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Does the Jigsaw Method Improve Student Conceptual Knowledge in Physical Science?

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DOES THE JIGSAW METHOD IMPROVE STUDENT CONCEPTUAL KNOWLEDGE IN PHYSICAL SCIENCE?

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I would like to dedicate my thesis to my parents, the late Haywood Morgan, Sr. and Brenda H. Morgan, thank you for your love and support and for instilling in me an inner desire to succeed and be “The Best of the Best!” To my children, Brenton and Brooke Morgan, thank you for being understanding and patient with me as you made the necessary sacrifices that allowed me to pursue a Master’s degree. To my siblings, Haywood Morgan, Jr. and April M. Marshall, my extended family and devoted friends, thank you for your continued support and encouraging words during the moments when I needed them the most. I love and appreciate all of you.

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ABSTRACT

The goal of my research is to determine if the Jigsaw Method has an effect on student conceptual knowledge of Physical Science in a classroom setting that predominately uses cooperative learning. The assessment instruments that were given in pretest and posttest format to assess student knowledge were the Matter Concept Inventory (MCI) and Edusoft Assessments. The research study group consisted of two sections of a ninth grade Physical Science class (N = 42) in a rural high school in Louisiana. As an intervention prior to the study, students were introduced to working in cooperative learning groups. The students in the experimental group used the jigsaw method as a cooperative learning strategy to acquire knowledge of content material. The information acquired was redelivered to their peers in small group settings. Due to mandates that required that cooperative learning be used in all classes, the control group members learned the material as a small group, but the information was divided and presented to the class a whole. The data was collected and analyzed using independent t-test analysis. The result did not prove that the jigsaw method solely increased student conceptual learning of Physical Science. This study did however show that some form of cooperative learning does increase students' conceptual understanding of Physical Science.

INTRODUCTION

Can I just teach my students? This is a question that many highly qualified teachers constantly ask. These teachers have knowledge of the content that they are teaching; they understand the student population, as well as instructional strategies to teach the students to successfully master the content. Why are these teachers frustrated and posing this question to colleagues, administrators, district personnel, and political leaders and activists? The primary goals of education and the demands of teaching have changed drastically over the past decades. Teachers and students are required to perform at more rigorous levels. The traditional classroom and the present day classroom environments are vastly different; however teachers are still expected to deliver instruction that produces learning and achievement.

Traditionally, the emphasis in education was delivery of content to students. The teacher would introduce a concept during the class period. The students would be assigned the initial tasks of defining and studying vocabulary words and outlining the chapters. The students would receive the notes in a lecture format, which included the teacher reading and explaining the information to the class, as the students frantically took notes being written on the board or overhead transparencies. The students would be led to complete or review a few example problems, and then they practiced working assigned exercises in class, as the teacher circulated and provided academic feedback to individual students. The students took responsibility for their academic learning process by completing assigned sets of problems or section reviews for homework. At the beginning of class the next day, homework was reviewed and the process repeated itself, with the teacher introducing new material. This cycle was repeated until the teachers and the students had covered all of the material in the chapter. At that point, the chapter review and practice test were assigned and reviewed over the course of a day or so. Finally, an

assessment would be administered to gauge student leaning and levels of achievement. This systematic process of events would continue for the entire school year, until all of the topics in the curriculum had been covered.

Most students mastered the information and were successful on their assignments and assessments, if they followed the process described above. The teacher did not have to teach students how to think, speak, listen or work in cooperative groups with their peers. Cooperative learning was very minimal, if any. When cooperative learning did occur, it was prompted by the teacher's permission to work with a partner. The classroom was a very structured and orderly learning environment. The teacher did the majority of the talking. The students did the listening, as they sat in desks that were arranged very orderly in straight rows. The classroom was silent and students spoke when called upon or if they were given permission to ask a question about the material being taught. The lesson format was predictable for both the teacher and students, as it pertained to the classroom instruction, procedures and levels of teacher to student and student to student interaction.

Today's classroom looks and sounds extremely different from the traditional classrooms of the past. The teacher does less talking and the students are active participants in their learning process. The teacher is a facilitator of the leaning process. The teacher is expected to become a master of the implementation of various cooperative grouping learning strategies, as well as various instruction strategies that relate to the content being taught. The concepts of subject matter are expected to be presented in a manner that allows the teacher to teach subject specific instructional strategies between topics and concepts. Teachers are also required to teach analytical, practical, and creative and research based thinking over the duration of multiple

lessons. Teachers should also be skillful in planning and fostering learning opportunities that allow students to make real world connections to the content covered.

