

EVALUATING THE EFFECTS OF REQUIRED SCIENCE JOURNAL ENTRIES FOR
FIFTH-GRADE SCIENCE STUDENTS DURING A SCIENCE-SPECIFIC FIELD TRIP

by

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STATEMENT OF PERMISSION TO USE

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ABSTRACT

Journaling our experiences can help us learn to appreciate an awareness of that experience. In this action research-based project, I used multiple methods including student interviews, student attitude surveys pre and post treatment, and multiple teacher interviews to measure effectiveness of journal-use during a fifth-grade science-specific field trip. It was also determined if journal use during this science-specific field trip allowed a measurable result in improved attitude towards science in general. Upon conclusion of the data reviewed, the results indicated journal-use is effective in increased awareness and improved attitude towards scientific thinking.

INTRODUCTION AND BACKGROUND

Journaling our thoughts, ideas, and feelings has not only been around for thousands of years, but the very act of journaling encourages humans' growth overall growth. Journaling involves the ability to reason with one's environment and write at a level of appreciation towards a facet of life with that reasoning. It has been used in many educational settings from teacher to student and referenced for a wide array of information. Journaling our experiences can help us learn to appreciate an awareness of that experience and help our understanding of that experience in relation to our background perception. Connoisseurship is this art of appreciation. It can be displayed in any realm in which the character, import, or value of objects, situations, and performances is distributed and variable, including education practice (Eisner, 1985).

This action research-based project took place between the months of January 2013 and May 2013. Two fifth-grade science Professional Educators and their classrooms were observed, interviewed and from those two classrooms, a sub-set of 12 science students, who attended a science-specific SeaCamp field-trip, were used for the conduct of student interviews and subsequent student inquiry questionnaires. These fifth-grade science students attended Reis Elementary School in the Clark County School District located in Las Vegas, Nevada. During the 2012-2013 school year, this public elementary school had approximately 880 students enrolled. The elementary school has predominantly Caucasian, Hispanic, and African-American students and a few Asian, Pacific Islanders, and American Indian students enrolled (Reis Elementary School, n.d.). A sub-group of 21 fifth graders (14 males and 7 females) attended a SeaCamp science fieldtrip and this action research project was allowed to take place with the assistance of

the school's Vice-Principal and a Professional Science Educator. On the days of my observations/interviewing, I sat in multiple science classrooms where the students learned the required concepts in science via lecture and weekly labs. These concepts are the standardized concepts as noted by the National Science Education Content Standards (Appendix E). On the days of my observations of the Professional Educators and before and after the SeaCamp field-trip, I conducted face-to-face/one-on-one interviews of all the SeaCamp students.

The purpose of my study was to evaluate the effectiveness of required journal entries during a science field-trip. My focus question was as follows:

1. What are the effects of pre-defined, pre-formatted science journals on fifth grade science students' attitudes and grades during a science field trip?

The secondary focus questions were:

1. Do student attitudes about journal entries change when it is required for a field trip?
2. Do student attitudes about journal entries change when it is identified as preparatory for an assessment regarding the completed field trip?
3. Do grades improve as a result of incorporating a required completion of journal entries for a specific science-related event?

CONCEPTUAL FRAMEWORK

Required journal entries on an organized science field trip can provide reliable data of a student's perception of their environment and inquiry but also motivates students to retain those perceptions and inquiry for future use. The great science experience with optimized content and achieved student motivation is key to successful

learning. The performance assessment based on optimized science experiences are secondary only to student motivation leading to successful learning (Griffin, 2007). Journal entries associated to an upcoming performance assessment have been widely investigated (Bennett, 1993; Birenbaum & Tatsuoka, 1987; Birenbaum et al., 1992; Shohamy, 1984; Traub & MacRury, 1990). Further studies of journal entries secondary to science-centered field trips sought answers and therefore investigated further. Students' journal entries add motivation of thoroughness in anticipation of the conclusions draw at the end of a field trip. Journal writing will, moreover, reduce bias due to debilitating factors, consequently reflecting students' true achievements and accomplishments during a field trip (Birenbaum, M., & Feldman, R.A. 1998).

In general, organized science field trips can provide students with educational experiences, particularly when the field trip emphasizes scientific inquiry skills building over content knowledge acquisition (Parsons & Breise, 2000). For decades educator researchers have questioned whether field trips offer significant science related learning and prompt student inquiry, particularly compared with everyday school-learning experiences (Bitgood, 1989). Organized science field trips are designed to support voluntary, student self-directed learning. The emphasis of this self-directed learning is purportedly to affect students' responses towards science and improved self-empowerment in making sense of scientific processes in the world we live. (Falk & Dierking, 1992, 2000; Friedman, 2008) "Rich with real-world phenomena, these are places where people can pursue and develop science interests, engage in science inquiry, and reflect on their experiences through sense-making conversations" (National Research Council, 2009, p. 15).

