HOW EFFECTIVE IS THE JIGSAW METHOD WHEN USED TO INTRODUCE NEW SCIENCE CURRICULA IN MIDDLE SCHOOL SCIENCE?

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Abstract

The purpose of this study was to determine the effects of the Jigsaw method, a cooperative learning tool, on content knowledge and attitude toward learning science. A group of 64 students in an 8th grade physical science class located in rural western New York participated in this study. As an intervention for this action research study, science content was introduced using the Jigsaw method. Research design included a quasi-experimental approach with control group. Methodology included pre and post-assessments of content knowledge and attitude. In addition, a teacher log was kept of observations throughout the experience. The achievement gain made by the control and experimental groups was essentially the same and in general, the attitudes towards learning were higher using the frontal method. However, the experimental group expressed they felt more important and had more opportunity to participate in class. It is recommended the intervention be repeated with one to two weeks of training students how to use the Jigsaw method before data is collected.

Research Focus

As an eighth grade science teacher in a rural school district, teaching 12, 13, and 14 year-olds can be a difficult task at times (the first author, Mark, is the science teacher and the second author, Kate, is the university professor). One of my core values as a teacher is to keep the classroom and lessons fun and interesting for the students, and for myself. Using cooperative learning strategies in the classroom has previously made me anxious because I was unsure how beneficial it was for the students academically. Typically, I viewed cooperative learning as a way to give the students a break from the monotony of a teacher-centered class and as a way to work with friends, be social, but still practice crucial skills and concepts in a laboratory setting.

> *Is a cooperative learning strategy such as the Jigsaw Method an effective tool for middle level students to learn and understand new material? Will students enjoy science class more with the use of the Jigsaw Method?*

This study was designed to help me answer these questions in a systematic and definitive way. Experimenting in my science classes using the Jigsaw method was designed to give me evidence I am looking for to confirm whether this strategy is right for my classroom. This action research study partially fulfilled the requirements of my university to graduate with a Master's Degree. The following section reviews some of the important concepts about the Jigsaw method that helped guide this study.

Literature Review

What is Cooperative Learning?

Cooperative learning can be defined as, "Instructional programs in which students work in small groups to help one another master academic content" (Slavin, 1996, p. 200). Slavin also said that the goal of all cooperative learning strategies is to harness the students' enthusiasm, activity, creativity, and craving for independence in a safe environment. These strategies are rooted in a human need for social interdependence according to Johnson, Johnson, and Holubec (1998). Jean Piaget theorized that individuals in a setting that used cooperative learning were encouraged to take a side and therefore enhance their level of reasoning skills (see Johnson, Johnson and Holubec, 1998).

Numerous cooperative learning strategies are used in classrooms all over the world. Some of the more popular methods include Think Pair Share (TPS), which is a simple method that can be done several times in one class. Students are asked a question and asked to think about it on their own. They then share their thoughts with a student near them and finally, together, they share their response with the class. Learning Together is another common cooperative learning strategy where students work together to complete a task such as a worksheet and their group receives the recognition for accomplishments. Team-Games-Tournament (TGT) is a strategy in which students represent their teams in academic games while competing with others who have had similar past accomplishments (Slavin, 1981). Finally, the Jigsaw Method, a popular method of cooperative learning, was the focus of this intervention and will be described in further detail.

What is the Jigsaw Method?

The Jigsaw Method is a cooperative learning method originally devised by a man named Elliot Aronson. According to Aronson (2005), the teacher chooses a main theme and several subtopics about that theme. Students are broken up into heterogeneous groups of 4 or 5, known as the home groups. Each student in the group becomes an expert on one of the subtopics by discussing their topic of expertise with members of other groups who had the same subtopic. The students then go back to their home groups, and through dialogue, help the other group members become informed about their topic. They teach their group their acquired knowledge and learn the main theme information from their peers. This is followed by an assessment which is given to students individually. This quiz allows for individual accountability.

Essential Elements for Use

Slavin (1988) found two essential elements for the Jigsaw method to be effective. The first is there must be a group goal for the students. This can be a certificate, a few minutes of free time, or even bonus points on a grade. Group goals are important to motivate students to help one another. Without a group goal, students may not give adequate explanations to their team members about their subtopics because they were not motivated to do so.

The second essential element is individual accountability. There should be some form of assessment that recognizes the efforts of each individual. This will encourage all group members to do their jobs well because everyone's grade may be dependant on the information they give to fellow group members. If a group reward is given on the basis of individual achievement of the group members, then cooperative learning can increase student achievement (Slavin, 1987).

