

THE EFFECTS OF EXPLICITLY TEACHING METACOGNITIVE TECHNIQUES IN
A COLLEGE LEVEL HUMAN BIOLOGY CLASS

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 2014

STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

Quincie R. Lords

July 2014

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ABSTRACT

The success rate for Basic Human Biology at Great Falls College – MSU has been declining the last three years. While reflecting on possible reasons for the decline, I narrowed it down to the three most common reasons students seek my help during office hours. These were difficulty with note taking, poor time management and failure to learn from errors.

This project evaluated the effect of teaching metacognitive strategies on academic performance, self-efficacy, and ability of students to select appropriate metacognitive strategies. Students were taught time management and study strategies along with reflection activities.

Data collection for this project included surveys, interviews, field notes, and exam scores. The results indicated that note taking, study skills and time management improved. Self-efficacy remained the same while academic performance results were inconclusive. The positive outcomes from this project have encouraged me to continue implementing these strategies.

INTRODUCTION AND BACKGROUND

Great Falls College-Montana State University is a non-residential two-year college located in Great Falls, Montana. The enrollment for 2011-2012 was 2,527 with a full time equivalency of 1,441 students. Full-time students comprised 52% of the student population while part-time students made up the remaining 48%. Average age of students in the school was 28, 45.4% were 18-24 years old and 52% were 25 years of age or older. Female students accounted for 71% of the population and males students 29%. Financial aid was received by 71% of our students (MSU-Great Falls, 2012).

Eighty-two percent of the students in my class were taking Basic Human Biology to help prepare for Anatomy and Physiology I. This group of 29 students was predominately white, with females comprising 83% and males 17%. Seventy-three percent of the students were returning to college to pursue a second career or make a second attempt at higher education after withdrawing previously for various reasons. The average age of the students was 28 years old, and all were pursuing health science careers. Basic Human Biology is strongly recommended prior to taking Anatomy and Physiology I. This group of students was split into two sections with twenty-one students in each section. Students had lecture class twice a week for seventy-five minutes and lab once a week for one hour and fifty minutes.

Over the last four semesters there has been a decrease in the number of students successfully completing Basic Human Biology with a grade of "C" or better. This trend was in all sections of Basic Human Biology. In 2009 the success rate was 69.8%, while in

2010 it was 61.3 % and in 2011 it was 51.7% (Figure 1).

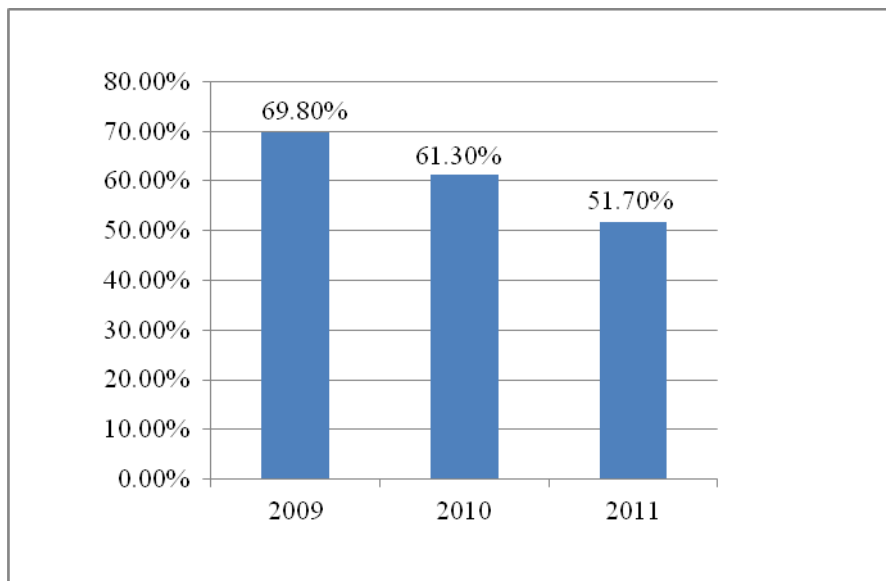


Figure 1. Average Year Success Rate.

