THE EFFECT OF PARTICIPATION IN PLACE-BASED ENVIRONMENTAL EDUCATION PROGRAMS ON STUDENT AFFECT TOWARD SCIENCE: A CASE STUDY OF F.T. STONE LABORATORY'S MIDDLE SCHOOL PROGRAM

A Thesis
Presented in Partial Fulfillment of the Requirements for
the Degree of Master of Science in the
Graduate School of The Ohio State University

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ABSTRACT

This case study focuses on the effect of participation in a place-based environmental education program (the F.T. Stone Laboratory student workshop) on the science affect (feelings) of current and former sixth grade students. The specific case involves sixth graders following completion of a one and a half day program. F.T. Stone Laboratory's sixth grade programs include a wide variety of activities and instruction covering topics such as ornithology, exotic species, invertebrates, edible plants, water quality, seining, and fish dissections, as well as many other science-based activities in a uniquely interactive and hands-on environment.

The purpose of the study was to determine the role that a place-based field environmental education facility has on student affect toward science. To date, findings regarding such programs' impacts on student attitudes have shown mixed results. This study is an effort to add to the body of research and to help reach a consensus of how these programs influence learners. A second purpose of the study was to establish whether F.T. Stone Laboratory (hereafter, Stone Lab) is meeting a portion of its stated objectives for the educational programs.

The study was conducted in two phases. The first phase comprised a pre-test/post-test survey design used to measure short-term immediate effects of a program for sixth graders. Results from the survey were analyzed for the entire instrument and
also using subscales which included student responses on similar items. The second phase of data collection consisted of an open-ended questionnaire used to examine student self-reports and perceptions of long-term affect change among participants (a delayed post-test for cohort groups) from previous years. In this case, seventh, ninth and twelfth graders completed the questionnaire that focused on their memories of their sixth grade Stone Lab experience. Demographic data also were collected from the students to identify potential trends in affect change for students of varying gender and ethnicities.

The researcher’s findings suggest that the Stone Lab experience influences students’ affect toward science in the short-term. Across the entire short-term sample there was a small but consistent positive change in student response, which was significant in the subscales for “General Science Feeling” and “Value of Science.” This suggests that participation in the Stone Lab workshop has a positive influence on general affect toward science. In demographic analysis, male learners and learners from the white ethnic group showed more significant change in affect than students in other demographic groups. Long-term results were slightly more ambiguous. While students were split on whether participating in Stone Lab workshops influenced how much they like science, nearly half emphasized that they felt they learned more at Stone Lab than in their traditional science classes. Furthermore, over 74% stated they enjoyed their Stone Lab experience. In conclusion, Stone Lab seems to have an influence on student affect by fostering more positive feelings toward science following student participation in the program for some learners. Although some notable trends are evident in the data, future research on student affect toward science and on Stone Lab’s effect on learners needs to be completed to further develop the theory base.
Dedicated to my father, Dennis Michael Dudley,
for instilling in me a deep love and appreciation for nature.
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CHAPTER 1

INTRODUCTION

One of the key goals of environmental education, as defined by the North American Association for Environmental Education (NAAEE), is to help learners develop the skills they need to be effective and knowledgeable decision makers (Braus & Wood, 1993; NAAEE, 1998). An important characteristic that influences an individual’s ability to make decisions is attitude regarding the issue of concern. Specifically, an individual’s attitude dictates his/her motivation to participate in the decision making process (Janis & Mann, 1968). Furthermore, research in how people perceive and judge risk has suggested that people use their feelings to guide them in making decisions (Finucane et al., 2000). Poulou & Norwich (2002) found that teachers’ feelings about education dictate the decisions they make regarding their classrooms. In essence, the development of a particular attitude toward a certain issue affects the decisions a person will make. Therefore, if we want students to be involved in environmental decisions, they must have the ability and the inclination to become knowledgeable about and understand science-based issues.

Merriam-Webster (2001) defines attitude as “a mental position with regard to a fact or state” or “a feeling or emotion toward a fact or state.” Attitude research has gone further by developing a general consensus that, while attitude is difficult to define
specifically, it has three important interacting components: affect (or feelings), conation (or behavior) and cognition (or knowledge) (Azjen & Fishbein, 1980; Shrigley et al., 1988). Research treats these three personal attributes as integral to the development of a particular individual’s attitude toward an issue or object. Although there has been some disparity in defining the exact role each component plays in determining an individual’s overall attitude and resulting prediction of behavior, affect is generally regarded as the component with the greatest influence on attitude development (Fishbein & Azjen, 1975).

Previous research investigating education’s effect on science attitude change has shown mixed results. Place-based and environmental education programs, in particular, have been shown to vary in their effectiveness in changing learners’ attitudes about science-related topics (Crompton & Sellar, 1981; Dettmann-Easler & Pease, 1999; Eagles & Demare, 1999). Some studies have shown a positive influence on student attitudes toward science (Dettman-Easler & Pease, 1999), whereas others have shown none or even a negative effect (Crompton & Sellar, 1981; Eagles & Demare, 1999). Numerous reasons have been cited for these varying levels of effect, such as whether the programs were accompanied by reinforcement within the classroom and the qualities of the environment where the program takes place (Dettman-Easler & Pease, 1999). Other studies have shown that demographics can play a role in determining the attitudes students have toward science (Haladyna, Olsen & Shaughnessy, 1982; Kellert, 1985; Atwater, Wiggins & Gardner, 1995; Eagles & Demare, 1999). Thus a consensus has yet to emerge regarding the key factors that determine whether a program facilitates a positive attitudinal change toward science. The field of "life experiences" has listed many different influences for environmentalists to become involved in their field, including
outdoor experiences and programs (Chawla, 1999) but less is known about the short- and long-term effect of a particular place-based environmental education program on a select group of students.