Manning and Lucking (1991) added that it is important for students to be placed in heterogeneous groups. Not just in terms of ethnicity but in terms of academic ability as well. A slower student will learn best from another student who is slightly higher academically. Mixing the student according to ethnicity will increase social diversity and interaction.

Benefits of the Jigsaw Method

Competition vs. Cooperation: One of the primary advantages of the Jigsaw Method and most other cooperative learning strategies is that they tend to eliminate competition in the classroom and increase the cooperation among the students. Jacobs (1990) stated that it is necessary for students to see each other as collaborators and not as competitors. Singh (1991) recognized the goal is not to entirely eliminate competitiveness from students so that they will not be successful in a competitive world, but to teach cooperation as a skill that can be called upon in useful situations. Also, Holliday (2002) found that depending on classmates for success places peer pressure on lower achieving students to increase the level of their work. Peer pressure due to interdependence became an excellent source of motivation for these students. Slavin (1987) discovered that occasionally students working hard on class material were seen as "teacher's pets" and thus discouraged to put forth large amounts of effort. Using cooperative learning creates a kind of team atmosphere among the groups, which is more acceptable to peers. Academic work is valued because it leads to the success of the group.

Academic Benefits: Academically, the Jigsaw Method in K-12 settings is likely to have a positive impact on academic achievement according to Thompson and Pledger (1998). Aronson (2005), the original developer of the Jigsaw Method, found that students taught using the Jigsaw Method showed a greater academic improvement than other students. Dori, Yeroslavski, and Lazarowitz (1995) discovered that teaching the cell topic to middle level students using the Jigsaw Method showed a significant improvement in their scores compared to students taught the same topic using the traditional frontal method. Students using the Jigsaw Method increased pretest scores by 70.91% while students who were taught using the traditional format only increased 61.28%. Similarly, Stearns (1999) reported that a middle school in El Paso, Texas showed an improvement from 19.9% of eighth grade students passing the math, reading, and writing assessments to 71%. The difference was that a new principal arrived and decided to incorporate a school wide change to increase cooperative learning in the classroom. Slavin (1981) reported that out of 27 studies on cooperative learning that were reviewed, 19 found positive academic effects, 7 found no significant difference, and only 1 study found in favor of the control group. More specifically about 50% of the Jigsaw Method studies showed positive effects and the other 50% showed no difference in academic achievement.

However, Thompson and Pledger (1998) conducted a study with 50 college level students. He gave all of them a pretest, and then taught half using cooperative learning strategies and the other half using lecture method. They found that there was no significant difference in the scores of college students taught by the lecture method and students taught by the Jigsaw technique, but declared that there were no adverse effects of using cooperative learning on the collegiate level. Lee, Ng, and Jacobs (1997) found that cooperative learning could be an effective mode of instruction for higher level thinking tasks. This is because positive interdependence and individual accountability created the conditions for groups to think together. Cooperative learning can even be used with gifted and talented students. Robinson (1991) stated that the motivation of academically talented students could be affected by the kind of task given to them. If a task is challenging to talented students then they are more likely to work together to achieve their goals.

The Jigsaw Method is not a cooperative learning strategy associated with a specific type of learner. There have been positive results found in very diverse settings. "The positive effects of cooperative learning methods on student achievement appear equally frequently in elementary and secondary schools, in urban, suburban, and rural schools, and in subjects as diverse as mathematics, language arts, social studies, and reading." (Slavin, 1981, p. 657)

Social Benefits: The Jigsaw Method and other cooperative learning styles help students not just academically but socially as well. Manning and Lucking (1991) declared that learning cooperatively could lead to social benefits for students of heterogeneous ethnic and achievement backgrounds.

The Jigsaw Method is an effective way to create a feeling of equality among students. According to Singh (1991), prejudice may be reduced by equal status contact between majority and minority students in the pursuit of common goals. If competition is a variable in racial tension, then methods such as Jigsaw, which eliminates competition, can only decrease racial tension. Slavin (1988), discussed how cooperative learning methods have become more common in ESL classrooms. They can be used as a way to improve relationships among students of different racial and ethnic backgrounds. According to Ross, Seaborn, and Wilson (2002), in a research group composed entirely of African Americans, no academic difference was shown between one group learning with traditional lecture methods and another group using cooperative learning methods. However, students responded that they were more comfortable using cooperative learning methods due to the social aspect. This confirms what Slavin (1981) stated about racial differences. He stated that African Americans gained tremendously in achievement as a result of cooperative learning.

