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EFFECTS OF TEACHER-DIRECTED AND STUDENT-CENTERED INSTRUCTION ON SCIENCE COMPREHENSION OF EIGHTH GRADE STUDENTS

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EFFECTS OF TEACHER-DIRECTED AND STUDENT-CENTERED INSTRUCTION ON SCIENCE COMPREHENSION OF EIGHTH GRADE STUDENTS

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ABSTRACT

EFFECTS OF TEACHER-DIRECTED AND STUDENT-CENTERED INSTRUCTION ON SCIENCE COMPREHENSION OF EIGHTH GRADE STUDENTS

By

Christopher Jackson

This action research compared two types of teaching methods on eighth graders' learning of physical science concepts. The research question explored differences between student-centered learning and teacher-directed learning. Participants were 41 eighth-grade science students and their teacher at a rural upper Midwest school. Twenty-one students were taught through student-centered active learning. A second section of 20 students worked using textbooks and teacher-directed instruction. Both sections of students studied a series of lessons on basic electricity concepts required by the State of Michigan. The students worked in small groups of two to four students in each section. The research used an identical pretest and posttest repeated measures design over a period of six weeks. Posttest scores were significantly higher than pretest scores for both sections of students. Results supported student-centered and teacher-directed learning as effective methods for students to gain science knowledge over a short time frame. Student-centered learning and teacher-directed learning were found to benefit students' understanding of science concepts. Confounding factors of teacher-directed learning practiced by a teacher who favors student-centered instruction are discussed. Future research includes a post-posttest of science comprehension for electricity concepts.

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INTRODUCTION

This thesis follows the format prescribed by the Publication manual of the American Psychological Association.

Given the need to prepare students for more advanced job environments, educational researchers must study teaching strategies that will improve students understanding and implementation of science processes. To achieve the national educational goal of helping learners use their minds well and be prepared for responsible citizenship, teachers must go beyond teaching subject matter to providing students with skills to become effective learners (Keengwe, Onchwari, & Onchwari, 2009).

Problem-based active learning in science can affect seventh grade students' academic achievement, positive attitudes, and understanding of science concepts positively by keeping science misconceptions to a minimum (Akinoğlu & Tandoğan, 2007). However, active learning takes more time in the science lab. Given the time-intensive to teach Michigan Grade Level Content Expectations (GLCE), I am concerned about the increased amount of class time needed to cover required material in a science course that uses active learning. In my classroom, the majority of the lessons are taught through student-centered learning. Although research supports student-centered learning, I have often wondered if teacher-directed instruction is just as effective as student-centered learning without having to go through the extra effort it takes to coordinate a student-centered environment.

My thesis topic compares student-centered learning and teacher directed learning in middle school science classrooms. The introduction continues with background information, the purpose of study, research questions, conceptual and theoretical frameworks, related terms, and assumptions and limitations of the research topic. I concluded the introduction with a brief summary.

Background of Problem

Classroom learning has moved in the direction of involved learning where students have actively engaged in their learning. Teachers usually achieved higher student involvement through the implementation of cooperative learning, investigative learning, and problem based learning. Collectively, these pedagogies are known as student-centered learning. Students, who had opportunities to work in partnership, learn faster and more efficiently, had greater retention, and felt more positive about the learning experience (Dickinson, 1994, Cooperative Learning Section, para. 1), but do students really comprehend what is learned? Traditional teacher-directed instruction includes lectures, reading and homework, completing worksheets and taking standardized tests. With worksheets and homework, students do the work and teachers can see what students do and do not comprehend. However, students can sit passively during teacher-directed instruction, absorb pre-processed information, and then regurgitate the information on a worksheet. Students could be learning only at the surface (passive) level rather than at the deep (active) level (McCarthy & Anderson, 2000).

McCarthy and Anderson (2000) saw a need for further research in using student-centered instruction in the classroom. They conducted a study among two honors level "Introduction to American Government" college classes. One set of students formed the experimental group that preformed an activity, and the other set of students formed the control group, which received a traditional lecture. The results of the McCarthy and Anderson study showed that post-secondary students who engaged in the student-centered activity preformed significantly higher than students exposed to the teacher-directed method did. Would eighth grade students show similar results?

Purpose of Study

Take a few minutes to think about a classroom you know in which the learning had been positive. When you have identified the situation, recall the room, conditions, people and so on. The details of the things that made the experience positive were probably such things as students involved in the learning process, collaboration with peers, being active in the classroom, and maybe taking thoughtful risks without a fear of making mistakes (Watkins, Carnell, & Lodge, 2007). Given the abovementioned positive aspects of active learning, I wonder if the positive classroom conditions contribute to student comprehension without costing too much time. The goal of this study was to examine the effects of student-centered vs. teacher-directed instruction on science comprehension in the eighth-grade physical science classroom.

Research Questions

Two research questions guided the study: (1) How does student-centered learning affect student comprehension? (2) Does student-centered learning affect the ability of students to be able to retain information over time, as addressed by an additional posttest given after students have had the opportunity to complete a non-related unit?

Student-Centered Theoretical Framework

Student-centered learning followed the theoretical framework of Kolb's Experiential Learning Cycle, which emphasized the central role that experience played in the learning process (Kolb, Boyatzis & Mainemelis, 1999). Experiential learning involves a direct encounter with the phenomena being studied rather than merely thinking about the encounter or only considering a possibility of doing something about the phenomena being studied (Smith, 2001). Experience plays a significant role in the experiential learning process. Students with direct encounters should show higher learning gains.

Teacher-Directed Theoretical Framework

Teacher-directed learning followed the theoretical framework of Psychologist Lev Vygotsky's Zone of Proximal Development. Vygotsky believed that knowledge was constructed through guided discovery, teaching, models, and coaching as well as the individual's prior knowledge and beliefs. Lev Vygotsky's Zone of Proximal Development, as seen in Figure 1, is the area between the child's current development level "as determined by independent problem solving" and the level of development that the child could achieve "through adult guidance or in collaboration with more compatible peers" (Woolfolk, 2007, p. 44).

