MULTIPLE INTELLIGENCES: THE EFFECTS OF USING ACTIVITIES THAT INCORPORATE MULTIPLE INTELLIGENCES IN A COLLEGE ANATOMY AND PHYSIOLOGY CLASS ON STUDENT UNDERSTANDING OF CONCEPTS

by

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A professional paper submitted in partial fulfillment of the requirements for the degree of Master of Science in Science Education

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Bozeman, Montana

July 2015
DEDICATION

I would like to dedicate this paper to my supportive husband, Trevor and my daughter, Talena. They sacrificed a lot of time with me in order for me to work towards my master’s degree. I would also like to acknowledge my colleague and mentor, Tom Reeves, who has encouraged me, helped me with assignments, provided advice and proofread papers. Without his support, I wouldn’t be where I’m at today.
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ABSTRACT

The students in Anatomy and Physiology II at Dawson Community College in Glendive, Montana are exposed to a lot of information in a short amount of time. The goal of this research was to see if there was an impact of incorporating multiple intelligences on student learning. Data was collected from pretests, posttests, delayed tests, surveys, written interviews, journaling, and colleague observations to determine if there was an effect on student understanding, long-term memory, attitude and motivation as well as teacher attitude and motivation.

The results indicated that there was no effect between the non-treatment and treatment units on student learning, however there was an effect on long-term memory. Students and instructor evidence showed an effect on attitude and motivation throughout the research study.
INTRODUCTION AND BACKGROUND

Throughout my career as a teacher, I have viewed education as a method of learning which should be taught in a way that touches every student’s learning style. I believe the success of a student’s learning is due to their unique learning style interfaced with the teaching methods of the instructor. I chose the topic of learning styles for my capstone project because I strive to reach out to my students and give them the best opportunity to learn. All too often, I hear of college teachers that write notes on the board and ask students to “learn” the material. The purpose of this project is to see the effects of student learning of anatomy concepts and terms by providing students with variable teaching methods to connect to the auditory, visual, or kinesthetic learners. I feel the need for my project is important to best prepare my students for a four year university, or the work force. This research topic is significant to not only me, but my students as well. I have been a kinesthetic learner and struggle with understanding concepts that are given to me only by lecture or auditory methods. I know some of my students have the same struggles, thus influencing me to want to study the effects of varying my teaching methods in order to aid students who are auditory learners, visual learners, or kinesthetic learners like myself. I intend to share my results with my colleagues and administration.

I will be completing my capstone project through Dawson Community College in Glendive, MT. The school has a 12:1 student to teacher ratio with approximately 250 on-campus students in a town of nearly 5,200. The class I chose to complete my capstone project is the spring semester course of Anatomy and Physiology II. There are about 20
students in the class; 75% of them are student athletes, involved with men’s and women’s basketball, softball, baseball, and volleyball. My focus question was: What are the effects of using activities that incorporate multiple intelligences, such as visual, auditory, and kinesthetic, in my community college Anatomy and Physiology class on student understanding of concepts? My subquestions are as follows: what are the effects of using activities that incorporate multiple intelligences on students’ long-term memory; what are the effects of using activities that incorporate multiple intelligences on students’ attitude and motivation; and what are the effects of using activities that incorporate multiple intelligences on my attitude and motivation as a teacher.

The learning styles I focused on were visual, auditory, and kinesthetic from Howard Gardner’s list of multiple intelligences. Gardner defines visual learning as a method that involves drawings, pictures, graphs, maps, charts, and video media. Auditory or linguistic learning is defined as a method of learning that involves reading, lecture, and creating songs or poems. Last, the kinesthetic learning method involves physical activities, acting out, role playing, touching, and creating.

This topic is significant to me and my students because I strive to be an effective educator and provide students with the best opportunity to gain knowledge and motivation in science education. I want colleagues, administration, and parents to see students graduate from Dawson Community College with success not only in the grades earned from the coursework, but also in their motivation to learn.

Throughout the MSSE program, a team of specialists helped me develop my action research project. The first and foremost member of my support team was Tom
Reeves, my colleague and chemistry instructor at Dawson Community College. Tom has been my critical friend throughout the entire program. He has reviewed and edited papers and projects, suggested and discussed ideas and themes, observed my classroom and my instruction, and has been my encouragement through it all. Another support team member is Dr. Michael Booker, the history instructor at DCC. He is very adept at writing professional papers and encourages professional development and assessment analysis. Jewel Reuter, Ph.D., was my MSSE project advisor and was instrumental in developing my action research capstone project.