Students using journals enhance their learning by making connections between theory, what they have been instructed, what they see or experience on a field trip, and practice, by asking questions and engaging in dialogue either verbally or within the journal with higher critical thinking ideas (Connor-Greene 2000; Kerka 1996). Most research-based student-prompted inquiry programs initiated by educators aim to teach skills such as asking the right types of questions, making predictions, understanding experimental process, review and analysis of outcomes, drawing conclusions, and communication of those results (White & Frederiksen 1998, Dymont, J. 2010). Another important factor in learning is *metacognition*, or learners' abilities to monitor and reflect on their own understanding (Bransford, J., & Schwartz, D. 1999, Naveh-Benjamin, M., McKeachie, W.J., & Lin, Y.G. 1987).

METHODOLOGY

SeaCamp in San Diego, California offers educational programs that Clark County School District embrace as an affordable, highly valued field-trip opportunity. Thousands of visitors from around the world visit these SeaCamp programs yearly. "SeaCamp artfully combines education and entertainment in a way that connects people to the sea and sea life like nowhere else" (Marine Science Education for Today's Students, 2013). This sub-set of Reis Elementary fifth grade science students attended a three-day long field trip to explore marine and animal life, oceanography, beach ecology, and beach botany. Students hand-fed sting-rays, kayaked, boogie boarded, nature hiked along the beach coastline, and fed a bottlenose dolphin. SeaCamps are accredited by the American Camp Association (ACA), meeting or exceeding their standards.

The impact of using journals on a science fieldtrip to increase content retention and understanding and to reduce student stress was studied in the classrooms I observed and analyzed via data review of completed questionnaires such as the Student Assessment Survey (SAS). This survey reviews a student's perception of learning and journaling and Pre-Post Journal Inquiry Questionnaires which zero-in on student attitude towards science, journaling, and science-content inquiry outside the classroom environment. An additional focus of this research was the effect of using journals on the classroom climate. The treatment consisted of reviewing current journal use in two fifth grade classrooms and presenting a science journal to a group of sub-set of fifth graders going on a science fieldtrip. Prior to the fieldtrip and post the fieldtrip, a Student Attitude Survey questionnaire was administered to two fifth grade science classrooms. Additionally, a variety of data collection tools were used to evaluate the effect of journal-use as a teaching strategy. IRB permission was requested and satisfied the criteria for the IRB exemption review at Montana State University.

To evaluate the effect of journal-use, the Student Attitude Survey Questionnaire, using a Likert scale, a scale to quantify a student's attitude towards a thought or question. In this study's scale, a score of 5 equaled an "always" value whereas a score of 1 equaled a "never". This questionnaire was administered to two classrooms of fifth grade science students prior to the fieldtrip to evaluate stress level, confidence and opinions of science. For this questionnaire and all assessment tools, the students were told their answers would not be given to their teacher and would not affect their grade. The same questionnaire was given again post science fieldtrip to all students to see the effect of journal-use. Additionally, student interviews using the Post Treatment Journal Inquiry

Questions were also conducted after the fieldtrip (Appendix C). The answers obtained secondary to these student interviews were processed for analysis via generalizations extracted in student attitude and passion for science-content learning. A sample of 21 students comprised of a general mix of ability levels were interviewed pre-field trip. The interview was repeated post-field trip to see the effect of a science journal-use had on their learning fieldtrip experience.

The impact of science journal use on content understanding was evaluated using assessments at the beginning of the fieldtrip and again at the end of the fieldtrip to compare gains in understanding of the material. There was also a comparison of the average grades on summative assessments in non-treatment units and the treatment unit to see the overall success of the students during the treatment unit. These many forms of data are outlined in the Triangulation Matrix (Table 1). A teacher journal was also kept during the process of the research. Journal entries included observations of both the teacher and classrooms. The journal also provided supporting data on classroom climate and student stress level. These data points provided interesting comparisons to the student interview data.

