

EFFECT OF REFLECTION ON STUDENT ACHIEVEMENT AND SELF-  
CONFIDENCE IN THE SCIENCE CLASSROOM

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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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.

Sara Danielle Grotbo

July 2014

## ACKNOWLEDGEMENTS

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**ABSTRACT**

The focus of this project was on the use of guided reflection in the middle school science classroom. Students reflected using various strategies both at the beginning and end of each class period. The goal of the project was to see how this daily reflection would affect student achievement and self-confidence for the learning goals of a unit. Students' achievement and self-confidence was evaluated by several methods: pre- and post-tests, surveys, interviews, student notebooks and direct observation. The results of the study indicated positive increases in both achievement and self-confidence with the addition of reflection activities to the science classroom.

## INTRODUCTION AND BACKGROUND

Currently, I am an eighth grade physical science teacher at Helena Middle School (HMS) in Helena, Montana. The previous two school years I was teaching seventh grade life science, English, history, computer and religion to seventh graders, as well as teaching fifth grade science and sixth grade English and computer at St. Andrew School in Helena, Montana. St. Andrew School is a non-diocesan Catholic private school. From August 2008 to June 2011, I taught seventh and eighth grade science at North Middle School in Great Falls, Montana. Moving frequently from the start of my career in education has had its challenging moments, but I am truly enjoying my position at Helena Middle School.

Helena, Montana, is a larger town with a population of 29,134, according to the U.S. Census Bureau's 2012 estimate. Of these people, 93.3% are identified as "White." The median household income from 2008-2012 was \$49,445, with a percent of all ages of people in poverty, during the same time period, being 12.8%. While the percent of people, 25 or older, having graduated from high school, is 95.3%, the percent of these same people holding a bachelor's degree is 46.2% (U.S. Census Bureau, 2014).

Helena Middle School is one of two public middle schools within the city limits. The total student body, as reported on November 22, 2013, was 661 students. The current eighth grade population on that date was 216 students. Ethnicities reported were 6.5% American Indian/Alaska Native, 0.5% Asian, 2.3% Hispanic or Latino, 1.9% Black or African American, 79.2% White Non-Hispanic, and 9.7% unclassified. Helena Middle School is a Title I school with 43% of students qualifying for free and reduced lunches (J. McKay, personal communication, November 22, 2013).

Throughout all disciplines and grade levels, there is a focus on our Montana Behavioral Initiative universals, “Be Safe, Be Responsible, Be Respectful, Be A Learner.” These universals are discussed and modeled in the various classrooms, announcements, and BOB (“Being Our Best at HMS”) lessons on a daily and weekly basis. In addition, the Helena Public Schools is implementing Multi-Tiered Systems of Support at the district level with a focus on graduation at all grade levels (Helena Middle School, 2013).

Within my classroom this year at HMS, students kept a record of all learning in a science notebook. This science notebook included a Daily Science (D.S.) question, which was generally a review question from the learner outcome or goal the day prior. The following are fairly typical for a daily science activity: *A blue whale can travel at a rate of 20 km per hour on average. How far could a blue whale travel in 1 day? Remember: distance = speed x time, or Describe a situation in which friction (or a lack of it) worked in your favor. Describe a situation in which it did not.* In addition to D.S. entries, the science notebook included all class notes, demonstrations, and hands-on activities. Students were sometimes allowed to utilize this resource on tests or quizzes. The science notebook, along with quizzes, tests, and projects, was then used as evidence of students attaining learning goals for a unit of study. At the beginning of each class period, students were introduced to the learning goal(s) for the day, along with a quick run-down of planned activities and assigned homework. The end of each class period consisted of a verbal review of the day’s goal(s), the homework requested, and a heads-up for the next day’s work.

Despite having use of science notebooks on some tests and quizzes, and the experience of hands-on activities and models, students did not always score well on tests and quizzes. In addition, I had noticed over the last five and half years of teaching that students, especially those in middle school, do not like to spend time reflecting on what they are learning, the process of learning, and how they are doing. I chose to focus on helping them learn to be learners through guided reflective practices. In short, the purpose of this classroom research project was to focus on student reflection and its effect on student achievement and self-confidence. The question derived from the purpose was, *Does student reflection on a daily basis increase student self-confidence and achievement of the learning goals in a unit of study?* In order to answer this question, students completed daily reflection activities in a science notebook to determine whether it indeed had an impact on their achievement and self-confidence.

### CONCEPTUAL FRAMEWORK

Metacognition was defined by John Flavel in the 1970s as the ability to think about thinking (Keeley, 2008). A metacognitive learner is a learner who knows how he or she best learns, constantly reflects on learning or achievement, and makes adjustments in order to progress towards learning goals (Tomlinson & McTighe, 2006). The ability to think about one's thinking requires a set of skills that can and should be taught in the classroom within the context of content area curriculum (Keeley, 2008). Student use of those metacognitive skills can lead to positive effects on achievement and attitude (Tomlinson & McTighe, 2006).

Teaching cognitive skills, such as metacognition, has been shown to increase achievement (Resnik, 1999). Students who are taught metacognitive skills tend to self-

regulate their thinking and thus develop better understandings of science concepts.

Research has also shown that conceptual change is dependent upon this ability in elementary grades. In addition, the inclusion of metacognitive skills in science instruction has helped students retain information longer and transfer the concepts to new situations easier than their counterparts who did not receive metacognitive instruction along with the science content (Abell, 2009). Student reflection helps students maintain cognizance of their own growth in learning, and therefore they tend to become higher achievers in the process (Stiggins, 2001). Even students with learning difficulties have made progress in achievement when they have been taught reflective strategies to aid their learning (Allen, 2007). It seems the bulk of research supports the idea that metacognitive and reflective strategies positively impact student achievement.