CONCEPTUAL FRAMEWORK

In this conceptual framework, I will summarize several themes that I discovered from previous research on incorporating teaching methods that aim to touch the different learning styles of students. I researched the effects of student understanding, long-term memory, student motivation and attitude, and teacher motivation. The framework for my research was based on multiple intelligences (MI) and learning styles from Howard Gardner (1983). Gardner believes that people express seven multiple intelligences; verbal or linguistic, logical or mathematical, musical or rhythmic, bodily or kinesthetic, visual or spacial, interpersonal, and intrapersonal (Ozdemir, Guneysu, & Tekkaya, 2006). These multiple intelligences are uniquely varied in every person. The learning styles of people is directly related to their multiple intelligences (Ozdemir, et al., 2006).

However, on the other hand, critiques have argued that the “MI theory cannot be validated through application research because such research assumes the validity of the intelligences because positive application effects may be caused by confounding independent factors such as novelty and excitement (Waterhouse, 2010).
The concepts and theories students are expected to learn in the anatomy and physiology college course can be challenging and overwhelming. The field of science often has concepts that are too big or too small to process with the visual eye; for example the solar system or cells or atoms (Barak, et al., 2010). Therefore, teaching methods must be diverse and creative in order to present the material for students to learn successfully. Student success is obtained by matching the teaching methods with the students’ dominant multiple intelligence. Duman (2010) states, “learning styles are factors directly affecting students’ learning processes” (p. 2078). Teachers are able to connect with their students more effectively when they present information in a variety of ways (Dobson, 2009).

Numerous studies show that student understanding, motivation and long-term memory are positively affected when teaching methods engage numerous multiple intelligences. Students gain a deeper knowledge of the material when it is presented in alternate methods (Manner, 2001). Traditional teaching methods use visual and logical intelligences as the dominant means of presenting material to students (Ozdemir et al., 2006). Most material presented in college courses is of visual context, including lecture notes, graphs, pictures, diagrams, charts, and drawings from a book (Cook, 2012).

In one particular study, fourth grade science students were tested before treatment on their knowledge of the diversity of living things and again after the multiple intelligence (MI) teaching strategy was applied. Students were later tested two months after the MI teaching strategy to analyze their retention of the knowledge. Results showed that using the MI teaching strategy improved the long-term memory of students
Another study by Komarraju, et al. (2011) showed that students retain information longer when they are encouraged to think more deeply about the subject. A third study on retention rate discovered that college students greatly increased their retention rate with the use of kinesthetic skills learning while in the laboratory (Sonnadara, et al., 2012).

Motivation of students and teachers increases when instruction is given through a variety of ways that reach out to the different learning styles of students. Students are more excited about learning the material and teachers are able to review material by incorporating different methods (Manner, 2001). Manner (2001) found auditory learners appreciate lectures, videos, and discussion where as kinesthetic learners prefer hand’s on experiments. With this knowledge, teachers can offer reading material so supplement concepts or theory as pertain to each of these different learning styles. According to Barak, et al. (2010), the use of animated videos on a concept in science gave positive results in motivation and learner achievements among the students, especially at the university level. Auditory learners would appreciate lectures, videos and discussions (Manner, 2001). Kinesthetic learners would learn best by doing hands-on experiments, research projects, field trips, creating, or building things, and demonstrations (Manner, 2001). Teachers may assess student learning, long-term memory and motivation through portfolios, journals, artwork or group projects (Manner, 2001).

I also hypothesize that teacher motivation increases when students are successful. Teaching methods that consider the learning styles of students “positively affect creative intelligence, academic achievement, and motivation” (Duman, 2010, p. 2082). In order
for students to be successful, teachers should provide students with opportunities and various methods to learn because most students learn best through a variety of learning styles, not just one dominant style (Manner, 2001). Teachers should instruct students by using a variety of teaching methods to reach the broad range of student’s multiple intelligences and learning styles (Manner, 2001). Another important point teachers need to be aware of to facilitate student success in their classroom is to not present too much material at one time (Cook, 2012). Students are expected to use their visual learning style to view notes on the board, write them down, all while using their auditory learning style to listen to the teacher presenting the material.