This study investigates the degree to which a specific place-based, field environmental education program is effective in changing students’ affect (or feelings) toward science. A related question is whether students attribute a long-term change in their feelings toward science to their participation in this program. Affect toward science was chosen as a focus for this research because of the belief that it has a larger influence on attitudes than either cognition or conation.

To obtain a measure of student affect in both the short- and long-term, a sample of students was drawn from a northern Ohio school district that sends all of its students to F.T. Stone Laboratory (hereafter, Stone Lab) workshop. Most other schools participating in the program send only their accelerated students. By using a sample comprised of students with varying levels of experience and interest in science, we gain a clearer picture of the effect of the Stone Lab experience on student affect. In addition, this school district has been sending all students to Stone Lab during the sixth grade for many years, thus providing the opportunity to survey students who recently visited the lab, as well as students who visited at various times in the past.

Need for this study

The study was designed to examine the role that place-based environmental education plays in facilitating a change in affect toward science for learners. While many studies have looked at the extent to which place-based and environmental
education facilities have influenced change in students’ attitudes toward science (Atwater et al., 1995; Crompton & Sellar, 1981; Dettman-Easler & Pease, 1999; Eagles & Demare, 1999; Keen, 1991), there is a need for more research focusing on this topic since an overall consensus has not been formed addressing the exact influence that these programs have on learners’ attitudes. Data from the present study will be valuable to the field.

A second need for the study focuses on determining whether a particular place-based environmental education facility is meeting its own stated educational goals. For this study the researcher investigated a sixth-grade science program offered at F.T. Stone Laboratory, The Ohio State University’s Lake Erie research and learning laboratory. Although the Ohio Sea Grant College Program has developed a thorough and detailed strategic plan for the laboratory (detailing specific research and educational goals), until now there has been no extensive inquiry into whether Stone Lab workshops and programs have successfully worked toward meeting the goals set forth in the plan. The particular goal and objective of interest for this study is stated in Stone Lab’s strategic plan as:

*Improve the quality of science education by creating high-quality, hands-on science education opportunities for students in grades 5 through adults.*

(Ohio Sea Grant College Program & The Ohio State University, 2000, p. 15)

As part of that goal, Stone Lab strives to:

*Increase knowledge levels and interest in aquatic science students.*

(Ohio Sea Grant College Program & The Ohio State University, 2000, p. 46)
The action that Stone Lab planned to take toward meeting this objective is to:

*Develop a follow up survey program, to evaluate the effectiveness and/or impact of the workshop program on students’ environmental awareness, choice of college and/or major, choice of recreational activities and their ultimate choice of careers.*

(Ohio Sea Grant College Program & The Ohio State University, 2000, p. 46)

The present study is a first step. Along with evaluating Stone Lab’s influence on how students feel about science in general, additional data were collected from seventh, ninth and twelfth graders focusing on hobbies, course and career choices and whether these were affected by participation in the Stone Lab workshop.

**Research Questions**

This study has two purposes, first to investigate whether or not an experience-based and place-based field environmental education program is capable of influencing students’ affect component of attitude toward science and, second, to determine whether Stone Laboratory is achieving a portion of the key goals for its programs. Stone Laboratory programs rely heavily on experience-based, hands-on learning. This case study of the northern Ohio school district students’ experience at Stone Laboratory will provide information for the growing field of environmental education research.

The key research questions guiding this study are as follows:

- To what extent does participation in a Stone Laboratory workshop influence (in short-term and/or long-term) the affect component of attitude toward science for participating students from a northern Ohio school district?
To what extent is the level of affect response to the Stone Laboratory experience related to demographics such as expressed interest in science, gender or ethnicity?

Definition of Terms

Attitude is a very complicated topic and researchers have written entire books on how to define it and its components. Below are the best definitions for the purpose of this research.

Affect: Widely considered the most important and influential component of attitudes. Affect is defined as “a person’s feelings toward and evaluation of some object, person, issue or event” (Fishbein & Azjen, 1975, p. 12).

Attitude: Attitudes are “complex systems comprising the person’s beliefs about the object, his feelings toward the object and his action tendencies with respect to the object” (Azjen & Fishbein, 1980, p. 19). Attitudes are specifically composed of three components: affect, cognition and conation (Shrigley et al., 1988).

Cognition: The knowledge component of attitudes, cognition focuses on what people know and believe about a particular object or issue (Fishbein & Azjen, 1975; Shrigley et al., 1988).

Conation: Conation is defined as the intent to act or behave as a result of an individual’s feelings and knowledge, otherwise known as “behavioral intention” (Fishbein & Azjen, 1975, p. 12; Shrigley et al., 1988).
Place-based Education: Education that is highly dependent upon the place where learning occurs. It is multidisciplinary, experience-based and "connects place with self and community" (Woodhouse & Knapp, 2000).

Limitations of the Study

1. The northern Ohio school district selected for this study is unique because it is the only district that sends all students to Stone Laboratory (rather than sending only accelerated or science-interested students). Therefore, it was not possible to obtain a comparison group for the subjects. This research is thus classified as a case study and cannot be generalized to other schools.

