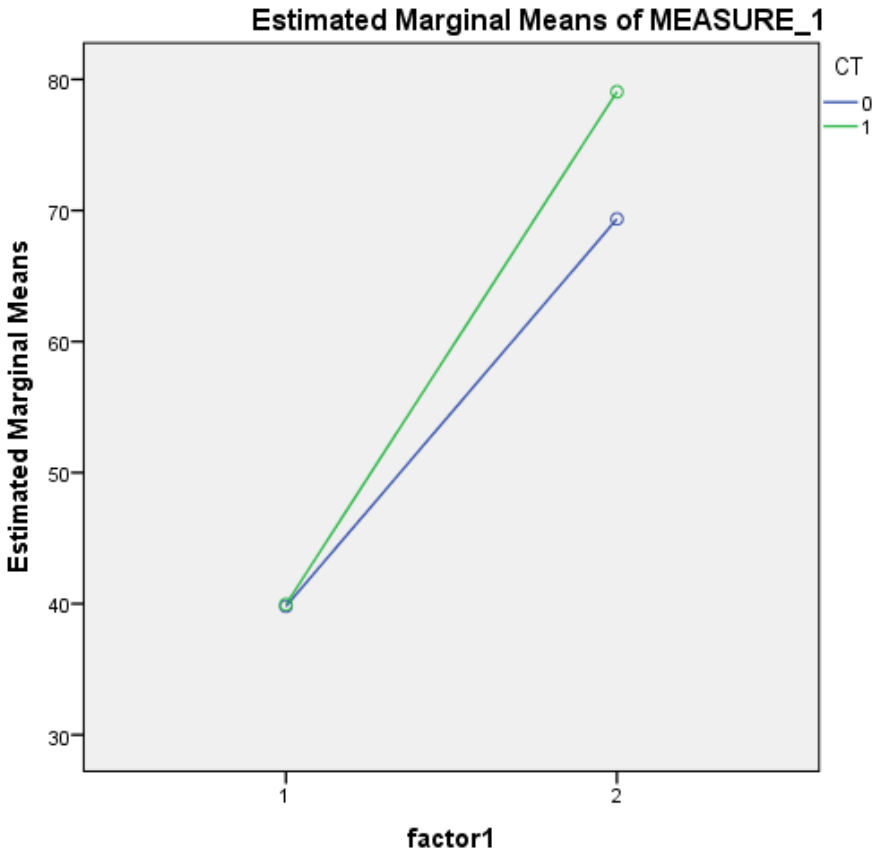


Figure 1. Student Pre-Scores in Co-Taught and Single-Taught Classes

The mean of the pre-test of students in a single-taught class was 39.0, and the mean of the pre-test for students in a co-taught class was 39.95, assuring the researcher that the average indicated students began in roughly the same place in terms of their physics knowledge before taking the course. The results of this general linear model indicated the statistical significance was zero, meaning there is significance in these results.

The data for each student in each section was placed into an Excel file, including section of the course, ethnicity, free and reduced lunch status, gender, presence of an IEP,

and district residential status. If the data showed no or weak correlation between the variables of co-teaching and achievement interval on pre- and post- tests, then the researcher wanted the opportunity to see which, if any factors, mattered in student achievement. Formulas were set in place on the Excel file so that when pre-and post-test scores were entered, the file was readily available for analysis. Co-teaching was coded as 1 and Single-Taught sections were coded as 0. The tables in Appendix C show a summary of each teacher's demographics as well as the mean on the pre and post-test for the entire class and various subgroups. Appendix C also includes a summary table of scores for both the Single Taught (ST) as well as the Co-Taught (CT) sections. Figure 2 clusters the results by students in a co-taught section and students in a single-taught section.

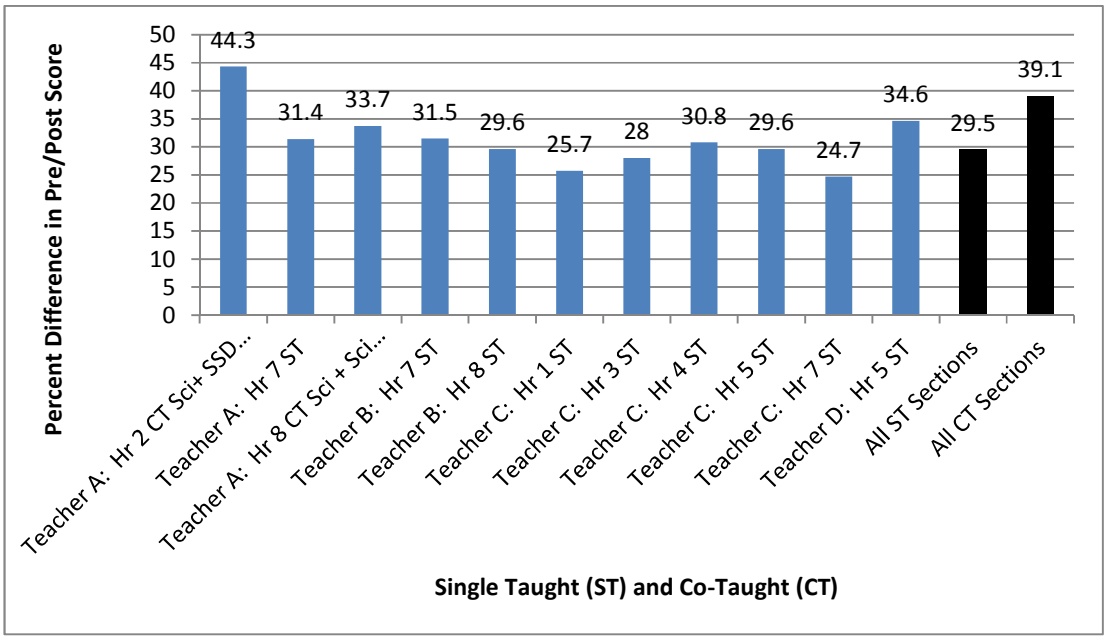


Figure 2. Pre/Post Score Difference in Co-Taught and Single-Taught Physical Science Classes