Table 1

Data Triangulation Matrix: Using Games in the Classroom to Reduce Student Stress and Increase Content Understanding

Focus Question	Data Collection Instrument				
	Pre-treatment Student Survey	Post-treatment Student Survey	Pre-treatment and post-treatment Assessments	Student Interview Pre- and post-treatment	Teacher Journal (reflections and observations)
Will journal-use reduce student stress before assessments?	X	X		X	X
Will the use of journal-use on a science fieldtrip increase content understanding?		X	X	X	
How will the use of journal-use on a science fieldtrip affect the fieldtrips' climate?	X			X	X

DATA AND ANALYSIS

The results of the Student Assessment Survey administered to two fifth grade science classrooms indicate that 60% of the fifth grade-grade science students who have been exposed to the use of a science journal/notebook in a science classroom *always* find keeping a journal helpful in the classroom, ($N=21$). Feelings of comfortableness in asking questions in the classroom was almost unanimous with 97% of students reporting that they *always* feel comfortable asking questions in their science classroom, and 97% replied that they *always* enjoy their science class. Only 26% *almost always* found using a science journal in the classroom helpful, whereas the remaining 74% found using a science journal *always* helpful. In terms of feelings towards their science teacher, 89% of

the students *always* thought their science teacher was enthusiastic about teaching science. During free time, 57% students responded that they *always* like to draw in a journal/notebook in their free time and no students reported that they *always* look for answers to their science questions online. In terms of family time outside of school, 86% of the students stated they *always* spent a lot of time with their family. When the science students were asked if they do science experiments at home, 60% of the students responded that they *never* do science experiments at home. Eleven percent *always* felt less stress when they were indoors, whereas 57% *never* get less stressed when indoors (Figure 1). Journal questions are as follows:

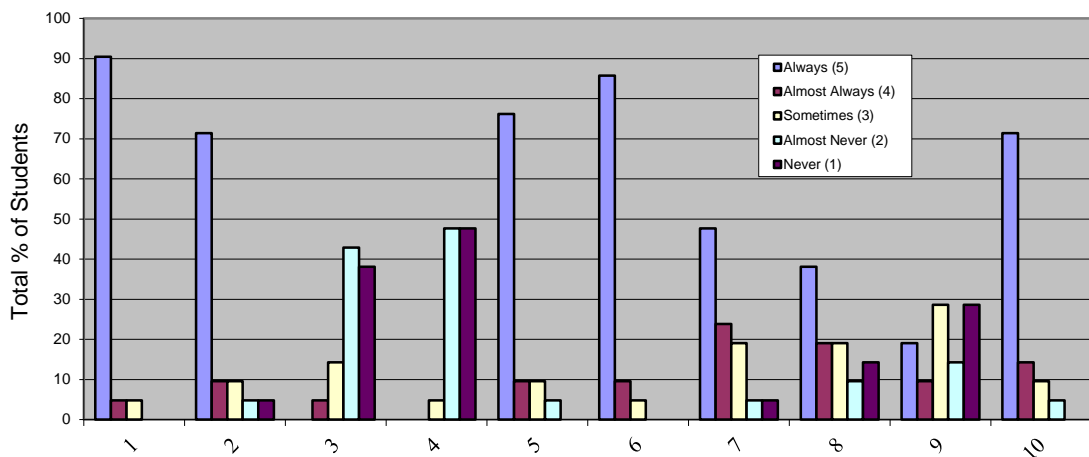


Figure 1. Student assessment survey, ($N = 21$).

- (1) I spend a lot of time with my family when I'm not at school.
- (2) I like to draw in a journal/notebook my free time.
- (3) I like to do science experiments at home.
- (4) I look for answers to my science questions online.
- (5) I enjoy my science classroom.
- (6) I feel comfortable about asking questions in my science classroom.
- (7) I find using a science journal in the classroom is helpful.
- (8) I look forward to writing notes in my science journal every time I go to science class.
- (9) When I am indoors I feel less stressed.
- (10) My teacher is enthusiastic about teaching me science.

The SAS questionnaire also examined student attitudes towards spending time away from school, journaling in general, and the students' attitudes towards science. Questions related to the Professional Educator's review and use of science journals in a science classroom had very clear-cut results. Of the students asked, 86% were *always* encouraged by the science teacher to make multiple journal entries and additionally 83% *always* felt encouraged to take notes of the science information being reviewed into their science journal (Figure 2). In the science classroom 100% of the students were *always* clear the journals entries were to be neat, with clear sentences and free from spelling errors and also felt the science teacher actually reviewed their journal entries. Only 37% felt *sometimes* the science teacher presented science materials in a variety of ways. Conclusively, 97% of students report that they *always* have fun in science class.