2. Field trips to Stone Lab are scheduled only once, in the sixth grade, for this school district. Therefore, if there are factors (e.g. inclement weather) that keep the students from fully experiencing the lab during their day and a half trip, they do not get a second chance to visit.

3. Student achievement levels are self-reported in the study. Because of time constraints and confidentiality laws actual grades of students were not obtainable for this research.

4. There was a low response rate for students in the study (32.1%) in phase one. However, since all of the sixth graders were in the initial sample group for phase one (resulting in 90 pre- and post-test responses), this phase's data should be practically significant and representative. For phase two, the response rate for surveyed seventh graders was high (81.1%), but very few questionnaires were returned for high school students (ninth and twelfth graders). Identifying
potential respondents in the high school grades had to be left to the school administration. Because of this, population size for this group was unknown and the contact methods for respondents were unclear. Therefore, data on the ninth and twelfth graders may not be representative of the groups.

Assumptions

This study has the following fundamental assumptions:

1. Students were honest in their responses in both phases of the study.

2. Stone Laboratory offers an experience different from regular in-school science class.

3. Stone Laboratory workshops for the students in each sample were similar in the experience, structure and content.
CHAPTER 2

LITERATURE

Influences of Environment and Experience

The workshop focused on in this study provides an example of outdoor and environmental education, participatory science learning, and a place-based program. These are the types of learning that students experience at the F.T. Stone Laboratory (Stone Lab). To understand the educational process that occurs at Stone Laboratory, we must look back at the history of experience- and place-based learning. In the 1930s, John Dewey (1938) emphasized that the "quality" of an educational experience has a large influence on what the learner takes away from the experience. He also argued that each experience should have some continuity with other prior experiences in the learners' lives. These experiences then ultimately enable learners to develop particular attitudes that shape their perspective about the experience itself and the topic that it encompasses (Dewey, 1938).

In addition to the experience of learning, it is also important to recognize that the environment where an educational program occurs can have a great impact on students (Fenwick, 2000). The environment can be a key influence in determining the success of a particular program (in terms of impact or effect on students and their particular affect.
regarding the experience or the lessons learned). Participatory science and place-based learning theory address the impact a program has when both the environment and experience are integral components of the program. Participatory science learning focuses on the idea that the actual experience of doing the science allows students to develop a personal ownership over the process of completing the activity, as well as offering them the ability to personally reflect on and derive meaning from the science that they practiced (Barab & Hay, 2001; Fenwick 2000).

Place-based education is a different form of experience that may often occur in conjunction with outdoor or environmental education (Woodhouse & Knapp, 2000). One of the main goals of place-based education is to offer students the opportunity to connect classroom lessons with real world experiences (Smith, 2002). Woodhouse and Knapp (2000) outlined the key components of place-based educational programs by identifying that most of these programs tend to “emerge from the particular attributes of a place,” are “inherently multidisciplinary,” are “inherently experiential,” focus on “broader objectives,” and “connect[s] place with self and community.” Thus a place-based program should lend itself well to a teaching method like participatory science. Sanger (1997) also emphasized the importance of experience and place in education by stating that “an experiential education of the land gives students not only knowledge of their place, but also communicates that the land has value, that students’ experiences outside the classroom have value, and that students’ own personal knowledge has value” (p. 5). In essence, the place-based experiential learning environment allows the environment to guide the experiences and education of the learners and helps them derive a more personal message from the program.
The emphasis on place in a program can have other effects on a learner as well. Vaske and Kobrin (2001) found individuals who establish some form of link with a particular natural area are more likely to exhibit environmentally responsible behaviors relating to that area. Interestingly, their research indicated that an interest in a particular place induced these behaviors even more often than an awareness of the actual environmental issues did. Therefore, the place where learning occurs can be an important influence on learners, at times more so than the knowledge that they gain about an issue.

Defining and Measuring Attitudes toward Science

Developing positive attitudes toward science is important because research has shown that attitudes can influence particular behaviors. Schibeci and Riley (1986) demonstrated that attitude toward science can affect students’ achievement in the sciences. Freedman (1997) also found a positive correlation between attitude and achievement. Furthermore, research in decision-making has indicated that individuals’ attitudes help to guide them in the decisions they make (Finucane et al., 2000; Poulou & Norwich, 2002). Keeping this in mind, this portion of the literature review addresses attitudes and how they are influenced by environmental and outdoor education programs.

Fishbein and Azjen (1980) comment in their text, *Understanding Attitudes and Predicting Social Behavior*, that the definition of attitude has undergone many transformations throughout the years. Even as some social scientists strive to define exactly what attitudes are, others develop competing definitions and classifications. While taking into account this lack of consensus in the social science community on the exact definition of attitude, the definition used in this study comes from Shrigley, et al.
(1988). Shrigley et al. defines the construct of attitude as a three pronged concept, including "affection, cognition and conation" (p. 659). Affection is also explained as the "evaluative quality" portion of attitudes or feelings, cognition as what the learners know or believe, and conation as "behavioral intention." Other researchers have also divided attitudes into these three (or three similar) components illustrating that this view is a popular one in attitude theory (Summers, 1970; Azjen & Fishbein, 1980). Although this belief is commonly used in defining attitude, Shrigley et al. (1988) emphasized that work still needs to be done to (completely) understand the relationship between the components. There also needs to be a focus on determining the degree each part contributes to the overall development of attitudes and attitude change.