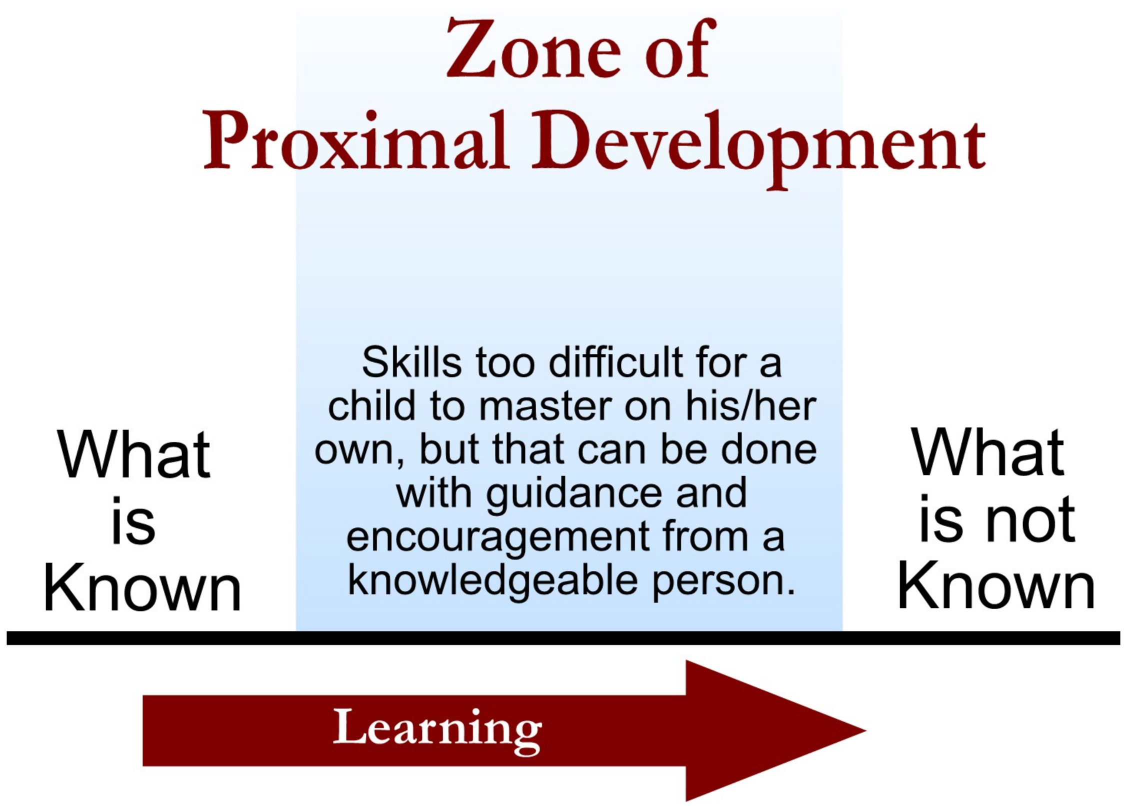

Figure 1. The area between the child's current development level and the level of development that the child could achieve (McLeod, 2007)

According to Vygotsky at any point in a student's development, a student is on the brink of being able to answer unsolvable problems. However, with the right guidance from a mentor, the student is able to master the problem. If a student continued to be actively involved in learning, the "magic middle" between what one knows and what one is unable to learn without help (also called zone of proximal development) is stretched to a new level of learning, thereby increasing what the student is able to learn and comprehend. Unreachable topics are reached, and the student is able to push forward to more advanced ideas (Woolfolk, 2007, p. 44). My research will contribute to the clarification of which theory offers the best support for the question: Does student-centered learning affect student comprehension?

Definition of Terms

For the purpose of the study, the following definitions pertain to selected terms used throughout this thesis.

Teacher-Directed Instruction: Systematic instruction for mastery of basic skills, facts, and information (Rosenshine & Stevens, 1986).

Active Learning: Active learning in college classrooms is defined as allowing active “students to talk and listen, read, write, and reflect as they approach course content through problem-solving exercises, informal small groups, simulations, case studies, role playing, and other activities -- all of which require students to apply what they are learning” (Meyers & Jones, 1993, p. xi).

Student-Centered Learning: A student-centered active learning process includes all activities which teacher is merely a guide (Akinoğlu & Tandoğan, 2007).

Comprehension: Learning is the process through which experience causes a permanent change in a student’s knowledge or behavior. A process qualifies as learning when a cognitive change is brought about by experience and interaction of a person with the environment (Hill, 2002).

Problem Solving: Formulating new answers and going beyond the simple application of previously learned rules to achieve a goal is problem solving. Problem solving is what happens when no solution is obvious (Mayer & Wittrock, 1996).

Summary

Over time, teachers have developed different styles of teaching. Some teachers follow a teacher-directed method and others teachers use a student-centered method. The focus of most of these styles had been to improve student comprehension. A more recent teaching style for science classrooms is active learning. This study analyzed if active learning is significantly beneficial to student comprehension.

In summary, this section introduced the topic, theories, definitions, and research questions used in this thesis. In addition, the background of the problem and the purpose of study, were explained. The next section includes a review of literature related to active learning methods, traditional learning methods, and student comprehension, as these topics pertain to my middle school science classrooms.

CHAPTER ONE: LITERATURE REVIEW

Student-centered learning is a method of teaching that incorporates the student as a dynamic partner in the classroom learning process. Student-centered learning is in opposition to teacher-directed or traditional lecture based learning, in which a passive student is dependent on a teacher to deliver information to be learned. The active learner, on the other hand, is not overly reliant on a teacher. An active learner usually uses a teacher as a resource person, guiding the learning process (Petress, 2008).