Teachers are also required to teach students how to be competent readers, despite what the students' reading standardized assessment scores. Writing is no longer isolated to the parameters of the English classrooms. It is also an expectation that teachers teach students how to write competently in all content areas. Students are taught to use graphic organizers to present and organize their ideas, with the goal of making connections between vocabulary words, the content and real world connections that will allow them to become competent writers. Students are encouraged and trained to read and explore the text to decipher word meanings, identify relevant information, cite textual evidence and justify their answers in well written constructive response formats.

Students have vital roles that require them to work independently of direct teacher instruction. Success in their learning process is dependent on their abilities to do so as they work with peers. They are the expected to consistently analyze, interpret, and discuss content material in a cooperative learning manner with their peers, as the teacher facilitates their learning process. Students are also expected to solve problems by using the skills of abstractions, categorizing, improving solutions and identifying relevant and irrelevant information. There is a constant roar of academically driven conversations between students, which afford them the opportunity to embark upon positive exploration, discoveries and experiences that promote academic achievement and success. The cooperative learning opportunities allow students to provide academic feedback to each other, as they develop competencies and confidence in the areas of speaking and listening, as they explore and discuss concepts.

Why all of the changes? The answer is simple, but the magnitude and implementation of the process is very complex. These goals and expectations fall under the "Common Core Umbrella" and have been deemed necessary to prepare students to be college and career ready upon graduating from high school. Countries throughout the world are constantly pursuing research in regards to learning techniques with the framework of education programs (Turacoglu *et al*., 2013). Cooperative learning is one of the most widely employed methods of instruction in elementary and secondary classrooms. Traditional methods of instruction do not offer students activities, which lead them to think, search and engage both mentally and physically in their learning process. Students recognize the importance of working together as a team to solve a problem complete a task, or accomplish a desired goal (Parker, 1985).

Cooperative learning fosters an environment that allows students to take control of their learning, improve learning and retention on cognitive and developmental levels (Oludipe and Awokoy, 2010). All students can benefit from cooperative learning activities. "In the process of helping, the helper is helped most." (Parker, 1985). Both "low" and "high" achievers benefit from cooperative learning. "Low achievers benefit from the help of their peers' explanation and abilities to present material in more understandable manner (Parker, 1985). "High achievers" benefit because they are able to effectively think about and clarify their thoughts by explaining material to their peers at various levels (Parker, 1985).

There are various cooperative learning strategies that are used in classrooms today. Some of these strategies are Turn and Talk, Think-Pair-Share, Reciprocal Teaching, Round Robin, Pairs Check and the Jigsaw Method. Of these cooperative learning methods, the technique that is most frequently preferred for the theoretical studies of science courses and has been proven to produce results at the end of many applications is the Jigsaw Method (Turacoglu *et al*., 2013).

The Jigsaw Method was developed by Erik Aronson and his colleagues at the University of Texas and the University of California in Santa Cruz (Doymus, 2007). The jigsaw is a cooperative learning technique that enhances learning by creating a system of accountability for students, as it fosters interdependence among group members. Students are given a specific group of well-designed tasks by the teacher. Students facilitate their own learning process by completing activities assigned by the teacher. When working in a jigsaw classroom students are members of two different groups, a home group and an expert group. Initially the students meet in the home groups to assign a portion of the required material to each student to learn. The home groups break apart, like pieces of a jigsaw puzzle and students convene in expert groups formed by members of other home groups. Each expert group focuses on a different topic. While in the jigsaw expert groups, students learn and discuss the material to gain knowledge of the concepts. The students then return to their home groups to teach the material to the rest of their group members (Doymus, 2007; Colosi and Zales, 1998; Mattingly and VanSickle, 1991). Figure 1 gives a pictorial view of jigsaw cooperative learning structure looks like. Researchers underlined that the jigsaw is an effective cooperative learning technique that promotes positive attitudes and interest in the learning issues, development of communication skills between student and also higher learning achievement in science (Lazarowitz et al., 1985; Colosi and Zales, 1998; Doymus, 2008; Eilks, 2005; Young et al., 1997).

The transition from a traditional classroom to a "Common Core" classroom is difficult for some educators to embrace and implement. The lack of implementation is not because the teachers do not want students to be successful. The issues are linked to teacher buy-in and lack of sufficient training in the area of cooperative learning. As the goals of education change, teachers are required to transform their teaching styles as the various education reforms are

mandated. The problem that most teachers voice concerns about is that before they can comfortably learn and implement the components of an education reform mandate, a new mandate is introduced and implemented. This cycle is the root of frustration for educators who do not feel properly trained or confident in their ability to successfully implement the techniques in their classes. The purpose of this research is to determine if the Jigsaw Method has an effect on student conceptual knowledge of Physical Science in a classroom setting that predominately uses cooperative learning.