This study focuses on a specific type of attitude assessment, a measurement of students' attitudes toward science. Paul Germann (1988) explained attitudes toward science by separating the definition into two groups of thought, "scientific attitude and attitude toward science" (p. 690). Basically, Germann defines "scientific attitude" as the attitude scientists take while investigating certain problems and ideas. Conversely, "attitude toward science" is defined as the attitude that people have toward science in general (as well as the separate topics that fall under the heading of science, such as ecology). In examining "attitudes toward science," Germann (1988) noted that there is a possible relationship between attitude and science achievement where "students with more positive attitudes attend better to classroom instruction, lab exercises, studying, and homework than students with a less positive attitude" (p. 699).

In Germann's (1988) development of the Attitude Toward Science in School Assessment (ATSSA), he focused primarily on students' attitudes toward science as a
subject in school. Accordingly, he devised his questions to help teachers “monitor
general attitude toward science in school among students” (p. 700). In development of
the instrument, Germann relied extensively on Hugh Munby’s 1983 analysis of the
Science Attitude Inventory and its ability to reliably assess science attitudes. Results
from this analysis were used in Germann’s consideration of how best to organize and
frame the ATSSA instrument. In addition, Germann also referred to the instrument used
in Simpson and Troost’s 1982 study that investigated what factors influence students’
learning of science and how committed they become to that endeavor. The instrument
used for that study included sixty items, which were then analyzed with fifteen different
subscales. Following his review of these instruments and pilot tests of his own,
Germann’s (1988) ATSSA instrument included fourteen items that focused on students
general feelings toward science in the classroom. That instrument was the basis for
development of the survey used in Phase One of this study. Further discussion of the
survey can be found in Chapter Three.

In order to clarify the definition and research on students’ attitudes toward science
we must look at other studies that have focused on it. In a study that surveyed the overall
attitudes toward animals held by sixth grade students, Eagles and Demare (1999) found
that the acquisition of knowledge did not directly correlate with the development of
specific attitudes. Therefore, there must be some other portion of the educational
experience interacting with student attitudes and achievement in science. Chawla’s
(1999) studies investigated the key experiences in the lives of environmentalists that
spurred their interest in science and the environment. Chawla’s research showed that
many memorable life-altering experiences (in terms of environmental attitudes) occur in
an experiential, outdoor setting and that her subjects listed these early experiences as important influences in determining their career choices. In fact, after surveying fifty-six environmentalists from Kentucky and Norway, 77% noted experiences in natural areas as key motivators in their decision to pursue environmental work (Chawla, 1999). In reviews of other life experience research, Chawla (1998) listed participating in outdoor activities and educational field trips as important experiences identified by subjects for having an influence on their feelings and motivations toward the environment.

Moreover, Eagles and Demaree (1999) also identified a trend in the research showing that most overall attitudinal change in students occurs during the high school years. This research then suggests that early experiences with place-based and participatory science programs can have a positive influence on students and how they feel about science.

However, other factors such as demographics and social influences can determine the degree to which attitudes are successful predictors for behaviors (Azjen & Fishbein, 1980). In a study using a very large sample size of 4000 students (ranging in age from elementary to high school), Simpson and Oliver (1985) found a significant decline in students’ attitudes towards science as learners progressed through middle school and into high school. Furthermore, they also found that there were significant differences in student attitude between genders where male students had significantly more positive attitudes toward science than females. However, by contrast, males were also shown to be less motivated to achieve in science than females. In Simpson and Oliver’s study, student responses were collected using an instrument similar to the one used in the present research. Other studies focusing on gender differences in science attitudes and interest reflected similar results. Hill, Pettus and Hedin (1990) conducted three studies
using a Likert-type scale survey noted that females tended to have a lower level of interest in science than males. They also found the same trend for minority students. The stereotype of science as a male-dominated discipline was suggested as an explanation for the female results. Other societal influences were identified for differences in ethnic group responses. Another study of note was by Jones, Howe and Rua (2000) who stated that while there were differences in gender for how students felt about science, it was also influenced by the type of science being discussed. They identified male students as gravitating toward the physical sciences whereas female students had more of an affinity for the biological sciences.

Atwater, et al. (1995) examined the science attitudes of sixth, seventh and eighth grade students in an urban area of the southeastern United States. Using an earlier variation of the same attitude survey used in this study, the authors found much variation in attitudes toward science between gender and ethnicities. African American students showed higher positive attitudes toward science than students of other ethnic groups (Atwater, et al., 1995). However, overall, only 25% of all students had positive attitudes toward science. The authors also noted that friends’ and peers’ attitudes can have an impact on another individual’s attitude toward science. Furthermore, and perhaps more importantly, Atwater et al. identified a trend in the data showing that learners’ attitudes toward science become more negative as they progress through the middle school years. The researchers also remark that students with a more negative attitude toward science tend to be less highly motivated to “achieve in school” than those students with more positive attitudes toward science (p. 673).
In a contrasting study investigating students’ attitudes toward science, Barrington and Hendricks (1988) did not find a significant difference between males and females. The subjects in this study were 143 subjects classified as either “intellectually gifted” or “average” students in the third, seventh and eleventh grades. In this study, students responded to questions focusing on their attitudes and knowledge about science in general, as a class, their teachers and career. Although the study identified differences between students of varying academic ability (gifted versus average), there was a lack of significant differences for gender. One trend that the authors did note in this study, however, is that, although not significant, females seemed to become slightly more interested in science as they grew older (compared to their male counterparts).