Journal questions are as follows:

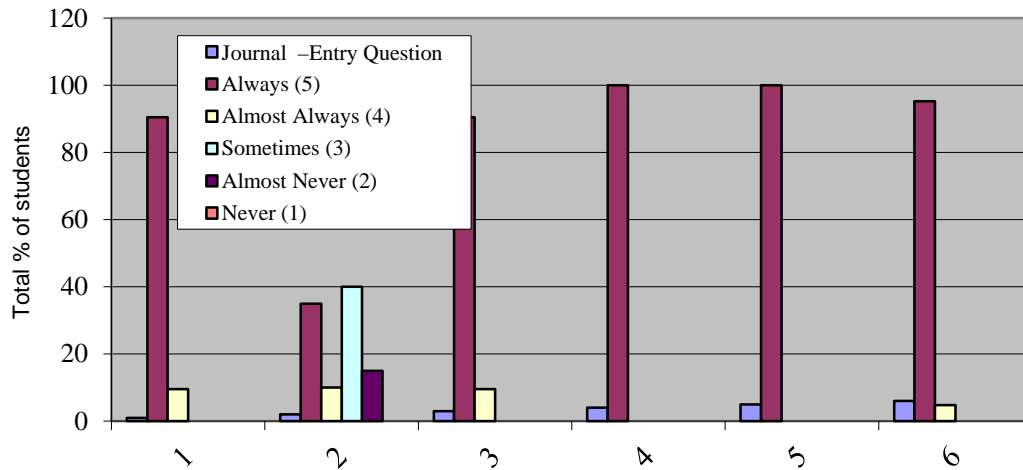


Figure 2. Student attitude survey, (N=21).

- (1) My teacher encourages me to do make multiple journal entries.
- (2) My teacher presents science materials in a variety of ways.
- (3) My teacher encourages me to take notes when reviewing new science information.
- (4) My teacher has made it clear my journal entries are to be neat, with clear sentences, and free from spelling errors.
- (5) I feel my teacher reviews my journal entries every time I make a journal entry.
- (6) I have fun in science.

Upon the conclusion of the science field trip, all of the requested journal entries had been completed for three prompts from all three days for all students. There was not one student who did not complete a journal entry. Conversely, as compared with previous detailed data, within the journal entries, the students voiced an understanding of science concepts noted during the field trip via simple statements within the journal of favorite key learning points. Largely, most students voiced a wide variety (different from others) favorite key learning point based on the various activities taking place that particular day. Specifically, the journal entries voiced the students' concepts of the lessons and information presented during all three days and additionally showed the students were

thinking about other concepts they wanted more information. For example, some of the questions asked were as follows:

1. How do sharks rest?
2. Why do jellyfish eat so much?
3. Why is the California Moray (Eel) lazy and blind?
4. How do crystal jellyfish glow in the dark?

The students I spoke with upon their return from SeaCamp stated “It was the time of my life!” (Figure 3)

Jaden

SEA CAMP STUDENT JOURNAL SEA CAMP

Prompt	Date
Entry 1: I felt as though this was the favorite part of my day:	April 22nd
1. Favorite Science Point I learned: There are some jelly fish that glow in the dark. 2. Favorite Activity I did: Teaching the fish and looking at the ocean.	
Prompt	Date
Entry 2: I felt as though this was a topic I wanted to know more about:	April 22nd
3. Science Point I wanted to understand better: why was the fish called why fish are called that ^{they look like} jellyfish 4. Why I wondered more about this science topic: is because I need to learn more about fish ^{with my mouth with my mouth} and how they're named and what	
Prompt	Date
Entry 3: I felt as though this was something I wanted to tell my friends and family as soon as I return home:	April 22nd
5. Most Important and Exciting Science Point I will tell: is how jelly fish/fish are special or how they do. 6. How can I use this back home? I could tell my family and friends by telling them how my first day was.	

REMEMBER, UPON YOUR RETURN, YOU WILL BE GIVEN A QUICK TEST OF KEY POINTS LEARNED AT SEA CAMP!!!!

Figure 3. Sample journal page image.

Upon return from the science field trip, the SAS questionnaire was administered again to the two 5th grade science classrooms. Whereas previously only 74% *always* found using a science journal in the classroom helpful, now 95% found using a science journal *always* helpful. In terms of feelings towards their science teacher, post the science field trip, before 89% of the students *always* thought their science teacher was enthusiastic about teaching science, now 76% of the students *always* thought their science teacher was enthusiastic about teaching science. Additionally, the difference before the field trip and after was a 13% increase of students who responded that they *always* like to draw in a journal/notebook in their free time and 52% students reported that they *always* look for answers to their science questions online (Figure 4).

SAS Journal questions post treatment are as follows:

