USING THE PRIMACY EFFECT TO INCREASE STUDENT ACHIEVEMENT IN SCIENCE

by

Seth D. Robertson

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

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

June 2011

STATEMENT OF PERMISSION TO USE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DEDICATION, ACKNOWLEDGEMENTS

Dedication

This paper is dedicated to my wife, Sarah, who has spent countless nights waiting on me to finish work on this or other professional development activities. Without her support, love and excellent editing skills, this project would not be completed.

Acknowledgments

I would like to acknowledge John Graves for his help throughout the action research process. I truly could not have asked for a better advisor. Also, thank you to Laurie Rugemer and Lisa Brown for your help in crafting and editing this paper. Thank you to Diana Paterson and Peggy Taylor and for all that you do for me and other MSSE students.

ABSTRACT

Research shows that people tend to remember the first information they receive better than information that follows. In essence, the old adage "first impressions count" is true in learning as well. Although there is research to show that this phenomena, known as the primacy effect, or serial position effect, is pronounced in remembering lists of simple symbols; i.e. letters or numbers, the purpose of this study was to see its effect in longer lessons focused on very specific parts of the scientific method.

I used the primacy effect to test how effective it was in increasing student performance in variable identification similar to our state's standardized science test. The results showed that the students who received instruction about variable identification at the beginning of class consistently outperformed those who got that instruction at other times of the lesson.

The implications of this study are that the learning cycle of instruction, practice, assessment can be highly effective in practicing specific skills in a science classroom. Furthermore, in a classroom where lessons are broken into short, developmentally appropriate blocks of time, instruction toward an overreaching concept can be effectively taught at the beginning of a lesson.

INTRODUCTION AND BACKGROUND

Background

I teach in a Title-1 6th through 8th grade middle school in suburban Renton, Washington. Our student population is approximately 1,150, of which 36% receive free and reduced lunch. (OSPI, 2011) My classes range between 28 and 31 students, which is normal for grade level science and slightly higher than that of most teachers in the school due to our full inclusion of special education and English language learners. Our student body could be considered very typical compared to other schools in our area. Our students consistently perform higher than other schools in our district on our state's science assessment, the Washington State Assessment of Learning (WASL). This year we are transitioning to a new state assessment called the Measurement of Student Progress (MSP). The MSP is very similar in style to the WASL and both focus(ed) on applied science skills such as identifying types of variables, making predictions, designing experiments with the correct number of manipulated variables, and writing a four part scientific conclusion which are science skills important for students' continued growth in science application and development. Although students in Washington take the MSP every year of school, they only take the science portion in 5th, 8th, and 10th grade.

My classroom curriculum is 6th grade life science. Students learn a variety of content ranging from the cell to insects and human anatomy. The overarching theme of the course is the diversity of life. Thematically integrated into these units is the scientific method and practical applications of the science content. Comparisons to other schools notwithstanding, our performances on the WASL made me realize that there is still significant progress to be made at in our school. I wondered what would happen if we harnessed the valuable time at the beginning of the class period to support the science skills that are assessed on the MSP. This led me to my project based on the action research model.

Focus Question

For my research I asked the question, “How effective is the primacy effect at increasing student achievement in the scientific method?” To test how important receiving information at the beginning of class is in recollection, I focused on beginning of class activities. In order to facilitate this, I changed the emphasis of the beginning of class activities from review and procedural activities to specific instruction, practice, and implementation of the scientific method using the entry tasks strategy. Entry tasks are beginning of the class activities that students engage in to provide structure for the students and allow the teacher precious time to do important logistical work as class begins. As a result, entry tasks are integral parts to many teachers’ lesson plans. Many lessons begin with entry tasks to practice review or other low level skills (Jones, 2000,p.118). This may waste the highest-yield time for learning. The purpose of this project was to determine the effectiveness of dedicated scientific skill building during the beginning of class.

CONCEPTUAL FRAMEWORK

In his groundbreaking psychological study *Forming Impressions of Personality*, Ashe (1946) showed that people's impressions of personality based upon a list of qualities is a complex and rich process. Anderson (1965) built upon this previous knowledge and showed that subjects who were asked to rate the favorability of individuals, repeatedly rated those with negative adjectives described to them first as less favorable compared to those who had those same traits described elsewhere in a description. In essence, first impressions, even when those impressions are simple bits of data, count strongly in our retention and perceptions.

Entry tasks are purposeful activities in which students engage during the time they enter a class and the class formally begins. This time is often wasted due to the physical activity of entering a class, getting to one's desk, organizing books and homework and waiting for the teacher to initiate instruction (Wong, 2000).

Utilizing entry tasks promotes consistency for students, making them feel safe and confident in the classroom. Wong (2000a) asserts that, "The most essential thing for a teacher to do is to structure an assignment the second the students walk into the room" (p. 1). Entry tasks also allow teachers to do important secretarial work such as taking roll, and they help guide the learning objectives of the class towards what the teacher wants to accomplish for that day (Wong, 2000a).

Unfortunately, these beginning practices often do not take into account the vastly important time that they occupy within the class period. In a study on the primacy effect, participants were asked to consider this list of ten letters, DNASXJFCIT and study it for 30 seconds. On average, participants in a study were able to identify the first letter with over 86% accuracy and the last letter with over 93% accuracy, the fourth letter was only recalled with 46% accuracy (Smith, 2011).