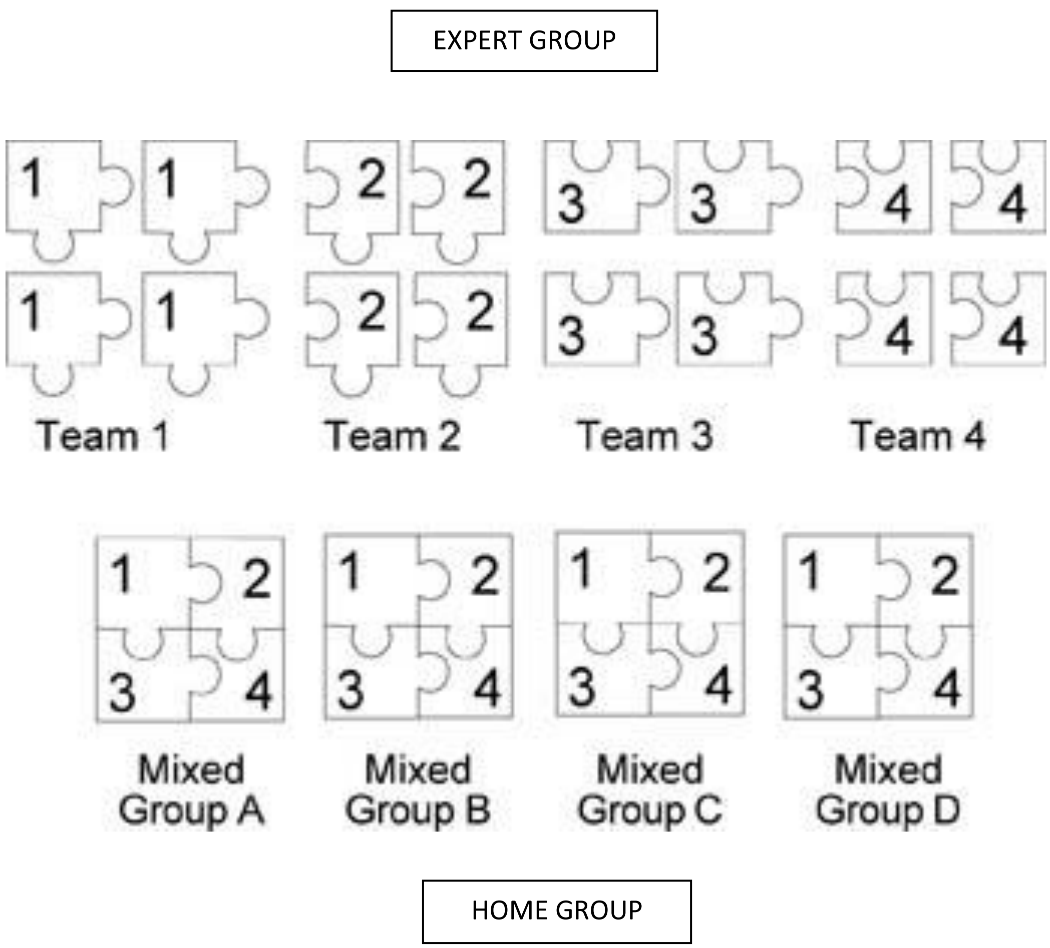

Figure 1. Pictorial representation of Jigsaw Method home and expert groups

LITERATURE REVIEW

In most chemistry classes, primary, secondary and college levels, traditional pedagogical methods are used and students are passive learners (Doymus, 2007). In some classes writing is viewed and incorporated as an active learning activity (Doymus, 2007). The value of cooperative learning is not realized in many science classes due to the nature of the content and the teacher's ability to effectively apply the various strategies. Well-designed lessons taught in a cooperative learning manner, enable more effective, productive, and quick teaching and learning activities, so that each student from the fastest to slowest learner can make a contribution to learning (Doymus, 2007).

In 2004 – 2005, Kemal Doymus investigated the effectiveness of cooperative learning methods compared with the traditional methods of lecture instruction on student academic achievement in a post-secondary general chemistry course (Doymus, 2007). The topic covered during the instructional research period was phases of matter and one component phase diagrams. The control group was taught in a traditional lecture method by the researcher and the experimental group used a combination of jigsaw cooperative learning methods.

The experimental group participated in two phases of the jigsaw cooperative learning during the study. The experimental group was divided into 3 – six member expert groups representing the three phases of matter. Students were randomly grouped in the solid (SG), liquid (LG) and the gas (GG) expert groups. The students learned, the material in the expert groups then prepared and presented information to the whole class pertaining to the assigned states of matter. After the initial presentations, new groups were formed where the students completed new activities that integrated the earlier topics. The students then prepared, and presented additional material to the whole class. Each group consisted of members from the initial expert

groups. The following groups were formed: solid-liquid (SLG), solid-gas (SGG), liquid-gas (LGG), and triple point (TPG).