Learning styles of students should directly reflect their more dominant multiple intelligences. Student success stems from diverse methods of instruction that correspond to the multiple learning styles of students. Being able to teach anatomy and physiology while applying multiple methods that correspond to the different learning styles should provide students greater opportunities to understanding concepts and be motivated towards the subject, as well as improved long-term memory of the concepts, and finally, an increase in teacher motivation. I will be testing the incorporation of the following types of learning activities to address the different learning styles of students in my class: visual, auditory, kinesthetic.

METHODOLOGY

My capstone project included a nontreatment unit and a treatment unit, both of which were conducted in the Anatomy and Physiology II spring college course at Dawson Community College in Glendive, Montana. The nontreatment unit was
conducted during the first three weeks of the project. The following three weeks included the treatment unit.

The nontreatment unit included the nervous system where the students learned about neurons and neuroglia and the process involved with electrical communication between cells. Treatment was not administered during this unit. The most common college teaching methods were used during this part of the project, including the use of notes presented on PowerPoint and written on the white board. These methods support the visual and auditory methods of teaching, but do not incorporate all the other learning styles. I tested student learning by doing pretests and posttests. These comprised questions in the form of multiple choice, chronological ordering and short answer. I tested student retention of the material by conducting a delayed posttest at least a week after the posttest. Data was collected on student motivation by surveys, interviews and colleague observation. Data was collected on teacher motivation by journaling and colleague observation.

The treatment unit included the general and special senses where students learned about the organs associated with the general senses and special senses. During the treatment unit, a variety of teaching methods were used to connect with the students’ different learning styles. Video animations were shown to demonstrate how the brain receives information from the nervous system for hearing, tasting, vision, and smelling. Videos were also used to show the anatomy and physiology of the organs associated with each of the general and special senses. In order to incorporate more kinesthetic learning opportunities, I included many laboratory activities during the treatment unit. Students
conducted numerous physiological tests for each of their special senses. For example, students located the cornea, retina, lens and other important structures associated with the special sense of vision as they dissected a sheep eyeball. Determining their blind spot and if they have color blindness, along with several other vision tests, were also conducted. Students used a model to locate the parts of the outer, middle, and inner ear that are responsible for hearing and equilibrium. The tympanic membrane and external auditory meatus was observed on lab partners using an otoscope. Hearing was tested by using tuning forks and a rubber mallet to determine if they could perceive the correct location from which the sound was coming from and determine a range of frequencies in which they could hear. Sensory receptors in human skin, such as the receptors for taste were detected by using various food sources to engage the sour, sweet, bitter and salty receptors. Visual teaching methods were used by writing on the board, drawing pictures, and observing diagrams and models of the sense organs. Class and small group discussions were included as the teaching methods for the auditory multiple intelligences. I also used group activities in which small groups would discuss and answer a review question from the end of the chapter, and then present it or discuss it with the entire class. Students also worked in small groups as they completed laboratory exercises. I incorporated teaching methods that coordinated with the auditory and visual learners, as well as the kinesthetic learners. Student learning, retention, and motivation were tested with similar data collection methods to the nontreatment unit. Instructor motivation and attitude were also examined similar to the nontreatment unit. After conducting the nontreatment unit and the treatment unit, I compared the effects of student learning,
student retention, student motivation and teacher attitude and motivation from the various sources of data collected during the units.

I believe my treatment technique helped me answer my capstone focus question and subquestions concerning student learning, retention, motivation as well as instructor attitude and motivation. I agree with the research I’ve observed, and feel strongly that by incorporating many different teaching techniques, the students will be more successful and fulfilled in their education.

Participants

The Anatomy and Physiology II spring course consists of 18 students. I used data from the 14 students who were available for all of the data collection methods. The majority of the students were interested in a health field. About 22% of the class were non-traditional students pursuing a nursing degree. About 30% of the class were college athletes. About 94% of the class were female students. The majority, about 95%, of the class was Caucasian. This group of students were very interested in science, especially anatomy, since most of them are pursuing a science-based career.