The phenomena of better memory at the beginning and end of the list appear to be through two different processes. The *primacy effect* is typically attributed to additional rehearsal of items earlier in the list, which puts those items into long-term memory. In contrast, the recency effect is typically attributed to short-term memory (Smith, 2011).

Because of the effects of primacy and recency, the middle section of a lesson may be better used when dedicated to drill and practice or lab activities, rather than new information. For example, in a 40 minute lesson, the middle ten minutes are downtime for learning new material, whereas the first fifteen and last fifteen minutes are the times to introduce new concepts (Cafarella, 2009b).

Wong (2000b) advocates for entry tasks as a method of keeping students busy while the teacher takes attendance. As he puts it, "Your first priority when class begins is not to take the roll; it is to get the students to work" (p. 1). He also notes that three to 17 minutes are typically wasted at the beginning of each classroom period, primarily because students are not on task. Routines trump other learning objectives, and it is hard to argue against entry tasks fulfilling a logistical purpose.

Both Cafarella (2009) and Wong (2000a) identify this time of the lesson as prime time where work is most meaningful to students. Fred Jones has this to say about entry tasks, "First, keep it simple. Second, make sure that it serves a purpose in getting the day's instruction started. Use it as a warm-up activity. It probably incorporates the review that you would have done anyway after settling in" (Jones, 2000, p.118).

Jones suggests that the most important part of an entry task is keeping it simple and structured but goes on to mention that an entry task is a “meaningful learning experience that does not require your active teaching” (Jones, 2000, p.118). Many entry tasks are questions about previous material in order for teachers to assess the students’ progress and there is evidence that improving formative assessments ultimately can raise standards (Black, 2001).

The primacy-recency effect leaves the beginning and the end of the class period as a prime time for new learning to occur (Cafarella, 2009a). This does not mean that the beginning of the class should necessarily be only new concepts. Since students need repetition to master concepts and skills, it is absolutely appropriate for a skill that has not been mastered to be the topic of an entry task. For example, a simple question is not appropriate for an entry task. An entry task should be a learning outcome. Since every lesson has a different learning outcome, it would be asinine to suggest that every entry task fit into a pre-ordained category. However the following activities can yield high returns (Marzano, 2001):

- Showing a video clip of a new concept while students write down important concepts (p. 29).
- Students engaging in a group activity to solve a problem (p. 84).
- Students setting up a laboratory exercise after reading through the procedure (p. 119).
- Students writing down the objectives of the lesson (p. 92).

Note that none of the activities require high levels of teacher activity. This leaves the teacher time to take roll, set up the next activity, or hand back papers.

Creating entry tasks that are high yield and yet require little teacher input is not an easy task. In all likelihood, most classrooms will not accomplish this every day of the school year. However, teachers consistently can make the effort to improve their entry tasks by taking the primacy-recency effect into account (Cafarella, 2009b). On days where it is impractical to debut a new concept at the beginning of the lesson, keeping entry tasks still promotes structure in the classroom.

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.

Before any treatment began in this study, one class was chosen as a control group to compare to other classes. I purposely chose my third period class because it was neither at the end of the day when student attention can wander, nor at the beginning when tiredness can be a factor in learning, but also because I informally identified it as my most average class, both in terms of academic success and in behavior.

The purpose of choosing a control group for this study was twofold. First, a control group was chosen to have a reasonable comparison to how effective the primacy effect was in increasing student achievement on a specific skill set. Without a control group for comparison, the gains in student achievement might be attributed to other learning strategies employed in the classroom that were common to my instruction for all classes. Secondly, utilizing a control group gave a comparison for the beginning of class procedures. Since I believe that entry tasks are important for setting a work-based atmosphere where students get to work at the beginning of class, I had reservations about dedicating instructional time that was inconsistent with previous practice. I wondered if there might be a reduction in student achievement because of procedures that were potentially less structured at the beginning of class and a control group model afforded the opportunity to isolate that variable.

Although several parts of the scientific method were practiced during the treatment phase of this study, only data about variable identification is examined in this study. The reason for this is to provide as straightforward of a conclusion about whether the treatment is effective in class. Student surveys and other qualitative data have their place in a project based on the action research model, but can serve to provide murky results.

The data collection methods focused on quantitative data as a method to measure student progress. Data was taken two weeks prior the beginning of the second quarter and then at the end of the third quarter. Although students had been assessed previously on the scientific method early in the year, the data collection in this study was chosen to mitigate the effect of diminished retention from the year prior. At the beginning of the year, many students appeared to remember some degree of variable identification, but had significant problems accessing that information. Collecting and analyzing data later in the year allowed student understanding to stabilize to the point where the effects of the treatment could be more indicative of true student learning. The pre-treatment phase involved gathering baseline data of student performance on several parts of the scientific method. Students were assessed on their ability to identify controlled, manipulated and responding variables; the ability to define a hypothesis; and their ability to identify that same data in a sample experiment. All students in the classrooms were given the same initial assessment, the Science Survey (Appendix A).