Personal classroom observations and discussions with other instructors revealed that students were struggling with how to study, read their textbook and manage time. I decided to attempt to teach these skills within my basic human biology course.

The purpose of this study was to evaluate the effectiveness of explicitly teaching metacognitive strategies to students in a college level human biology course. The following questions were explored.

1. What effect did teaching metacognitive strategies to students have on academic performance?
2. What effect did teaching metacognitive strategies to students have on self-efficacy?
3. What effect did teaching metacognitive strategies to students have on their ability to select the appropriate strategies?

CONCEPTUAL FRAMEWORK

Students are exposed to a large amount of information in their courses. How they manage and recall this information can greatly influence their academic success (Pintrich, 2002; Burchard & Swerdzewski, 2009). In general metacognition is the process of thinking about one's own thoughts (Flavell, 1979). A student's awareness of their own thoughts regarding how they learn and reason is an example of metacognition. Successful students are aware of more metacognitive strategies and tactics than their cohorts (Dunlosky & Metcalfe, 2009; Lee, Lim & Grabowski, 2010).

The definition of metacognition within the context of education varies widely in the literature (Dunlosky & Metcalfe, 2009; Schraw, et. al, 2006; Kaplan, 2008; Dinsmore, Alexander & Loughlin, 2008). Each of these variations provides a useful perspective on student learning. According to Dunlosky and Metcalfe (2009), metacognition incorporates the processes of knowledge, monitoring and controlling. Understanding how the brain processes information is an example of metacognitive knowledge. For example, students monitor their learning when they judge how well they have learned a topic and exercise control when they decide to use a different problem solving technique.

Schraw, Crippen and Hartley (2006) have a slightly different description of metacognition. They explain metacognition as "skills that enable learners to understand and monitor their cognitive processes" (p. 112). Within their description of metacognition, they subdivide it into two processes, knowledge and regulation of cognition. Knowledge of cognition includes knowledge about ourselves as students, knowledge about strategies, and knowledge of when and why to use a strategy.

Regulation of cognition includes planning, such as time management, monitoring, such as self-testing, and evaluating, such as re-evaluating goals.

Multiple metacognitive strategies have been researched regarding their use and effectiveness. Marzano, Pikcering and Polluck (2005) provide a detailed explanation of research-based strategies for increasing student achievement. Generating and testing hypotheses, summarizing and note taking, nonlinguistic representations and identifying similarities and differences are some of the metacognitive strategies they describe. Schraw et al., (2006) suggest strategies such as modeling, cooperative learning, making mental models and using electronic assessment systems to provide immediate feedback. Mintzes, Wandersee and Novak (2001) suggest strategies including concept maps, V-diagrams, clinical interviews, writing, and performance measures.

There are many ways that metacognitive strategies can be used. However, students do not seem to develop these strategies unless they are explicitly taught them (Kiewara, 2002; Pintrich 2004). A study by Rachal, Daigle and Rachal (2007) found that freshman and senior college students self-reported just as many learning difficulties, rather than less. It has been noted that strategy instruction is rarely part of the curriculum (Kiewra, 2002; Rachal, Daigle & Rachal, 2007; Burchard & Swerdzewski, 2009). Strategy instruction was emphasized by Cornford (1999 & 2002) as an effective educational practice to improve what he called “learning-to-learn strategies.” According to Cornford, these strategies are important to compete in the ever-changing work-force (1999 & 2002). Other educators have embraced this as well (Pintrich, 2002; Kiewra, 2002; Burchard & Swerdzewski, 2009). A mandatory cognitive skills course was implemented by a medical school to help at-risk students who failed their first semester

with both content and learning-processes (Winston, Van Der Vleuten & Scherpbier, 2010). Of the students who participated, 91% passed their repeat semester, compared to 58% who did not take the cognitive skills course.

Instructors can use multiple methods to teach students metacognition. The diversity of strategies enables an instructor to provide an individualized skill set to each student. With time and practice, students are better able to adapt to various learning environments.