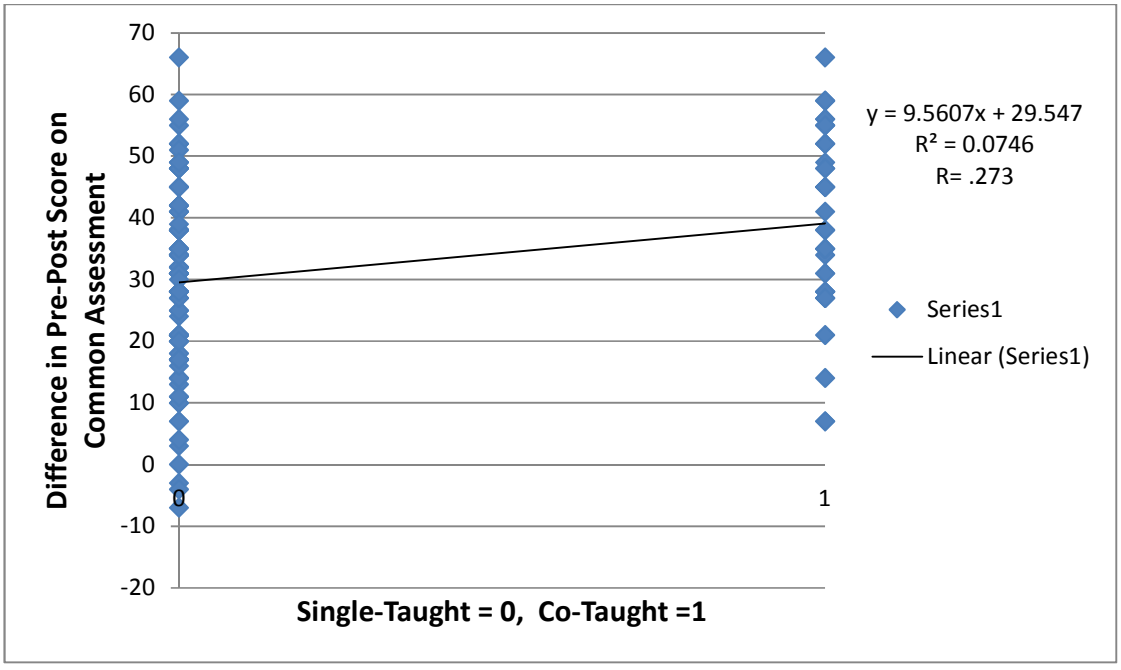
The results of the study were somewhat startling. The class with the highest post-test average was the co-taught class with the special education teacher, with a post-test mean of 80.8. This did not support Hypotheses 1: Co-teaching will not have an effect on student achievement as measured on a pre-and post-test; or, Hypothesis 2: If co-teaching has an effect, the increase interval between pre and post test scores will be greater if the co-teacher is subject certified rather than special education certified. The class with the special education teacher also had the highest increase in achievement, having a mean difference of 44.3%, even though the class had an IEP population of 43%, the highest of any class.

The second-highest class was the single-taught 5th hour led by Teacher D, the co-teacher in 8th hour. The mean of this single-taught class was 78.7%, with an increase

average of 34.6%. The co-taught class with two science teachers followed with students having a mean score of 77.2% with an average increase of 33.7%. The demographics of the single-taught class with Teacher D included an 11% IEP population, compared to a 29% IEP population in the co-taught class with two science teachers. Having more students with identified learning disabilities in Teacher A and D's co-taught class than in Teacher D's single taught class could explain why Teacher D's single taught class had a higher score differential. More data is needed to ascertain why Teacher D's ST class had a greater increase between pre and post-test results, but it does indicate that high achievement is certainly possible in the single-taught classroom. Having a special education teacher in the classroom did have a positive effect on student achievement, even higher than having two subject-certified teachers co-teaching, but the results of the study warrant a closer look and a more specific data analysis found on a regression analysis.

The first regression analysis compared students in co-taught (CT) classes to those in single-taught (ST) classes determine the significance and effect size of the aforementioned results. Figure 3 indicates that there was a difference in achievement when students are placed in a CT class as opposed to an ST class. There was an average increase of 9.5% when students are in a CT classroom. However, a closer inspection revealed that the R^2 value is 0.0746, a relatively small effect size. The square root of this value, the Pearson Correlation Coefficient of R, is just .2731, a generally weak linear dependence between co-taught and single-taught classrooms. The researcher then used the statistical software SPSS to determine if these results are significant or mainly due to

chance. SPSS was set to a $p < .05$, meaning the results achieved by co-teaching would only be significant if p was less than 5%. The results indicated that the scores were statistically significant with a p value of .000. Finally, a Test of Homogeneity of Variances was run to determine whether the ANOVA was valid. If the results of the Homogeneity Test are significant ($p<.05$), then the variances are significantly different from each other (Walen-Frederick, 2012). The results of this analysis have a statistical significance of 0.402 on the Homogeneity Test, indicating the results of the ANOVA are indeed valid.



Significant at p<0.01

Figure 3. The Effect of Co-Teaching on Student Performance on Common Assessment

The second hypothesis suggested that if co-teaching affected student achievement, students (those with or without IEP's) would achieve more in a secondary science course

when placed in a class of two subject-certified teachers than in a single-taught or co-taught class with a special educator. To determine if there was a strong correlation between the certification of the co-teacher and the achievement of the students, another regression analysis was performed. The co-teacher who was special education certified was coded as 0, and the co-teacher with science certification was coded as 1. Figure 4 illustrates the results.