The student Science Survey is a simple quiz-type set of five questions intended to determine whether students were able to identify, in writing, controlled variables, manipulated variables, and responding variables as well as what a hypothesis is, and that there is only one manipulated variable in a scientific experiment. Student responses were keyed for anonymity and responses were placed into one of two categories. Student responses were given a one if they answered the question correctly and a zero if they answered incorrectly.

The scientific method became an *entry task only* topic for the treatment groups. No instructional time was spent specifically practicing the scientific method except in the first portion of the class period. This time period typically ranged anywhere from 5-20 minutes. Some of the methods for training at the beginning of class involved:

- Powerpoint presentations on the four parts of a conclusion.
- Identification of variables in videotaped experiments (Appendix F)
- Assessment of own and other students' conclusions as compared to the MSP four point scale. (Appendix D)
- Mock experiments presented in which students identified, controlled, manipulated and responding variables. (Appendices B and C)
- Writing procedures for the day's lab exercise. (Appendix H)
- Writing procedures for a class lab demonstration. (Appendix I)
- Rote practice of scientific method terms (Appendix G)

The treatment phase also included making several adjustments to teaching style as well as changing the method in which students began their entrance into the room. Instead of being directed to an entry task that reviewed former material, entry tasks were written on the front white board and directed the learner to a specific task (Appendix E). To keep consistency students always began each class period by writing down their objectives for the day and were then directed toward the next portion of their entry task. Above all, during the time of the treatment, instruction given at the beginning of the class period focused on new scientific method material or material needed to be practiced. Time was not spent to review previous content material that students already understood unless it was related to the scientific process. However, not all days of the week were dedicated to the treatment. Typically 1-3 days per week were dedicated to some aspect of the scientific method.

One of the difficulties in ensuring fairness in comparing the two groups was making sure that the control group and the treatment groups still engaged in the same learning activities, but at different times. During days that the scientific method was part of the lesson, the control group received a different entry task, but to make sure that the totality of instruction was the same, the treatment groups always had the same questions asked of them, delivered in the same way, i.e. written, and were asked to write down their responses in the same place. This was to ensure that the same learning modalities were engaged for both the control group and the treatment groups. Typically my entry tasks have been designed to be short sentence answers to questions about the previous day's lesson or to elicit responses from students about prior knowledge for a new curricular concept. By focusing on the steps of the scientific process during the entry tasks, student progress throughout the quarter could be monitored and recorded. Appendix E shows a typical entry task from before this study compared to an entry task during the study. Note that both questions were asked of both the control and treatment groups, but at different times in the lesson. Students were given activities designed to practice of their knowledge of the scientific method. These did not always happen during the beginning of class, but were given at the beginning of class whenever possible.

In addition to the main thrust of this study, procedure writing was assessed at the end of the treatment to determine if correlation between the primacy effect was causal in the increase of the treatment group's performance. Theoretically, since procedure writing was not practiced at the beginning of class any more often for the treatment group compared to the control group, student ability should be relatively flat across the board, save for normal statistical differences.

These results of the study were shared with the science department to show the effectiveness of using the beginning of the class to improve our students' performance on scientific method skills. As a professional learning community our science department works closely together to share effective practices. The idea was to close the loop and to use the results from the assessments to drive instruction toward greater understanding of the scientific method beyond the classroom that the research occurred in. Unfortunately, since the students involved in the study will not take the MSP in science until their 8^{th} grade year, the full measure of the impact will have to wait three years. The hope is that the training that these students have received, combined with the furthering education in 7^{th} and 8^{th} grade will allow them to boost science scores as a whole for McKnight.

A summary of the data collection techniques can be found in Table 1.

Table 1
A Summary of Data Collection Techniques

	Science Survey	Sample lab activities	Lab Notebook
Effect of the primacy effect to increase student ability to identify scientific method vocabulary	X	X	X
Effect of the primacy effect to increase student ability to identify parts of a scientific investigation through mock experments		X	X
Student ability to write a detailed, step by step procedure complete with logical steps.			X

DATA AND ANALYSIS

All students were given the Student Science Survey in the pre treatment phase to identify their strengths and weaknesses in the scientific method (*N*=97). The average post treatment increase in correct Science Survey responses for the treatment group (*n*=72) was approximately 22% compared to approximately 11% for the control group (*n*=25). The average increase in identification of a hypothesis in the control group was 16%, while the treatment group increased an average of 28%. The average increase in identification of controlled variables in the control group was 23%, while the treatment group increased an average of 34%. The average increase in identification of manipulated variables in the control group was 11%, while the treatment group increased an average of 36%. The average increase in identification of responding variables in the control group was 40%, while the treatment group increased an average of 46%. The ability to identify the number of manipulated variables decreased an average of 24% in the control group, while the treatment group increased an average of 4% (Figure 1)