Data Collection Instruments

Data was collected using different sources for each project question. A triangulation was created from the various data collected from the units studied. Table 1 shows the data triangulation matrix. Quantitative and qualitative forms of data were collected from pre and post assessments, surveys, interviews, and journaling. The data analyzed helps provide answers to the questions of this capstone project.
Table 1

*Data Triangulation Matrix*

<table>
<thead>
<tr>
<th>Focus Questions</th>
<th>Data Source 1</th>
<th>Data Source 2</th>
<th>Data Source 3</th>
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<tr>
<td><strong>Primary Question:</strong></td>
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<tr>
<td>1. What are the effects of incorporating methods that relate to every learning style in my community college Anatomy and Physiology class on student learning?</td>
<td>Student pre-assessment measuring prior knowledge and growth of knowledge during the unit</td>
<td>Student post-assessment measuring prior knowledge and growth of knowledge during the unit</td>
<td>Student survey</td>
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<tr>
<td><strong>Secondary Question:</strong></td>
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<tr>
<td>2. What are the effects of using activities that incorporate multiple intelligences on students’ long-term memory?</td>
<td>Student post unit assessment</td>
<td>Student delayed unit assessment</td>
<td></td>
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<tr>
<td>3. What are the effects of using activities that incorporate multiple intelligences on students’ attitude and motivation?</td>
<td>Student survey before and after intervention</td>
<td>Student written survey before and after intervention</td>
<td></td>
</tr>
<tr>
<td>4. What are the effects of using activities that incorporate multiple intelligences on my attitude and motivation as a teacher?</td>
<td>Teacher journaling</td>
<td>Colleague observation journaling</td>
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Student attitude and motivation was measured through interviews and surveys that were presented before and after intervention of the treatment units, providing quantitative and qualitative data. See Appendix A for the interview questions and Appendix B for the student survey questions. The written interviews, surveys, along with the teacher journaling during both the nontreatment and treatment units, generated the triangulation matrix in order for an appropriate comparison. Student interviews were done during class
as written interviews. The interview questions pertain to the students’ motivation and attitude towards anatomy and how the students feel they learn best. The student survey was presented to the entire class. Student surveys were handed out at a time during lecture class when the majority of the class was present. The survey also pertained to motivation and attitude of each student. These two methods of data collection, student interviews and surveys, provided data for my focus question concerning student motivation and attitude towards anatomy and physiology when taught with multiple intelligence teaching methods.

The start of implementation of my capstone project was on January 20, 2015 where I began the nontreatment unit with routine teaching strategies on the nervous system and the physiology of the system. Data was conducted during the nontreatment unit for three weeks. During February, I executed the treatment unit on the anatomy and physiology of the general and special senses of the human body. The intervention of various teaching methods, which included kinesthetic activities along with visual and auditory teaching methods, was used during the treatment unit to study the effects of student learning, motivation and long-term memory, as well as teacher motivation and attitude. The project was completed in March of 2015. A general timeline of the project can be viewed in Appendix C.

DATA AND ANALYSIS

The purpose of this study was to determine the effects of incorporating methods that relate to every learning style in my community college Anatomy and Physiology class on student learning. The data was collected from a sample size (n) of 18, although
some statistical data was collected from only 14 students, those who were in class for all of the pretests, posttests, and delayed tests for both units.