Gender and Ability Differences: The Jigsaw Method can have varying affects on males and females. According to a qualitative study of eighth grade students performed by Ghaith and

Bouzeinddine (2003), males enjoy cooperative learning more than females. However, females demonstrated more knowledge of the subject material after learning a topic via the Jigsaw Method. Similarly, lower achieving students stated they enjoyed their cooperative learning experience more than higher achieving students. Ghaith and Bouzeinddine speculated this is because lower achievers feel more comfortable in small groups composed of supportive, motivating, and capable peers. Higher achieving students may feel that the topic is not challenging enough or may not be pleased that they are working with students with lower abilities than themselves.

Student Attitude toward the Jigsaw Method: Overall, students of all ages and levels find the Jigsaw Method to be an enjoyable and beneficial experience. Dori, Yeroslavski, and Lazarowitz (1995) discovered that students who were taught using the Jigsaw Method expressed a willingness to use the strategy again in class and even recommended using this method to their friends. These findings were similar to those found by Fennel (1991). By surveying 208 students who were taught using both lecture and cooperative learning formats, Fennel discovered that students found their Jigsaw experience to be enjoyable and useful. Only .05% of the participants indicated that they preferred the lecture format. The Jigsaw Method can also affect a student's attitude toward school. Aronson (2005) stated that students who were taught using the Jigsaw Method were absent less often than other students.

Purpose of the Study

The purpose of this study was to evaluate the effectiveness of the Jigsaw Method as a tool to introduce new curriculum to an 8th grade science class. The research questions follow:

1. Will using the Jigsaw Method to introduce new curricula improve content knowledge of 8th grade students in the science classroom?

2. Will using the Jigsaw Method to introduce new curricula improve the attitude of 8th grade students toward science class?

Method

Participants

This action research was conducted in a district classified by the New York State Education Department (NYSED) as a rural school with high student needs with relation to district capacity. The district is located in western New York and has a total of 1024 students with an average grade size of 74. Only 3.5% are classified as minority students and over 27% are eligible for free lunch. There is a 3.4% dropout rate and 3.6% of the students enter into a General Education Diploma (GED) program (NYSED 2006).

The groups of students who participated in this research consisted of four 8th grade science classes totaling 64 students. These classes were diverse in terms of ability and gender but nearly homogeneous in ethnicity. Three out of the four classes were inclusion classes and contain students with IEP's. In two of the classes an aide or special education teacher were present in the room at all times. Each class had an average of 16 students.

Intervention

The goal of the intervention was to determine the effectiveness of the Jigsaw Method on the academic achievement and attitude of 8th grade science students. The intervention lasted a total of 70 minutes and was divided into two, one-period sessions. The first step was to choose appropriate new curricula to introduce to the students. In order for the content to be a successful candidate for the Jigsaw Method it must be able to be broken up into 4 or 5 subtopics (Aronson 2005). For this study, the topic of "Phases of Matter and Phase Changes" was used. The 5 subtopics used were "Liquids", "Solids", "Gases", "Solids ↔ Liquids", and "Liquids ↔ Gases". The students were then all given a pre-attitude survey to determine their feelings about science class on a typical day. This was not a day in which the intervention was being implemented.

The next step was to give all of the students in the control group and experimental group a pre-test with content-knowledge questions about the topic to which they would later be introduced. Then the Jigsaw Method was implemented. The control group was taught the science topic using the traditional frontal method where they were introduced to the new subject via a Power Point based lecture and guided note-taking. On day one, they were presented with notes about phases of matter. On day two, they were presented with notes on phase changes. The experimental group was introduced to the new topic using the Jigsaw Method. Table 1 shows steps taken to incorporate the Jigsaw Method into the classroom as used in the experimental group.

Table 1. ***Steps for Implementing the Jigsaw Method***

Day 1	
	Students were broken up into heterogeneous groups of 4 to 5 students per group. These were called the "home groups". These groups were diverse according to ethnicity, race, gender, and ability.
	A team leader was assigned from among the students in each group. Their function was to facilitate group discussions and sharing.
	A different sub topic was assigned to each student in the home groups. Each student received a card with their subtopic on it, as well as a few leading questions to help them learn about their topic.
	Students were given time to work independently to research their topics via the Internet. Each student was assigned a laptop with Internet access. Students were given a few websites to help them stay on task and guide them as to where to find the information they need. The websites that the students used were; www.chem4kids.com, www.visionlearning.com, and www.idahoptv.org/dialogue4kids/season7/matter/facts.html. The teacher was available to guide them in the right direction on these Internet sites.
	Students then formed temporary "expert groups" by having all of the students with the same sub topic get into one group.
	In the expert group students were given time to discuss their subtopics and decide how they would present this information to their home groups.
Day 2	
	Students combine to form their home groups.
	Students presented their subtopics to the other group members. Group members were encouraged to ask questions for clarification.