The two assessments administered during the study were the Chemistry Achievement Test (CAT) and the Phase Achievement Test (PAT). The CAT was given in a pre/posttest format and the PAT was given to assess student knowledge of phase diagrams after the second round of home group presentations. CAT pretest results showed that the control and experimental groups were statistically the same prior to the treatment. CAT posttest results indicated that there was a significant difference in the chemistry achievement between the control group that received traditional lecture and the experimental group that utilized the jigsaw cooperative learning instruction. The scores in the experimental group were significantly higher than those in the control group after the intervention. The results of the PAT module (I-IV) showed that there was a significant difference in the two groups as it relates to the topic of phase diagrams. The mean scores in the experimental group were higher than those of the control group on modules (I-IV).

In most prior studies, jigsaw cooperative teaching and learning methods were found to be no more effective in terms of academic achievement than traditional instruction (Doymus, 2007). Doymus found in this study found that the jigsaw had a positive effect on learning phase diagrams in an undergraduate chemistry class (Doymus, 2007).

Chang and Mao conducted a study in Taiwan that included 770 9^{th} grade and junior high students from 20 classrooms taught by 8 different teachers. This study is unique because most of the research in cooperative learning that emphasized overall students' achievement, but few have studied the impact of cooperative learning strategies at different levels of cognitive domains of Bloom's Taxonomy (Chang and Mao, 1999; Humphrey *et al.*, 1982; Lazarowitz *et al.*, 1994;

Okebukola, 1985). The goal of the Chang and Mao study was to investigate the impact of using cooperative learning strategies vs. traditional teaching methods on students in earth science achievement, with an emphasis on knowledge-comprehension-and application level objectives of cognitive domains, as defined by Bloom's Taxonomy (Chang and Mao, 1999). The emphasis at the different cognitive levels of Bloom's Taxonomy provided evidence that align with the thinking and problem solving skills within the Common Core structure that require students to perform application based tasks.

The research participants and teachers in this study received prior practice, as it pertains to the skills necessary for successful implementation of the study. Teachers attended a 15 hour training workshop on cooperative learning required for the implementation of the specific activities conducted during this research. Participating students practiced cooperative learning strategies on topics other than the treatment content (Chang and Mao, 1999).

The control group was instructed in a traditional/lecture discussion manner, centered on the teacher providing students with instruction that included clear and detailed explanations. The experimental group received cooperative learning instruction, based on the jigsaw method. The instruction time allotment, content resources, and activities were the same for both groups. The cooperative learning strategies that were employed in the experimental group included a modified group investigation method (Sharan and Sharan, 1992).

The students formed 6 member groups to learn topics being taught using group inquiry and discussion. The students discussed concepts and clarified their own ideas with each other. The students worked on projects and/or analyzed and generated data from teacher directed hands-on activities. Finally, the students made presentations of their group's work and communicated relevant material to their peers in a whole group format. The key feature of the

teaching method was cooperative learning, including small group discussions, students' collaborative efforts and group presentations (Chang and Mao, 1999).

Data and analysis of pretest showed no significant difference in the homogeneity of the groups prior to the treatment. Posttest results showed no statistically significant differences between the groups as it pertains to overall earth science achievement or achievement at the knowledge and comprehension levels of cognitive domains of Bloom's Taxonomy (Chang and Mao, 1999). Test results did indicate that the experimental group had significantly higher achievement on the test items that related to the application cognitive domain, as defined by Bloom's Taxonomy. This study is consistent with other studies that proved science achievement among pupils at higher cognitive level of Bloom's Taxonomy occurs when employing cooperative learning related strategies in the classroom (Chang and Barufaldi, 1999; Ertepinar and Geban, 1996).

Tarhan and Sesen conducted a study that investigated the effectiveness of Jigsaw cooperation learning instruction on first-year undergraduates' understanding of acid and base theories (Tarhan et al., 2012). Students in the experimental group were introduced to the concepts using cooperative learning and the jigsaw method. Students in experimental groups were assigned to expert groups that studied portions of acid-base theories. Students made task distributions under the guidance of the instructor and they studied their subtopics outside of class. The students returned to the home groups the next class period and taught the subtopic information to the rest of the group. The results of this study revealed that jigsaw cooperative learning instruction is successful in improving students' conceptual knowledge of acid and base theories when compared to a control group that received a traditional lecture format.

(Tarhan et al., 2012). These findings were consistent with earlier studies which revealed that the jigsaw method leads to higher achievement (Doymus, 2008; Eilks, 2005).