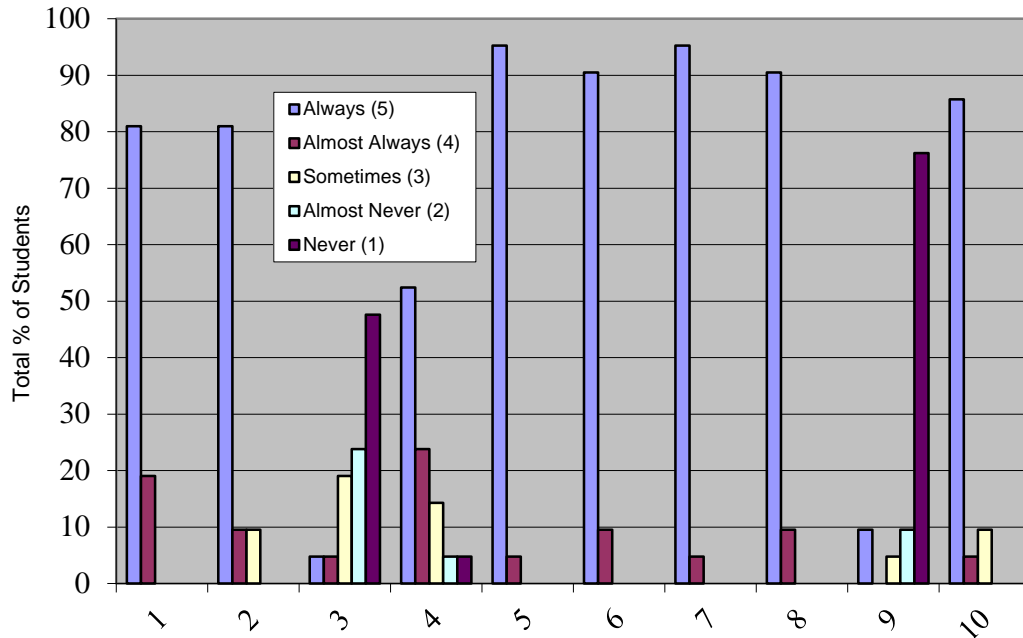


Figure 4. Post Field Trip; SAS questionnaire, ($N=21$).

- (1) I spend a lot of time with my family when I'm not at school.
- (2) I like to draw in a journal/notebook my free-time.
- (3) I like to do science experiments at home.
- (4) I look for answers to my science questions online.
- (5) I enjoy my science classroom.
- (6) I feel comfortable about asking questions in my science classroom.
- (7) I find using a science journal in the classroom is helpful.
- (8) I look forward to writing notes in my science journal every time I go to science class.
- (9) When I am indoors I feel less stressed.
- (10) My teacher is enthusiastic about teaching me science.

The following was a summary highlight of comparative data:

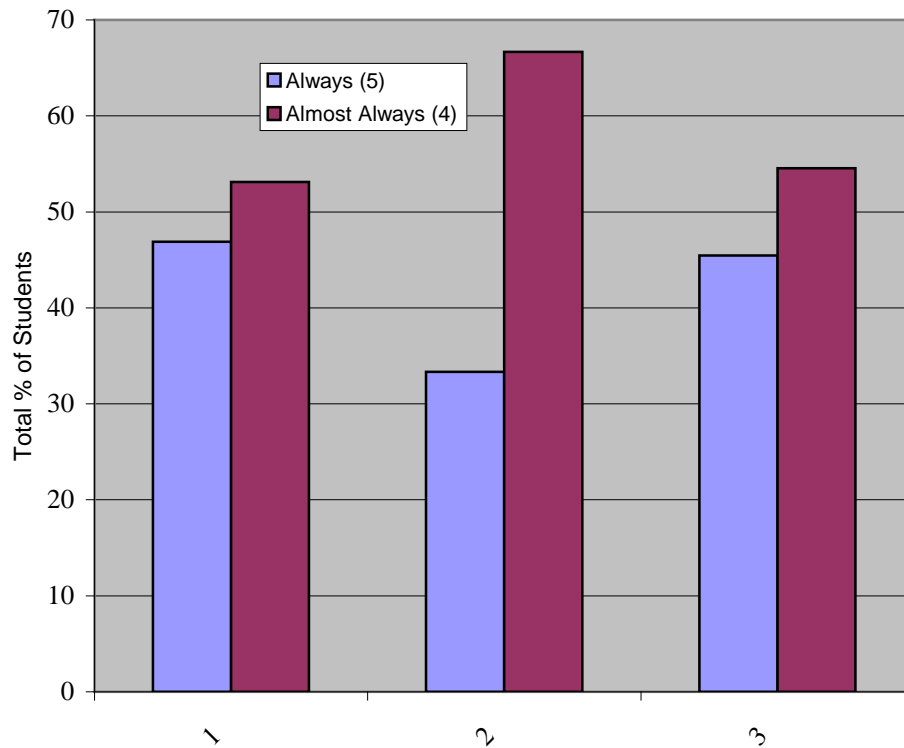


Figure 5. Pre treatment vs. Post treatment field trip; SAS questionnaire, highlight data, (N=21).

- (1) I like to draw in a journal/notebook my free-time.
- (2) I find using a science journal in the classroom is helpful.
- (3) My teacher is enthusiastic about teaching me science.