The entire process, from informing students of their topic, to presenting their subtopic to other home group members, took about 70 minutes. When the intervention was complete, students were given a post-test designed to measure content-knowledge as well as a post attitude survey.

Data Collection Strategies

This study used a quasi-experimental pre-and post-test research design with a control group. This is a popular research design with action researchers because it allows teachers to experiment with new curriculum, instruction, and/or assessment using their own students as participants. Group selection was based on the academic levels of the four classes, taking into account test grades, homework completions, and participation levels. Both control and experimental groups had mixed ability because they were separated into one average/above average section and one average/below average section for each group.

It is believed by the researchers that neither the control nor experimental group ever experienced the Jigsaw Method in the past. This was confirmed by the way they acted unknowingly when the Jigsaw Method was first introduced to them. The control group consisted of two (of the four) classes and they received the traditional frontal instructional method, consisting of note taking coinciding with a Power Point based lecture. The other two classes received the experimental intervention known as the Jigsaw Method, as described earlier in this paper.

Measuring content knowledge

A 15 item true/false survey relating to the phases of matter and phase changes was used to measure content knowledge of the science concepts at-hand (see Table 2). Short, closed-ended assessments are typically used to measure content knowledge quickly to make instructional decisions. The pre-test was administered one day prior to the intervention and the post-test was given immediately after the intervention. Results of the pre-test gave baseline data in order to quantify the amount of learning that had occurred due to the intervention. The same true-false survey was given to both experimental and control groups before and after the intervention. Mean scores were disaggregated by gender and prior achievement.

Table 2. ***True or false items used to measure content knowledge.***

Directions: Circle the "T" if the statement is true or "F" if the statement is false.

1. Phases of matter include solid, liquid, and gas.
2. Solids have more energy than liquids.
3. Changes in phase involve losing or gaining energy.
4. Melting is the phase change from liquid to solid.
5. Boiling results when a liquid changes to a gas.
6. Ice melts at zero degrees Celsius.
7. All matter is made up of particles.
8. Water can exist as a solid, liquid, and/or gas.
9. Gases have more energy than liquids and solids.
10. Condensation occurs when a gas changes to a liquid.
11. Boiling is an example of vaporization.
12. Freezing occurs when a liquid changes to a gas.
13. All objects are made up of matter.
14. Ice is an example of matter in the liquid phase.
15. Water freezes at zero degrees Celsius.

Measuring attitude
A six-item three-point Likert-type survey was used to measure student attitudes toward science class and their involvement in the lesson (see Table 3 for items).

Table 3. *Student Attitude Survey*

1. Today in science class, how happy do you feel?

Unhappy	Happy	Very Happy
1	2	3

2. Today in science class, how bored do you feel?

Not Bored	Bored	Very Bored
1	2	3

3. Today in science class, how important do you feel?

Not Important	Important	Very Important
1	2	3

4. Today in science class, how smart do you feel?

Not Smart	Smart	Very Smart
1	2	3

5. Today in science class, how much do you feel you learned?

Nothing	Some	A Lot
1	2	3

6. Today in science class, do you feel you had the opportunity to participate?

Not At All	Sometimes	A Lot
1	2	3

(Optional) Any additional comments:

This survey was modified from a previous study performed by Ghaith and Bouzeineddine (2003). These researchers used a similar survey to determine how using the Jigsaw Method with students in an English as a Foreign Language class, felt toward reading. The survey used in this study was customized with different questions relating to student attitudes about science class instead of reading. At the end of each attitude survey was a section for students to write any additional comments about the intervention.

Teacher Log
The second strategy used to help determine how attitudes toward science class were affected, was a teacher log. This was simply a chart where observations were recorded in order to track any unusual or abnormal actions, attitudes, social behaviors, or any unforeseen advantages and disadvantages students may encounter during the intervention. The teacher log is recommended to action research studies in addition to more structured and closed-ended data collection strategies to help teachers explain why they are seeing certain trends in quantitative data (Hendricks, 2006). This was a useful complement to the attitude scale to provide a broader picture of how students were affected by the jigsaw. Even though methods used for obtaining the qualitative data might be viewed as somewhat informal, it served as an excellent addition to the quantitative data collected on the attitude surveys.

Results

Achievement Results

Table 4 and Figure 2 show the mean results of each group on the pre-test and the post-test, as well as the change in scores.

Table 4

Comparison of Average Academic Pre-test and Post-tests.

	Pre-Test Score (%)	Post-Test Score (%)	Change(%)
Control	75.4	85.1	+9.7
Experimental	69.9	80.5	+10.6

The group of control students increased their scores by 9.7% and the students in the experimental group increased their scores by 10.6%. The difference between the learning growth of the control group and the experimental group was 0.9%. The achievement gain made by the control and experimental groups was essentially the same, with the control group slightly higher.