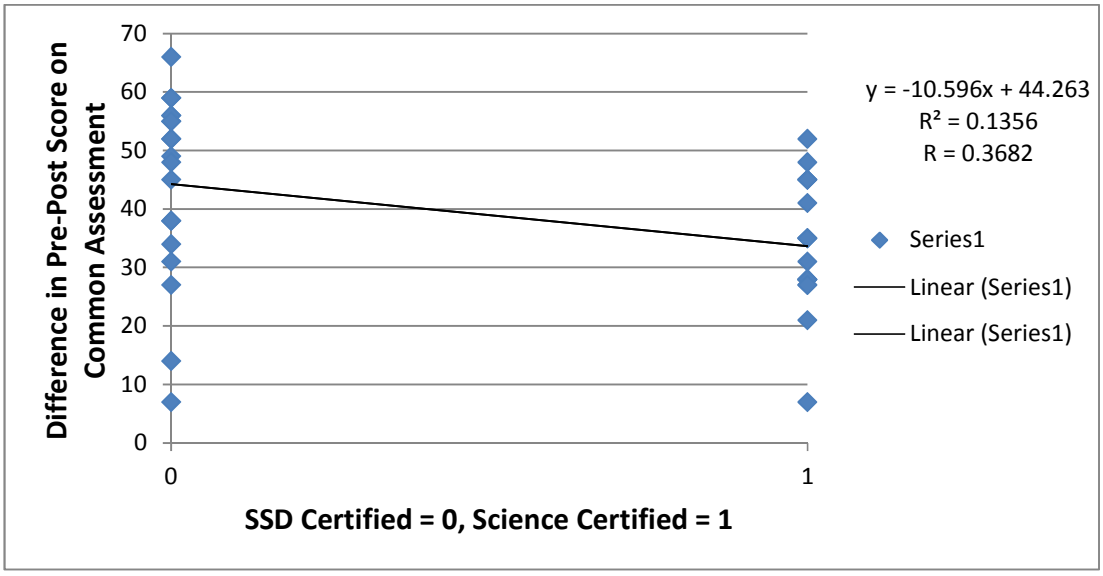


Figure 4. Certification of Co-Teacher and Its Effect on Pre- Post Test Interval

Figure 4 shows that co-teaching with a special education teacher leads to higher interval achievement scores than co-teaching with another subject-certified teacher. According to the data, students in the CT class with a special education teacher scored an average increase of 44.3%, whereas the students in the CT class with two science teachers averaged an increase difference of 33.7%. The effect size was within the moderate range with a Pearson Correlation of .37. As one can see, the first and second

hypotheses were not supported by these data. Contrary to the researcher's hypothesis that two science certified teacher would have the highest results on the post-test, the special education certified teacher's students scored higher than both the science teacher alone, as well as the science teacher with a science-certified co-teacher. These results are tempered by the fact the R^2 value is only 0.13, indicating the Pearson Correlation Coefficient is 0.37, a slightly moderate relationship between certification of the co-teacher and student achievement.

The data reveal intriguing results, but does the factor of certification of the co-teacher have significance? The researcher used SPSS to compare the variables and determine if there was significance to the correlation between overall increase on the pre- and post-test and certification of the co-teacher. The special education co-teacher was coded as 0 and the science-certified co-teacher was coded as 1. The results are displayed in Table 3.

Table 3

Correlation of Special Education Certified and Science Certified for Co-Teacher

CT Category	N	Mean	Std. Deviation
Special Education	19	44.26	15.867
Science	18	33.67	11.067

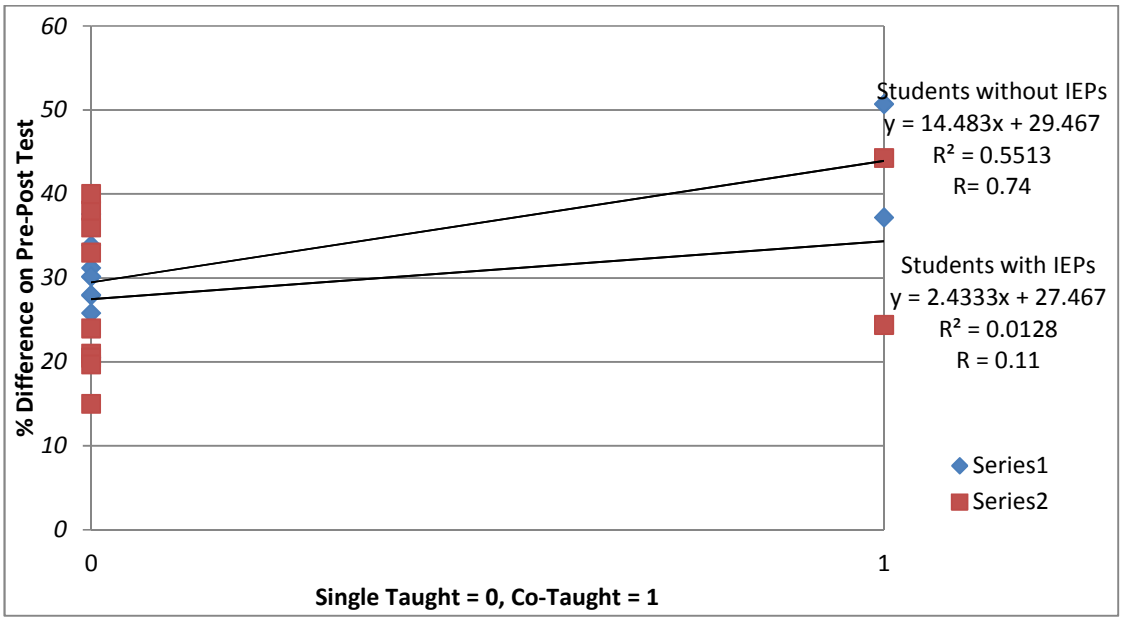
Significant at the p<.05

R Squared = .136 (Adjusted R Squared = .111)

Table 3 indicates there was a positive correlation, although as discovered in the aforementioned regression analysis, a weak to moderate one. However, the p-value is 0.025, below the acceptable p value of <.05. This indicates the results are statistically significant and the increase in range of test scores was not due solely to chance. The null hypothesis that the certification of the co-teacher has no effect on increasing student achievement as measured on this common assessment should be rejected.

These results should be interpreted with caution. The adjusted R^2 indicates an effect size of .111, demonstrating yet again that in this particular study, there was a very weak effect even though there statistical significance was present. In each analysis, an effect size of .1 or smaller indicates a student at about the 51^{st} percentile on a bell shape curve in the treated group (CT) as opposed to the 50^{th} percentile in the non-treated (ST) group (Coe, 2002).

To examine the third hypothesis and determine if students with IEPs indeed benefitted from CT classes more than students without IEPs, the researcher used Excel to create a regression analysis. Students in the single taught classes were coded as 0 whereas students in co-taught classes were coded as one. Figure 5 and Table 4 summarize the results.



Statistically significant at p<.05

Figure 5. The Effect of Co-Teaching on Students with and without IEPs

The purpose of CT classes is to augment the achievement of students with IEPs. It is written into the Individual Education Plan that the student will receive direct contact minutes with a special education teacher as an intervention to increase their achievement. The presence of the special education teacher in the CT classrooms fulfills this legal requirement of contact time and is meant to increase the achievement of students with special needs. According to the results of this study, students with IEPs only scored 2.4% higher on a post test. The effect size was extremely weak with a Pearson Correlation of 0.11. The most intriguing part of this analysis was the increased achievement of students without IEPs in CT classes as illustrated in Table 4.

Table 4
Effect of Co-Taught and Single-Taught Classes on Students without IEPs

	N	Mean	Std. Deviation
Single Taught	24	43.42	11.982
Co-Taught	13	31.15	16.025

Significant at p<.05 (2-tailed)

Table 4 indicates that students without IEP's scored nearly one standard deviation higher than their counterparts in ST classes. Table 4 illustrates a further analysis using SPSS, showing that the results found on the regression graph were statistically significant at $p<.05$ ($p = .026$).