INTERPRETATION AND CONCLUSIONS

The impact of using a pre-defined, prompted-entry journal during a science-content field trip to reduce student stress and increase content understanding was studied. Based on the conclusions drawn from the student interview data, the completed SAS questionnaires, the students exposed to a science field trip, journal writing during science class, benefitted from the journal use in growth and understanding of science-related

content. I observed how students respond to a teachers' enthusiasm and can contrast and compare one science teacher's enthusiasm to another science teacher's enthusiasm and decide the amount of effort to expend.

Retrospectively, I noted more time should have been spent with the teachers to better triangulate the data. Most significant would be an actual assessment previous to the fieldtrip and also post the field trip to compare grades the students achieved would benefit the claims made by my research. The students interviewed with journal-related concept questions certainly helped demonstrate student knowledge and eliminate to a degree the ability for student's need to guess. Qualitative data indicated the trends in students' attitudes were indicative of a general interest in science, their teachers' perception of science, and the ways science thought-process could be practiced outside of the classroom. When I initially interviewed the students, there was a lack of enthusiasm towards science whereas post the field trip, there was a dramatic increased excitement regarding science content. Within this concept was an excellent opportunity for a fantastically designed science field trip (away from the classroom) and experimental use of a required journal. Having a place within the journals for students to detail thoughts, ideas, concepts, and questions within the prompt provided a very valuable tool for the teacher and students alike in my opinion. Collecting data on more than just this one subset of fifth-grade science students who went on a science field trip would provided much greater detail regarding the students' attitudes toward journal writing, teachers and activities outside of the science classroom. Given the evidence provided by this research, additional studies should ensure a required journal integrated into the Next Generation Science Standards for all science students, fifth grade on up through high school. Another

question to address in future research would be the interaction between journaling and the teacher as journaling in generally may vary from topic to content.

VALUE

In general, science enthusiasm and journal writing increased post the conclusion of the science field trip. For future projects, researchers may find it beneficial to compare and contrast one format of journal entry versus another format and/or with/without formal assessments post content delivery and subsequent journal entry review. This research project allowed multiple faceted inquiries to come to the Professional Educators I worked with at Reis Elementary. If we as educators and administrators strive to improve our value and excellence, then the goal of action research should include standards/controls to increase the probability of reliable information gathered during the data collection phase of the research. With reliable data, the likelihood of improvement would be good. If a teacher expresses the true value of a journal on a science field trip or during a classroom setting, then students should want to use a journal in a variety of settings. If a student can perceive the teacher's wanting of betterment of the individual student as well as the class as a whole, a sense of community would aid the expected success of achieving an acceptable level of understanding.

Journaling, by definition, creates a hands-on activity. Journaling combined with other interactive classroom tools provides effective, productive teaching tools. Journaling can foster an increase in students' enthusiasm with science. Not all activities are created equal. I believe one of the most interesting research projects could entail journals used during a science related activity for information collecting online, in or outside of the classroom.

As other research has shown and my research highlights, journal use on a science field trip can promote a better retention of concepts students are exposed to as well as allow student inquiry. During the last decade, there have been calls for more student ownership and flexibility in the assessment process, including use of journal entries for all or part of a given assessment period. By culturing a classroom environment of student ownership, responsibility and flexibility, it would seem to be an educator's due diligence to teach the required material in a way which fully enables a student for a successful outcome to the assessment, including but not limited to required journal entries. A prime example of this full process design is noted in A Framework for K-12 Science Education (NRC, 2011) that informed the Next Generation Science Standards within the Science and Engineering Practices section, "Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people" (p. K-2-ETS1-2). Building flexibility into the process of journaling and subsequent value placed on that journal entry could provide students with more control over their assessments due directly to having made adequate journal/notebook entries of the learned content, and thus bettering their learning experience.

In the classroom climate or the field-trip environment, personalities and behaviors of the students and the teaching skills/background of formal educators often vary tremendously. Student's use of journaling is conducted at critical intervals during an academic year, a formation of what works best for those students could develop at the beginning of the year instead of at the conclusion. "Once noted, these may lead to more

systematic thinking, as well as lend intellectual relevance to more directed experience” (Mills, 1959 p. 221).

When I set out on this action research journey, I felt immune to discouragement as I truly looked forward to finding answers to my questions. However during the observation and interviews, I began to grow discouraged. I was discouraged by the students’ behaviour and my perceived lack of passion and enthusiasm by the teachers. But just when the discouragement began to settle in, I realized my refocus stated through my thoughts. I began to ignore the students’ behaviour outside of my questions and spent more time, one-on-one, with the teachers. I found through my discouragement, and subsequent re-focus, there came great purpose. I realized that exactly what I had experienced emotionally through this action research journey is precisely what science teachers endure daily during a given school year. What a greater purpose this action research became than to enable the science teacher with tools, such as a student science journal, so as to help encourage and maintain a level of enthusiasm at the heart of the science-content.