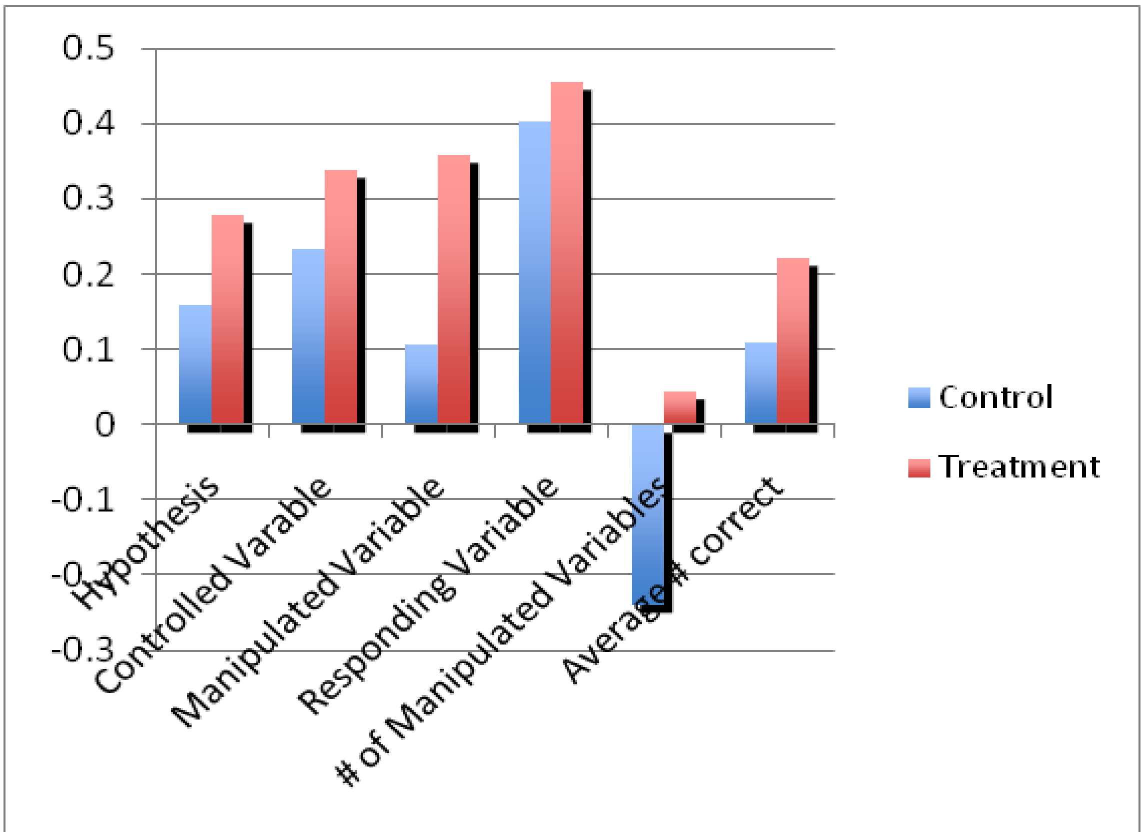

Figure 1. Change in Correct Responses to Science Survey Pre vs. Post Treatment, (*N*=97).

Students were also given two mock experiments (Appendices B and C) and asked to identify key parts of an experiment from them. One mock experiment was given pre-treatment, and the other was given post-treatment.

When given a mock investigation, the control group increased their ability to identify the experiment's hypothesis an average of 18% compared to 15% for the treatment group. The control group increased 18% and 17% in their ability to identify a controlled and manipulated variables respectively, compared to 28% and 29% for the treatment group. The control group decreased 7% in their ability to identify the responding variable, whereas the treatment group increased 40%. The overall score increase by the control group was 11% while the treatment group increased by 33%.

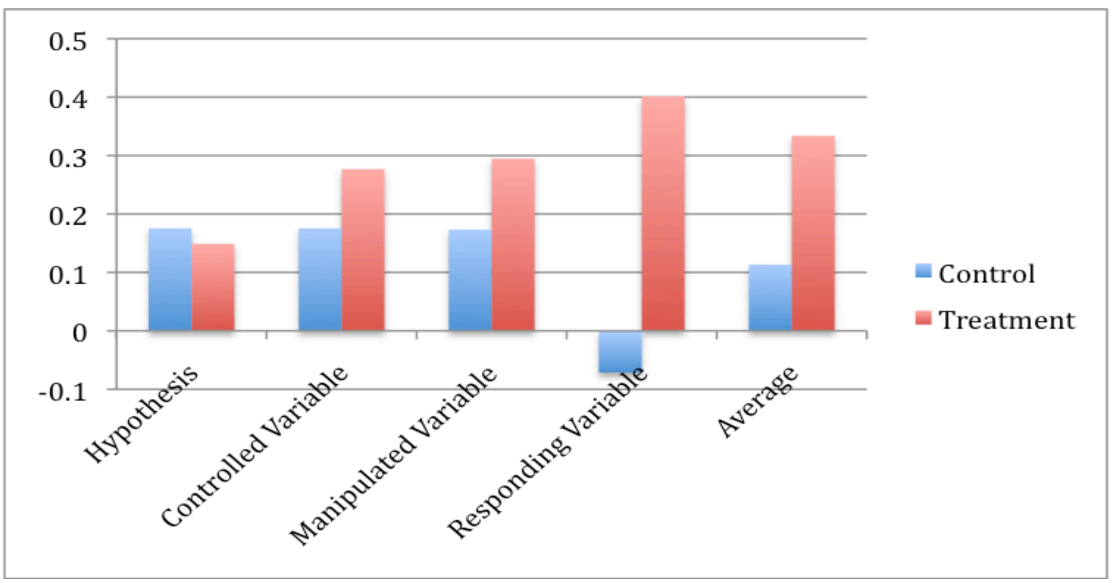

Figure 2. Change in Correct Responses from a Mock Experiment Pre vs. Post Treatment, (*N*=97).