After realizing that the benefits of CT classes were greater for the non- IEP students, the researcher then compared these results with the non-IEP students in ST classes. Did non-IEP students achieve the same whether in CT or ST classes? According to the results of an Independent Samples T-test in SPSS in Table 5, non-IEP students in CT classes achieve more than non-IEP students in ST classes:

Table 5
Effect of Co-Taught Classes on Students without IEPs

	N	Mean	Std. Deviation
Single Taught	116	30.00	13.873
Co-Taught	24	43.42	11.982

Significant at the p<.01

R Squared = .865

The significance was below the $p<0.1$, indicating these results are statistically significant. The mean of students without IEPs was nearly one standard deviation higher in the CT classes compared to the ST classes as indicated by the .93 Effect Size. This was an unexpected outcome and an interesting result to find from using a methodology established specifically to benefit achievement of students with IEP's.

Finding that students without IEPs benefitted the most from the CT classes, the researcher pondered if certification of the co-teacher was related to the increase in student performance. The researcher used SPSS to perform an independent samples T-test, omitting all students with an IEP and coding the special education co-teacher as 0 and the science co-teacher as 1. The results as illustrated on Table 6 reinforced that the students in the class with the special education co-teacher had a significant increase in achievement compared to the ones with the science co-teacher.

Table 6

Effect of Certification of Co-Teacher on Students without IEPs

Certification of CT	N	Mean Difference Between Pre- Post-Tests	Std. Deviation
Special education certified	11	50.73	10.555
Science certified	13	37.23	9.584

Significant at the p<.01

R Squared = .314

The effect size was in the moderate range with a Pearson Correlation of 56%. According to Coe (2002), approximately sixty-nine percent of students in the CT

classroom with two science teachers would score below the average in the CT classroom with the special educator present. The statistical significance coupled with a moderate effect size indicates there are benefits to having a special educator as a co-teacher in the ninth grade physical science course. The beneficiaries of their efforts, however, were not the intended target, namely students with IEP's. One must consider that these are the results of the two co-teachers within this one study; whether these results would be repeated with different educators in another class is a topic for future study.

The researcher questioned if other factors influenced the increased achievement in the CT and ST classes. A Repeated Measures ANOVA was run in SPSS to determine if variables such as Free and Reduced Lunch status or gender had any effect on the outcome. The pre- and post-tests are the repeated measures, the CT status is the independent variable, and IEP, Non-resident of the district (NR), Free and Reduced Lunch (FRL), Ethnicity, and Gender are the other covariates. The results indicating whether other factors affected achievement are illustrated in Table 7.

Table 7
ANOVA Repeated Measures Test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
PrePostTests * IEP	415.581	1	415.581	4.402	0.037	0.026
PrePostTests * NR	194.282	1	194.282	2.058	0.153	0.012
PrePostTests * FRL	12.499	1	12.499	0.132	0.716	0.001
PrePostTests * Ethnicity	30.633	1	30.633	0.324	0.57	0.002
PrePostTests * Gender	43.847	1	43.847	0.464	0.497	0.003
PrePostTests * CT	1514.95	1	1514.95	16.045	0	0.088

Box's Test of Equality of Covariance Matrices p = .773

As illustrated in Table 7, Box's Test of Equality of Covariance Matrices lists a significance of .773. Since these results are not significant, one can reject the null hypothesis that none of these subgroups had an effect on achievement in the CT classroom and proceed with the analysis. The Multivariate Tests reveal that IEP status is significant at $p < .05$. This is not surprising, considering the previous analysis revealed that students without IEPs scored significantly higher than their counterparts in CT classes. It has been established in aforementioned data analyses that co-teaching did indeed have an effect on student achievement. The other covariates were not significant: non-resident students (NR) had a significance of .153, free and reduced lunch (FRL) had a significance of .716, Ethnicity had a significance of .570, and Gender had a significance of .497. When compared to the other covariates, co-teaching showed the most

significance with $p < .01$. This result again indicates that the higher scores were not just due to chance and seem to indicate co-teaching does indeed have a positive effect on student achievement. However, the effect size, as indicated on the Partial Eta Squared column, is 8.8% for the entire group of students in the CT class. Coe (2002) compares such a minimal effect size to people guessing which students were in the treated group and which were in the control group based on their difference between the pre- and post-test, and they'd have a 52% chance of guessing correctly. The students in the CT class would be at the fifty-fourth percentile when compared to the average students in the ST class, a rather small increase. If the variance between groups is less than 10 percent, there is a generally weak effect of co-teaching on student achievement in this ninth grade course.

Based upon the findings, it would be reasonable to question whether these results could have been skewed by teacher attitudes towards co-teaching. Considering this possibility, a qualitative survey was developed and administered to each teacher involved in the study. The consensus seems to be all instructors had a positive outlook before, during, and after the semester. As the researcher responsible for designing the study, I entered the inquiry on the effect of co-teaching on student achievement as a willing participant in co-teaching, expressing interest in whether it affected students' achievement. I was convinced that it benefitted the teachers by having an extra pair of eyes and hands in the classroom; I could work more in depth with fewer students if I had another educator in the class. I could also learn from my colleague, noting his or her use of technological tools or implementation of labs I had never employed. Throughout my

career, I enjoyed learning from other teachers and I felt that co-teaching was an effective method of professional development. However, I was unsure if co-teaching benefitted students in terms of enhanced academic performance.

Teacher B sent copious amounts of emails to remain in contact with the other teachers so that her part-time status would have a minimal effect on the consistency of instruction across the classrooms. She was eager to see the results from the study, as she often wondered if this method of delivering instruction was beneficial to students.

Teacher C anticipated the findings of this study for the same reasons as Teachers A and B. Amazingly, it was one of his most collaborative years, closely following the labs and lessons of the other teachers in the study and in his words “finding new energy in this course I’ve taught for seven years.” Even if the study concluded that it did not academically benefit the students, he felt the increased collaboration, instilled to better control the study, did indeed increase the teachers’ pedagogical techniques and was worth the time.

In Teacher D’s response to the survey on co-teaching, she indicated she was apprehensive at first, never having been in a co-taught setting. She was worried about not having a common planning time and confusion over her duties. We learned to discuss at lunch our tactics for our afternoon CT class so we were both clear on who would take the lead on homework review or who the lead instructor was for the day. She was a willing participant, however, hoping to learn some teaching techniques, such as implementing technology and classroom management skills, from her more experienced colleague. In the end, she declared she would participate in this model again if she knew her co-teacher

and had a common planning period. She described it as a positive experience, even though there were struggles in the beginning as each teacher was defining his or her role.