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APPENDICES

APPENDIX A

STUDENT ATTITUDE SURVEY (SAS)

APPENDIX A

STUDENT ATTITUDE SURVEY

Prompt	CATEGORY SCALE – ONLY CHECK ONE FOR EVERY STATEMENT				
	Always	Almost Always	Sometimes	Almost Never	Never
Home					
1. I spend a lot of time with my family when I'm not at school.					
2. I take a daily multivitamin.					
3. I eat breakfast before school.					
4. I exercise daily.					
5. I watch less than two hours of television daily.					
6. I drink 3-5 glasses of water daily.					
Classroom					
7. I feel safe in the classroom.					
8. I feel comfortable about asking questions in class.					
9. I find the classroom to be a positive environment.					
10. I don't worry about being harassed in class.					
Teacher					
11. My teacher is enthusiastic about teaching.					
12. My teacher enforces classroom rules.					
13. I feel my teacher reviews my journal entries every time I make a journal entry.					
14. My teacher encourages me to do make multiple journal entries.					
15. My teacher presents science materials in a variety of ways.					
16. My teacher presents class material in a variety of ways.					
17. My teacher encourages me to take notes when reviewing new science information.					
18. My teacher has made it clear my journal entries are to be neat, with clear sentences, and free from spelling errors.					
Student					
19. I find science challenging.					
20. I am good at science.					
21. I have fun in science.					

APPENDIX B

PRE/POST TREATMENT INTERVIEW QUESTIONS (P-TJIQ)

Pre-TJIQ

1. Do you feel fully prepared for the Sea Camp field trip? Why or Why not?
2. Do you feel that your teacher reviewed the notebook expectations prior to this Sea Camp fieldtrip? Why or Why not?
3. What portion of the Sea Camp fieldtrip are you looking forward to the most?
4. What portion of the Sea Camp fieldtrip are you looking forward to the least?
5. Explain how you feel about this notebook you're required to complete while at Sea Camp.
6. What part of taking notes while listening to the teacher do you enjoy least?

Post-TJIQ

1. Do you feel you were fully prepared for the Sea Camp field trip? Why or Why not?
2. Do you feel the journal notebook helped you during this Sea Camp fieldtrip? Why or Why not?
3. What was your favorite part of the Sea Camp fieldtrip?
4. What was the greatest learning point you wanted to learn more about during the Sea Camp fieldtrip?
5. Explain how you felt about this journal notebook you completed while at Sea Camp.
6. What part of taking notes while listening to the teacher do you enjoy the most?

APPENDIX C

POST-TREATMENT JOURNAL INQUIRY QUESTIONS (PT-JIQ)

PO-TIQ

1. Do you feel that your teacher listened to any problems you had in class? Explain.
2. Do you feel that your teacher encouraged you in class? Why or Why not?
(If the student answers no, proceed to question 3. If the student answers yes, proceed to question 4.)
3. How could the teacher encourage you more in class?
4. Did the classroom environment facilitate your learning? Explain.
5. Do you feel that you had a choice in selecting group members for group activities? Explain.
6. How did you select members for your group?
7. What learning activities helped you learn best? Explain.
8. Do you feel that having had a choice in learning activities helped you learn better? Explain.
9. What did the teacher do to make lectures more interesting?

APPENDIX D

SAMPLE JOURNAL PAGE

STUDENT JOURNAL

Prompt	Date
<p>Entry 1: I felt as though this was the favorite part of my day:</p>	
<p>1. Favorite Science Point I learned:</p> <p>2. Favorite Activity I did:</p>	
Prompt	Date
<p>Entry 2: I felt as though this was a topic I wanted to know more about:</p>	
<p>3. Science Point I wanted to understand better:</p> <p>4. Why I wondered more about this science topic:</p>	
Prompt	Date
<p>Entry 3: I felt as though this was something I wanted to tell my friends and family as soon as I return home:</p>	
<p>5. Most Important and Exciting Science Point I will tell:</p> <p>6. How can I use this back home?</p>	

REMEMBER, UPON YOUR RETURN, YOU WILL BE GIVEN A QUICK TEST OF KEY POINTS LEARNED AT SEA CAMP!!!!