**Impact of incorporating multiple intelligences on student learning**

The primary question of this study was to see if there was an effect on student learning when incorporating several teaching methods that corresponded with students’ multiple intelligences. Students took a pretest and posttest during both, non-treatment and treatment units. When comparing the average percent gain from the two units, there was a 54.05% gain during the non-treatment unit and a 35.88% gain in the treatment unit. There was a greater average percent gain in the non-treatment group when comparing the pretest to posttest scores. I compared the scores to determine if there was a statistically significant mean difference between the two units. The mean of the non-treatment pretest was 41.21% (SD = 15.85). The mean of the non-treatment posttest was 95.06% (SD = 7.14). The difference in the means between the non-treatment pretest and posttest was 53.85%. The mean of the treatment pretest was 49.29% (SD = 13.28). The mean of the treatment unit posttest was 85.00% (SD = 12.86). The difference in the means between the treatment pretest and posttest was 35.71%. Therefore, a larger increase from pretest to posttest was shown during the non-treatment unit. The difference between the posttests means were 95.06% in the non-treatment unit and only 85.00% in the treatment unit. Thus, the greater posttest mean score was found in the non-treatment unit. Both the non-treatment and treatment units increased in mean scores from pretest to posttest, however there was a larger increase in the non-treatment unit. I used the Wilcoxon test to examine the null hypothesis that the median difference between the pretest and posttest in
the non-treatment unit is zero. The p-value was 0.001063 and a 95% confidence interval, so I am able to reject the null hypothesis. I also discovered the median distribution between the pretest and posttest in the treatment unit. The p-value was 0.0009628 with a 95% confidence interval, so I am able to reject the null hypothesis. This shows that there is statistically significant differences between the median distributions between both units’ pretest and posttest scores. Next, I tested the null hypothesis that the median posttest score differences between the non-treatment and treatment units is zero. When comparing the median scores of the posttests of the non-treatment and treatment units, using the Wilcoxin test, the p-value was 0.01072. Therefore, I can reject the null hypothesis. Both units led to student learning, however there was more of a statistically significant difference in the non-treatment unit rather than the treatment unit.

**Impact of incorporating multiple intelligences on student memory**

The first subquestion addressed by the data in this study is whether or not using activities that incorporate multiple intelligences have an effect on students’ long-term memory. Students took a posttest during the non-treatment period on the nervous system and a delayed test two weeks later. During the treatment period, students took a posttest on general and special senses and two weeks later completed a delayed test. I then compared the scores to determine if there was any statistically significant difference in the non-treatment to treatment group. The mean of the non-treatment posttest was 95.06% (SD = 7.14). The mean of the nontreatment delayed test was 86.81% (SD = 13.64). The mean of the treatment posttest was 85.00% (SD = 12.86). The mean of the treatment delayed test was 79.29% (SD = 14.39). I used the Wilcoxin test to examine the
null hypothesis that the median difference between the posttest and delayed test in the non-treatment unit is zero. The p-value was 0.06563 and a 95% confidence interval, so I am unable to reject the null hypothesis. I also discovered the median distribution between the posttest and delayed test in the treatment unit. The p-value was 0.0655 with a 95% confidence interval, so I am unable to reject the null hypothesis. In both units, there was a slight statistical significance. When comparing the delayed tests from both units, the p value was 0.04523. Thus, there was a statistical significance between the delayed tests from both units. I also compared the percent gain averages of the two units. The average percent gain of the non-treatment unit was -15.53% and the treatment unit was -5.77%. Both units decreased in the percent gain averages, yet the treatment group showed less of a decrease than the non-treatment group. The effects of using activities that incorporate multiple intelligences on students’ long-term memory is statistically significant. The students retained information better during the treatment unit.

**Impact on incorporating multiple intelligences on student attitude and motivation**

The next subquestion is whether or not using activities that incorporate multiple intelligences has an effect on student attitude and motivation. I gathered data from student surveys and open-ended written interview questions. The Likert survey conducted had responses from 17 individuals in the non-treatment unit and 14 in the treatment, due to a few absent students when the survey was conducted. In comparing the question from the survey, “I enjoy science” from the non-treatment unit to the treatment unit, I discovered the frequency distribution to be the exact same at 0.290 for the strongly agree responses. The frequency distribution of the agree responses went
from 0.225 in the non-treatment unit to 0.161 in the treatment unit. Therefore, there is no statistically significant difference between the two units. At the beginning of the study, I asked each student if they enjoyed science. Thirteen responded with “yes” and three of those students added that they either “love it” or “very much” or “it’s one of my favorite classes.” The remaining four students answered, “kind of” or “sometimes” or “most of the time.” After the study, when asked in an interview if they enjoy science, three students answered yes and added “it’s very fascinating” or “I really enjoy science.” Ten said yes and one said “for the most part.” Overall, most to all of the students enjoy science. Another question on the survey asked, “Are you motivated to learn about anatomy and physiology of the human body? Why or why not?” Before treatment, seven students responded with yes and explained that it is required for their career choice. Nine responded with yes and explained that the body is fascinating or that there were interested in how the body works. One student just replied with “yes” and did not explain. After treatment, nine answered with yes and related it to their career path. The other five also responded with yes and added that it was either easy for them, interesting, or they were intrigued with how the body works. Overall, there was no statistical significant difference between the non-treatment unit and treatment unit on student motivation and attitude. Generally, all of the students enjoy science and are motivated to learn anatomy due to a career requirement and/or because of their curiosity of the subject. When I asked students about their feelings of incorporating multiple learning methods into their education, most seemed to enjoy the treatment unit over the general and special senses rather than the nervous system. All fourteen of my students stated that they liked the
incorporation of the multiple learning methods, two even stated that it was “fun.” Several mentioned that during the nervous system, there was an abundance of note-taking and no activities which made it hard to understand. One even mentioned that “it was just too much to soak in and I did not learn the material, I just memorized it.” Multiple learning methods does not seem to have a statistically significant effect on student attitude and motivation, yet there is an overall positive attitude and positive motivation from the students in the Anatomy and Physiology II class.