As a classroom teacher, I believed students must do more than just listen. Students must read, write, discuss, and be engaged in solving problems. To be actively involved in learning, students must engage in higher-order thinking tasks as analysis, synthesis, and evaluation. Many different techniques can be used to get students involved, for example, experimental learning, cooperative learning, problem-solving exercises, and writing tasks, speaking activities, class discussion, case study methods and simulations (Keyser, 2000). Although student-centered learning methods may vary, all share the same four basic characteristics: encouragement of critical thinking, responsibility for learning placed on the learner, engagement in open-ended activities and the organization of learning activities by the educator. Berry (2008) found that for college students to be successful students, the approach to teaching needs to be efficient and effective. Using the efficiency of a lecture and the effectiveness of an active learning approach to student-centered learning, Berry (2008) may have found the best environment for students to succeed.

Barriers to Student-Centered Learning

Student-centered learning comes with resistance and barriers. Some teachers feel these barriers are too numerous and troublesome to outweigh any positive influences student-centered learning might have on both teacher and students' educational experience. Some barriers to instructional change are educational tradition, faculty self-perceptions and self-definition of roles, the discomfort and anxiety change often creates, and the limited incentives for faculty to change. Certain specific obstacles are associated with the use of student-centered learning. These obstacles included limited class time, a possible increase in preparation time, student attendance, a lack of needed materials, equipment, or resources and the potential difficulty of using active learning in large classes (Bonwell & Eison, 1991).

I have found that student-centered activities are fun for students, but the activities have a tendency to take a longer amount of time. I believe students have fun with hands-on science, but I am uncertain students understand the science processes that I want them to learn during student-centered inquiry. Frequently, I find absent students lose interest in the inquiry learning because they have missed vital parts of the science process being learned. Students with high absenteeism have a difficult time forming conclusions, due to missed class time.

The large number of students in a typical science classroom limits educators' ability to incorporate discussion, timely feedback and active problem solving, which has been linked to success in short and long-term achievement growth among students (Bott, Gaither, Messineo, & Ritchey, 2007). Bott et al. (2007) surveyed 14 separate college classrooms where student numbers ranged from fewer than 50 students to a classroom to over 150 students to a classroom. A large class appeared to affect students' expectations and contribute to the lack of student responses typically observed in large classes. Students appeared to gain comprehension and confidence in their learning when participating in a student-centered classroom. Bott et al. (2007) posited that students should expect and become accustomed to an active learning environment. Teachers should be able to overcome every barrier, obstacle or risk to incorporating student-centered learning in the classroom through careful and thoughtful planning (Bonwell & Eison, 1991).

Implementation of Student-Centered Learning

The modification of traditional lectures is the simplest and most common way to incorporate student-centered learning in the classroom. If an educator allows students to consolidate their notes by pausing three times for two minutes each time during a lecture, students will learn significantly more information. An excellent first step in the introduction of student-centered learning in classrooms is to select components of student-centered learning that teachers are comfortable introducing into their classrooms. These introductory components are typically of short duration and thoughtfully planned out, focusing on subject matter familiar to both the teacher and the students (Bonwell & Eison, 1991).

Richardson (2008) suggests looking at current lectures and weaning out material not necessarily vital to the concept. This reduction of non-relevant material could free up class time to do a student-centered learning exercise. As with any type of change in curriculum, a support system surrounding those educators facilitating the change is vital. Administrators could both stimulate and support efforts to change by highlighting the importance of student-centered learning in newsletters distributed to teachers and parents, not to mention having student-centered learning programs as the subject of faculty development workshops. Through the combined efforts of educators, administrators and students, student-centered learning can be incorporated into classrooms (Bonwell & Eison, 1991).

Teachers' and Students' Roles in a Student-Centered Learning Classroom

The success of a student-centered learning environment depends upon the ability of the participants to communicate effectively and consistently. Departure from a normal routine may lead to positive results simply because of the novelty of the design for the students and teachers involved (Phillips, 2008). Student-centered learning can be in danger of focusing completely on the individual learner and taken to its extreme, does not take into account the needs of the whole class. If each child is unique and each child requires a specific approach to learning appropriate to him or her, the construction of an all-embracing pedagogy or general principle of teaching becomes impossible (O'Neill & McMahon, 2005). The instructor must modify the teaching behavior in the classroom to be consistent with the educational goals for the course, helping the learner to learn rather than merely convey information to the student. If this attitude change occurred, necessary curricular changes would follow (Modell, 1996).

By deciding to implement a student-centered learning environment in the classroom, educators entered into an unspoken agreement with students. Under the terms of the unspoken agreement, the instructor became the "coach" whose responsibilities included helping students to understand why they should agree to "play the game". The coach ensured that course activities followed the "rules of the game" and reassured students who were “playing the game” that being an active member is not as easy as being a spectator, the goal of understanding and applying information can only be reached by continuing to be an “active player” (Modell, 1996).

Student Comprehension and Achievements

Students’ achievements, including higher test scores and the ability to understand science processes, were positively affected by a student-centered learning classroom because student-centered learning created an interest and an excitement for learning (Richardson, 2008). Several strategies promoting student-centered learning have been shown to influence students' attitudes and achievements favorably. Visual-based instruction, for example, could provide a helpful focal point for other interactive techniques. In-class writing is another productive way to involve students and help initiate thinking about what they are doing (Bonwell & Eison, 1991). Many articles have been published in the education literature on the merits of student-centered learning and collectively these articles refer to a surplus of compelling evidence showing various student-centered learning methods and procedures that actually do work to enhance students’ learning (Richardson, 2008).

In an attempt to help students develop strategic problem solving skills, educators are increasingly moving away from teaching approaches that foster teacher-directed learning (i.e., lecturing) in favor of those promoting active or experiential learning (Diamond, Koernig, & Iqbal, 2008). For example, Seo, Templeton and Pellegrino (2008) conducted a study on how pre-service teachers’ subject knowledge changed in the course of producing developmentally appropriate technology to create multimedia projects including slideshows, power point presentations, etc. The results showed the pre-service teachers perceived their knowledge of the subject matter had improved dramatically, particularly in how to structure the patterns and relationships among the facts and concepts.

Summary

Student-centered learning allowed students to become facilitators of their own education. Students working together in pairs or small groups learned from their peers' conclusions, had greater retention, and felt more positive about the learning process. Since teaching at its finest requires educators to consider every educational tool available, these active learning techniques and technologies provided students with the richest educational experience possible. Student-centered learning enhanced student retention of concepts, particularly when students are the author of their own learning (Cherney, 2008).