METHODOLOGY

The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A). Students were taught specific metacognitive strategies to help improve the greatest area of need as self-reported in the Student Pre Interview (Appendix B) and based upon results from the Learning Style Inventory (Appendix C). Students were taught when to use specific strategies, why to use the strategies and how to adapt the strategies to their needs. The skills taught included note-taking, time management strategies, and study strategies.

During the first unit, Organization of the Body, students were not taught any metacognitive strategies. They were asked to voluntarily participate in Post Test Reflections (Appendix D). In the next two units, Covering, Support, and Movement of the Body, Parts I & II, students were taught note taking skills, how to make concepts, and create tables to organize information. The concept card is a type of flashcard for vocabulary or concepts. The front of the card has the word used in a sentence and a location where the word can be found. The back of the card has the definition and a

diagram or illustration representing the word (Figure 3).

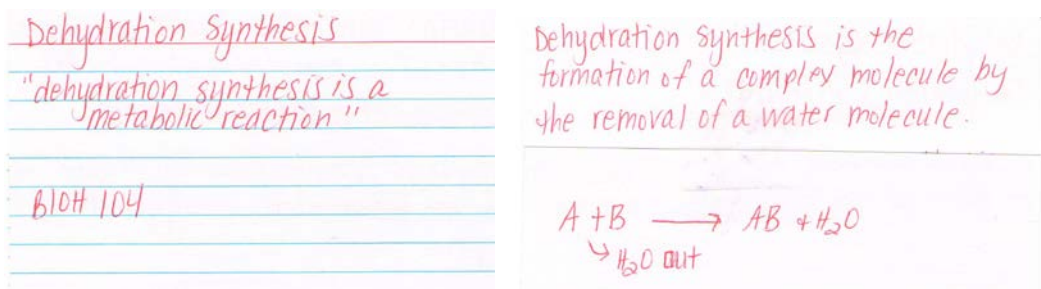


Figure 2. Concept Card

Students used the cards to develop a foundational knowledge and then in class worked on relating the concepts to each other or to body systems. In addition to the strategy, students were asked to continue to voluntarily participate in post-exam reflections. During the fourth unit, Regulation and Integration of the Body, students were not taught additional strategies.

The data collection began at the end of the semester in fall of 2012. Exam scores were gathered for use as comparison to the spring 2013 exam scores. The data collection instruments included the Student Pre/Post Interviews (Appendix B), the Learning Style Inventory (Appendix C), the Student Post Test Reflections (Appendix D), and comprehensive unit tests (Table 1). The Student Pre/Post Interview was used to help determine the students' familiarity with metacognitive skills such as note taking and time management (Appendix A). Other questions within the survey focused on self-efficacy and knowledge of student learning style(s). Student volunteers were used to participate in the interview. The interviews took place during office hours and after class. Students were asked to answer the questions as they pertained to their basic human biology class.

Students were asked to elaborate when answering questions if needed. Notes were taken and interviews were recorded electronically, when possible, to keep accurate records.

The Learning Style Inventory was used to help determine the various ways each student prefers to acquire and learn content (Appendix C). The results were used to group the students by learning style. Once grouped, they were taught one study strategy relevant to their style of learning during the second and third units. The visual learner's were taught how to create flow charts and tables using colors and shapes to group concepts. The auditory learners were tasked with reading out loud to themselves and listening to audio recordings of the class. Kinesthetic learners were encouraged to build models and to move around when they study. Grouping students by learning style also provided opportunities for them to share and compare effective individual learning strategies.

Data from the Pre and Post Student Interview along with teacher observation and reflection were compared in order to determine the effects of teaching students metacognitive skills on self-efficacy and ability to select appropriate learning strategies.

The Student Post Interview was used to determine if their self-efficacy, attitudes, and knowledge of their learning style(s) and metacognitive strategies had changed (Appendix B). The post-interview questions were the same as the pre-interview questions. The Student Post Test Reflection was used to determine their ability to adapt metacognitive strategies (Appendix D). The comprehensive test scores from fall and spring semester were used to measure academic performance before and after treatment. I kept field notes to record student observations and personal reflections.