Teacher E, the special education co-teacher, indicated that she loves co-teaching and would teach this course again if she was able to work with Teacher A. She felt that at times she did not contribute much, but she was happy to see how the class worked and felt more confident in being able to help her students navigate this course after experiencing the expectations for herself.

Each educator spoke of wanting to know whether co-teaching affected student achievement and of their efforts to maintain similarities with daily activities between classes to help control the study. It was evident from the responses that all teachers involved gave their best efforts and worked hard to make the study a success. If the study could ascertain whether co-teaching had a strong effect on student achievement, other educators in the school of study noted they would be more willing to participate in this pedagogical technique. Teachers work hard in a co-taught setting, spending numerous hours collaborating and establishing classroom routine. Educators want to know if the student outcomes are substantial enough to merit their extra efforts.

The newness of being a co-teacher worried Teacher D, but the results showed her competence as both a co-teacher as well as an individual teacher. Her lack of experience may have contributed to the fact that the CT class with the special education teacher scored significantly higher than the CT class with two science teachers, but more results are needed before this would be a valid conclusion as years of experience was not analyzed within this study.

Summary of Findings

After multiple analyses, it was evident that the data indicate that co-teaching statistically significantly increases student achievement. However, the Effect Size of less than 10% indicates that there is too weak of an effect size to warrant endorsement of co-teaching in the ninth grade physical science course. What was perhaps most interesting was the finding that the students who benefitted the most in the CT classroom were the unintended beneficiaries of co-teaching, students without IEPs. Although multiple covariates were analyzed, such as gender and free and reduced lunch status, they failed to explain the remaining factors that influenced increased achievement in the co-taught classroom.

Chapter 5: Conclusions, Recommendations, and Implications

This study focused on whether co-teaching affected student achievement. Research on the topic of co-teaching tends to focus on the benefits to the teachers involved in the co-taught classroom. It is rare to find studies investigating whether or not this model actually meets the needs of students and results in higher achievement. This study was tightly controlled by having the same teacher in both co-taught classrooms as well as teaching the same subject alone. The educators involved also indicated in their survey that they were dedicated to providing the best co-taught and single-taught course they could deliver and were committed to helping all students succeed. They faithfully collaborated weekly to provide a consistent experience for all students in every physical science classroom. The results revealed that CT classrooms had statistical significance with respect to enhancing students' achievement at $p < .01$. However, the small Effect Size (8.8%) and therefore minimal impact upon students renders it difficult to justify the thousands of dollars it takes to finance this pedagogy, as well as the extensive planning time needed for collaboration.

It was interesting to note many colleges are embracing co-teaching within the university courses and are finding many benefits to this method of instruction. However, the literature review herein revealed that few researchers have approached this methodology from the viewpoint of whether or not it enhances student achievement. The school of study will use this method to continue gathering information from all co-taught classrooms, not just those within science with the particular teachers involved in this original study. Coe (2002) cautions against making policy on the basis of a single

experiment, stating “confidence in the generality of a result can only follow widespread replication” (How can Knowledge section, para. 3). An increased sample size taught by different special educators and subject certified teachers can determine if the findings of this study are indeed supported by additional data.

A surprise result within this study was that the second-highest scoring classroom was the one led by Teacher D as a single-taught class. Teacher D is the female who was in her fourth year of teaching at the time of the study and the first year in the school of study. A hypothesis as to why the single-taught class scored higher is that the teacher (Teacher D) taught both introductory and regular level physics; she knew exactly what the students needed to know for future physics classes, and she tended to lecture and practice the math more in review sessions; whereas the other teachers were mainly ninth grade physical science teachers and tended to supplement lessons with projects and presentations. Although the labs and main activities were the same across the classrooms in the study, small changes such as methods for review or amount of homework given could have contributed to the difference between achievement scores from class to class.

Another unexpected finding was the group that benefitted the most from the co-taught classroom was the students without IEPs. Co-teaching was established by special education teachers and classroom educators as a means to increase achievement among students with learning disabilities. To discover that the primary beneficiaries of this method are students without IEPs was rather startling and deserves further study in different grade levels of science as well as other subject matters. Schools should be cautioned about using an expensive methodology such as co-teaching as a way to

increase learning for students with IEP's when it was shown to have little effect on this subgroup within the ninth grade science course at the school of study.

In interpreting the results of this study, one needs to consider the approach of the co-taught classes. In the co-taught class with the special education teacher, the teachers agreed that the science certified teacher would complete 100% of the lesson design and teaching, including modifications. The co-taught class with the two science certified teachers had a similar approach with a varying execution, alternating the lead teacher in the One Teach/One Assist method described earlier. Perhaps the increased result could be viewed as the old marriage adage: Marriage is not 50/50, it is 100/100, meaning both partners need to give 100%. The special education teacher gave 100% of her skill, namely redirecting, refocusing, and re-teaching. She was learned in the practice of co-teaching and directly tuned in to how she could re-teach and reinforce the material. The science co-teacher gave 100% in the 50% of the time that she was delivering education; both science teachers worked 100% of the time, but it was always on instruction, lesson design, and assessing students. There was not truly an additional focus on the needs of the IEP students simply because the experience of the two teachers was to focus on the class as a whole. One cannot negate the special education teacher's vast experience as a co-teacher. Her techniques were obviously valuable even though she had no previous experience with the course "Force and Motion."

As a result of this study, recommendations for future studies are warranted. The researcher intends to continue collecting data in subsequent classes since funding for co-teaching has been allocated for at least one more academic year. Other possible

covariates not present in this study should be considered, although they may be difficult to collect. For example, how much time did the students in the second hour class (CT with special educator) spend on homework? Homework completion averages would be easy to include in the study, although these scores may be skewed due to factors outside the teacher's control (how many students copied the homework from others, how many falsely report number of minutes spent on homework, etc.). Another covariate may include how many students were new to the district and school of study as opposed to how many entered the district as ninth graders and were not used to the rigors of this district. Still yet, one could study whether socio-economic status of the students influences their performance in the ST or CT classroom. The time of day could have influenced the results, noting that the co-taught class with the special education instructor occurred at 9:30 AM whereas the co-taught class with the second science teacher was at the end of the day (1:30PM), a notoriously difficult time slot to keep students focused and on task.