Psychological research has found positive correlations between self-confidence and metacognitive processes (Kleitman & Stankov, 2006). Student motivation is often influenced by what they think they can bring to classroom. If students believe they can do something, have the freedom to do it, and have some connection to the content, then they tend to be motivated to learn and are vested in solving the problem. One way to improve these student beliefs is through reflective thinking and metacognitive strategies (Jensen, 2009). Students who can develop metacognitive skills and can exhibit them tend to become self-confident in their ability to control their learning and tend to take ownership of their work (Waldman & Crippen, 2009).

Various metacognitive strategies have been employed by educators to research the impact on student achievement. These strategies include the use of guided reflection papers, science journals, interactive journals, reflective questions or prompts, and rubrics

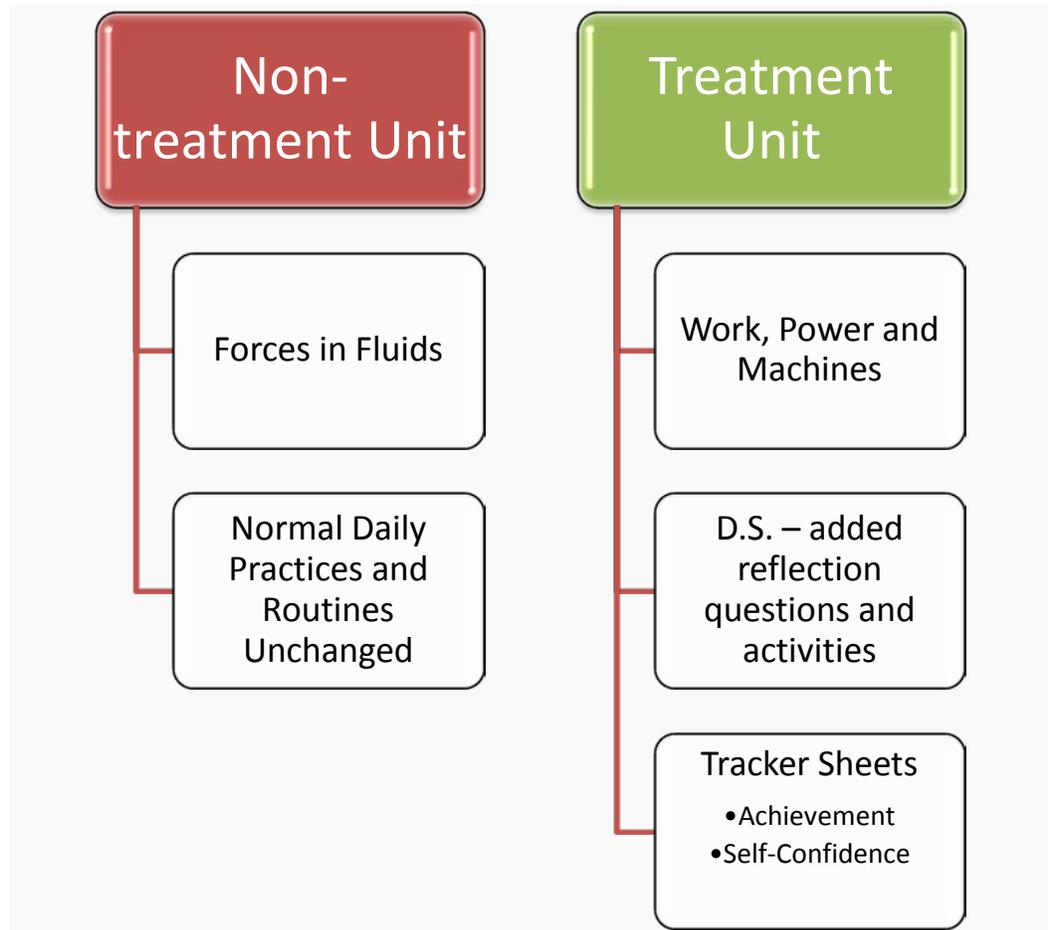
for self-assessment (MacDonald & Dominguez, 2009; Waldman & Crippen, 2009; Tomlinson & McTighe, 2006). Guided reflection papers use pre-formulated prompts to aid students in self-reflection (Waldman, 2009). These prompts encourage students to reflect on what they understand or do not understand, what went well and what did not, what was easiest to accomplish and what was most difficult, and what was learned and how learned concepts connect to other ideas or experiences (Tomlinson & McTighe, 2006). Similarly, reflective questions or prompts can be teacher or student generated in science journals. These journals provide record not only of student collection of data but the meaning constructed or not constructed from data analysis (MacDonald & Dominguez, 2009). Interactive journals allow for both student and teacher directed activities. Student directed activities are often centered on metacognitive processes (Walden & Crippen, 2009). Finally, self-assessment through the use of rubrics helps students identify strengths and weaknesses and create goals for improvement. A rubric can be adjusted to create the possibility of both student and teacher assessment. A reflective rubric should include a place for students to reflect on their performance and set personal goals (Tomlinson & McTighe, 2006).

While research, from both an educational standpoint and a psychological standpoint, indicate positive effects of reflection on student achievement and self-confidence, some suggest the need for caution. Evidence of learning thinking skills in the regular classroom is not thorough enough, according to Ron Brandt (2001), Association for Supervision Whiand Curriculum Development editor and consultant. On one side, it is argued that teaching thinking skills like metacognition by themselves has little effect on long term thinking ability and therefore should be taught with subject specific content

(Brandt, 2001). The counter-argument is that because teaching metacognitive skills increases a person's awareness of the skills and how to use them, they should be taught without the inclusion of content (Presseisen, 2001). It seems that the complex nature of thought continues to require additional research in specific contexts. The current discussion in the education field is that metacognitive skills should be taught within the context of content area curriculum, and that classroom research has shown positive effects on student achievement and attitude.