On the Pre-treatment Science Survey (Appendix A), approximately 11% of all students gave a correct response to all five questions on the survey whereas approximately 30% gave no correct responses at all. Approximately 28% of the students gave one correct response. Approximately 5% gave four correct responses, 11% gave two correct responses and 15% gave three correct responses On the Post-treatment Science Survey (Appendix A), approximately 17% of all students gave a correct response to all five questions whereas approximately 9% gave no correct responses at all. Approximately 9% of the students gave one correct response. Approximately 25% gave four correct responses, 15% gave two correct responses and 22% gave three correct responses (Figure 3).

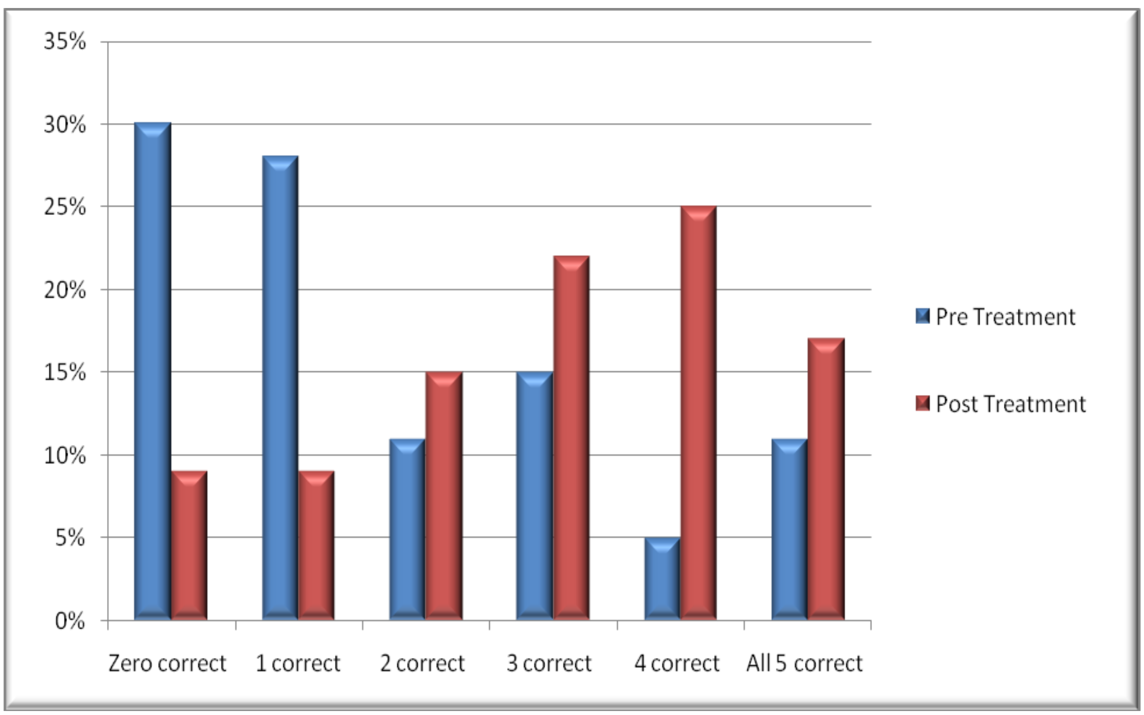

Figure 3. Pre vs. Post Treatment Percentage of Correct Responses, (*N*=97).

The question on the Pre-treatment Science Survey (Appendix A) answered with the most correct responses (*n*=60) involved identifying a hypothesis with 58% of all students answering correctly. On the other end of the spectrum, when asked to identify a responding variable, approximately 18% correctly answered the question. When all students were asked to identify a controlled variable, manipulated variable, and how many manipulated variables exist in a proper scientific experiment, they correctly responded 32%, 34%, and 30% of the time.

In the post treatment phase of the Science Survey, students were assessed at the end of the treatment with the same questions as before the treatment. When asked to identify a hypothesis, 83% of all students were able to do so. Sixty-five percent of students were able to identify and define a controlled variable. Sixty-one percent of students could identify and define a manipulated variable. Sixty-two percent could identify a responding variable and thirty-three percent could identify the correct number of manipulated variables in a proper experiment. Overall student correct responses increased to an average of approximately 62% (Figure 4).

No question from the Science Survey showed an overall decrease in correct responses. The change for all students was most dramatic in the question about responding variables, where they increased 40%. The smallest change was in identifying the correct number of manipulated variables in an experiment. This increased approximately 3% (Figure 4).