The conclusion of the researcher is that co-teaching had a moderately meaningful effect on students without IEPs as indicated by the Pearson Correlation Coefficient of 0.56, even though these students were not the catalyst for creating the pedagogical approach of co-teaching. Co-teaching had a minimal effect on student achievement for those with an IEP and should only be used sparingly in conjunction with other methods of support so as to increase the total effect size of all interventions. Hattie (2009) authored a text synthesizing the results of over 800 meta-analyses relating to student achievement. The influence in the teacher domain that produced the highest effect was

providing formative evaluations. When educators establish the objectives before the beginning of a unit and create benchmarks throughout, students increased nearly 1 standard deviation. Likewise, microteaching, a teaching technique usually used with student teachers, also has a large effect size of .88. Microteaching involves videotaping a lesson and then debriefing with the teacher to analyze the teaching techniques. Co-teaching could combine with microteaching and/or purposeful use of formative evaluations to increase the effect size on students with IEP's. Schools struggling with a low budget should investigate other models to use instead of co-teaching.

Although the data are certainly intriguing and lead to further questions, statistical analyses performed by regression analysis and repeated measures ANOVA indicate there is simply not a large enough effect size to warrant increasing funding for this model of teaching for the benefit of students with IEPs. Statistical significance was definitely present, but the consistently weak effect size indicates co-teaching in the ninth grade physical science class does not have a meaningful effect on student achievement. The recommendation would be to continue this study into the next school year, since funding has already been allocated for five more CT classes with different educators. Through additional studies, it may be possible to definitively determine that co-teaching is indeed <u>not</u> worth the thousands of dollars it costs in a weak attempt to leave no child behind.

References

Arndt, K., & Liles, J. (2010). Preservice teachers' perceptions of co-teaching: A qualitative study. *Action in Teacher Education, 32*(1), 15-25. Retrieved from EBSCOhost.

Billingsley, B. S. (2004). Promoting teacher quality and retention in special education. *Journal of Learning Disabilities, 37*, 370-376.

Blakemore, H. (2012). Emergent teacher-researchers: A reflection on the challenges faced when conducting research in the English classroom. *English Teaching: Practice and Critique*, 11(2), 59-69.

Christianakis, M. (2008). Teacher research as a feminist act. *Teacher Education Quarterly, 35*(4), 99-115.

Cochran-Smith, M. , & Lytle, S. L. (1993). *Inside outside: Teacher research and knowledge.* New York: Teachers College Press.

Coe, R. (2002). It's the effect size, stupid: What effect size is and why it is important. *Education On-line*. School of Education, University of Durham, 12 Sept. 2002. Web. 2 Dec. 2012. <http://www.leeds.ac.uk/educol/documents/00002182.htm>.

Conderman, G. (2011). Methods for addressing conflict in co-taught classrooms. *Intervention in School & Clinic, 46*, 221-229.

El-Haj, A T., & Rubin, B. C. (2009). Realizing the equity-minded aspirations of detracking and inclusion: Toward a capacity-oriented framework for teacher education. *Curriculum Inquiry, 39,* 435-463. doi:10.1111/j.1467-873X.2009.00451.x

Eick, C. J., Ware, F. N., & Jones, M. T. (2004). Co-teaching in a secondary science methods course: Learning through a co-teaching model that supports early teacher practice. *Journal of Science Teacher Education, 15*, 197-209.

Emdin, C. (2008). The three C's for urban science education. *Phi Delta Kappan, 89*, 772-775.

Friend, M., Cook, L., Hurley-Chamberlain, D., & Shamberger, C. (2010). Co-teaching: An illustration of the complexity of collaboration in special education. *Journal of Educational & Psychological Consultation, 20*(1), 9-27.

Goldstein, M. (2012). Studying teacher moves. *Education Next*, *12*(1), 22-28.

Gunawardena, S., Weber, R., & Agosto, D. F. (2010). Finding that special someone: Interdisciplinary collaboration in an academic context. *Journal of Education for Library & Information Science, 51*, 210-221.

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. New York: Routledge.

Honigsfeld, A., & Dove, M. (2008). Co-teaching in the ESL classroom. *The Delta Kappa Gamma Bulletin, 74*(2), 8-14.

Jones, B. F., Wuchty, S., & Uzzi, B. (2008). Multi-university research teams: Shifting impact, geography, and stratification in science. *Science, 322,* 1259-1262.

Kohler-Evans, P. A. (2006). Co-teaching: How to make this marriage work in front of the kids. *Education, 127,* 260-264.

Kusnick, J. (2008). Teaming up for better teaching. *Science Scope, 31*(8), 52. Retrieved from EBSCOhost.

Loiacono, V., & Valenti, V. (2010). General education teachers need to be prepared to co-teach the increasing number of children with autism in inclusive settings. *International Journal of Special Education, 25*(3), 24-32.

McDuffie, K. A., Mastropieri, M. A., & Scruggs, T. E. (2009). Differential effects of peer tutoring in co-taught and non-co-taught classes: Results for content learning and student-teacher interactions. *Exceptional Children, 75,* 493-510.

McFall, R.M., & McDonel, E.C. (1986). The continuing search for units of analysis in psychology: Beyond persons, situations, and their interactions. In R.O. Nelson & S.C. Hayes (Eds.). *The conceptual foundations of behavioral assessment* (pp. 201-241). New York: Guilford.

Meier, Scott T. (2008). *Measuring Change in Counseling and Psychotherapy*. New York: The Guilford Press.

Mervis, J. (2007). A new twist on training teachers. *Science, 316*, 1270-1277.

Milne, C., Scantlebury, K., Blonstein, J., & Gleason, S. (2011). Co-teaching and disturbances: Building a better system for learning to teach science. *Research in Science Education, 41,* 413-440.

Murawski, W. W. (2005). Co-teaching in the inclusive classroom: Working together to help all your students find success. Bellevue, WA: Bureau of Education and Research.

Murawski, W. W., & Dieker, L. (2008). 50 ways to keep your co-teacher. *Teaching Exceptional Children, 40*(4), 40-48.

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 115, Stat. 1425 (2002).

Otero, V., Pollock, S., & Finkelstein, N. (2010). A physics department's role in preparing physics teachers: The Colorado learning assistant model. *American Journal of Physics, 78,* 1218-1224. doi:10.1119/1.3471291

Owens, K. D. (2000). Scientists and engineers in the middle school classroom. *Clearing House, 73*(3), 150. Retrieved from EBSCOhost.

Peters, E., & Johnson, T. (2006). Thriving in the co-taught classroom. *Science Scope, 30*(4), 56. Retrieved from EBSCOhost.