#### METHODOLOGY

The goal of this current study was to get students thinking about the material and their understanding of the material more often in order to become more confident in their ability to learn and to improve their academic achievement in the class. The first portion of the study included a pre-test and post-test on a unit taught and experienced by the students the way described in the background above. The second portion of the study included another pre-test and post-test, along with surveys and guided reflection activities designed to keep students thinking about what they were supposed to be learning and understanding and how well they were learning and understanding the goals in the unit. The following figure is a summary of the non-treatment and treatment unit differences (Figure 1).



*Figure 1.* Difference in the Non-treatment and Treatment units.

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).

The first unit taught served as a way of gaining baseline data for comparison. The Forces in Fluids Unit Goals were posted on the white board as covered in class, approximately one or two goals per day (Appendix B). The unit lasted approximately two weeks with the Forces in Fluids Test (Appendix C) being administered on the first and last day of the unit. This test was textbook generated and consisted of 28 multiple choice

questions. The data from the pre-test and post-test were compared for use in further data analysis with the second unit.

The second unit, based on the Work, Power, and Machines Unit Goals (Appendix D), began with student prior knowledge being assessed using the Work, Power, and Machines Test (Appendix E). Again, this test was a textbook generated test with 27 multiple choice questions. The results of this pre-test determined the flow of learning goals throughout the unit, as well as the amount of background knowledge covered in class. Students were also given a Reflection Survey at the start of the unit in order to gain an understanding of their views of reflection and their use of it as a strategy to increase comprehension (Appendix F). In addition to assessing student knowledge of work, power and machines, as well as reflection, students completed a Work, Power, and Machines Self-confidence Survey (Appendix G) in regards to their ability to accomplish the learning goals of the unit. Both surveys were scored using a Likert scale. The Reflection Survey responses were scored as follows: *Strongly Agree* (1), *Agree* (2), *Disagree* (3), *Strongly Disagree* (4) and *Unsure* (5). The Work, Power, and Machines Self-confidence Survey was scored: *None*, (1), *Low* (2), *Medium* (3), *High* (4).

Following pretesting, treatment began with students keeping a learning log of all activities within their science notebook as usual, along with the added inclusion of various guided reflection strategies that were utilized on a daily basis. These strategies were included as D.S. entries at the start of the class period and tracking sheets at the end of the period (Appendix H). Ten notebooks (two per class period) were assessed randomly on a daily basis for qualitative data with regard to student comprehension and

confidence. In addition, direct observations were noted daily as students engaged in the treatment activities. Treatment continued on a daily basis until the completion of the unit.

At the end of the unit, all students took the Work, Power, and Machines Test again (Appendix E). Student scores from the pre-test and post-test were compared for changes in achievement. In addition, students again completed the Reflection Survey and the Work, Power and Machines Self-confidence Survey (Appendices F & G). The pre-unit and post-unit scores were also compared for both surveys. Finally, three students per class period were randomly chosen and individually given the Student Post-Unit Interview (Appendix I).

The following data table (Table 1) is a summary of the data collection strategies used within the course of this project for the two-fold research goal of assessing the effect of reflection on student achievement and self-confidence. Note that the focus question has been split into two parts for the ease of listing data collection strategies applied to each section of the question.

Table 1  
*Data Triangulation Matrix*

Focus Question	Data Source 1	Data Source 2	Data Source 3	Data Source 4	Data Source 5
1. Reflection increases student achievement of learning goals	Work, Power, and Machines Test (Pre-test and Post-test)	Reflection Survey (Pre-survey and Post-survey)	Student Interviews	Student Notebooks	Direct Observation
2. Reflection increases student confidence in their ability to achieve learning goals	Work, Power, and Machines Self-Confidence Survey (Pre-survey and Post-survey)	Reflection Survey (Pre-survey and Post-survey)	Student Interviews	Student Notebooks	Direct Observation

## DATA AND ANALYSIS

The results of the Forces in Fluids Test in the non-treatment unit indicated that students scored an average of 10 points higher on the post-test than on the pre-test instrument ( $N=107$ ). When taking the Work, Power, and Machines Test in the treatment unit, students scored an average of 17 points higher on the post-test ( $N=107$ ). This translated to a 17% average gain for the non-treatment unit and a 31% average gain for the treatment unit. The class average on both post-tests was 68%, below a C.

The major themes identified in the Reflection Survey (Appendix F) were the following: student understanding of reflection, their perceived frequency of reflection, their reflective practice outside of the classroom, and their opinion on the effect of reflection on learning and self-confidence. The pre-survey was completed by 108

students, while the post-survey was completed by 98 students. The modes and averages did not vary much. The mode for all Reflection Survey responses was *Agree*. While student Likert averages declined slightly in their perceived frequency of reflection, their reflective practice outside of the classroom increased slightly. Their understanding of reflection average was lower on the post-survey than the pre-survey, 1.8 and 1.9 respectively. Student reflection on what came easily to them increased slightly, but student reflection on what was difficult for them and why remained the same. Student results regarding whether reflection helps self-confidence differed from mode to average, mode decreasing from *Strongly Agree (1)* to *Agree (2)*, but the average increasing from 2.2 to 2.3 (Table 2).

Table 2

*Pre- and Post-Unit Reflection Survey Results*

Key: 1=Strongly Agree, 2=Agree, 3=Disagree, 4=Strongly Disagree, 5=Unsure,  
Pre-survey (N=108), Post-survey (N=98).