A study by Catsambis (1995) investigating science attitude and achievement found that while there were gender differences in student attitudes toward science, this was not true for achievement levels. This study used a national study of 24,500 eighth grade students. The researcher also analyzed the results by ethnic group and found that while African American students typically had lower levels of achievement [than members of other ethnic groups, e.g. white students], overall they had positive attitudes about science.

Another study noted the importance of grade level in attitude development, when Kellert (1985) studied the overall knowledge and attitudes of 267 students in varying grades (second, fifth, eighth and eleventh) towards animals. Using a variety of surveying methods, including “multiple choice questions,” “picture identification” and “film tests” (p. 30-31), the author found that while attitudes about animals varied greatly across grade level, gender and ethnicity, overall knowledge and positive attitudes regarding animals
increased as students progressed through middle school and into high school. Because of such research findings on attitudinal change during the middle school years, the inclusion and comparison of demographic differences in this study could help explain results and add to the growing body of knowledge in this field.

Affect toward Science

This study in particular focuses on the affect (or feelings) component of the attitude construct. The complex relationships between the three identified components of attitude seem to dictate that the best method of studying attitudes is to focus on the influence of each component individually. The affect component of attitude is defined as the individual’s feelings or emotions about a particular issue or object (Fishbein & Azjen, 1975; Shrigley et al., 1988); it is also identified as the evaluative portion of an individual’s attitude.

Affect is considered by many researchers to be the key ingredient in student attitudes toward science (Dutton & Stephens, 1963; Koballa & Crawley, 1985; Oliver & Simpson, 1988). In fact, Koballa (1988) identified affect as the “most important quality of the attitude concept” (p. 117). Oliver and Simpson (1988) define a student’s attitude toward science as whether or not they actually like the subject, thus making it an affective measure more than a behavioral or cognitive one. Koballa and Crawley (1985) also emphasized a like or dislike of science as the defining measure of attitude toward science. Keeping these classifications in mind, this study has been designed to focus on the feelings that students have toward science and whether a program such as Stone Laboratory’s can influence these feelings.
Affect may be directly related to certain behaviors such as achievement and decision-making, though other factors can also play a role in these behaviors (Rennie & Punch, 1981; Steinkamp & Maehr, 1983; Finucane et al., 2000; Poulou & Norwich, 2002). Environmental and demographic influences can impact the degree to which affect dictates an individual’s behavior. Rennie and Punch (1981) conducted a study investigating the relationship between students’ affect toward science and their achievement by surveying 390 eighth grade students (using a Likert-type scale) in Australia. While Rennie and Punch found that students’ particular feelings toward science can be influenced by previous achievement in the subject, other studies have shown that some demographics (i.e. gender) can manipulate the degree to which affect and achievement are related. Steinkamp and Maehr (1983) also concluded this in their research review, which noted that males tend to have greater success in science classes than females do. In addition, males seemed to have a greater affect toward science than females, though this may depend upon subject areas as females showed more positive affect toward biology and chemistry than males did (Steinkamp and Maehr, 1983).

Finucane et al. (2000) observed that university students use their feelings about the risks and benefits of high-profile issues to dictate the decisions they make about it. The researchers showed this influence to be more dramatic when subjects were placed under time constraints and were limited in the amount of time they could actually think about an issue. They also illustrated that the influence of affect on a decision can be influenced by the information a subject learns about the issue. However, the main idea here is that affect does have a role in helping people make important decisions. To further show the influence that affect has on individuals’ decisions, Poulou and Norwich
(2002) investigated how teachers responded to students with “emotional and behavioral difficulties” who needed additional assistance in their learning (p. 111). The researchers stated that both feelings and knowledge play a very important role in determining what decisions teachers make regarding the level of assistance they provide to students. However, they also remarked that the teachers with particularly negative feelings toward a student would withhold the amount of help they provided that student, indicating that perhaps affect or feelings play a larger role than cognition (or knowledge).

More recent research into the affective component of attitudes has identified several dimensions for further specifying ways to measure it. The identified dimensions in risk communication include degrees of feelings ranging from good to bad, feelings ranging from calm to upset, feelings related to meaning and connection, feelings focusing on honesty and responsibility and feelings focusing on control and stability (Poulou & Norwich, 2002; Slovic, 2000). While these are important components to identify, this study looks at affect in a more general sense with questions ranging across a number of these sub-components. The format of the survey from its origin has it focused primarily on the measure of positive and negative feelings toward science. Although it is important to identify these newer classifications in affect and attitude research, this study was not designed with them in mind and should not be used as an illustration of Stone Lab’s impact on any one of these dimensions in particular.

Studies of Environmental and Outdoor Programs’ Influence on Attitude

Environmental education occurs in many forms, and a variety of approaches to teaching about environmental and science topics have been investigated in educational
research. Many of these studies focus on specific camps or workshops, with a wide range of results reported. Because the quality of the environment, the instruction and the program treatment must mesh in order for the program to have an impact on the student, not every program facilitates attitudinal change (Volk & McBeth, 1997). While some programs have been considered successful (Dettmann-Easler & Pease, 1999; Mittlestaedt, Sanker & VanderVeer, 1999; Broussard, Jones, Nielsen & Flanagan, 2001), others have found experience-based learning processes to fail in achieving certain program goals and/or bringing about attitudinal change (Crompton & Sellar, 1981; Keen, 1991; Eagles & Demare, 1999).