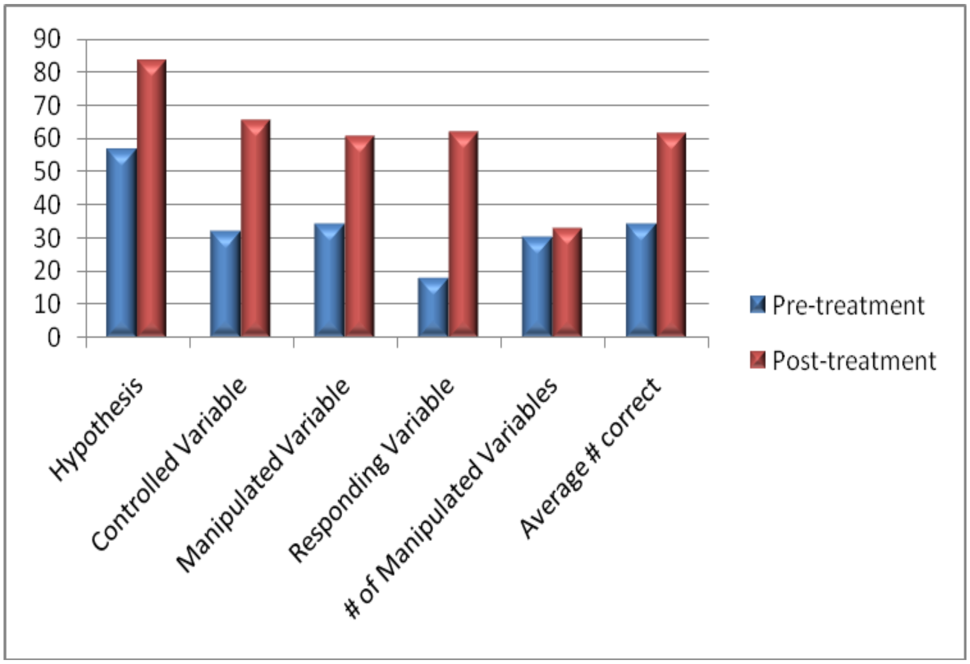

Figure 4.

Science Survey Percent Correct Responses by Question, (*N*=97).

The second set of data analyzed was students' ability to identify parts of a scientific experiment from a sample experiment. When given a mock experiment (Appendix B), the control group was initially able to identify the experiment's hypothesis 68% of the time, compared to 85% of the time in the treatment group. The control group was initially able to identify a controlled variable 68% of the time compared to 72% for the treatment group. The control group was able to identify the manipulated and responding variables 64% and 50% of the time respectively, compared to 62% and 51% for the treatment group.

In the post –treatment phase, students were assessed on a second mock experiment (Appendix C). The control group was able to identify a hypothesis 86% of the time, compared to 100% of the time in the treatment group. Coincidentally, the control group was also able to identify a controlled variable 86% of the time compared to 100% for the treatment group. The control group was able to identify the manipulated and responding variables 81% and 43% of the time respectively, compared to 91% for both in for the treatment group. The average overall score for the control group was 74% compared to the treatment group which scored an average of 96% (Figure 5).

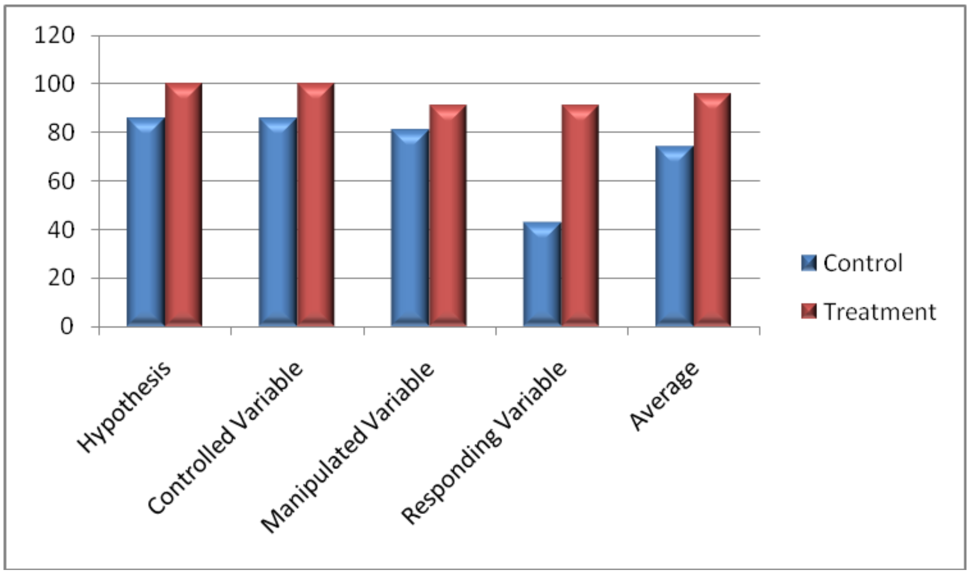

Figure 5. Final Average Correct Mock Experiment, (*N*=97).

Students were assessed post-treatment on the ability to write clear and logical procedures. In the control group, 62% of the students wrote clear, step by step procedures complete with measurement details, whereas 67% of the students in the treatment group did the same. This 5% difference is less than the gains made by the treatment groups over most of the variables.

INTERPRETATION AND CONCLUSION

First and foremost, this study reaffirms a well-known rule of teaching: practice of skills leads to greater student achievement. Before interpreting any results of this study, this basic maxim of teaching must be acknowledged. This is shown throughout the study as one observes the scores of students from the beginning of the study to the end of the study. In both the treatment and control group student ability to identify parts of the scientific method increased dramatically.