Statement	Pre-Survey Mode	Post-Survey Mode	Pre-Survey Average	Post-Survey Average	Pre- to Post-Survey Change in Average
I know what it means to reflect.	2	2	1.9	1.8	-0.1
I often reflect on how I learn best.	2	2	2.3	2.1	-0.2
I often reflect on what is difficult for me and why.	2	2	2.2	2.2	0
I often reflect on what is easy for me and why.	2	2	2.0	2.1	0.1
I often reflect on the information I learn in class.	2	2	2.4	2.2	-0.2
I reflect on a daily basis.	2	2	2.7	2.6	-0.1
I reflect on a weekly basis.	2	2	2.2	2.1	-0.1
I reflect on what I've learned outside of class time.	2	2	2.2	2.3	0.1
I think reflection can improve my learning.	2	2	2.1	2.0	-0.1
I think reflection can improve my self-confidence.	1	2	2.2	2.3	0.1

Science notebooks on day one of the testing unit showed that students at least had a basic understanding of what reflection was. When asked what it meant to reflect on learning, many students used the words “look back” or “think about.” Student responses paralleled many of the survey statements. For example, several of the Reflection Survey statements dealt with the difficulty of information and reflection on why it was difficult or easy. Students noted in their definition of reflection that it is thinking about what they

did well or what they did not, what they found difficult to do or understand, and what they found easy. While many equated reflection with review of information taught, others noted that reflection included evaluation of their learning or performance, writing statements like reflection is to “think about what could have been done better.” Finally, other students related reflection to finding “real-life” significance. One student defined reflection as taking a look at “what you got out of” the lesson. Another student stated that it was seeing “how you can apply it to your life.”

Eleven out of the 15 students interviewed answered in the affirmative that reflecting in their science notebook at the beginning of each day helped them with the learning goals for the unit. The remaining four students that did not answer *yes* said “sort of,” “sometimes,” and “a little bit.” When asked why it helped, students answered, “It helped me remember how to do something,” “It helped keep me on track of where I was and where I wanted to be,” and “It was like a review that made me understand it more.” When asked if reflecting at the end of the period helped, the majority of students interviewed again said *yes* because it helped them study and remember the information better, as well as it helped them see what they still needed to work on. All students stated that reflecting should continue in class, although not necessarily by doing daily reflection activities. Finally, all but one student agreed that their self-confidence was helped by reflecting. One student went on to explain, “It made me feel like I could accomplish goals in a few days.” Another student stated that it made her feel “confident that I could learn and be good at it.”

The Work, Power, and Machines Self-Confidence Survey (Appendix G), given prior to the start of the treatment unit, indicated that students felt low to medium

confidence in their ability to attain the learning goals for the unit. The modes for each of the learning goals ranged from *Low* confidence (2) to *High* confidence (4) (Figure 2).

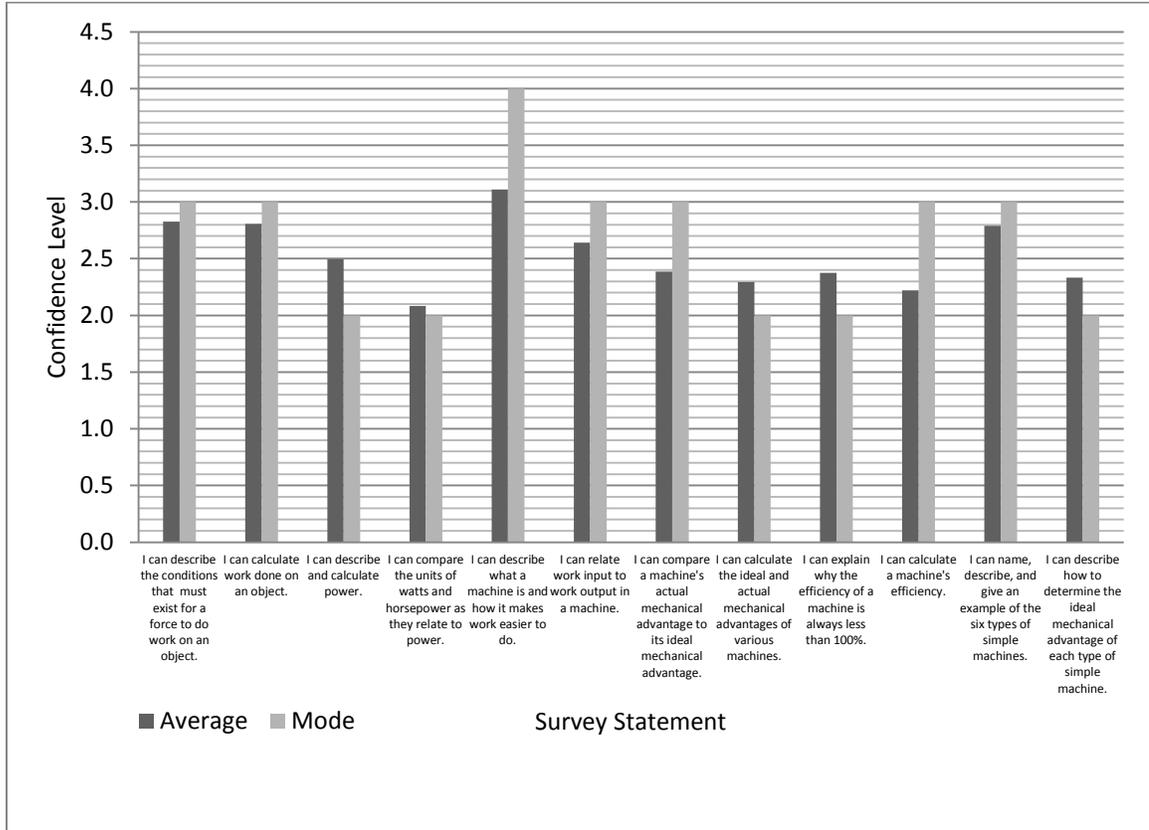
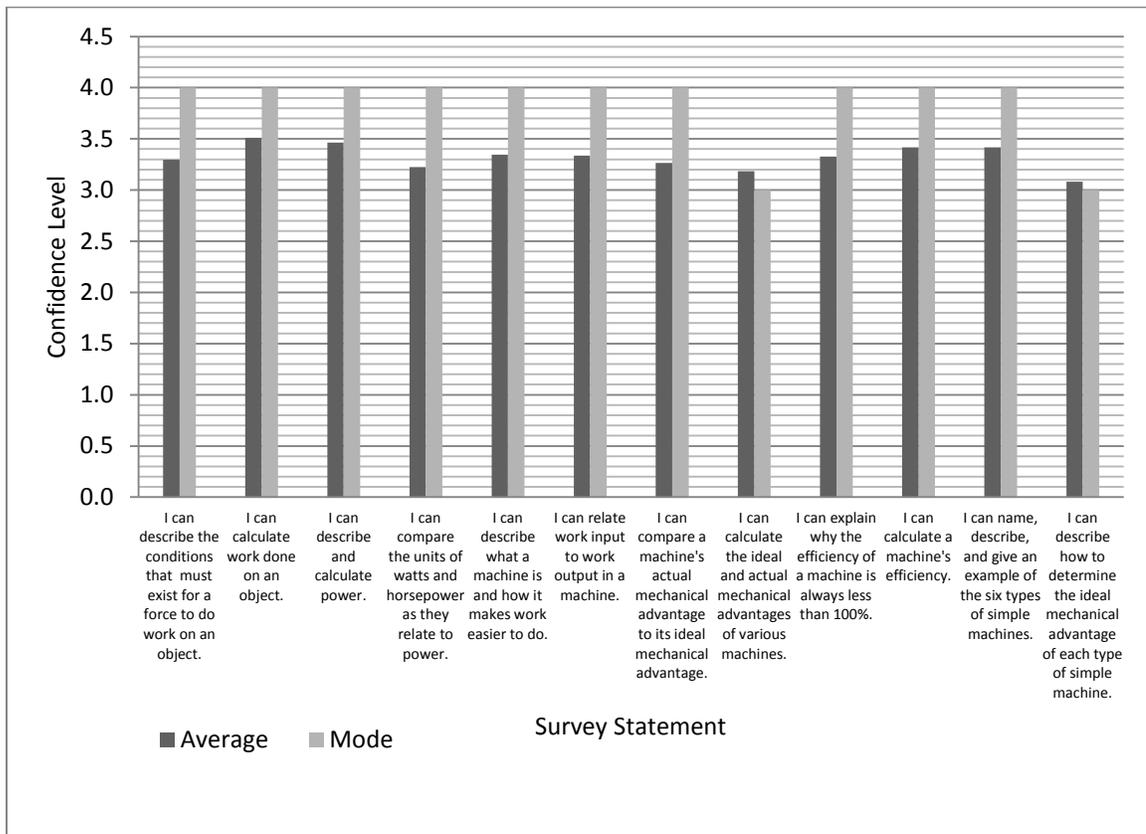