METHODS

Research Sample

The research sample was composed of the students in two ninth grade Physical Science classes at a rural high school in Louisiana. The student population at the school is 71% African American, 28% Caucasian, and 1% Hispanic. The control group consisted of 21 participants and the experimental group consisted of 21participants. The students who participated in the study were volunteers. They received and signed an informed consent waiver that explained the conditions of the study and required parental permission. Classes were held five days a week for 50 minutes each day. Both the control and the experimental groups used cooperative learning strategies. The experimental group used the jigsaw method of instruction. All students were introduced to various literacy strategies, such as annotating, text coding, sketching through the text and reading with a purpose, prior to the units of study. The students were also introduced to and became familiar with the practices of proper etiquette and protocol when working cooperatively in groups.

The assessments used during this study were the Matter Concept Inventory (MCI) and Edusoft assessments. The MCI is a derivative of the Chemistry Concept Inventory (CCI) that was developed by researcher at Arizona State University to target misconceptions that students have pertaining to chemistry. The MCI was designed to assess student misconception at lower grade levels. It is a 30 question multiple choice assessment that covers properties of the states of matter. The Edusoft assessments are assessment tools used by school districts across the nation to monitor and assess student achievement in core content area. The Edusoft Benchmark, Edusoft Unit 3 and Edusoft Unit 4 assessments contained 32, 24, and 36 questions, respectively.

The content covered on these assessments were the periodic table, chemical bonding, solutions and types of reactions.

Design and Procedures

The research study was designed with several factors in mind. The primary factor was to satisfy district and school mandates that were expected as a result of initiatives that the school was participating in. One of those requirements was that “Common Core like” instruction was taking place in all classrooms. The focus of the classroom was mandated to be a student centered learning environment were students were actively working cooperatively in groups, reading and discussing content and thinking and solving problems. The teacher responsibility was to facilitate the students learning process and to provide academic feedback to lead student thinking in a manner that optimized learning. This mandate prevented the control group from being strictly a lecture based class, as is typically done in most of the present studies. The design of the research was specifically and strategically planned to execute and meet all district and school requirements. There were no formal procedures defined in the literature to indicate what specific activities should be used in a Jigsaw classroom.

In this research, the control group and the experimental groups were both given five class periods to prepare presentations for each content unit. Each student received an instructional packet that contained note-taking sheets, graphic organizers, activity worksheets and periodic tables, when applicable. Each group received the same objective(s), guiding questions, and completed the same activities that corresponded to their respective assigned sections. The key difference between the experts in the control and experimental groups was that the experts in the control group collectively presented the material learned to the whole class, whereas the experts in the experimental group presented the material to only their home group members.

There were 5 – 6 groups in both the control and experimental groups. Each control group had 4-5 group members that were grouped homogeneously. The groups in the experimental groups were divided into heterogeneous home groups and homogeneous expert groups of 4-5 members, using Scholastic Reading Inventory (SRI) reading scores. The students with the lower SRI reading scores were assigned the introductory concepts of the chapter. The students with the higher SRI reading scores were assigned the more difficult concepts in the chapter. The group expectations and rubrics were reviewed with the students in practice units, prior to the study. The procedures for the control and the experimental groups were broken down in the following format:

- Day 1:

  Students were assigned to groups and topics were selected. The students also defined their group roles (group leader, recorder, materials manager, spokesperson, and timekeeper). Student packets/handouts were given and explained to the students. The students received guided questions and objectives for each section. The students analyzed the sections assigned as a group by reading, taking notes, identifying relevant information and organizing concepts using literacy strategies that had previously been taught.

- Day 2:

  The students continued to analyze the sections assigned. The students discussed the topic to ensure that all group members understood the content. The students began to design a poster containing relevant information and pictures that summarized the concepts in the sections studied. The poster would serve as a visual aid for their peers when material was presented to the whole class.

- Day 3:

  The students finalized poster designs within respective groups.

- Day 4:

  The students completed an activity pertaining to the assigned topic in small collaborative groups. The activity was selected from curriculum resources or designed by the teacher. The teacher explained the process using the I Do, We Do, You Do model, when applicable. For the activities that weren't applicable to that model, the teacher reviewed the directions with each group. The teacher reviewed the process with the students, provided academic feedback, answered any questions, and encouraged students to work cooperatively in groups. The students verified their answers collaboratively, as the teacher circulated to ensure that student answers were correct.

- Day 5:

  The students practiced presentations within small groups to ensure that they could competently explain their individual assignments. The students provided academic feedback, support and encouragement for each other during this process.

- Days 6 – 10:

  The students in both groups presented the information and facilitated the activities that were completed in their respective groups to their peers, using the I Do, We Do, You Do model. The experts in the control group presented their respective parts of the section to the class, as a whole. In the experimental group, experts presented the material only to the assigned home groups members.