Table 1
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
<i>Primary Question:</i>			
What effect did teaching metacognitive strategies have on student performance?	Pre and post treatment exam scores	Student post interview	Teacher field notes
<i>Secondary Questions:</i>			
What effect did teaching metacognitive strategies have on student self-efficacy?	Student pre interview	Student post interview	Student post test reflection
What effect did teaching metacognitive strategies have on students' ability to select appropriate strategies?	Student pre interview	Student post interview	Teacher field notes

DATA AND ANALYSIS

The comparison of exam scores between the fall semester and spring semester allowed for examination of percent changes in scores between the non-treatment group, with 39 students, and treatment group with 29 students (Table 2). The results of the unit exams show better comprehension by the treatment group. The positive changes for the treatment group were +0.51% for the first exam, +0.79% for the second, and +0.54% on the third. The overall average on the cumulative final shows better comprehension by the non-treatment group with a 74.27%, while treatment group average was 73.00%.

Table 2
Percent Change in Exam Scores for Fall and Spring Semester

Semester	Exam 1	Exam 2	Exam 3	Final Exam
Fall 2012 (<i>N</i> =39) (Nontreatment Group)	72.31%	67.88%	70.73%	74.27%
Spring 2013 (<i>N</i> =29) (Treatment Group)	72.82%	68.67%	71.27%	73.00%
Percent Change from fall to spring	+0.51%	+0.79%	+0.54%	-1.27%

At the beginning of the semester 96.5% of the students believed they were a good student, while 100% students believed they were capable of success. By the end of the semester 100% of the students reported they believed they were good students. One student commented, “I decided to go to college because I believe I am capable of success.”

The Student Pre Interview indicated that 51.7% of the students knew their learning style. The Post Student Interview indicated that 93% of the students knew their learning style. One student commented that “I like to be able to see the concepts. I prefer visual aids for learning.” The Learning Style Inventory indicated that 61% of students were visual, while 29% were auditory and 10% were kinesthetic. None of the students’ inventory results indicated multiple learning styles.

In the Student Pre Interview, 41% of students reported they knew how to take notes, 52% reported they knew how to study and 41% reported they knew time management strategies. In the post interview 69% of the students reported they knew how to take notes, 62% reported they knew how to study and 72% reported they knew time management strategies (Figure 1). One student commented that they “knew time management strategies before, but now I use them.”

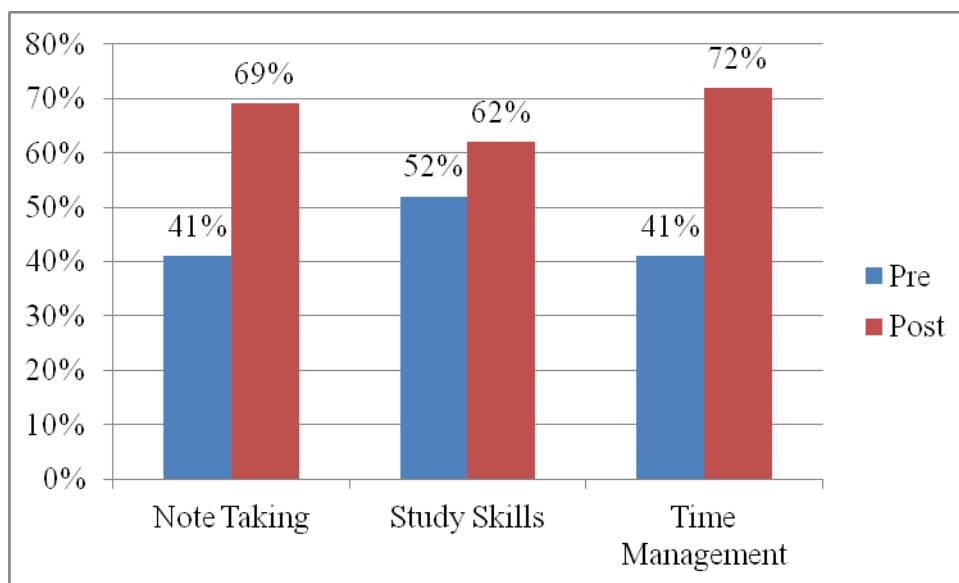


Figure 3. Change in Reported Ability from Pre to Post Treatment, (N=29).