Figure 2. Average and mode of responses to the pre-unit Work, Power, and Machines Self-Confidence Survey, (N=109). 1=None, 2=Low, 3=Medium, 4=High

In the post-unit Work, Power, and Machines Self-Confidence Survey, the mode responses increased from low to medium confidence to mostly high confidence with a few medium confidence marks (Figure 3).



*Figure 3.* Average and mode of responses to the post-unit Work, Power and Machines Self-Confidence Survey, ( $N=98$ ). 1=None, 2=Low, 3=Medium, 4=High

The average confidence level increased across the learning goals from the pre-unit survey to the post-unit survey. In response to being asked if and how reflecting helped self-confidence, one student stated, “I think it made me more confident cause I remembered what we were learning about. It kept it in my mind.” Another said, “Yes, it helped me be more confident with homework. I didn’t have check as much.” A third student stated, “It raised it. I could see how good I was doing.” The average responses for the post-survey were all three (medium confidence). The pre-survey indicated averages ranging from approximately low (two) confidence levels to medium (three) confidence levels.

## INTERPRETATION AND CONCLUSION

This project provided evidence that supports the idea that guided student reflection on a daily basis helps students in their achievement of the learning goals for a unit of study as well as their self-confidence in attaining those learning goals. In terms of increased achievement, students in the treatment unit showed a greater gain from pre-test to post-test than in the non-treatment unit. Students also commented positively when interviewed that reflection helped them achieve the learning goals by helping them to remember the information and track their progress better. Students also gained self-confidence through reflection. The Work, Power and Machines Self-Confidence Survey provided evidence that the level of self-confidence indicated by students increased for every learning goal of the unit from the first time they took the survey to the second and final time. Student interview responses again provided further evidence of students finding reflection helpful in increasing their self-confidence throughout the unit as well as their achievement.

While it provided positive evidence in terms of achievement and self-confidence, this project had both its challenges as well. First, students needed more time and practice with reflection. Even though they indicated they knew what reflection was, their short and sometimes nonexistent answers to the reflection activity portion of the D.S. suggested they perhaps did not understand the activity or did not want to engage in that activity. Some typical answers included “IDK,” “everything,” and “nothing” (Figure 4).