APPENDIX E

NATIONAL SCIENCE EDUCATION CONTENT STANDARDS

National Science Education Standards

Science Contents Standards

Overview			
Category	Grades K-4	Grades 5-8	Grades 9-12
Unifying Concepts and Processes <ul style="list-style-type: none"> • Systems, order, & organization • Evidence, models, & explanation • Change, constancy, & measurement • Evolution & equilibrium • Form & function 			
Science as Inquiry <ol style="list-style-type: none"> 1. Understanding of scientific concepts 2. An appreciation of "how we know" what we know in science 3. Understanding of the nature of science 4. Skills necessary to become independent inquirers about the natural world 5. The dispositions to use the skills, ability, & attitudes associated with science 	<ol style="list-style-type: none"> 1. Abilities necessary to do scientific inquiry <ul style="list-style-type: none"> ○ Ask a question about objects, organisms, & events in the environment ○ Plan & conduct a simple investigation ○ Employ simple equipment & tools to gather data & extend the senses ○ Use data to construct a reasonable explanation ○ Communicate investigations & explanations 2. Understanding about scientific inquiry <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Abilities necessary to do scientific inquiry 2. Understanding about scientific inquiry <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Abilities necessary to do scientific inquiry 2. Understanding about scientific inquiry <p>Full Standard</p>

Category	Grades K-4	Grades 5-8	Grades 9-12
Physical Science	<ol style="list-style-type: none"> 1. Properties of objects & materials 2. Position & motion of objects 3. Light, heat, electricity, & magnetism <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Properties & changes of properties in matter 2. Motions & forces 3. Transfer of Energy <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Structure of atoms 2. Structure & properties of matter 3. Chemical reactions 4. Motions & forces 5. Conservation of energy & increase in disorder 6. Interactions of energy & matter <p>Full Standard</p>
Earth & Space Science Standards	<ol style="list-style-type: none"> 1. Properties of Earth materials 2. Objects in the sky <ul style="list-style-type: none"> ○ The Sun, Moon, stars...all have properties, locations, and movements that can be observed & described ○ The Sun provides the light & heat necessary to maintain the temperature of the Earth 3. Changes in Earth & sky <ul style="list-style-type: none"> ○ Objects in the sky have patterns of movement. The Sun, for example, appears to move across the sky in the same way every day, but its path slowly changes over the seasons. The Moon moves across the sky on a daily basis much like the Sun. The observable shape of the Moon changes from day to day in a cycle that lasts about a month. <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Structure of the Earth system 2. Earth's history 3. Earth in the solar system <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Energy in the Earth system 2. Geochemical cycles 3. Origin & evolution of the Earth system 4. Origin & evolution of the universe <p>Full Standard</p>
Category	Grades K-4	Grades 5-8	Grades 9-12
Science & Technology Standards	<ol style="list-style-type: none"> 1. Abilities to distinguish between natural objects & objects made by humans 2. Abilities of technological design <ul style="list-style-type: none"> ○ Identify a simple problem ○ Proposal a solution ○ Implementing proposed solutions ○ Evaluate a product or design ○ Communicate a problem, design, & solution 3. Understanding about science & technology <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Abilities of technological design (see K-4) 2. Understanding about science & technology <p>Full Standard</p>	<ol style="list-style-type: none"> 1. Abilities of technological design (see K-4) 2. Understanding about science & technology <p>Full Standard</p>

Life Science Standards	<ol style="list-style-type: none"> 1. Characteristics of organisms 2. Life cycles of organisms 3. Organisms & environments <p style="text-align: center;">Full Standard</p>	<ol style="list-style-type: none"> 1. Structure & function in living systems 2. Reproduction & heredity 3. Regulation & behavior 4. Populations & ecosystems 5. Diversity & adaptations of organisms <p style="text-align: center;">Full Standard</p>	<ol style="list-style-type: none"> 1. The cell 2. Molecular basis of heredity 3. Biological evolution 4. Interdependence of organisms 5. Matter, energy, & organization in living systems 6. Behavior of organisms <p style="text-align: center;">Full Standard</p>
Science in Personal & Social Perspectives Standards	<ol style="list-style-type: none"> 1. Personal health 2. Characteristics & changes in populations 3. Types of resources 4. Changes in environments 5. Science & technology in local challenges <p style="text-align: center;">Full Standard</p>	<ol style="list-style-type: none"> 1. Personal health 2. Populations, resources, & environments 3. Natural hazards 4. Risks & benefits 5. Science & technology in society <p style="text-align: center;">Full Standard</p>	<ol style="list-style-type: none"> 1. Personal & community health 2. Population growth 3. Natural resources 4. Environmental quality 5. Natural & human-induced hazards 6. Science & technology in local, national, & global challenges <p style="text-align: center;">Full Standard</p>
History & Nature of Science Standards	<ol style="list-style-type: none"> 1. Science as a human endeavor <p style="text-align: center;">Full Standard</p>	<ol style="list-style-type: none"> 1. Science as a human endeavor 2. Nature of science 3. History of science <p style="text-align: center;">Full Standard</p>	<ol style="list-style-type: none"> 1. Science as a human endeavor 2. Nature of scientific knowledge 3. Historical perspectives