Rehling, L., & Lindeman, N. (2010). Vive la différence: What we learn from each other by teaching together. *Business Communication Quarterly, 73,* 91-96.

Robins, J. (2005). Beyond the bird unit. *Teacher Librarian, 33*(2), 8-19.

Roy, K. (2006). Collaborating safely. *Science Scope, 30*(4), 64.

Salkind, N. J. (2008). *Statistics for people who (think) they hate statistics* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Sileo, J. M., & van Garderen, D. (2010). Creating optimal opportunities to learn mathematics. *Teaching Exceptional Children*, *42*(3), 14-21.

Smith, J. M., Edwards, P. M., & Raschke, J. (2006). Using technology and inquiry to improve student understanding of watershed concepts. *Journal of Geography*, *105*, 249-258.

Tobin, K., & Roth, W-M. (2005). Implementing co-teaching and cogenerative dialoguing in urban science education. *School Science & Mathematics, 105*, 313-322.

Walen-Frederick, H. (2012). Help Sheet for Reading SPSS Printouts. Retrieved from http://www.psych.iupui.edu/capstone/data/enter_data.htm.

Weiss, M. P. (2004). Co-Teaching as science in the schoolhouse: More questions than answers. *Journal of Learning Disabilities*, *37*, 218-223.

Weiss, M. P., & Lloyd, J. W. (2002). Congruence between roles and actions of secondary special educators in co-taught and special education settings. *The Journal of Special Education*, *36*, 58–68.

Weiss, C., & Sosulski, K. (2003). Quantitative Methods of Social Sciences. Retrieved from http://ccnmtl.columbia.edu/projects/qmss/samples_and_sampling/types_of_sampling.html

Zigmond, N. (2006). Reading and writing in co-taught secondary school social studies classrooms: A reality check. *Reading & Writing Quarterly*, *22*, 249-268.

Appendix A

Common Assessment

Force and Motion

1. Make a position vs. time graph from the following data:

Time (s)	Position (m)
1	4
2	8
5	20
7	28
8	32
10	40
12	48

Use the position vs. time graph you just created to answer the following questions.

2. What is the slope of the graph? Show work and units!

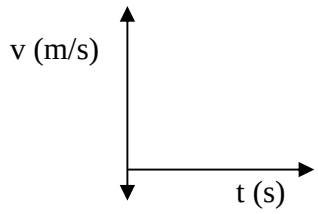
ans:_____

3. Describe the motion of the object in a complete sentence.

_____

_____

4. Sketch a qualitative velocity vs. time graph from this position vs. time graph.



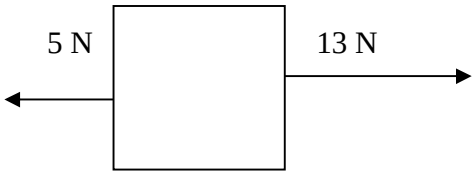
Helpful Equations:

$v = \Delta x/\Delta t$	$a = \Delta v/\Delta t$	$F_{net} = ma$

5. You are in a car that goes from 0m/s to 10m/s in 5 seconds. What is your acceleration? Show work and units!!

ans:_____

6. What is the net force for the following box? Show work and units!!



7. In what direction will the box move?

_____

8. If the mass of the box above is 2kg, what is its acceleration? Show work and units!!

ans:_____

9. A science class puts wide wheels onto a small cart and lets it roll down an inclined ramp and then across the floor. They measure the distance the cart travels. The investigation is repeated using the same cart but this time fitted with narrow wheels.

What is the independent variable in this experiment?
_____

What is the dependent variable in this experiment?
_____

What must be held constant in this experiment?
_____

What is the relationship being studied in this experiment?
_____

Appendix B

Interview Questions

Co-Teaching Interview Questions

1. What are your areas of certification?

2. In which courses have you co-taught?

3. What concerns (if any) did you have about co-teaching?

4. What were the positive outcomes of your co-teaching situation in this semester?

5. What issues arose during your co-teaching situation? Were the issues resolved, and if yes, what methods did you use to resolve them?

6. Under what circumstances would you agree to co-teach again?

7. Comments/Suggestions/Observations:

Appendix C

Tables C1-C13

Table C1
Teacher A: Hr 2 Co-Taught 1 Science/ 1 Special Education (Teacher E)

	(n)	M (Pre)	M (Post)	D (Difference)
	19	**36.5**	**80.8**	**44.3**
Ethnicity				
White	14	39	80.6	41.6
Black	3	23	69	46
Asian	2	39.5	100	60.5
Mixed	0			
Hispanic	0			
Gender				
M	9	32.9	77	44.1
F	10	39.8	84.2	44.4
Free & Reduced Lunch				
Y	2	36.5	76	39.5
N	17	36.5	81.4	44.8
IEP				
Y	8	33.1	68.5	35.4
N	11	39	89.7	50.7
Non-Resident of District				
Y	0			
N	19	36.5	80.8	44.3

Table C2

Teacher A: Hr 7 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	14	**46.29**	**77.64**	**31.4**
Ethnicity				
White	5	55.2	85.8	30.6
Black	6	37.3	66.7	29.3
Asian	1	76	100	24
Mixed	1	24	72	48
Hispanic	1	48	86	38
Gender				
M	9	46.3	75.6	29.2
F	5	46.2	81.4	35.2
Free & Reduced Lunch				
Y	4	40.8	69.8	29
N	10	48.5	80.8	32.3
IEP				
Y	3	36.7	72.7	36
N	11	48.9	79	30.1
Non-Resident of District				
Y	1	38	90	52
N	13	46.9	76.7	29.8

Table C3

Teacher A : Hr 8 CT 2 Science Teachers (Teachers A and D)

	(n)	M (Pre)	M (Post)	D (Difference)
	18	**43.56**	**77.22**	**33.7**
Ethnicity				
White	11	44.5	76.8	32.4
Black	5	44	76.6	32.6
Asian	0			
Mixed	1	34	86	52
Hispanic	1	41	76	35
Gender				
M	9	39.7	73.2	33.6
F	9	47.4	81.2	33.8
Free & Reduced Lunch				
Y	5	36.2	79.2	43
N	13	46.4	76.5	30.1
IEP				
Y	5	45.4	69.8	24.4
N	13	42.8	80.1	37.2
Non-Resident of District				
Y	0			
N	18	43.6	77.2	33.7