The data shows that students in the treatment group consistently outgained their peers in assessments on the same subject matter. The data only extremely rarely showed students in the control group outgain the treatment group in any section of assessment. On this rare occasion when the control group did outgain the treatment group, the difference was very small. Additionally the number of assessed variables showing a large swing in favor of the treatment group is far greater by comparison.

The relatively equal distribution of scores of students in the control group and in the treatment group goes to underscore that the treatment had positive effects on student achievement. If students in the treatment group could be shown to consistently outperform the control group in this area as well, it could go to show that there was something internal or external influencing the results of the study. Though we cannot possibly eliminate all of this type of influence from the study, the data does go to show that significant inconsistencies of internal or external factors likely do not exist.

The conclusion that students who receive specific instruction at the beginning of class will outperform students who get that instruction later is not without important reservations. Given the relatively small sample sizes, the margin of error is inconsistent with the ability to make widespread judgments about the practice. The data supports the original hypothesis that the early part of a lesson is most memorable, but quantifying that effect without a much larger sample size is problematic. Additionally other, hard to quantify effects cannot be discounted in this data set either. It is ostensibly possible that the instruction given to students in the control group was not as high in quality due to outside environmental factors, or to my own subconscious motivation. Extreme care was taken to keep this subconscious sabotage from being the case, but it cannot be discounted, especially given the dynamic nature of instruction and the small sample size of the students assessed.

For further study, this effect should be studied on a greater scale and take into account the difficulty in removing outside influence from affecting results. Comparing two different teachers who teach the same concepts at different points in the lesson can contribute to the body of work supporting this important phenomenon, even when there are new sets of inconsistencies with that procedure. Only with large-scale study with a large sample size and repeated over many trials with different instructors will we be able to quantify accurately the primacy effects' influence on student achievement. More studies in more varied environments will provide a clearer conclusion.

In addition, further study may be able to identify the impact the primacy effect has on different types of skills students use. It seems to reason that over time lower level skills can be picked up by most students given enough repetition regardless of the time period instruction happens. In fact, the results of that study suggest that, since the control group also made significant gains in performance. It could be that higher level thinking may take more instruction, and therefore utilizing the primacy effect may be even more effective. Clearly this effect has advantages, the level and scope of which are deserving of more attention and study.

VALUE

This study had a positive impact on my teaching very early on in the process. Even before assessments began to show that students in the treatment group were outperforming their peers in the control group, I could tell through informal assessments that the retention rate was higher. The purpose of any project based on the action research model is to make value judgments as to whether the treatment is worth continuing in the future. The results of this study show me that the answer to that question is unequivocally yes. The degree to which the treatment was effective can be called into question due to a small sample size, but the results are consistent enough to show that continued use of this technique is warranted.

In the larger context of teaching, the implications of this study show that the student retention rates can be higher for specific skills that are introduced in the beginning of a lesson. The changes I take out of the results of this study follow a basic schedule: 1) instruct on new skills 2) give practice opportunities of those skills 3) assess. Since assessment drives instruction, the assessment given at the end of the class period can be used to drive the instruction of the next day. Though this schedule seems logical, I have found that over time the push to fit curriculum into a specific time frame pushes instruction to where it fits most conveniently, rather than where it is most effective.

There is also a not-so-subtle lesson from this study about respecting the attention spans of learners. I know that the attention spans of my students are rarely greater than

15 minutes (Cafarella, 2009A), which means in a typical class I may need to re-engage my students three times. In the future I plan on making sure that my lesson development respects that idea.

If anything, the results to the study also serve to remind us that practice of skills is extremely important for student achievement. I was surprised to see how consistently students in the treatment outperformed the control group, but I was equally impressed with the gains of students across the board.

REFERENCES CITED

Anderson, N. (1965). *Primacy effects in personality impression formation using a generalized order effect paradigm.* Journal of Personality and Social Psychology, *2*(1), 1-9.

Ashe, S. *Forming impressions of Personality* (1946) Retrieved January 13, 2011 from http://www.all-about-psychology.com/solomon-asch.html.

Black, P and Dylan, W. (2001). *Raising Standards Through Classroom Assessment.* Wimbledon, London, UK.

Cafarella, J. (2009). *A Trip Down Memory Lane.* Retrieved January 27, 2011from http://sciencegnus.com/fivememorylanes60minute.pdf (A)

Cafarella, J. (2009). *Primacy Recency Effect*. Retrieved April 27, 2011 from http://sciencegnus.com/Primacy%20Recency%20Effect.pdf. (B)

Jones, F. (2000). *Tools For Teachers*. Fredric H. Jones & Associates: New York.

Lee, Y. (2001). *Primacy effects on Impression Formation.* California State University, Fullerton. Retrieved 3/29/2011 from http://psych.fullerton.edu/mbirnbaum/psych466/ykl/report.htm.

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement*Association for Supervision and Curriculum Development: Alexandria, VA.

Office of the Superintendent of Public Instruction. (2011) *Washington State Report Card*. Retrieved 4/29/2011 from http://reportcard.ospi.k12.wa.us/summary.aspx?groupLevel=District&schoolId=1314&reportLevel=School&orgLinkId=1314&yrs=&year=2007-08.

Smith, M. *The Forgotten Middle Child of Memory: the Serial Position Effect.* Retrieved 4/27/2011 from http://frank.mtsu.edu/~sschmidt/Cognitive/sample_report.htm.