Impact of incorporating multiple intelligences on teacher attitude and motivation

My last subquestion is whether or not using activities that incorporate MI has an effect on teacher motivation and attitude. I gathered data from journaling and from colleague observations. I noticed in my journal records during the non-treatment group that I seemed bored and unmotivated. I felt exhausted after covering so many notes in a 75 minute period. Students would yawn during my lectures. I did minimal drawings on the whiteboard and only showed one short video clip about neurons. I found myself looking up at the clock to see how much time was left. During the treatment group, I felt anxious and excited to lecture and include new learning methods. I wasn’t looking at the clock to see how much time was left. Now I was looking at the clock to see if we were going to run out of time. One day, I put cupcakes in the back of the room and add a Scentsy candle with a vanilla frosting scent. As students wandered slowly into the classroom, they would make comments about the smell. I didn’t say anything, but felt excited that they noticed. I used that method to introduce the special sense of olfaction or smell. Then I let the students eat the cupcakes and explained the gustatory or taste sense.
It was fun and exciting for me and the students were more awake and had curiosity to what the smell was and I had them thinking about how the smell was traveling into the nasal cavity and to their olfactory epithelium and so on until the message reached the cerebrum and interpreted the smell. It was a game to see who could decipher the smell first. Another example of my motivation during the treatment unit was during one lab exercise when students found ear wax in a lab partner’s ear. Students were smiling, laughing, and wanting to see the wax as well. I even asked to view the student’s ear. My colleague, Tom Reeves, observed during the treatment unit and stated, “my overall impression was of a comprehensive lab, engaging students in a variety of tasks and exercises all related to the topic at hand. I noticed that no one was unoccupied; each group was busy at their task of the moment and seemed to be very interested.” To answer my subquestion, I believe the effects of MI towards my own motivation and attitude is positive. This could be due to the new implementations and not just due to the nature and quality of the intervention.

INTERPRETATION AND CONCLUSION

The goal of this study was to see if there was any effect on student learning when incorporating multiple teaching methods in an Anatomy and Physiology II community college course. The quantitative data showed a greater increase in mean distribution from pretest to posttest in the non-treatment group rather than in the treatment unit. The average percent gain for both units showed a decrease from posttest to delayed test, however, the lesser decrease was during the treatment unit. Quantitative and qualitative data from surveys and written interviews shows a positive response to student attitude
and motivation in the treatment unit. Students stated they liked the treatment unit better because it was more fun, exciting, and hands-on. The motivation and attitude of myself, as the instructor, showed a more positive response during the treatment unit. The positive attitude and motivation of the instructor was supported by the observation of a colleague. After analysis and interpretation of the data gathered, the impact on student learning is inconclusive. However, there was positive impact on student retention, student motivation and teacher motivation.

According to the literature review, student understanding of the material may or may not be impacted when teaching methods engage many multiple intelligences. Howard Gardner believes that people express seven multiple intelligences; verbal or linguistic, logical or mathematical, musical or rhythmic, bodily or kinesthetic, visual or special, interpersonal, and intrapersonal (Ozdemier, et al., 2006). Duman (2010) states, “learning styles are factors directly affecting students’ learning processes” (p. 2078). Numerous research shows positive impact on student understanding, motivation and long-term memory when teaching methods engage many MI’s. Some studies say that the MI theory may be invalid due to the excitement of the independent factors (Waterhouse, 2010). The evidence from my action research shows that the attitude and motivation in both students and instructor are both positively affected when incorporating numerous teaching methods. Students’ long-term memory was better with the treatment unit, as well. However, evidence did not show a significant difference on student learning. This could be due to the short time period of the research project, the possibility of different
levels of difficulty between the two units, or the excitement of the new activities that were incorporated.