Table C4

Teacher B: Hr 7 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	15	**35.6**	**67.1**	**31.5**
Ethnicity				
White	8	47.4	76	28.6
Black	7	22.1	56.9	34.7
Asian	0			
Mixed	0			
Hispanic	0			
Gender				
M	9	35.1	68.8	33.7
F	6	36.3	64.5	28.2
Free & Reduced Lunch				
Y	5	25.4	48.4	23
N	10	40.7	76.4	35.7
IEP				
Y	2	32.5	65.5	33
N	13	36.1	67.3	31.2
Non-Resident of District				
Y	1	21	14	-7
N	14	36.6	70.9	34.2

Table C5

Teacher B: Hr 8 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	17	**36.7**	**66.4**	**29.6**
Ethnicity				
White	8	46.6	76.3	29.6
Black	5	22.8	44.2	21.4
Asian	2	32.5	84.5	52
Mixed	2	36	64	28
Hispanic	0			
Gender				
M	7	40.4	70.9	30.4
F	10	34.1	63.2	29.1
Free & Reduced Lunch				
Y	7	30.4	59.3	28.9
N	10	41.1	71.3	30.2
IEP				
Y	1	24	45	21
N	16	37.5	67.7	30.2
Non-Resident of District				
Y	2	24	36.5	12.5
N	15	38.4	70.3	31.9

Table C6
Teacher C: Hr 1 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	18	**45.8**	**71.6**	**25.7**
Ethnicity				
White	12	45.8	71.7	25.9
Black	3	43.7	71.3	27.7
Asian	2	60.5	79.5	19
Mixed	1	24	55	31
Hispanic	0			
Gender				
M	9	49.3	74.7	25.3
F	9	42.3	68.4	26.1
Free & Reduced Lunch				
Y	5	47.4	69	21.6
N	13	45.2	72.5	27.3
IEP				
Y	3	59.7	74.7	15
N	15	43.1	70.9	27.9
Non-Resident of District				
Y	0			
N	18	45.8	71.6	25.7

Table C7

Teacher C: Hr 3 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	9	**44.11**	**72.11**	**28**
Ethnicity				
White	3	48.3	80.7	32.3
Black	3	40.3	56.3	16
Asian	2	32.5	72.5	40
Mixed	1	59	93	34
Hispanic	0			
Gender				
M	3	50.7	81.7	31
F	6	40.8	67.3	26.5
Free & Reduced Lunch				
Y	1	52	62	10
N	11	43.1	72.8	29.7
IEP				
Y	2	52	76	24
N	10	43.1	71.1	28
Non-Resident of District				
Y	0			
N	9	44.1	72.1	28

Table C8

Teacher C: Hr 4 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	15	**35**	**65.8**	**30.8**
Ethnicity				
White	10	35.5	68.7	33.2
Black	5	34	60	26
Asian	0			
Mixed	0			
Hispanic	0			
Gender				
M	8	36.1	61.3	25.1
F	7	33.7	71	37.3
Free & Reduced Lunch				
Y	5	27.8	62	34.2
N	10	38.6	72.8	34.2
IEP				
Y	5	38	76	38
N	10	33.5	71.1	37.6
Non-Resident of District				
Y	1	21	21	0
N	14	36	71.9	35.9

Table C9

Teacher C: Hr 5 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	16	**35.31**	**64.88**	**29.6**
Ethnicity				
White	6	35	69.7	34.7
Black	6	27	54.5	27.5
Asian	2	62.5	84.5	22
Mixed	2	34	62	28
Hispanic	0			
Gender				
M	7	35	66.1	31.1
F	9	35.6	63.9	28.3
Free & Reduced Lunch				
Y	6	59	57.5	-1.5
N	10	43.3	69.3	26
IEP				
Y	2	48.5	69	20.5
N	14	43.8	64.3	20.5
Non-Resident of District				
Y	2	31	56.5	25.5
N	14	35.9	66.1	30.1

Table C10

Teacher C: Hr 7 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	16	**36.56**	**61.25**	**24.7**
Ethnicity				
White	10	35.4	61.1	25.7
Black	5	34.4	55.8	21.4
Asian	1	59	90	31
Mixed	0			
Hispanic	0			
Gender				
M	7	45.4	72.6	27.1
F	9	29.7	52.4	22.8
Free & Reduced Lunch				
Y	6	35.7	62	26.3
N	15	35.5	59.3	23.8
IEP				
Y	3	26.3	46	19.7
N	13	38.9	64.8	25.8
Non-Resident of District				
Y	1	52	90	38
N	10	37.1	72.8	35.7

Table C11

Teacher D: Hr 5 Single-Taught

	(n)	M (Pre)	M (Post)	D (Difference)
	17	**44.1**	**78.7**	**34.6**
Ethnicity				
White	10	47.5	83.4	35.9
Black	3	27.3	62.7	35.3
Asian	1	72	100	28
Mixed	0			
Hispanic	3	40.3	72	31.7
Gender				
M	9	47.4	83.3	35.9
F	8	40.4	73.5	33.1
Free & Reduced Lunch				
Y	7	34.3	75.7	41.4
N	10	51	80.8	29.8
IEP				
Y	2	51.5	91.5	40
N	15	43.1	77	33.9
Non-Resident of District				
Y	0			
N	17	44.1	78.7	34.6

Table C12

Group Data: All single-taught sections

	(n)	M (Pre)	M (Post)	D (Difference)
	137	**39.8**	**69.4**	**29.5**
Ethnicity				
White	72	43.5	73.6	30.1
Black	43	30.8	58	27.3
Asian	11	53	84.7	31.7
Mixed	7	35.3	67.4	32.1
Hispanic	4	42.3	75.5	33.3
Gender				
M	68	42.5	72.4	29.9
F	69	37.1	66.3	29.2
Free & Reduced Lunch				
Y	46	33.6	62.7	29.1
N	91	43	72.7	29.8
IEP				
Y	21	41.7	68.7	27
N	116	39.5	69.5	30
Non-Resident of District				
Y	8	30.3	52.6	22.4
N	129	40.4	70.4	30

Table C13

Group Data: All co-taught sections

	(n)	M (Pre)	M (Post)	D (Difference)
	37	39.9	79.1	39.1
Ethnicity				
White	25	41.4	78.9	37.5
Black	8	36.1	73.8	37.6
Asian	2	39.5	100	60.5
Mixed	1	34	86	52
Hispanic	1	41	76	35
Gender				
M	18	36.3	75.1	38.8
F	19	43.4	82.8	39.4
Free & Reduced Lunch				
Y	7	36.3	78.3	42
N	30	40.8	79.2	38.4
IEP				
Y	13	36.8	69	32.2
N	24	34.8	84.5	49.8
Non-Resident of District				
Y	0			
N	37	39.9	79.1	39.1