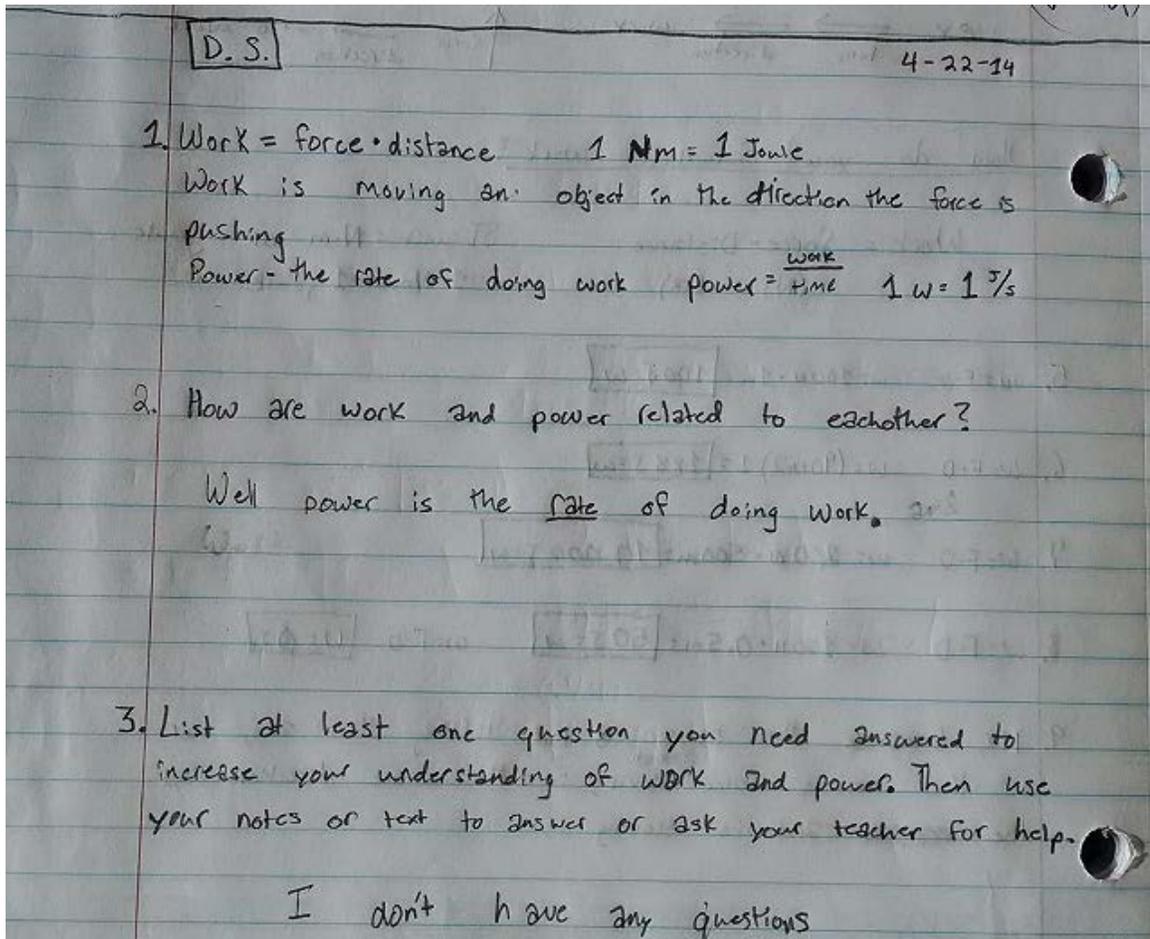


Figure 4. Example of student D.S. responses.

Students *agreed* that they reflected on a daily and weekly basis, when it was a struggle to get them to do so in class for a short seven-day unit. These eighth graders seemed to overestimate their reflection frequency and ability to reflect.

Second, the use of particular reflection activities seemed to engage students better and increase their knowledge of the content area learning goals and their confidence. Students indicated liking the Achievement Tracker when interviewed, and it served for many students as a study guide (Appendix H). The downside to the tracker sheet was that again students overestimated their understanding of the learning goals. They marked that they could complete the learning goals without help from teacher or text, yet their post-

test scores indicated different levels of achievement. Similar to the Achievement Tracker, the Self-Confidence Tracker (Appendix H) was used as one of the end-of-day reflection activities. Students were often confused about whether the sheet wanted what they believe they could do now versus in the future. It is for this reason, that use of this activity will not be continued.

Finally, one of the biggest challenges by far was motivating students late in the year. The first time students took pre-surveys, they were more than happy to oblige because it was something new. The second time, more than a few groans were heard. In addition, it was getting more difficult for students to independently complete their D.S. entries at the beginning of class. This is something they had been doing well since the beginning of the year, but their participation decreased as the year was closing. Students left more than a few blank D.S. activities and reflection activities.

#### VALUE

Overall, I found that reflection increased student achievement. While it may have not been as much improvement for all students as I wanted, it was improvement for many of them. Next year, I will be continuing to include more and more guided reflection activities in the hope that as students have more experience with it, they will improve. I need to develop varied ways of getting students to reflect, potentially with the use of different technology and web-based quizzes and surveys. My hope is that students will not tire of one strategy of reflecting. Students also need more direct instruction in terms of what the different types of reflection are and what helpful reflection looks like versus what unhelpful reflection looks like.

One particular activity that I plan to utilize for each unit I teach next year is the Achievement Tracker (Appendix H). Because students over- or underestimated their achievement based on comparison to test scores, I want to include a place for students to describe what each learning goal looks like, and I will provide examples of student work in order to help them visualize each of the achievement levels. My hope is that this will avoid some of the confusion I observed during my project. In addition, I plan to include peer evaluation on the sheet in order for students to have another person assess their learning as well.

While I do not plan on continuing the Self-Confidence Tracker (Appendix H), I will continue having students monitor their self-confidence in some way. I may use small Likert surveys, written or online. Student self-confidence is attached to their attainment of the learning goals, so student self-confidence should improve as their understanding and achievement improves.

My research into the area of guided reflection will continue, as I search for more engaging and effective reflection strategies and continue assessing the value of the strategies I am currently using. I would like within this next year to focus on subgroups within my classroom. New questions, like *How does reflection help my students who struggle with reading or math?* and *How does reflection help my lower income students?*, are going to drive this next school year.

While completing this project, I found that my reflection on my teaching increased as I asked students to reflect on their learning. My reflection not only had the ability to increase my understanding of where students were, but also my ability to see what they needed. This made me feel more confident in preparing materials for individual

students and small groups of students. I always had the desire to keep a reflection journal to help me with planning the next year's lessons, to know what went well and what did not. Yet, I have not successfully stuck with it. The results of this project showed me that the combination of my reflection with student reflection is well worth the effort.