As the semester progressed students were using their planners more often to write down important information and dates. There were five student comments in the discussion area available online during the first unit and they related to due dates for assignments. During the second unit, thirty comments were made and forty comments during the third. This area was made available to students to use in addition to our face to face lecture, lab and review times. During units two through four, students used this area to ask questions about content and study strategies as well as to create study groups. Students reported an 18% increase when asked about reading their book regularly and a 10% increase in comprehension of material read.

The Student Post Test Reflection was used after the first three unit exams. The majority of students, over 85%, on each exam ranked their performance as *fair* or *good*. When asked what one or two things they thought were most helpful in preparing for the first exam, one student commented, “I’m not sure what helped.” Another student, when asked the same question after the second exam, commented, “Creating mind-maps and

color coding tables really helped.” When asked if there was anything they would do differently to prepare for the second exam, one student commented, ” Read the book and attend the review sessions.” Another student, after the second exam said “Make more tables to help organize information.”

INTERPRETATION AND CONCLUSION

Overall I believe that teaching students metacognitive skills, such as time management and post test reflection, improved student success in all areas. According to the data, the students reported an increase in their metacognitive abilities. Like the Pre/Post Student Interviews, student written responses on the reflections, indicated an improved understanding of which learning strategies to use.

I was very surprised by the high level of self-efficacy reported in the Pre Student Interview when asked about their ability to be successful and if they were a good student. The students sitting in class with me at the beginning of the semester did not seem confident. They barely made eye contact or asked questions. By the end of the semester their presence and participation had greatly increased and improved.

I observed, and the students reported, that their ability to take notes, manage time and study were low. I was surprised to find that it didn't take much time away from the content to teach these skills. Students were appreciative and their skills improved. This led to them being better prepared for class and using their time more effectively.

An overall increase in academic performance was expected for the treatment group compared to the non-treatment group. Yet the difference between the final exam and lecture exams between the two groups was inconclusive. This could have been due to differences in the overall class demographics, the times the classes were held, or even

how I taught the material. There are many variables that could have affected the results. I will continue to research this area of possible academic improvement. I may include test corrections to have students reflect on why they got the question wrong and how they can prevent themselves from getting it wrong again.

VALUE

The students gained a great set of skills, such as note taking, study strategies, and time management strategies to choose from and integrate into their academic and professional careers. I gained a better appreciation for taking the time to teach study skills, specifically concept cards, because it led to a better classroom experience for both the students and me. This is an area that I will continue to research and to implement because it's what I believe is best for the students.

The research process provided an opportunity for me to analyze what was taking place in my class. I have a better appreciation for the value of both qualitative and quantitative data. The students' feedback was the most valuable information for me. It provided me with confirmation of what I was observing. I will continue to use surveys and interviews with my students because I believe they are the best indicator of how we as teachers can change and grow.

Colleagues were intrigued by what I was doing in class. This created some helpful talking points in our department about what we are doing and why we are doing it. This was a great experience. It has changed the way I teach by helping me to focus more on the why than the what. I have found that analyzing why students should know or do something helps me to better explain and emphasize specific points. Instead of every objective being of equal importance, I am able help students see the "forest" then I can

bring greater attention to some “trees” over others. As a teacher, I changed from being the leader to being their teammate. I have really focused on developing their skills as students. When they were better prepared as students they were able to do more application based learning activities such as case studies. They took more initiative to facilitate their own learning and knew I was there if they needed me.

Overall the experience was one which provided opportunities for growth personally and professionally. Personally I feel as sense of accomplishment. Professionally, my ability as a teacher to analyze the classroom, my students, and possible solutions has increased greatly. I am much more confident in my abilities as an instructor to provide what my students need.

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APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL



INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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MEMORANDUM

TO: Quincie Lords and John Graves
FROM: Mark Quinn, Chair *Mark Quinn CH*
DATE: December 4, 2012
RE: "The Effects of Explicitly Teaching Metacognitive Technique to Students in a College Level Human Biology Course" [QL120412-EX]

The above research, described in your submission of December 4, 2012, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

STUDENT PRE/POST INTERVIEW

Student Pre/Post Interview

Participation in this interview is voluntary and participation or non-participation will not affect your grade or class standing.