Mittlestaedt et al. (1999) used a survey format (not the survey used in this study) to determine whether participating in a summer camp influenced attitudes toward the environment. The subjects were children ranging in age from nine to twelve. In data analysis, the researchers found that although the majority of the students participating in the program came in with positive attitudes toward the environment, they left the program with “an even stronger positive attitude” (p. 147). Dettmann-Easler and Pease (1999) studied fifth and sixth grade students’ overall attitudinal change toward wildlife after participating in six different residential environmental education programs. The researchers collected their data by surveying and interviewing the students. While their studies indicated that positive attitudinal change could occur from participation in such a program, there were other factors that impacted the success of the program as well. For example, the researchers noted that residential EE programs tend to be more effective in this topic area (attitude change toward wildlife) than regular school classes, however, pairing such programs with actual in-class activities (for their regular classroom) can help
to reinforce the lessons learned in the camp setting. Furthermore, Dettmann-Easler and Pease’s (1999) literature reviews showed that most studies that focused on the effectiveness of similar EE programs found them to be successful in encouraging positive attitudes toward environmental issues when paired with “in-class reinforcement.”

In a study of a program developed to help foster an interest in forest stewardship in middle school students, Broussard et al. (2001) showed the use of outdoor education, particularly in demonstration forests, can have a profound impact on students’ knowledge and attitude. The researchers elaborated on this impact by stressing that although knowledge gain about forests can be accomplished in the classroom, attitudinal change in students (in terms of having students feel more positively about forestry and forest stewardship) occurred when students were given the opportunity to see a demonstration forest and the results of a forest harvest. This also reasserts Dettmann-Easler and Pease’s (1999) claim that in-class reinforcement can increase the impact that a program has on a student.

The interaction between an EE program and in-class reinforcement was identified again when Keen (1991) examined the effects of an experience-based earth education program (Sunship Earth) on the development of knowledge and environmental attitudes in fifth and sixth grade students. The study found that while the program was successful in developing ecological knowledge in learners, it failed to significantly affect the learners’ attitudes toward the environment. Keen attributed this lack of attitudinal development to the short duration of the program and a lack of reinforcement in the classroom following the program, and she postulated that these factors were most likely to blame for the failure of the program to incite attitudinal change in its learners.
Crompton and Sellar (1981) conducted a review of outdoor educational programs to determine their overall effectiveness. They defined outdoor educational programs as those which occur in a non-specific, but outdoor, environment and tend to focus on the development of a sensitivity and awareness toward environmental and conservation issues. In addition, they included programs that encourage involvement in a physical activity of some fashion. In these cases, the researchers found that while there was some positive change in the affective domain of student attitudes (or the students' personal self-development), there was little progress in the acquisition of a "positive attitude toward school and the classroom" (p. 27). However, Crompton and Sellar did identify some inconsistencies in the research cases they reviewed. The lack of positive results may thus relate more to researcher error in measurement and a limitation in the number of cases available for review, than to a lack of effectiveness in the programs.

In consideration of the discrepancies in findings regarding the impact that environmental and outdoor educational programs have on students' attitudes and feelings toward science, there is a great need for additional research in this area. This study seeks to contribute an additional case study to this theory base in hopes of helping to reduce the dissonance in this branch of attitude research.
CHAPTER 3

METHODOLOGY

Study Design

Variables

This study was designed as a longitudinal case study focusing on the Stone Laboratory workshop experiences of sixth grade students from a northern Ohio school district. The study is grounded in place-based and participatory science learning theory, and how these types of experiences influence the affect component of attitude toward science for participants. Data collection occurred in two phases, with a different instrument measuring affect in each phase.

The identified dependent variable is the varying measures of students' feelings toward science (measured through both surveys in Phase One, and questionnaires in Phase Two). The main independent variable is participation in the Stone Laboratory experience. Other independent variables that factor into the study (and into attitudinal change) include general demographic items (e.g. sex, ethnicity), prior interest levels in science and science achievement. The researcher has noted intervening variables, such as differing experiences within the Stone Laboratory program (i.e. inclement weather), in the results section as they pertain to variations in the data. Students were surveyed immediately prior to and following the Stone Laboratory experience to minimize the
influence of any intervening variables on the students’ science affect between the pre-and post-tests of the survey.

Setting

F.T. Stone Laboratory, in cooperation with the Ohio Sea Grant College Program, offers programs for a wide variety of age groups and grade levels, including programs for students in elementary through high school, college courses, and teacher education. The program examined here is the sixth grade program, which generally lasts between one half and two days (the specific workshop for the study sample lasted one and one-half days). These programs include activities and instruction covering topics such as ornithology, exotic species, invertebrates, edible plants, water quality, seining, and fish dissections, as well as many other science-based activities.

Following the criteria outlined here, Stone Laboratory is a place-based, environmental education facility because many of the programs offered are hands-on and highly influenced by the environment where the activities occur. Furthermore, Stone Laboratory’s setting on Gibraltar Island, and the diverse ecological and historical characteristics that the island possesses, provides the students with a unique environment to explore and experience. For example, Stone Laboratory is surrounded by Lake Erie, has unique geological features, has an interesting history including a role in the War of 1812 and the Civil War, and also many other physical and biological features that can be related to the school curriculum. According to Fortner (2001), several teachers emphasized during a focus group that they take their students to Stone Lab because they feel that “Stone Lab provides a unique experience in academic and personal growth,
introduces novices to special field science skills, instills a sense of wonder about lake resources and their connected sciences, and engenders a commitment to protect and enhance the environment in general.” Through these discussions with teachers, it is evident that experience and place-based learning (through the combination of environment, experience and education lessons) occurs at Stone Laboratory (Kelly, 1997; Fortner, 2001).