In the future, I will add more questions to the pretest, posttest, and delayed test that include labeling diagrams, short answers, true/false, and fill in the blank questions instead of only multiple choice questions. I believe more complex test questions will show greater differences between the two units. I would also like to conduct this study over a longer period of time and with a greater sample size. It would be interesting to conduct a similar action research on the general biology class who are not all science majors. I would also categorize each assignment as to the elements of learning it addresses and ask students to identify what type of learner they view themselves as.

VALUE

After conducting action research in my classroom, I have learned a lot about my teaching skills and the learning methods that work best for my students. I found myself giddy and excited about several of the new teaching methods I incorporated into my classroom. For example, the day I put a Scentsy warmer with frosting scented wax in the classroom as well as a container of cupcakes, I found myself excited as I noticed the expressions and comments from the students as they walked into the room and sat down at their desks. Students were inquisitive and started guessing the smell. I lectured on olfaction (smell) and asked what they smelled. Once they guessed the smell, I asked them how they were able to decipher the smell. They used the correct terminology to explain the olfactory pathway. Then I let them eat the cupcakes and explain the gustatory pathway. It was such a fun and productive class period. I enjoyed lecture days like this,
rather than just a note-taking lecture period. I found that the teaching methods I used which incorporated MI’s not only motivated me, but also the students. I learned that I need to broaden my teaching skills to keep engaging my students with MI’s.

As I grow professionally, I will continue to further my knowledge of numerous teaching methods to use as I teach students difficult material in order to help them understand the concepts. I’ve learned from the students that they enjoy learning by varied teaching methods that incorporate multiple intelligences and that they retain the information better.

Breckler, J. & Yu, J. R. (2010). Student responses to a hands-on kinesthetic lecture activity for learning about the oxygen carrying capacity of blood. *Adv Physiol Educ*, (this is how it was on the article I read….I was unsure of it, but how do I fix it?) 35, 39-47.


APPENDICES
APPENDIX A

STUDENT INTERVIEW
1. Do you enjoy science? Why or why not?

2. Why is science important?

3. Are you motivated to learn about anatomy and physiology of the human body? Why or why not?

4. What is your career goal? (What do you want to be when you grow up?)

5. How do you learn best? (by visual aids, video, lectures, or hands-on?) Why?

6. Do you think you can learn by using a combination of these methods (visual, auditory, kinesthetic)? Why or why not?

7. Do you enjoy doing laboratory exercises? Why or why not? Do laboratory activities help you understand the concepts better? Why or why not?

8. Are you a good memorizer? Do you think memorizing information is a good way to learn material? Explain.

9. Do you retain information well? (For example, do you remember what you learned from the previous chapter? Or the first chapter you studied)

10. Does group discussion or group assignments affect your understanding of the topic? Why or why not?

11. What class activities make biology more enjoyable or help engage your interest?

12. Is there anything else you think I should know to better understand your feelings about anatomy as a subject, or is there something I should have asked you about but didn’t that you want to comment on now? Please briefly explain.
APPENDIX B

STUDENT SURVEY
Appendix B

Student Survey

Please check the appropriate box corresponding to how you feel about each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I enjoy learning about science.</td>
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<tr>
<td>2. I understand the importance of science.</td>
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<td>3. I learn best by listening to someone speak about the topic.</td>
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<td>4. I learn best by watching a video or movie about the topic.</td>
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<tr>
<td>5. I learn best by using my hands, building models, or touching and examining models that are about the topic.</td>
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<tr>
<td>6. I am a good memorizer.</td>
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<tr>
<td>7. I learn best by drawing diagrams, graphs, or any type of visual aid about the topic.</td>
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</tbody>
</table>
APPENDIX C
Pre/Post/Delayed Unit Assessment: Nervous System
Matching Questions:

_____1. Cells that send and receive signals are called
   a) Neuroglia
   b) Endocrine
   c) Hormones
   d) Neurons

_____2. Which of the following is NOT part of the neuron structure?
   a) Soma
   b) Striation
   c) Terminals
   d) Dendrites
   e) Myelin sheath