Wong, H. (2000) *How to Start a Class Effectively*. *The Gazette* Retrieved 4/30 from http://teachers.net/wong/OCT00/. (A)

Wong, H and R Wong. (2000). *The First Five Minutes Are Critical. The Gazette*_ Retrieved 4/30/2011 from http://teachers.net/wong/NOV00/. (B)

APPENDICES

APPENDIX A

STUDENT SCIENCE SURVEY

APPENDIX A

STUDENT SCIENCE SURVEY

Student Science Survey

In scientific experiments we identify many terms. Please answer these questions as accurately as possible.

What is a hypothesis?

What is a controlled variable?

What is a manipulated variable?

What is a responding variable?

How many manipulated variables can you have in a proper scientific experiment?

APPENDIX B

MOCK INVESTIGATION A

APPENDIX B

MOCK INVESTIGATION A

Jenny wanted to test the effect of water on the height of plants. She took three containers with plant seeds in them. All of the seeds had their sunlight and soil kept the same. Each day she added a certain amount of water to them and recorded the plants' height after 60 days. One plant got 10 milliliters of water each day. One plant got 20 milliliters of water each day and one plant got 30 milliliters of water each day. Jenny predicted that the plant with the most water would grow the highest.

Diagram:

Data:

	10 milliliters of water	20 milliliters of water	30 milliliters of water
Height of plant	55 centimeters	80 centimeters	65 centimeters

What was Jenny's Hypothesis?

What was one controlled variable in this experiment?

What was the manipulated variable in the experiment?

What was the responding variable in the experiment?

APPENDIX C

MOCK INVESTIGATION B

APPENDIX C

MOCK INVESTIGATION B

Danny wanted to test the effects of cigarette smoke on the lifespan of crickets. He took three containers with one day old crickets. He made sure he fed and watered them every day of the experiment. One container had a cricket with no cigarettes. The next container had one lit cigarette lit in it. The last container had two lit cigarettes in it. Every day the cigarettes were replaced with new ones. Danny predicted that the cricket with the most cigarettes in its cage would have the shortest life span.

Diagram:

Data:

	Cricket with no cigarette	Cricket with one cigarette	Cricket with two cigarettes
# of days alive	345	120	10

What was Danny’s hypothesis?

What was a controlled variable in this experiment?

What was the manipulated variable in the experiment?

What was the responding variable in the experiment?

APPENDIX D

CONCLUSION WRITING PROGRESS REPORT

APPENDIX D

CONCLUSION WRITING PROGRESS REPORT

Conclusion writing progress report
Check your lab partner for the four parts of a scientific conclusion.

Does their conclusion answer the investigative question? If it does, write down the sentence that answers the question. If not, write one for them.

Does their conclusion include Both high AND low data? If so, what are they. If not, write them down.

Does their conclusion show how the data supports the answer to the investigative question? If so, write down the sentence(s) that do so. If not, write one for them.

If your partner were to get a score for the MSP, what would it be? ____/4

APPENDIX E

COMPARISON OF ENTRY TASKS

APPENDIX E

COMPARISON OF ENTRY TASKS

PRIOR TO STUDY

You WILL need your lab notebook today!

Welcome! Please fill out your objectives and open up to your Warm-ups section of your lab notebook.

In class yesterday we identified bacteria as having all of the many characteristics of life. Sammy says that fire is alive because it uses energy, reproduces, exchanges gases, and produces waste. Do you agree with her? Why or why not?

DURING STUDY

You WILL need your lab notebook today!

Welcome! Please fill out your objectives and open up your lab notebook to your bacterial yogurt investigation from yesterday. Today we will be identifying anything that makes this investigation “less fair.” Please identify 3 things that might have made the results inaccurate.

APPENDIX F

ENTRY TASK VIDEO

APPENDIX F

ENTRY TASK VIDEO

- On the next open page of your lab notebook please add the title “Mythbusters variables” to the top of the page. For the arrow on horseback myth we will be identifying the…..
- Manipulated variable

  AND
- Responding variable

APPENDIX G

VARIABLE PRACTICE

APPENDIX G

VARIABLE PRACTICE

- Welcome! Please fill out your objectives and finish these statements in your warm-ups section.
- A controlled variable is the variable you ____
- A manipulated variable is the variable you ___
- A responding variable is the variable you ____

APPENDIX H

PROCEDURE WRITING

APPENDIX H

PROCEDURE WRITING

Please fill out your objectives and open your lab notebook to the “plant investigation” page.

Today you will:

1. **Write your final question, hypothesis and variables in your lab notebook.**
2. **Finalize your procedure and write it in your lab notebook**
3. **Finalize your diagram and write it in your lab notebook.**
4. **Begin your plant investigation**

APPENDIX I

CONCLUSION PRACTICE

APPENDIX I

CONCLUSION PRACTICE

- Welcome! Please fill out your objectives and write a conclusion to this experiment in your Warm ups section.

Question: Which do mice prefer, cheese or peanut butter?

Shelley	**Stan**	**Annie**	**Wilfred**
0.02 Grams of lettuce	0.005 Grams of lettuce	0.1 Grams of lettuce	0.01 Grams of lettuce