CHAPTER TWO: METHODOLOGY

The intent of this quantitative research study was to explore how student comprehension relates to learning style. The introduction introduced the need for the study and presented the purpose of study examining the effects of student-centered versus teacher-directed instruction on science knowledge in the eighth-grade physical science classroom. Chapter 1 reviewed literature pertaining to student-centered learning styles, including different forms of student-centered learning.

Chapter 2 provides an in-depth look at research methodology and includes the following sections: appropriateness of research method, participants, validity of study, instructor directions for study, material and procedures, laboratory activities, and data collection. This chapter provides the research framework to examine the relationship between learning method and student comprehension, utilizing a pretest-posttest repeated measures design.

Appropriateness of Research Method

The purpose of this action research project was to see if student-centered learning produces science comprehension at the same levels as teacher-directed learning produces. Students in the student-centered classroom learned about electricity through guided inquiry in small groups.

The HSRRC permission is HS09-258.

Participants

I teach eighth grade physical science at a middle school in the Upper Peninsula of Michigan. Our district currently divides our curriculum into earth science, life science and physical science classes. Our eighth grade contains 95 students in four science classes that meet daily for 46 minutes. I targeted my fifth and sixth period classes for my research. The class hosting the student-centered learning contained 21 students. The class hosting the teacher-directed instruction contained 20 students. The 41 science students were of average science ability. I chose these classes because my two remaining classes consisted of honor students and special education/at-risk students. I wanted the focus of the study to be on student-centered learning and teacher-directed instruction and to keep all other variables constant, including teaching the classes during the same time each day. I wanted to test the impact of the type of instruction on students' ability to obtain science knowledge.

Validity of the Study

My data were generated by comparing the students' knowledge of electrical circuits before and after a unit on electricity. Students' comprehension was documented through a pretest and posttest. Collecting data from two classes, rather than one, allowed a comparison group and a larger testing pool. One class was taught through student-centered learning, while the other class was taught through traditional teacher-directed methods. Having the classes taught using entirely different learning methods would increase the validity of the results. Overlap of teacher-directed instruction in the student-centered class or students helping students in the teacher-directed instruction class would have the potential to invalidate the results.

Instructor Directions for Study

The unit was broken down into three topics covering one week each. The first week focused on defining electricity. During the second week, the students were introduced to the parts of a circuit as well as conductors and insulators. The third week involved building and describing circuits using batteries, wires, bulbs, and resistors. The labs are designed for the teacher to lead through guided inquiry.

During the first semester of school, the students were exposed to hands-on learning through the scientific method and chemistry. The second semester covers electricity and other physics topics. Students began the first semester with a lab partner and were accustomed to working in a lab anywhere from three to four days a week. Over the course of the year, students were comfortable with hands-on activities as well as individual class work. Preparing the students for daily group work took a lot of class time. Would students benefit from using this time for more science content learning through teacher-directed instruction?

Materials and Procedure

The classroom consisted of an area with individual seating as well as seven lab stations that were designed to have two groups of two students. The lab stations allowed for 14 groups of two students in each group. Each lab was equipped with basic chemistry materials, electrical outsets, a sink with working water, and natural gas outlets. Other materials needed for the unit on electricity included batteries, wires, battery clips and holders, light bulbs and holders, and the TOPS electricity workbook.

The electricity unit was the first unit taught in the second semester. Students were not given any information about electricity and circuits. Students were given an identification number to be used on the pretest and posttest. The test is in Appendix B. The students were asked to answer the questions to the best of their ability. The pretest and posttest were identical. The pretest and posttest consisted of nine items. The questions varied from diagramming, multiple choice and short answer. I allowed the students as much class time as needed to complete the pretest and posttest in both the student-centered and the teacher-directed classrooms. Their answers were scored using a rubric. The scale for the rubric was represented by (2) accurate answers, (1) answers under development, and (0) inaccurate answers.

Student-Centered Classroom

The unit covering electrical circuits took approximately three weeks to complete. Students were given background information and questions to guide them in their lab groups. Each class period ended with a discussion to find out what the students results were from the activity. Most labs involved giving the students procedure, materials, and follow up questions. The unit ended with the students completing a circuit board. The students were asked to explain how the circuit board worked and identify component parts.