Sanger's (1997) definition of place-based learning (as discussed earlier in this manuscript), describes Stone Laboratory because the Lab offers students an opportunity to take information (either previously known, or learned during a Stone Laboratory classroom experience) and apply it in a real-world setting through hands-on activities (Fortner, 2001). This also groups Stone Laboratory as a “participatory science learning” program, as the students are able to actually do the things that they learn about (Barab & Hay, 2001; Fortner, 2001).

Phase One

Instrument

A survey format was used to measure students’ affect toward science as a result of the Stone Laboratory experience. According to Fraenkel and Wallen (1996), surveys are a good tool for describing the characteristics of a population. In this case, using a survey allowed the researcher to compare the responses on the pre-visit set of items (prior to completion of the Stone Laboratory program) to those collected following the students’ participation.
The survey instrument in this phase of the study was adapted from the Attitude Toward Science in School Assessment (ATSSA) (Germann, 1988). The ATSSA was based on a number of previously existing attitudinal surveys (Moore & Sutman, 1970; Simpson & Troost, 1982; Talton & Simpson, 1987; Germann, 1988). Germann's (1988) main goal in developing the ATSSA was to specifically measure the attitudes of students toward science. A Likert-type scale was used to identify the degree of strength of the students' attitudes on each statement within the instrument. Initial tests of the instrument showed it to have a high degree of both reliability and validity in measuring attitudes. Field testing of the ATSSA instrument, completed by Germann using the original 14 items, showed significance on each of the items at a Cronbach alpha level of at least 0.95 (Germann, 1988).

Simpson and Troost's (1982) initial study using a survey instrument with similar formatting and questions had an internal reliability of 0.94. Those researchers used a very large sample size of 4500 students. Previously developed instruments by Talton and Simpson (1987) also established content validity using a five-member panel of sociologists and educators, and had an overall reliability of 0.88. These studies were referred to by Germann (1988) in his development of the ATSSA instrument. Additional tests focusing on accurately measuring extreme levels of negative and positive attitudes toward science, completed by Germann, showed a high level of validity in the instrument as well. More recently, Atwater, et al (1995) used Simpson and Troost's (1982) original instrument for measuring urban students' attitudes toward science. Atwater, et al (1995) established content validity using a "panel of sociologists and science educators, and factor analysis" (p. 668). They also calculated a Cronbach's alpha of approximately 0.87.
for overall attitude toward science (with some slight variation between grade levels). Cronbach's alpha levels varied considerably (as low as 0.43) on other subscale topics (e.g. attitude toward school and attitude toward family), however, the authors discussed that they expected many of these values to be low as some subscales had only two or three questions within the category. The researchers' "attitudes toward science" subscale comprised seven questions.

The instrument itself was only slightly revised by the researcher from Germann's format. Revisions constituted of the addition of a few statements to compare in attitudinal analysis. However, most of these additional statements were drawn from another reliable and valid science attitude instrument, the Science Attitude Inventory (SAI) (Moore & Sutman, 1970; Moore & Foy, 1997), specifically from the portion of the SAI that tested for positive and negative emotional attitudes. Statements were slightly altered to match the same language used in the ATSSA, and were adapted from the SAI II, a recent revision of the original SAI (Moore & Foy, 1997). In addition, statements focusing on science fieldwork were also added to compare this aspect of the Stone Laboratory workshop to student feelings toward the traditional in-class science experience. A copy of the instrument used in this study can be found in the appendix. For ease of analysis, the survey questions were divided into subscales. Measured subscales, and the questions that loaded on each, are shown in Figure 3.1. The internal reliability for each subscale between pre- and post-visit ranged from 0.7116 to 0.9273 (Table 3.1).
<table>
<thead>
<tr>
<th>General Science Affect</th>
<th>Science Class or In School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science is fun.</td>
<td>It bothers me to study science.</td>
</tr>
<tr>
<td>I have good feelings toward science.</td>
<td>I would like to learn more about science.</td>
</tr>
<tr>
<td>Most people can understand science.</td>
<td>I would feel sad if I never had science class again.</td>
</tr>
<tr>
<td>Science is interesting to me, and I enjoy it.</td>
<td>Studying science makes me impatient.</td>
</tr>
<tr>
<td>Science is fascinating and fun.</td>
<td>Science is a topic that I enjoy studying.</td>
</tr>
<tr>
<td>I do not like science.</td>
<td>Science is boring.</td>
</tr>
<tr>
<td>I feel at ease with science and I like it very much.</td>
<td>During science class, I am usually interested.</td>
</tr>
<tr>
<td>I feel a definite positive reaction to science.</td>
<td>Science makes me uncomfortable.</td>
</tr>
<tr>
<td></td>
<td>It is hard for me to understand science.</td>
</tr>
<tr>
<td></td>
<td>Science is hard.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The Value of Science</th>
<th>Science as a Career</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is important to understand science.</td>
<td>I would like to be a scientist.</td>
</tr>
<tr>
<td>Science is important.</td>
<td>I would enjoy studying science in the future.</td>
</tr>
<tr>
<td>Science is useful.</td>
<td>Working in a science lab would be fun.</td>
</tr>
<tr>
<td>Everyone should understand science.</td>
<td>Scientists have exciting lives.</td>
</tr>
<tr>
<td>Science is not really related to my life.</td>
<td>Scientists don’t contribute useful things to the world.</td>
</tr>
</tbody>
</table>

The following statements did not load on a subscale and were analyzed separately:
- Working outside in science is boring.
- I am uncomfortable doing science outdoors.