1. Do you know how to take notes?
 - a. If yes, how do you take notes?

 - b. If no, have you ever been taught how to take notes?

2. Do you know how to study to perform well on tests?
 - a. If yes, how do you study?

3. Do know how to schedule your time to accomplish your tasks?
 - a. If yes, how do you manage your time?

 - b. If no, have you ever been taught how to manage your time?

4. Do you read your textbook regularly?
 - a. If no, why not?

5. Do you understand the material you read in your textbook?
 - a. If yes, how do you know you understand the material?

 - b. If no, how do you know that you don't understand the material?

6. Do you find your college courses interesting and absorbing?

7. Do you believe you are capable of succeeding?

8. Do you believe you are a good student?

9. Do you know your learning style(s)?
 - a. If yes, what (is it/are they)?

 - b. If yes, how did you discover (it/them)?

 - c. If no, what type of instruction do you prefer? (give examples if necessary)

10. Is there anything you would like to add?

APPENDIX C
LEARNING STYLE INVENTORY

Learning Style Inventory

Participation in this learning style inventory is voluntary and participation or non-participation will not affect your grade or class standing.

For these questions, choose the first answer that comes to mind and then write a, b, or c on the line. Don't spend too much time thinking about any one question; go with your initial impulse.

- _____ 1. When you study for a test, would you rather
- Read notes, read headings in a book, and look at diagrams and illustrations
 - Have someone ask you questions, or repeat facts silently to yourself
 - Write things out on index cards and make models or diagrams
- _____ 2. Which of these do you do when you listen to music?
- Daydream (see things that go with the music)
 - Hum along
 - Move with the music, tap your foot, etc.
- _____ 3. When you work at solving a problem, do you
- Make a list, organize the steps, and check them off as they are done
 - Make a few phone calls and talk to friends or experts
 - Make a model of the problem or walk through all the steps in your mind
- _____ 4. When you read for fun, do you prefer
- A travel book with a lot of pictures in it
 - A mystery book with a lot of conversation in it
 - A book where you answer questions and solve problems
- _____ 5. To learn how a computer works, would you rather
- Watch a movie about it
 - Listen to someone explain it
 - Take the computer apart and try to figure it out yourself
- _____ 6. You have just entered a science museum, what will you do first?
- Look around and find a map showing the locations of various exhibits
 - Talk to a museum guide and ask about the exhibits
 - Go into the first exhibit that looks interesting, and read directions later
- _____ 7. What kind of restaurant would you rather not go to?
- One with the lights too bright
 - One with the music too loud
 - One with uncomfortable chairs

- _____ 8. Would you rather go to
- An art class
 - A music class
 - An exercise class
- _____ 9. Which are you most likely to do when you are happy?
- Grin
 - Shout with joy
 - Jump for joy
- _____ 10. If you were at a party, what would you be most likely to remember the next day?
- The faces of the people there, not the names
 - The names but not the faces
 - The things you did and said while you were there
- _____ 11. When you see the word “d-o-g”, what do you do first?
- Think of a picture of a particular dog
 - Say the word “dog” to yourself quietly
 - Sense the feeling of being with a dog (petting it, running with it, etc.)
- _____ 12. When you tell a story, would you rather
- Write it
 - Tell it out loud
 - Act it out
- _____ 13. What is the most distracting for you when you are trying to concentrate?
- Visual distractions
 - Noises
 - Other sensations like hunger, tight shoes, or worry
- _____ 14. What are you most likely to do when you are angry?
- Scowl
 - Shout or “blow up”
 - Stomp off and slam doors
- _____ 15. When you aren’t sure how to spell a word, which of these are you most likely to do?
- Write it out to see if it looks right
 - Sound it out
 - Write it out to see if it feels right
- _____ 16. Which are you most likely to do when standing in a long line at the movies?
- Look at the posters advertising the movies
 - Talk to the person next to you.
 - Tap your foot or move around in some other way

APPENDIX D

STUDENT POST TEST REFLECTION