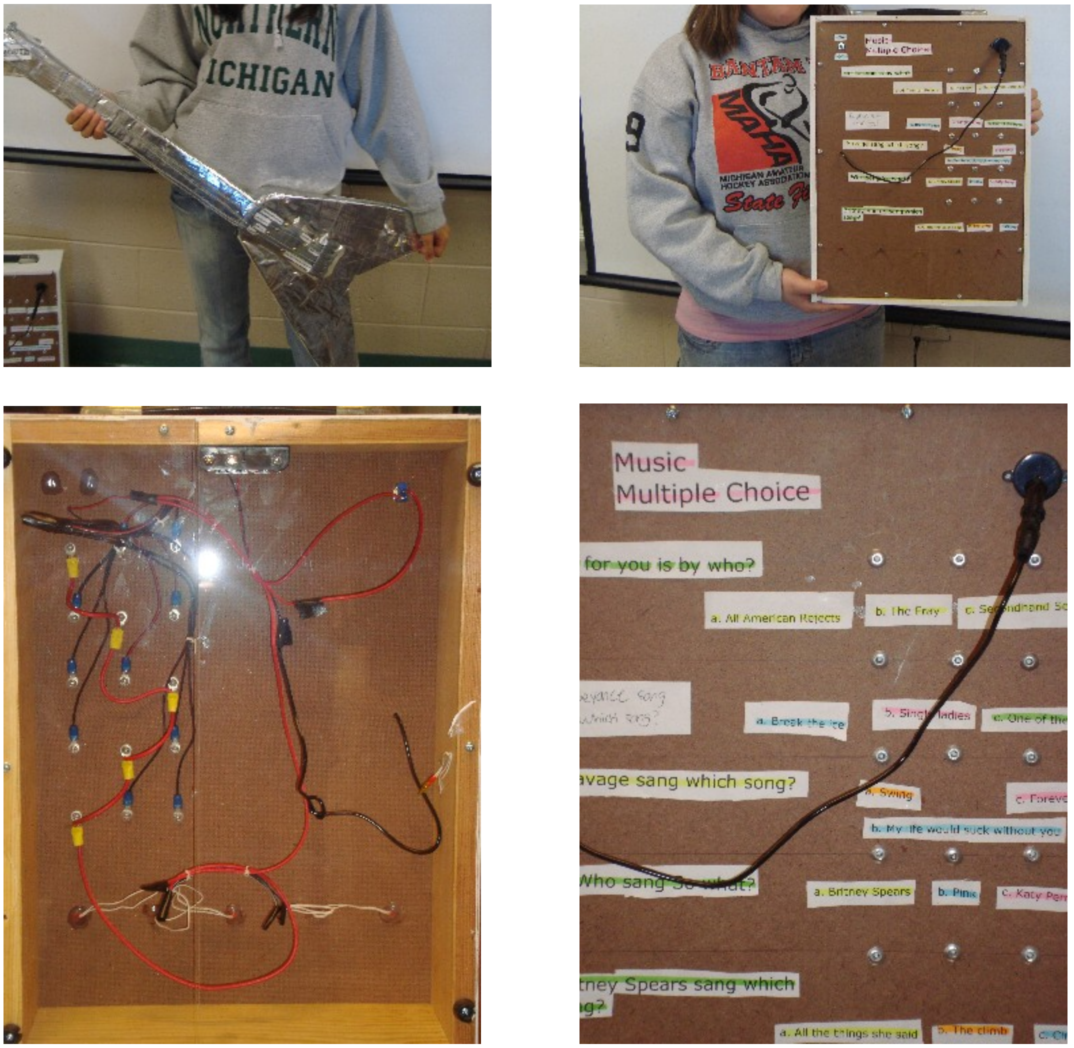

Figure 2. Student examples from active learning projects.

Teacher-Directed Classroom

The second class of students was taught through traditional learning methods using the Prentice Hall series titled “Electricity”. Students used worksheets from a workbook provided by the textbook publisher. The worksheets were knowledge based. Students read and outlined the material in the electricity unit. Following the reading, students were led through discussion topics included in the Prentice Hall Teachers

Edition. Students had the opportunity to learn the same concepts as the first class through methods of note taking, outlining, reading, discussion and worksheets provided by the textbook publisher.

Figure 3. Students participating in traditional learning methods.

Laboratory Activities

1. Induction, conduction, and static electricity lab
2. Make a light bulb light. Difference between open and closed circuits. (TOPS)
3. Resistors and insulators. (TOPS)
4. Series and parallel bulbs and batteries. (2 days)
5. Build a flashlight. (TOPS)
6. Switches. (TOPS)
7. Two-way switches.
8. Ohm’s Law. 2 days (TOPS)

Data Collection

At the end of the unit, the students in both conditions took a posttest that was identical to the pretest. The scores from the pretest and posttest were compared. The data from the two tests are in Appendix C.

CHAPTER THREE: RESULTS

Chapter 3 has the results of repeated measures ANOVA analyses of data for the two sections (student-centered and teacher-directed). This chapter contains four sections, which includes results for participants, time comparison of pretest and posttest, consistency of problem sets, and analysis of the instructional method.

Participants

A unit covering electricity was taught to 41 eighth grade students at a rural Upper Peninsula middle school in Michigan. Of the 41 students in the study, 21 are taught through student-guided lessons and 20 are taught though teacher guided lessons. All 41 students took both the pretest and the posttest.

Pretest

The overall pretest for all 41 students shows that 4.9% of the students score eight or higher. The overall posttest for all 41 students shows that 70.8% of the students score eight or higher, which is an increase of 65.9%.

Pretest cross tabulation is represented by Table 1. On the pretest, six student-centered students and four teacher-directed students scored two points or less. Four students in the student-centered section scored six points or higher and five students in the teacher-directed section scored six points or higher on the pretest.

Table 1. Frequency of Students' Pretest Scores by Learning Condition

Pretest Scores	Student-Centered	Teacher-Directed	Total
1	4	1	5
2	2	3	5
3	1	2	3
4	10	9	19
6	2	5	7
7	0	0	0
8	2	0	2
Total	21	20	41

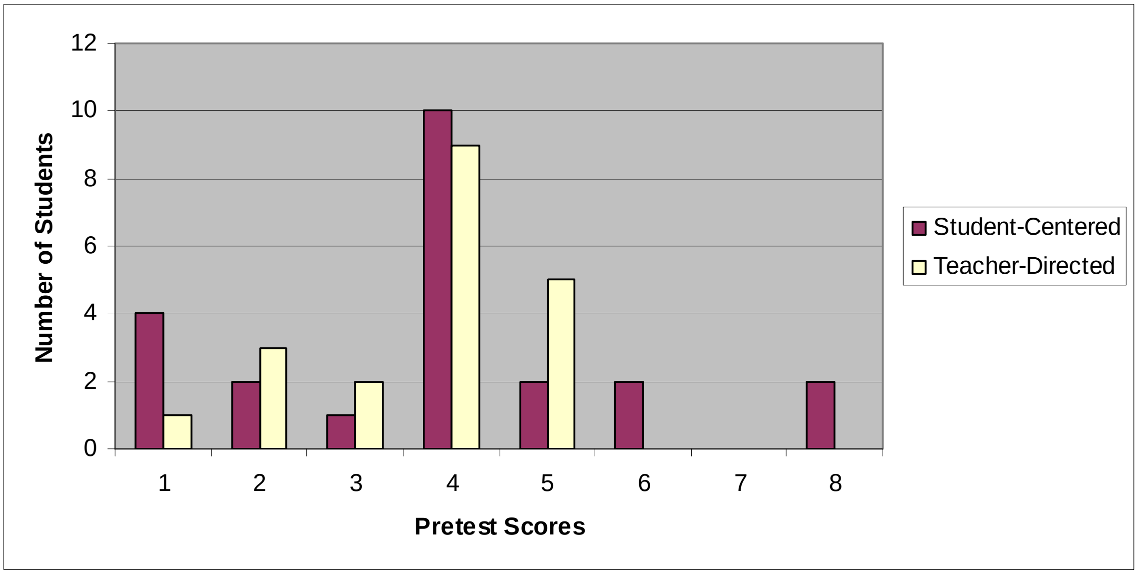

Figure 4. Frequency of students' pretest scores by condition.