_____3. Resting potential is at
   a) 0mV
   b) 50mV
   c) 70mV
   d) 90mV
   e) 120mV

_____4. _______ neurotransmitters promote action potentials, while ________
neurotransmitters suppress action potentials.
   a) Excitatory/Inhibitory
   b) Positive/Negative
   c) Inhibitory/Excitatory
   d) Negative/Positive

_____5. Which of the following is NOT a meningeal layer of the brain?
   a) Pia mater
   b) Dura mater
   c) Toe mater
   d) Arachnoid mater

_____6. The largest part of the brain is the
   a) Cerebellum
   b) Pons
   c) Medulla oblongata
   d) Cerebrum
7. “Fight or flight” is describing the _______ division of the ANS, which occurs when someone is scared.
   a) Parasympathetic
   b) Somatic
   c) Sympathetic
   d) Peripheral

8. Chemical messengers that are secreted into the bloodstream by endocrine cells are called
   a) Toxins
   b) Capillaries
   c) Hormones
   d) Extracellular fluid

9. The gland that releases regulatory hormones is the
   a) Hypothalamus
   b) Pituitary
   c) Adrenal
   d) Pancreas

10. The gland that lies between the stomach and small intestine and secretes insulin and glucagon is the
    a) Adrenal
    b) Pancreas
    c) Gonads
    d) Pituitary

11. Rapid, automatic responses to stimuli are called
    a) resting potential.
    b) reflexes.
    c) motor nerves.
    d) autonomic responses.

12. Number the steps in a neural reflex.
    ____Response of peripheral effector
    ____Information processing by postsynaptic cell
    ____Arrival of stimulus, activation of receptor
    ____Activation of sensory neuron
    ____Activation of motor neuron

Short Answer Questions:
13. What composes the white matter and gray matter of the spinal cord?
APPENDIX D

PRE/POST/DELAYED UNIT ASSESSMENT: GENERAL AND SPECIAL SENSES
Name_______________________________

Pre/Post/Delayed Unit Assessment: General and Special Senses
General and Special Senses
Spring Semester 2015
Anatomy & Physiology II

Matching

1. The conscious awareness of a sensation is called
A) reception.
B) perception.
C) proprioception.
D) adaptation.
E) desensitization.

2. Gustation refers to the special sense of
A) balance.
B) touch.
C) equilibrium.
D) vision.
E) taste.

3. Which of the following is a primary taste sensation?
A) sweet
B) putrid
C) pungent
D) metallic
E) fruity

4. The transparent portion of the fibrous layer of the eye is the
A) conjunctiva.
B) cornea.
C) iris.
D) pupil.
E) canthus.

5. Nearsightedness is more properly called
A) emmetropia.
B) myopia.
C) retinal detachment.
D) hyperopia.
E) glaucoma.

6. The photoreceptors of the retina are called ________.
A) bipolar cells
B) horizontal cells
C) amacrine cells
D) ganglion cells
E) rods and cones

7. A structure that allows the middle ear to communicate with the nasopharynx is the
A) pinna.
B) vestibular duct.
C) tympanic duct.
D) auditory tube.
E) external auditory canal.

8. The sense of hearing is provided by receptors of the
A) outer ear.
B) middle ear.
C) internal ear.
D) pinna.
E) semicircular canals.

9. In the middle ear, which muscle pulls on the malleolus?
A) stapedius
B) stylohyoid
C) masseter
D) tensor tympani
E) buccinator

10. Which statement regarding sensory reception is correct?
A) The larger the receptive field, the better is one's ability to localize a stimulus.
B) The CNS can tell the difference between a "true" sensation and a "false" one.
C) Output from higher centers can dampen receptor sensitivity.
D) The CNS interprets the nature of sensory information entirely on the basis of the area of the brain stimulated.
E) In general, the stronger the stimulus, the lower the frequency of action potentials.
APPENDIX E

GENERAL TIMELINE
General Timeline

Start Implementation: January 20\textsuperscript{th}, 2015

January 20, 2015: Nontreatment Unit with Routine Teaching Strategies, 3 weeks – Nervous System

February 12, 2015: Treatment Unit with Intervention, 3 weeks – General and Special Senses

End Project Implementation: Approximately March 9, 2015