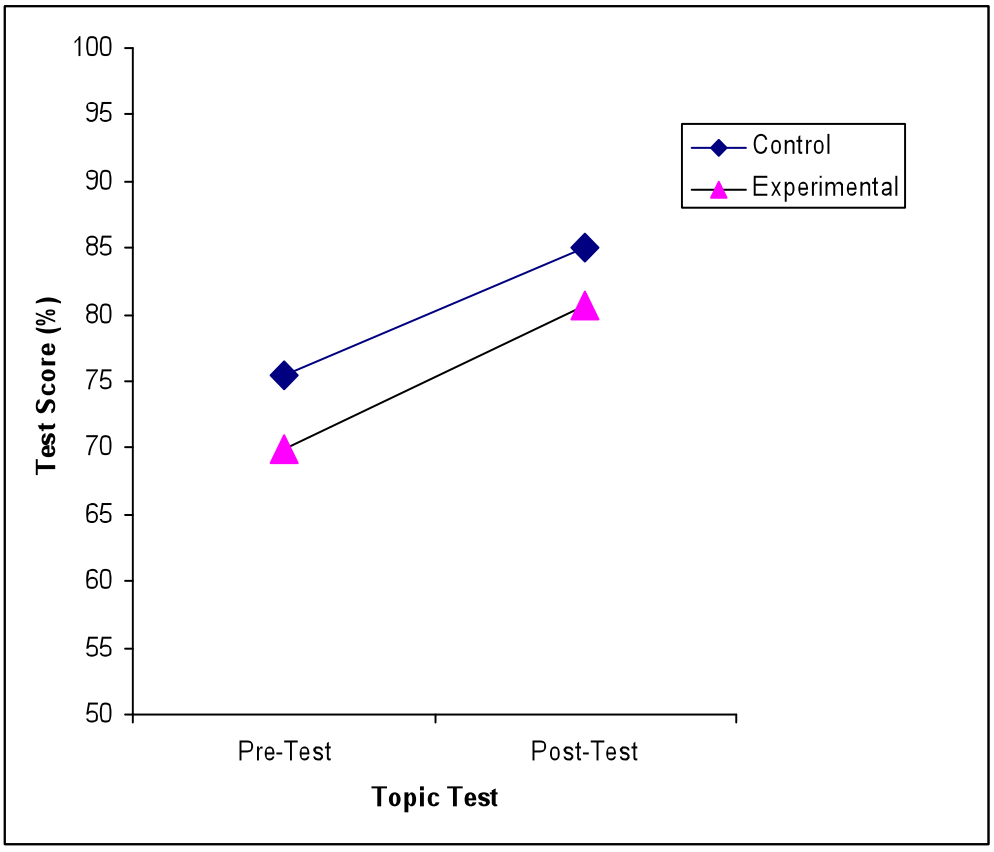

Figure 1. Comparison of Pre-Test and Post-Test Scores for the Topic Test Given to the Experimental Group and the Control Group.