Posttest

Table 2 highlights the cross tabulation of the posttest scores for the 41 students. Four students in the student-centered lesson scored six points or less on the posttest compared to five students from the teacher-directed lesson. In the student-centered lesson, no participants scored five points or less on the posttest. On the high end, nine students scored 10 points or more on the posttest in the student-centered section and seven students scored 10 points or higher in the teacher-directed section.

Table 2. Frequency of Students' Posttest Scores by Learning

Posttest Scores	Student-Centered	Teacher-Directed	Total
5	0	2	2
6	4	3	7
7	1	2	3
8	5	4	9
9	2	2	4
10	6	4	10
11	3	3	6
Total	21	20	41

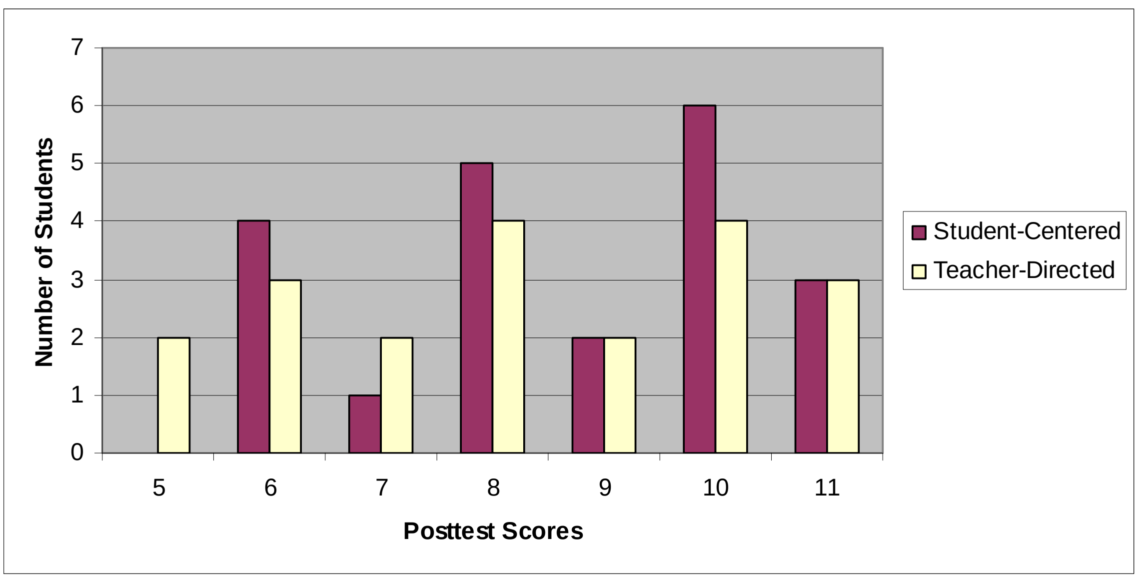

Figure 5. Frequency of students' posttest scores by learning condition.

Overall Pretest and Posttest Descriptive Statistics

Table 3 has the overall pretest and posttest descriptive statistics for both classes. The pretest mean score is 3.85 with a standard deviation of 1.78 and the posttest the mean score is 8.46 with a standard deviation of 1.86.

Table 3. Overall Pretest and Posttest Descriptive Statistics

		Pretest	Posttest
Mean		3.85	8.46
Median		4.00	8.00
Mode		4.00	10.00
Standard Deviation		1.78	1.86
Percentiles	25	2.50	7.00
	50	4.00	8.00
	75	4.00	10.00

Note. N = 41 students

Statistical Analysis

Repeated measures ANOVA helped to determine whether the type of instruction made a significant difference in the students' learning. The data for the repeated measures used Mauchly's Test of Sphericity to test for normality of the data. The hypothesis of sphericity was not rejected ($p > .05$). The sphericity assumption was met and showed no statistical differences with sphericity assumed for the distribution of pretest or posttest data.

Comparison of Pretest and Posttest

Repeated Measures ANOVA is used to determine if differences occur in student responses on pretest and posttest measures in student-centered and teacher-directed learning conditions. Statistically significant main effects are found between pretest and posttest data ($F(1, 39) = 185.978$, $p < .000$).

Analysis of Instructional Method

The resulting F-value shows no statistical difference with instructional method ($F(1, 39) = .061$, $p = .807$). Instructional method of students-centered versus teacher-directed instruction is found not to be statistically significant.

Pretest means are not significantly different for the student-centered participants or teacher-directed participants. The posttest means are not significantly different from the student-centered participants or teacher-directed participants. Student-centered participants' pretest scores started .19 points lower and their posttest scores were .42 points higher than the teacher-directed participants pretest and posttest. However, these slight variations are non-significant, as shown in Figure 4.

Figure 6. Estimated Marginal Means of Instruction

Summary

Repeated Measures ANOVA was used to determine if differences occur in student responses on pretest and posttest measures under the two learning conditions. Descriptive statistics showed posttest gains in the student-centered section to be 4.91 points higher compared to the teacher-directed section which showed an increase of 4.3 points higher. No statistically significant differences occurred on the science pretests or posttests between conditions.

CHAPTER FIVE: DISCUSSION

Utilizing the theoretical frameworks of Vygotsky's Zone of Proximal Development and Kolb's Experiential Learning Cycle this study examines the relationship between learning method and student comprehension. The research design uses a pretest and posttest within subjects repeated measures ANOVA.