RESULTS AND DISCUSSION

Prior to the treatment, the MCI and Edusoft Benchmark assessments were given to determine if there was any difference in the prior knowledge of the experimental and control groups. An independent t-test found no statistical difference between the mean exam scores in the groups. The statistical mean difference between the groups for the MCI and the Edusoft Benchmark assessments ($p > 0.05$), as represented in Table 1 and Table 2, which is interpreted to indicate that prior to the treatment, the control and experimental groups were from the same homogeneous population of students. After the treatment, test results indicated that there was no significant difference in the learning acquired between the control and experimental groups ($p > 0.05$) for the MCI and Edusoft Benchmark assessments. These results are summarized in Table 1 and Table 2.

Table 1. Comparative Analysis of Pretest and Posttest MCI Scores

Instrument Used	Group (N)	Mean	Standard Deviation	Uncertainty of Mean	p-value
Pretest	Experimental (19)	31.73	10.26	2.35	0.797
	Control (19)	32.58	9.73	2.23	
Posttest	Experimental (19)	40.10	9.46	2.17	0.849
	Control (19)	39.42	12.30	2.82	

Table 2. Comparative Analysis of Pretest and Posttest Edusoft Benchmark Scores

Instrument Used	Group (N)	Mean	Standard Deviation	Uncertainty of Mean	p-value
Pretest	Experimental (21)	34.00	8.41	1.81	0.784
	Control (20)	34.75	8.97	2.00	
Posttest	Experimental (21)	51.71	15.73	3.43	0.278
	Control (20)	57.40	17.34	3.88	

Analysis of pretest results for the Edusoft Unit 3 and Unit 4 assessments proved homogeneity in both groups, prior to the treatment. Independent t-test analyses of the assessment mean values showed that there was not a statistical difference in the control and experimental groups ($p > 0.05$). Posttest results of Unit 3 and Unit 4 assessments, given after the treatment did not show s statistical difference in the control and experimental groups ($p > 0.05$). These results are summarized in Table 3 and Table 4.

A comparative analysis of the learning gains for the control and experimental groups were also conducted for the MCI, Edusoft Benchmark, Edusoft Unit 3 and Edusoft Unit 4 assessments. Learning gains were calculated using the formula, (posttest scores – pretest scores)/ (100 – pretest scores). The results for each assessment showed that there was no statistical difference in the learning gains acquired as a result of the treatment ($p > 0.050$) for each assessment. The data analyses results for these independent t-tests are shown in Table 5.

Table 3. Comparative Analysis of Pretest and Posttest Edusoft Unit 3 Scores

Instrument Used	Group (N)	Mean	Standard Deviation	Uncertainty of Mean	p-value
Pretest	Experimental (17)	35.41	10.33	2.51	0.118
	Control (18)	28.28	15.51	3.66	
Posttest	Experimental (17)	44.47	14.38	3.49	0.498
	Control (18)	47.72	14.13	3.33	

Table 4. Comparative Analysis of Pretest and Posttest Edusoft Unit 4 Scores

Instrument Used	Group (N)	Mean	Standard Deviation	Uncertainty of Mean	p-value
Pretest	Experimental (21)	29.00	11.05	2.41	0.331
	Control (20)	32.05	8.58	1.92	
Posttest	Experimental (21)	41.14	8.91	1.94	0.262
	Control (20)	45.65	15.7	3.50	

Table 5. Comparative Analysis of Learning Gains

Instrument Used	Group (N)	Mean	Standard Deviation	Uncertainty of Mean	p-value
MCI	Experimental (19)	10.47	19.67	4.51	0.912
	Control (19)	9.80	17.27	3.91	
Edusoft Benchmark	Experimental (121)	25.57	28.36	6.19	0.257
	Control (20)	35.11	24.48	5.47	
Edusoft Unit 3	Experimental (17)	13.73	13.73	4.56	0.108
	Control (18)	24.84	24.84	1.01	
Edusoft Unit 4	Experimental (21)	15.93	15.93	2.88	0.411
	Control (20)	20.29	20.29	4.54	

An independent t-test analysis of pretest to posttest scores for each assessment given was conducted separately for the control group and the experimental group. The results of these analyses did indicate that there was acquisition of conceptual knowledge as a result of some aspect of the treatment for the assessments given. There was a statistical difference for each assessment, except the MCI for the control group ($p < 0.05$). The pre to post analysis for the experimental group indicated that there was a significant difference in the conceptual knowledge acquired after the treatment for each assessment ($p < 0.05$). This data is summarized in Tables 6 and Table 7, respectively.