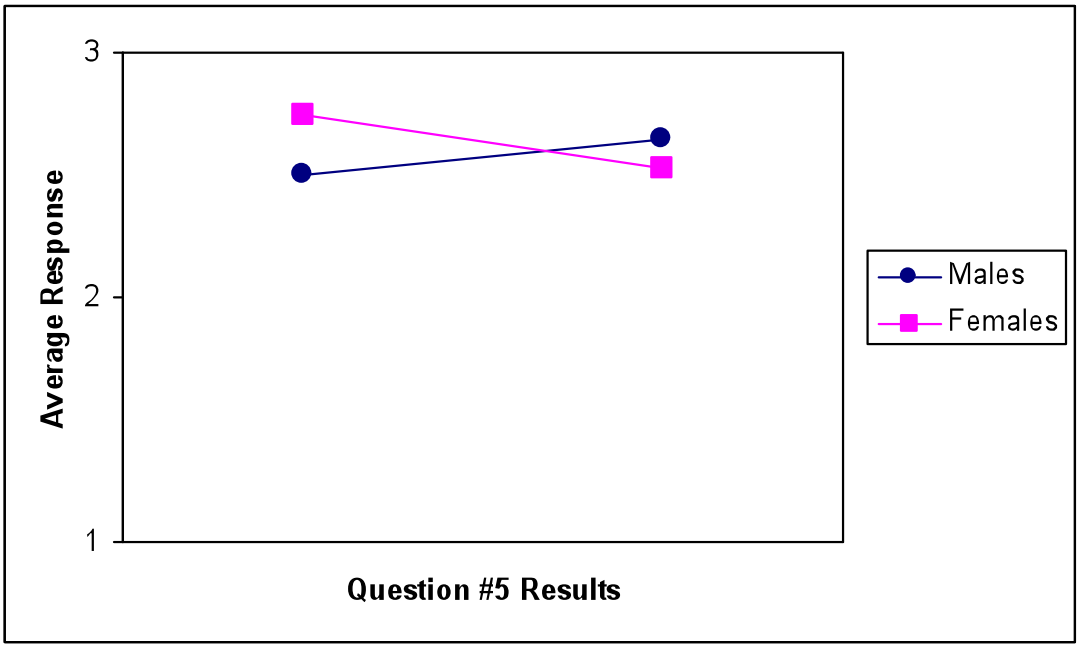

Figure 2. Today in Science Class, how much do you feel you learned?

Attitude Results

Table 5 shows how attitude changed before and after the intervention.

Table 5. *Mean Attitude Change From Pre-Attitude to Post-Attitude Survey*

Attitude Survey Question	Control Group Results			Experimental Group Results		
	pre	post	change	pre	post	change
#1 Today in science class how happy do you feel?	2.17	2.35	0.18	2.18	2.23	0.05
#2 Today in science class, how bored were you?	1.31	1.24	-0.07	1.30	1.40	0.10
#3 Today in science class, how important do you feel?	1.72	1.90	0.18	1.97	2.00	0.03
#4 Today in science class, how smart do you feel?	2.07	2.17	0.10	2.21	2.06	-0.15

#5 Today in science class, how much do you feel you learned?	2.59	2.62	0.03	2.27	2.21	-0.06
#6 Today in science class, do you feel you had the opportunity to participate?	2.38	2.17	-0.21	2.48	2.37	-0.11

Key: pre = Pre-test results; post = Post-test results;
1 = not at all/nothing; 2= average; 3 = a lot/very

The results were unexpected. The results of every item except Question 6 favored the frontal method. According to the attitude survey, the experimental group showed very little gain (.03) and the control group showed more of an increase in importance (.18). Questions #4 asked the students, "Today in science class, how smart do you feel?" The students in the control group felt 3.3% smarter the day of the post-survey. However, the experimental group showed a decrease of 5.0% in "how smart they feel" after using the Jigsaw Method. Question #5 inquired, "Today in science class, how much do you feel you have learned?" Students in the experimental group felt they had learned slightly less, 2.0%, using the Jigsaw Method, compared to the students using the traditional frontal method of teaching, who felt they increased their knowledge by 1.0%. Question #6 asked the student, "Today in science class, do you feel you had the opportunity to participate?" Both groups showed a decrease in their responses. The control group showed a larger decrease, 7.0%, in opportunities to respond than the experimental group, who felt they had 6.4% less opportunities to respond. There are many reasons why this study did not show positive results similar to what is found in the literature review. First, students needed more training in how to participate effectively in the Jigsaw method, perhaps one to two weeks of training should be conducted before collecting data. It is possible that the student's lack of prior exposure to cooperative learning methods could have contributed to only viewing "learning" as a teacher directed construct and when presented with a student centered approach, this viewed less as learning than the frontal method.

Student Responses

Not uncharacteristic for a group of eighth graders, only 3 students took the opportunity to respond on the optional comment line in the attitude survey. All 3 responses were from students in the experimental group and all of them were on the post-survey. The one positive comment came from a student who was not at all bored in class, but also felt that they did not have an opportunity to participate. The student said, "I really liked working on the lap tops." The next comment came from a student who was not at all happy in class and did not feel important. The student's comment was, "My group was talkative and never stayed on task." The last student comment comes from one of the students who improved their pre-test score by 20% on the post-test. The response was, "It wasn't as fun as learning through a teacher."

Teacher Log

While the students were working on completing their tasks assigned to them in the Jigsaw Method, the teacher was walking around the room and recording observations in the teacher log. In addition to observations of student behavior, concerns with the intervention were also recorded. Table 6 shows the observations recorded on the teacher log. Two of the observations were similar in that they dealt with student absences. "If students are absent, it is difficult for them to catch up and be a productive member of a group if the Jigsaw Method is prolonged over two days" and "I filled in for a student that was absent on the second day so that the group would not miss out on the material. Did that group get a better explanation than the others and therefore give them an unfair advantage?" During this intervention, there were several students who were absent for either the first day or the second day. If they were absent the first day, they were asked to join a group and simply listen to the presentation given by other students.