Comparison of Pretest and Posttest

Means increased from pretest to posttest for each of the learning methods. No significant difference in means was found when comparing student-centered learning to traditional teacher-directed methods.

A significant increase in posttest scores in the student-centered classroom indicates support for Kolb's Experiential Learning Cycle, which emphasizes the central role that hands-on experience plays in the learning process (Kolb et al., 1999). Students who are involved in student-centered learning are required to listen to other students' ideas, which allow them to form conclusions that may differ from their own original conclusions. By learning through inquiry, students seem to be vested in the process of leaning science. These experiences, through discussion and hands-on learning, indicate support for Kolb's Experiential Learning Cycle. The students' scores demonstrated that student-centered instruction was a beneficial part of the learning process.

Students who are involved in teacher-directed instruction are guided through the lessons by the teacher, which allows the teacher to use what students have learned in the past to understand the new material being taught. This process is supported by

Vygotsky’s Zone of Proximal Development, where students use prior knowledge to process new science content with guided help from a teacher mentor. The students knew to rely on the teacher to guide them through the science content. I find that students feel comfortable knowing that their teacher will guide them through science material intended to be learned during class.

Limitations

As in any educational research, some drawbacks are prominent. The time to get a lesson through to completion using student-centered learning is the first obstacle. Thinking of the state guidelines, a teacher may be inclined to feed information to cover the full science content required in the time allotted. A second restriction is attendance. If students are not present, they will not be able to learn the material. Discussions are happening before, during and after the student-centered learning experience. An absence can create a hole in the understanding of the science process and is particularly challenging in a student-centered instruction based on group work. A third deterrent is to rely on students to be involved in the student-centered learning process. The more involved in the process the students get, the more students will learn. If the students are not cooperating with the student-centered learning classroom, then the instructor must intervene with social skills training and problem solving, which takes time away from learning science. Occasionally, cooperative learning groups must be dissolved and the educator ends up feeding students the science information, which is reminiscent of a traditional teacher-directed classroom atmosphere.

Suggested Changes

Student attitude toward the learning process is an important component. Including a survey, along with the pretest and posttest to see how students feel about learning science would be beneficial. Including all four sections of my science classes would have been beneficial, which would allow for the inclusion of the gifted and talented students as well as the special education students who were excluded from the study, which might have produced a larger effect between the teaching methods and would have allowed for a larger number of participants.

Future Research

In an educational environment, teachers will always use different types of learning methods. Based on my research, both traditional teacher-directed and student-centered learning will work in the short term. I still wonder about the robustness of inquiry versus teacher-directed learning over time. What happens after my students leave my science classes? Would students be able to apply what they have learned through the student-centered learning process in later education and life? Do students feel more comfort when learning science through student-centered learning or teacher-directed learning? Are students more apt to take additional non-required science courses in the future? Not to mention, what is the impact of student-centered learning on special education students, at-risk students and gifted students?

The reason for the insignificant increase in posttest scores, when using student-centered learning, may be due to the overall lack of length to the study, only three weeks. I would like to retest these same students after an extended time and compare their retention of the science processes covered under the two learning conditions. I ran out of time to do so during this academic year. A comparative study would research two groups of students with one group taught through conventional teacher-directed methods and the other group taught student-centered methods. These students would be pretested and then reassessed a year later to see which group possessed a deeper understanding of the science content.

In summary, this chapter includes the significance of the study and the relationship between learning method and student learning of science content. Major findings illustrate a significant increase in student learning when students were exposed to student-centered learning and teacher-directed learning. Results also show a non-significant difference between student-centered learning methods and teacher-directed learning methods. These findings provide evidence that, over a limited period of time, student-centered learning is as effective a method for learning as teacher-directed learning.

CONCLUSION

The research conducted on student-centered and teacher-directed learning leaves one pertinent question remaining, what do the results mean for today's education? This study finds support for both Kolb's Experiential Leaning Cycle and Vygotsky's Zone of Proximal Development. Significant increases were found in both classes on the posttests. According to Vygotsky, the teacher-directed students are able to use what they already knew to develop what they are able to achieve through the guidance of the teacher and social interaction. Consequently, the teacher-directed classroom gains on the posttest do support the role of the teacher-mentor in Vygotsky's theory. Vygotsky's theory finds support in the teacher-directed because of the guidance from the teacher-mentor and the student-centered classrooms because students have social interaction.

According to Kolb, students in the student-centered learning classroom use their experiences through inquiry to gain an understanding of science knowledge. Similar to Kolb, this research finds that the student-centered learning students test scores increase indicating the students are able to gain science knowledge through their experiences of learning through inquiry.

In theory, the results of this study show that student-centered learning is an effective learning method giving students an opportunity to relate to their educational process in a new way relative to teacher-centered lecture. In fact, through the utilization of student-centered learning, students are constructing knowledge and understanding of the science processes. In reviewing the study conducted in my own science classes and seeing the students' progress in those classes, I am confident that, based on my own observations of student enthusiasm toward inquiry, feedback incorporating student-centered learning into a students' education is most beneficial in their overall learning. Students are taking away not only an acceptable level of science content as demonstrated on classroom quizzes, but they are also obtaining this knowledge from a hands-on inquiry approach to science using group work, which should help students gain experience with problem solving skills and application of social skills through the increased interaction of working with peers.

As an educator, I recognize students have the capability to learn successfully through both traditional teacher-directed methods and alternative methods of education in my classroom. Results from my research allow me to conclude that the student-centered learning, which I am currently using in my classroom, is effective and creates a more enjoyable classroom for the students. I have plans to continue teaching through student-centered learning.

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Appendix A: HSRRC Approval Letter

Northern Michigan University

Continuing Education
1401 Presque Isle Avenue
Marquette, MI 49855-5301

March 10, 2009

TO: Christopher J. Jackson

Education

FROM: Cynthia A. Prosen, Ph.D. (CR)
Dean of Graduate Studies & Research

RE: Human Subjects Proposal # HS09-258

"Do Students Learn More Through Active Learning?"