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APPENDICES

APPENDIX A

IRB APPROVAL FORM



## INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects  
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### MEMORANDUM

**TO:** Sara-Danielle Grobbo and John Graves  
**FROM:** Mark Quinn, Chair *Mark Quinn*  
**DATE:** December 5, 2013  
**RE:** "Effect of Retention on Student Achievement and Self-confidence" [SG120513-EX]

The above research, described in your submission of December 5, 2013, 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

FORCES IN FLUIDS UNIT GOALS

## FORCES IN FLUIDS UNIT GOALS

1. I can describe and calculate pressure.
2. I can identify appropriate SI units for measuring pressure.
3. I can describe the relationship between water depth and the pressure it exerts.
4. I can describe how forces from pressure are distributed at a given level in a fluid.
5. I can explain how altitude affects air pressure.
6. I can describe how pressure is transmitted according to Pascal's principle.
7. I can explain how a hydraulic system works to change a force.
8. I can explain how the speed and pressure of a fluid are related according to Bernoulli's principle.
9. I can explain the effect of buoyancy on the apparent weight of an object.
10. I can explain Archimede's principle in terms of volume displaced and buoyant force.
11. I can describe the relationship among object density, fluid density, and whether an object sinks or floats in a fluid.
12. I can describe the relationship among object weight, buoyant force, and whether an object sinks or floats in that liquid (Wysession, Frank, & Yancopoulos, 2011, 388A).
13. I can build a Cartesian diver and explain how it works.

APPENDIX C  
FORCES IN FLUIDS TEST

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

ID: A

**Chapter 13 Test****Multiple Choice***Identify the choice that best completes the statement or answers the question.*

- \_\_\_\_\_ 1. In order to calculate pressure exerted on a surface, what quantity is divided by the surface area?
- |             |           |
|-------------|-----------|
| a. altitude | c. mass   |
| b. force    | d. volume |
- \_\_\_\_\_ 2. If the air inside a balloon exerts a force of 1.5 N on an area of 0.5 m<sup>2</sup>, what is the pressure inside the balloon?
- |                         |                         |
|-------------------------|-------------------------|
| a. 0.5 N/m <sup>2</sup> | c. 2.5 N/m <sup>2</sup> |
| b. 1.5 N/m <sup>2</sup> | d. 3 N/m <sup>2</sup>   |
- \_\_\_\_\_ 3. What is the SI unit of pressure?
- |                      |               |
|----------------------|---------------|
| a. g/cm <sup>3</sup> | c. the newton |
| b. m/s <sup>2</sup>  | d. the pascal |
- \_\_\_\_\_ 4. A pressure of 70 N/m<sup>2</sup> equals
- |           |             |
|-----------|-------------|
| a. 7 Pa.  | c. 700 Pa.  |
| b. 70 Pa. | d. 7000 Pa. |
- \_\_\_\_\_ 5. Where is fluid pressure greatest?
- 30 centimeters below the surface of a swimming pool
  - 1 meter below the surface of a swimming pool
  - 2 meters below the surface of a swimming pool
  - The pressure is the same in all parts of a swimming pool.
- \_\_\_\_\_ 6. Which of the following materials is NOT a fluid?
- |         |             |
|---------|-------------|
| a. air  | c. gasoline |
| b. cork | d. water    |
- \_\_\_\_\_ 7. Which of the following is NOT possible?
- compressing 10 liters of oxygen gas into a 1-liter volume
  - compressing 2 liters of water into a 1-liter volume
  - filling a balloon using helium gas from a pressurized tank
  - allowing 5 liters of compressed air to expand to a volume of 100 liters
- \_\_\_\_\_ 8. The pressure of a fluid at a specific depth
- depends only on the type of fluid.
  - is exerted only in the downward direction.
  - varies with the total volume of the fluid.
  - all of the above.
- \_\_\_\_\_ 9. Two identical test tubes are filled with equal volumes of water and mercury. Which of the following statements is true?
- The weight of both liquids is the same.
  - The bottom area of both test tubes is the same.
  - The pressure at the bottom of both test tubes is the same.
  - All of the above.

APPENDIX D

WORK, POWER, AND MACHINES UNIT GOALS

## WORK, POWER, AND MACHINES UNIT GOALS

1. I can describe the conditions that must exist for a force to do work on an object.
2. I can calculate work done on an object.
3. I can describe and calculate power.
4. I can compare the units of watts and horsepower as they relate to power.
5. I can describe what a machine is and how it makes work easier to do.
6. I can relate work input to work output in a machine.
7. I can compare a machine's actual mechanical advantage to its ideal mechanical advantage.
8. I can calculate the ideal and actual mechanical advantages of various machines.
9. I can explain why the efficiency of a machine is always less than 100%.
10. I can calculate a machine's efficiency.
11. I can name, describe, and give an example of the six types of simple machines.
12. I can describe how to determine the ideal mechanical advantage of each type of simple machine. (Wysession, Frank & Yancopoulos, 2011, 410A)

APPENDIX E

WORK, POWER, AND MACHINES TEST



APPENDIX F  
REFLECTION SURVEY

## REFLECTION SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Place "X" under the word which BEST fits your feelings or understandings about reflection.

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree	Unsure
I know what it means to reflect.					
I often reflect on how I learn best.					
I often reflect on what is difficult for me and why.					
I often reflect on what is easy for me and why.					
I often reflect on the information I learn in class.					
I reflect on a daily basis.					
I reflect on a weekly basis.					
I reflect on what I've learned outside of class time.					
I think reflection can improve my learning.					
I think reflection can improve my self-confidence.					