Table 6. *Record of Observations Noted on the Teacher Log*

Group	Observation
Experimental	If students are absent, it is difficult for them to catch up and be a productive member of a group. If the Jigsaw Method is prolonged over two days.
Experimental	I filled in for a student that was absent on the second day so that the group would not miss out on the material. Did that group get a better explanation than the others and therefore giving them an unfair advantage?
Experimental	There is a student who refuses to do their part of the assignment. What can you do about students who refuse to participate? What happens with their group when they do not get the information they need?
Experimental	What about students who are nervous or shy about presenting to groups? Are they giving other students all the information or are they cutting it short because they don't want to talk in front of them?
Control	During the traditional method, it is much more difficult to assess how many of the students are on task. Other than the fact that they are writing in the notes, how much are they really listening?

They were not responsible for educating any of the students in a home group. A problem arose when students were present on the first day and then absent on the second day. In this situation, the teacher took the student's spot in the home group. The students in the home group were given all the necessary information about the topic that they needed and that they may not have received from their original group member. Some students were overheard commenting how it was "not fair" the teacher was working with one of the groups.

Another observation was stated, "There is a student who refuses to do their part of the assignment. What can you do about students who refuse to participate? What happens with their group when they do not get the information they need?" This student eventually was helped along by the other members of his expert group to ensure he had the correct information for his home group. "What about students who are nervous or shy about presenting to groups? Are they giving other students all the information or are they cutting it short because they don't want to talk in front of them?" This observation came after several students expressed extreme displeasure with having to give a sort of presentation to the other students. Perhaps a rubric for oral presentation within the Jigsaw Method would guide students to improve their presentations to one another.

During the control group's lecture and note taking session only one major observation was recorded. "During the traditional method, it is much more difficult to assess how many of the students are on task. Other than the fact that they are writing in the notes, how much are they really listening?" While constantly walking around the room during the lecture, the

teacher was able to make sure that the students were at least actively following along. The other way that the teacher checked to ensure that students were paying attention, was by randomly calling on students to respond to questions to which the answer was previously discussed. It was clear, when students were more actively participating, with interventions such as the Jigsaw Method, students are more accountable for their learning.

Conclusions

Achievement

Students showed improvement during both methods of instruction. The actual difference between test score improvements was 0.9% in favor of the Jigsaw Method. To me, 0.9% is not enough of a difference to conclude with certainty, that the Jigsaw Method is a stronger academic tool than the traditional method of lecture and note taking.

On the contrary to the overall group averages, the individual scores lead to a better understanding of the outcomes observed in this study. Students who had their scores decrease, had a much larger decrease in scores in the experimental group compared to the control group. This lack of difference could be due to two things. The first is a possible limitation in the true-false test format giving students a 50/50 chance at getting the answer correct even if the student does not know the correct information. This may have skewed some of the results giving falsely higher pre-test and possibly post-test scores. This is the only way to account for a decrease in scores because certainly the students did not unlearn the material that they had previously understood in order to lower their scores. The control group's scores did not decrease as greatly as the experimental group's scores. This leads me to the conclusion that perhaps students in the experimental group were not being given correct information by their peers in their home group. The use of the expert groups is one thing that should have stopped this from happening because students researching the same topic could share the information that they had found with each other. Perhaps this could have been prevented if the students were given pre-typed materials in which to obtain the information from instead of allowing them to search the Internet.

When looking at the difference in test scores based on gender it is good to see that the students using the Jigsaw Method had identical average increases in test scores whether they were male or female. This suggests that the Jigsaw method is not a gender-biased cooperative learning strategy. This same comparison in the control group was puzzling because it showed the male students not increasing their scores as high as the female students. The irony behind this result is that on the attitude survey the males actually responded that they felt that they had learned more compared to the responses given by the females.

Attitude

When examining the differences between the pre-survey and the post-survey for each group, the data does not easily facilitate a common theme. The control group had several large variations in their responses from the time of the pre-survey to the post-survey. Since the control group was taught using the same method both times, it is shocking to see some of these large differences of opinion. It is possible that other outside factors that were completely unrelated to science class may have influenced these responses.

Looking at the results from the attitude surveys, and comparing the replies from the control and the experimental groups' post-surveys, several conclusions can be made. Students who were taught using the traditional method of teaching using a lecture and note taking strategy, appeared happier, less bored, they felt smarter, and felt they had learned more than the students who were taught using the Jigsaw Method. On the contrary, students who were part of the cooperative learning groups stated that they felt more important and they felt they had much more opportunity to participate in class. It is speculated that the data showing that the control students were happier and less bored could be directly related to the fact that other than taking a few notes, they did not have to do a whole lot of work. The students more or less just sat back and were entertained. As for the results showing that the control group felt smarter and that they had learned more, it may be a matter of the students who used the Jigsaw Method feeling less confident in their knowledge and giving lower responses because of

having only students presenting the content to them, rather than the control students rating the questions significantly higher on the survey. This sense of frustration and uncertainty was observed in the teacher log and was also confirmed by a few of the student responses.