The Internal Review Board (IRB) has reviewed your proposal and has given it final approval. To maintain permission from the Federal government to use human subjects in research, certain reporting processes are required. As the principal investigator, you are required to:

A. Include the statement "Approved by IRB: Project # (listed above) on all research materials you distribute, as well as on any correspondence concerning this project.

B. Provide the Internal Review Board letters from the agency(ies) where the research will take place within 14 days of the receipt of this letter. Letters from agencies should be submitted if the research is being done in (a) a hospital, in which case you will need a letter from the hospital administrator; (b) a school district, in which case you will need a letter from the superintendent, as well as the principal of the school where the research will be done; or (c) a facility that has its own Institutional Review Board, in which case you will need a letter from the chair of that board.

C. Report to the Internal Review Board any deviations from the methods and procedures outlined in your original protocol. If you find that modifications of methods or procedures are necessary, please report these to the Human Subjects Research Review Committee before proceeding with data collection.

D. Submit progress reports on your project every 12 months. You should report how many subjects have participated in the project and verify that you are following the methods and procedures outlined in your approved protocol.

E. Report to the Internal Review Board that your project has been completed. You are required to provide a short progress report to the Internal Review Board in which you provide information about your subjects, procedures to ensure confidentiality/anonymity of subjects, and the final disposition of records obtained as part of the research (see Section II.C.7.c).

F. Submit renewal of your project to the Internal Review Board if the project extends beyond three years from the date of approval.

It is your responsibility to seek renewal if you wish to continue with a three-year permit. At that time, you will complete (D) or (E), depending on the status of your project.

kjm

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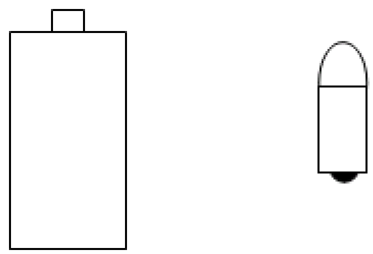
Appendix B: Pretest/Posttest

Name ______________________________________ Hour ___________ Date _________

Questions about Electricity:

1. The diagram below shows a battery and a small light bulb.
a. Draw wires to show how you could connect the bulb and the battery to make the bulb light.
b. Draw arrows to show how you think the current is flowing in the wires when the bulb is lit.

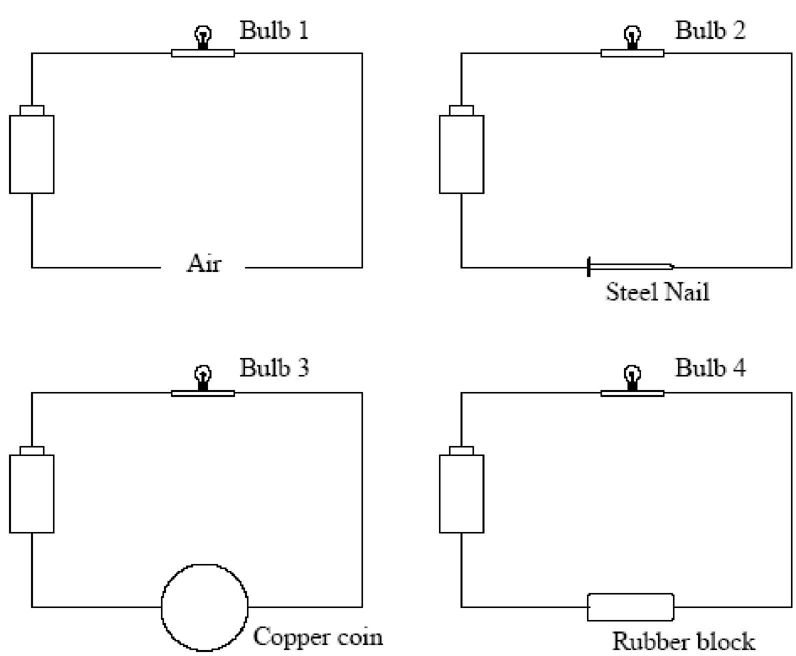


2. Which statement do you think is most accurate?
a. An electric current is flowing matter.
b. An electric current is flowing energy.
c. An electric current is neither matter nor energy.
Explain your answer.

3. What do you think the difference is between current and voltage?

The following diagrams show a flashlight battery and a bulb connected by wires to various substances.

4. Which of the bulbs will light?
a. 1 and 2 only
b. 2 and 3 only
c. 3 and 4 only
d. 1, 2, and 3 only
e. 2, 3, and 4 only
Explain your answer.



5. Why does my hair stand up when I take off my wool hat in the winter?

6. How do you think electricity is created?

7. Why do the wires in your toaster glow red when it is turned on?

8. Sometimes you can “zap” someone by scuffing your feet across carpeting and then putting your finger close to their skin. Why do you think this happens?

9. Where does electricity go when you “use it up?”

Appendix C: Data Spreadsheet

Student Guided	Pre Test	Post Test	Difference	Teacher Guided	Pre Test	Post Test	Difference
1	1	6	5	22	4	8	4
2	6	10	4	23	2	10	8
3	4	6	2	24	6	11	5
4	4	11	7	25	3	10	7
5	1	10	9	26	4	7	3
6	8	10	2	27	4	11	7
7	8	8	0	28	2	6	4
8	1	6	5	29	4	6	2
9	4	9	5	30	6	10	4
10	2	8	6	31	4	9	5
11	4	11	7	32	6	8	2
12	4	10	6	33	6	8	2
13	4	7	3	34	2	6	4
14	2	6	4	35	1	5	4
15	4	8	4	36	6	9	3
16	3	10	7	37	4	7	3
17	1	10	9	38	4	8	4
18	6	9	3	39	4	5	1
19	4	8	4	40	3	10	7
20	4	11	7	41	4	11	7
21	4	8	4				
Mean	3.76	8.67	4.90	Mean	3.95	8.25	4.30
Median	4.00	9.00	5.00	Median	4.00	8.00	4.00
Mode	4.00	10.00	4.00	Mode	4.00	8.00	4.00
Standard Deviation	2.05	1.74	2.30	Standard Deviation	1.50	2.00	2.00