Table 6. Experimental Group Pretest and Posttest Score Analysis

Assessment	Mean	N	Uncertainty of Mean	p-value
MCI Pretest	31.73	19	2.35	0.0013
MCI Posttest	40.10	19	2.17	
Edusoft Benchmark Pretest	34.00	21	1.81	4.90E-05
Edusoft Benchmark Posttest	51.71	21	3.43	
Edusoft Unit 3 Pretest	35..41	17	2.51	0.043
Edusoft Unit 3 Posttest	44.47	17	3.49	
Edusoft Unit 4 Pretest	29.00	21	2.41	0.002
Edusoft Unit 4 Posttest	41.14	21	1.94	

Table 7. Control Group Pretest and Posttest Score Analysis

Assessment	Mean	N	Uncertainty of Mean	p-value
MCI Pretest	32.58	19	2.23	0.065
MCI Posttest	39.42	19	2.82	
Edusoft Benchmark Pretest	34.75	20	2.00	7.38E-06
Edusoft Benchmark Posttest	57.40	20	3.88	
Edusoft Unit 3 Pretest	28.28	18	3.66	3.12E-04
Edusoft Unit 3 Posttest	48.55	18	3.33	
Edusoft Unit 4 Pretest	32.05	20	1.94	2.20E-03
Edusoft Unit 4 Posttest	45.65	20	3.50	

These findings did not prove that the jigsaw method solely increased student conceptual learning of Physical Science. This study did show that some form of cooperative learning does increase students' conceptual understanding of Physical Science. The cooperative learning strategies in this study required students to analyze and interpret textual information in order to identify relevant information, work collaboratively as small groups to achieve a common goal, participate in meaningful academic discussion that facilitated learning and self-reflection, and to

present information learned to others in a logical manner. The effectiveness of cooperative learning strategies in the secondary science classrooms has been supported by empirical evidence (Humphreys et al., 1982; Lazorowitz et al., 1994; Okebuloka & Ogunnniyi, 1984). The results of this study did align with the findings of the previously mentioned studies, in that results indicated that learning was evident in both the control and experimental groups.

CONCLUSION

The present study was conducted to determine if the jigsaw method has an effect on student conceptual knowledge of Physical Science in a classroom setting that predominately uses cooperative learning. The results reflected in the study do not directly show that the jigsaw method increased students' conceptual knowledge, compared to cooperative learning that took place in the control group. Data analyses did not show any significant differences in the posttest scores between the control and experimental groups. The results did indicate that significant positive learning gains did occur in both the control and experimental groups individually (see Table 5). The two groups in this study had a common characteristic that was mandated by the school and district. That characteristic was the requirement that students' academic goals be fostered in environments that promoted a student facilitated learning experience in a cooperative learning manner. This mandate was evident in the design of the control group treatment. Unlike the studies of Doymus, Tehran and Sesan, and Chang and Mao, previously referenced in the literature review, the control group in this study was not taught using a traditional lecture based instructional format with discussions that were teacher facilitated.

Both the control and experimental groups used cooperative learning strategies that consisted of reading, analyzing, and interpreting text to cite relevant information, discussing and clarifying ideas and viewpoints and conveying knowledge of information acquired to peers through speaking and listening skills. The key difference between the control and the experimental group was subtle and it was demonstrated during the final phases of the cooperative learning process. When the experts in the control presented, the students in each group divided the material to ensure that each group member was responsible for presenting information to the class as a whole. When the experts in the experimental groups presented, the knowledge attained

was presented only to their respective home group members. In both cases, significant learning was observed, as indicated by the learning gains calculated from pretest results and posttest results for each group. However, there was no statistical difference between the after the implementation of the two strategies observed.

The fact that both the control and experimental groups showed an increase in learning gains indicates that both cooperative learning strategies were effective. The fact that there were not statistical differences observed can be attributed to experimental design and planning, as well as the incorporation of cooperative learning strategies. US National Science Education Standard (NRC, 1996) proposed that, "Working collaboratively with others not only enhances the understanding of science, it also fosters the practices of many of the skill, attitudes, and values that characterize science" (Chang and Mao, 1999). The benefits of cooperative learning can be experienced in terms of higher achievement, greater persistence through graduation, higher level reasoning and critical thinking skills, deeper understanding of learned material better attention and less disruptive behavior in class, lower amounts of anxiety and stress (Cooper and Mueck, 1990; Johnson et al., 1991; McKeachie, 1986).

It is important for teachers to realize that students can achieve success, if taught how to effectively work cooperatively. The success of student achievement in a student facilitated learning environment is directly related to teacher preparation when employing cooperative learning in the classroom. One teacher in the Chang and Mao study stated that, "This kind of instruction (cooperative learning) is beneficial for students in terms of enhancing their thinking skill and interaction; however, implementing it requires more efforts in terms of classroom management and materials preparation" (Chang and Mao, 1999). The success of this present study, as it pertains to the realization that cooperative learning is vital in the instructional process

as it pertains to students gaining conceptual knowledge can be attributed to the prior planning and preparation on the teacher's part, in comparison to training as it pertains to the implementation of the methods and activities.