References

Andrew Rader Studios, *Chem4kids*. (2006, November) Retrieved November 2, 2006, from http://www.chem4kids.com

Aronson, E. (2005). *The jigsaw classroom*. Retrieved September 19th, 2005 from http://www.jigsaw.org

Bobrick, M. (1997). *Rising stars: Integrating language skills through shadow play*. Paper presented at the Meeting of the Teachers of English to Speakers of Other Languages, Orlando, FL.

Brookfield, S. D., Preskill, S. (1999). Strategies for reporting small group discussions to the class. *College Teaching*, 47, 140-143.

Dori, Y. J., Yeroslaviski, O., Lazarowitz, R. (1995). *The effect of teaching the cell topic using the jigsaw method on students' achievement and learning activity*. Paper presented at the Meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Fennel, H. A. (1992). *Students' perception of cooperative learning strategies in post-secondary classrooms*. Paper presented at the International Conference on Cooperative Learning, Thunder Bay, Ontario.

Ghaith, G. M., Bouzeineddine, A. R. (2003). Relationship between reading attitudes, achievement, and learners' perceptions of their jigsaw cooperative learning experience. *Reading Psychology*, 24, 105-125.

Hendricks, C. (2006). Final planning before implementation of the study. In A. Burvikovs (Ed), *Improving Schools Through Action Research* (pp. 101 –118). Pearson Education, Inc.

Holliday, D. C. (2002). *Using cooperative learning to improve the academic achievements of inner-city middle school students*. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA.

Idaho Public Television. (2006). *States of Matter*. Retrieved November 2, 2006, from http://www.idahoptv.org/dialogue4kids/season7/matter/facts.html

Jacobs, G. M. (1991). *Foundations of cooperative learning*. Paper presented at the Meeting of the Hawaii Educational Research Association, Honolulu, HI.

Johnson, D., Johnson, R., Holubec, E. (1998). *Cooperation in the Classroom*. Boston: Allyn and Bacon.

Lee, C., Ng, M., Jacobs, G. M. (1997). *Cooperative learning in the thinking classroom: research and theoretical perspectives*. Paper presented at the International Conference on Thinking, Singapore.

Manning, M. L., Lucking, R. (1991). The what, why, and how of cooperative learning. *Clearing House*, 64, 152-157.

New York State Education Department (2006). *New York State district report card comprehensive information report*. Retrieved May 1, 2007, from http://www.nysed.gov

Robinson, A. (1991). *Cooperative learning and the academically talented student, research based decision making*. Paper presented at the National Research Center on the Gifted and Talented, Washington, DC.

Ross, M. C., Seaborn, A. W., Wilson, E. K. (2002). *Is cooperative learning a valuable instructional method for teaching social studies to urban african american students?* Paper presented at the National Association of African American Studies, Baton Rouge, LA.

Singh, B.R. (1991). Teaching methods for reducing prejudice and enhancing academic achievement for all children. *Educational Studies*, 17, 237-255.

Slavin, R. E. (1981). Synthesis of research on cooperative learning. *Educational Leadership*, 48(5), 655-660.

Slavin, R. E. (1987). Grouping for instruction in the elementary school. *Educational Psychologist*, 21(2) 109-128.

Slavin, R. E. (1987). Cooperative learning and the cooperative school. *Educational Leadership*, 45(3), 7-14.

Slavin, R. E. (1988). Cooperative learning and student achievement. *Educational Leadership,* 53(2), 31-33.

Slavin, R. E. (1996). Cooperative learning in middle and secondary schools. *Clearing House*, 69(4), 200-205.

Sparapani, E. F., Abel, F. J., Easton, S. E., Edwards, P., & Herbster, D. L. (1997). Cooperative learning: an investigation of the knowledge and classroom practice of middle grade teachers. *Education*, 118(2), 251-259.

Stearns, C. J. (1999). A middle venture into cooperative learning: success and dilemmas. *Theory into Practice*, 38(2), 100–105.

Thompson, M., Pledger, L. (1998). *Cooperative learning versus traditional lecture format: A preliminary study*. Paper presented at the Meeting of the National Communication Association, New York, NY.

Thornton, P. (1999). Reading together. In D. Kluge & S. McGuire (Eds.), *JALT Applied Materials: Cooperative Learning.* Tokyo: JALT

Visionlearning Inc., Visionlearning. (n.d.) Retrieved November 2, 2006, from http://www.visionlearning.com

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