APPENDIX G

WORK, POWER, AND MACHINES SELF-CONFIDENCE SURVEY

### WORK, POWER, AND MACHINES SELF-CONFIDENCE SURVEY

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Directions: Please check the box which BEST fits your level of self-confidence in achieving the following learning goals or outcomes.

<b>LEARNING GOAL/OUTCOME</b>	<b>NONE</b>	<b>LOW</b>	<b>MEDIUM</b>	<b>HIGH</b>
<b>1.</b> I can describe the conditions that must exist for a force to do work on an object.				
<b>2.</b> I can calculate work done on an object.				
<b>3.</b> I can describe and calculate power.				
<b>4.</b> I can compare the units of watts and horsepower as they relate to power.				
<b>5.</b> I can describe what a machine is and how it makes work easier to do.				
<b>6.</b> I can relate work input to work output in a machine.				
<b>7.</b> I can compare a machine's actual mechanical advantage to its ideal mechanical advantage.				
<b>8.</b> I can calculate the ideal and actual mechanical advantages of various machines.				
<b>9.</b> I can explain why the efficiency of a machine is always less than 100%.				
<b>10.</b> I can calculate a machine's efficiency.				
<b>11.</b> I can name, describe, and give an example of the six types of simple machines.				
<b>12.</b> I can describe how to determine the ideal mechanical advantage of each type of simple machine.				

APPENDIX H  
REFLECTION STRATEGIES

## ACHIEVEMENT TRACKER

**Directions:** Track your progress in accomplishing these learning goals as we progress through this unit. This is based on your opinion of your learning. Indicate your level of achievement by placing the date of your achievement in the box. 1= I know nothing about this, 2= I am starting to understand this, 3=I can do this with help, and 4=I can do this by myself.

LEARNING GOAL/OUTCOME	1	2	3	4
1. I can describe examples of force.				
2. I can explain the how the motion of an object is affected when balanced an unbalanced forces act on it.				
3. I can compare and contrast the four kinds of friction.				
4. I can illustrate and describe how Earth's gravity and air resistance affect falling objects.				
5. I can identify the forces that produce projectile motion.				
6. I can describe Newton's first law of motion and its relation to inertia.				
7. I can describe Newton's second law of motion and use it to calculate acceleration, force and mass values.				
8. I can relate the mass of an object to its weight.				
9. I can explain how action and reaction forces are related according to Newton's third law of motion. .				
10. I can calculate the momentum of an object.				

## SELF-CONFIDENCE TRACKER

**Directions:** Track your self-confidence in your ability to accomplish these learning goals as we progress through this unit. This is based on how you feel. Indicate your level of self-confidence in each box by placing the date in the box which best describes your level of self-confidence.

LEARNING GOAL/OUTCOME	NONE	LOW	MEDIUM	HIGH
1. I can describe examples of force.				
2. I can explain the how the motion of an object is affected when balanced an unbalanced forces act on it.				
3. I can compare and contrast the four kinds of friction.				
4. I can illustrate and describe how Earth's gravity and air resistance affect falling objects.				
5. I can identify the forces that produce projectile motion.				
6. I can describe Newton's first law of motion and its relation to inertia.				
7. I can describe Newton's second law of motion and use it to calculate acceleration, force and mass values.				
8. I can relate the mass of an object to its weight.				
9. I can explain how action and reaction forces are related according to Newton's third law of motion. .				
10. I can calculate the momentum of an object.				

## DAILY SCIENCE ENTRIES WITH REFLECTION QUESTIONS

Day 1

What does it mean to reflect on your learning?

Day 2

Let's reflect on yesterday.

- 1) List as many things about work as you remember.
- 2) How is the scientific definition of work different from our everyday definition?
- 3) What information from yesterday did you find difficult or harder to "get"?
- 4) What could you do between now and Tuesday to cement this information in your mind?
- 5) Practice Problem: How much work is done when a 10-newton force is used to move an object 2.5 meters?

Day 3

- 1) What do you remember about work and power?
- 2) How are work and power related to each other?
- 3) List one thing you "get" or understand about work and power.
- 4) List one thing that still is not clear.

Day 4

- 1) What is a machine?
- 2) How do machines make work easier to do? (three ways)
- 3) How can you make work output greater than work input?

- 4) List 2 things from yesterday you understand.
- 5) List at one thing you still do not understand.

### Day 5

- 1) How is the IMA for a machine different than the AMA?
- 2) If a screwdriver is used as a lever to open a paint can lid, can you identify the following?
  - a) input force
  - b) input distance
  - c) output force
  - d) output distance
- 3) Can you write the formulas for work, power, IMA and AMA from memory? Try it!

### Day 6

- 1) List the six types of simple machines and give an example of each.
- 2) List as many terms from this chapter that you know well.
- 3) List the terms you do not understand yet.
- 4) Did you miss any terms?

### Day 7

- 1) Can you list the five formulas you need for this chapter from memory?
- 2) How does an inclined plane reduce effort force?
- 3) How to you find the IMA of a pulley system?
- 4) How do you find the IMA of a wheel and axle?

APPENDIX I  
STUDENT POST-UNIT INTERVIEW

Directions: Read all portions to the student.

**Do you understand that participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way?**

1. Did reflecting in your science journal at the beginning of each day help you with the learning goals for this unit?
  - a. Could you please explain how it helped you?
  - b. Could you please explain why it did not help you?
2. Did reflecting at the end of each class period help you?
  - a. Could you please explain how it helped you?
  - b. Could you please explain why it did not help you?
3. Did your feelings about the learning goals change as you reflected on them?
  - a. Could you please explain how they changed?
  - b. Why do you think they did not change?
4. How did reflecting affect your self-confidence in your abilities?
5. Do you think daily and weekly reflection is something that should be continued in this class? Why or why not?
6. Did you enjoy a particular reflection activity that we did? Could you please explain which one it was and why you enjoyed it?
7. Is there anything else you would like me to know?