Unlike the research of Chang and Mao, this study did include formal instructional training for the teacher, as it pertains to the activities implemented or the facilitation of a cooperative learning environment. The fact that statically significant learning gains were observed indicates that these cooperative learning strategies can be successfully designed and implemented by a teacher with no prior specific training in teaching activities that involve cooperative learning strategies. In addition, these results show that cooperative leaning works well with the student demographics population at my school.

Anecdotally, students in the cooperative learning classrooms seemed to be more highly engaged and happier than previous classrooms where active learning was not utilized. The teacher stated and modeled the expectations for the students, provided the necessary materials for the process and activities, and the students worked in small collaborative groups to achieve a common goal. It is the desire that this study serves as a catalyst in the area of science education to demonstrate that students of all demographics can learn cooperatively, if teachers plan and foster cooperative learning environments that allow students to take charge of learning process. This research study will be continued in the future by studying the use of the jigsaw method and cooperative learning techniques at various grade levels and science content matter.

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APPENDIX

Application for Exemption from Institutional Oversight

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

LSU

Institutional Review Board
Dr. Robert Mathews, Chair
131 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu
lsu.edu/irb

-- Applicant, Please fill out the application in its entirety and include the completed application as well as parts A-F, listed below, when submitting to the IRB. Once the application is completed, please the completed application to the IRB Office or to a member of the Human Subjects Screening Committee. Members of this committee can be found at http://research.lsu.edu/CompliancePoliciesProcedures/InstitutionalReviewBoard%28IRB%29/item24737.html

-- A Complete Application Includes All of the Following:

(A) A copy of this completed form and a copy of parts B thru F.
(B) A brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts 1&2)
(C) Copies of all instruments to be used.
*If this proposal is part of a grant proposal, include a copy of the proposal and all recruitment material.
(D) The consent form that you will use in the study (see part 3 for more information.)
(E) Certificate of Completion of Human Subjects Protection Training for all personnel involved in the project, including students who are involved with testing or handling data, unless already on file with the IRB. Training link: (http://phrp.nihtraining.com/users/login.php)
(F) IRB Security of Data Agreement: (http://research.lsu.edu/files/item26774.pdf)

1) Principal Investigator: ✓ Althea Morgan **Rank:** GraduateStudent

Dept: Natural Science **Ph:** 225-578-9478 **E-mail:** althea.morgan@wbrschools.et

2) Co Investigator(s): please include department, rank, phone and e-mail for each
*If student, please identify and name supervising professor in this space

✓ Dr. John Hopkins, Associate Professor, Dept. of Chemistry, 225-578-3478, chhopk@lsu.edu

IRB# E8354 LSU Proposal #
✓ Complete Application
✓ Human Subjects Training
✓ IRB Security of Data Agreement

3) Project Title: Does the Jigsaw Method improve student conceptual knowledge in Physical Science?

Study Exempted By:
Dr. Robert C. Mathews, Chairman
Institutional Review Board
Louisiana State University
203 B-1 David Boyd Hall
225-578-8692 | www.lsu.edu/irb
Exemption Expires: 7/14/2016

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

Also, if YES, either ◯ **This application completely matches the scope of work in the grant**
OR ◯ **More IRB Applications will be filed later**

5) Subject pool (e.g. Psychology students) High School Students
*Circle any **"vulnerable populations" to be used:** (children <18; the mentally impaired, pregnant women, the ages, other). Projects with incarcerated persons cannot be exempted.

6) PI Signature Althea Morgan **Date** 7/8/13 (no per signatures)

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

Screening Committee Action: Exempted ✓ Not Exempted ____ Category/Paragraph 1
Signed Consent Waived?: Yes (No)
Reviewer Mathews **Signature** Robt C Mathews **Date** 7/15/13

VITA

Althea A. Morgan was born in Baton Rouge, Louisiana. She graduated from Port Allen High School in May 1990. She received her Bachelor of Science Degree in Chemistry from Southern University in Baton Rouge, Louisiana. She furthered her studies at Southern University by completing the Alternative Certification program for teachers. Her areas of certification are Mathematics, 6^{th} – 12^{th} and General Science 6^{th} – 12^{th}, Chemistry and Physics. She has been teaching for the past 15 years and is currently teaching at her alma mater, Port Allen High School in Port Allen, Louisiana. She enrolled in the Graduate School at Louisiana State University in June 2012. She will receive a Master's in Natural Science in August 2014. She plans to begin work on her doctorate degree in 2015.