Figure 3.1: Subscales for survey instrument in Phase One and the questions loaded on each.
<table>
<thead>
<tr>
<th>Subscales</th>
<th>Reliability</th>
<th>Variance</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Science Affect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.8932</td>
<td>0.0546</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.9255</td>
<td>0.0283</td>
</tr>
<tr>
<td>Science Class or In School</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.8824</td>
<td>0.0192</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.9273</td>
<td>0.0348</td>
</tr>
<tr>
<td>The Value of Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.7116</td>
<td>0.0151</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.6668</td>
<td>0.0135</td>
</tr>
<tr>
<td>Science as a Career</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.7784</td>
<td>0.0296</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.7684</td>
<td>0.0592</td>
</tr>
</tbody>
</table>

Table 3.1: Reliability coefficients for each of the measured subscales between pre- and post-test measures.

A similar version of this instrument was pilot tested with sixth graders attending Stone Laboratory during the fall of 2001. This test occurred in conjunction with Dr. Rosanne Fortner’s NR 810 course (Case Studies and Evaluation of Environmental Communication) at The Ohio State University. Pilot test results showed comprehension of the questions, and ultimately resulted in illustrating a significant shift in attitude for a small sample of students participating in the Stone Laboratory workshop (Bixel et al., 2001). T-test analysis was conducted on individual items and responses were found to be significant on four of the analyzed items at the $\alpha=0.10$ level (Bixel et al., 2001). Four statements Figure 3.2 shows the statements that were found to have significant positive change between pre- and post-surveys in the pilot test.
Science is fun.  
We do a lot of fun activities in science.  
I have good feelings towards science.  
I usually look forward to science activities.

Figure 3.2: Statements that showed significant change in student feelings in the pilot test of this study (Bixel et al., 2001).

The pilot test was part of a course project and had a very small sample size (n=20). The pilot instrument had no subscales. Testing was primarily done to determine understandability and utility of the survey items for this audience.

Subjects

Short-term or immediate effect of the Stone Laboratory program was tested among the sixth grade (usually 10 - 12 years old) participants from a northern Ohio school district. According to the United States Census Bureau’s website (2002), Erie County, which includes the school district featured in this study, had a population of approximately 79,312 in 2001. Of this population, 24.7% was under the age of eighteen at that time (25.4% for the state of Ohio). In terms of gender, 51.3% of the Erie County population was female and 48.7% was male. This population breakdown is almost identical to the average in the state of Ohio. A summary of ethnic groups within the county and in Ohio is provided in Table 3.2. Erie County has a higher percentage of white individuals than the rest of Ohio, and fewer African American and Asian individuals.
Table 3.2: Percentages of predominant ethnic groups within the population of Erie County as of 2000. Of individuals in Erie County, 1.6% identified with more than one race; 1.4% did so in the entire state of Ohio.

Source: U.S. Census Bureau (2002)

Of persons aged 25 or older, 84% are high school graduates and 16.6% have completed at least a bachelors degree (some have gone farther in their schooling) as of 2000. The median household income in 1999 was $42,746, which is almost $2,000 more than the average median income for Ohio. The population in Erie County includes 8.3% below the poverty line (in 1999) compared to an average of 10.6% in the rest of the state. Therefore, Erie County is somewhat more affluent than the rest of Ohio with a slightly dissimilar make up in terms of ethnic groups.

Seven groups of approximately forty sixth grade students each participated in the Stone Lab workshop over a period of a week and a half, with each group on site at the Lab for one and a half days. For each of these groups, pre-and post-visit surveys were administered, measuring the students’ affect toward science before and after the Stone Lab experience. This population is ideally suited to answering the research questions because the school district sends all sixth graders to Stone Lab, rather than selectively sending only the advanced or “gifted” students as done in many other districts. Because
of this practice, it will be possible to examine Stone Lab’s influence on affect toward science for students with a wide range of interests and ability levels.

In 2001, 3195 students participated in Stone Lab workshops; 58% of these learners were middle school students (Ohio Sea Grant College Program, 2002). The subject group for this study will be of particular importance because of its focus on the middle school program. During the subjects’ stay at Stone Lab, the students participated in activities that dealt with exotic species (30 minute slide show), science cruise (2 hours), science careers (covered throughout the day), ornithology (1 hour walk), plankton and fish labs (2 hours), and insect collecting (1 hour) (Dress, 2002). Of these activities, the ones that included hands-on components were the science cruise, plankton and fish labs, insect collecting and ornithology (bird walk). In classroom sessions at their school immediately prior to and following the Stone Lab experience, students learned how to identify organisms under a microscope and to identify fish. They also learned about boating safety and about the War of 1812. The school also infuses activities from the Oceanic Education Activities for Great Lakes Schools (OEAGLS) curriculum, which was produced by Ohio Sea Grant Education, in their sessions complementing the Stone Lab workshop. This supplemental curriculum was created as an integrated science activity set to help students develop their knowledge and awareness about oceanic and lake ecosystems (Mayer & Fortner, 1993).

Data Collection and Analysis

Data collection for this phase consisted of pre- and post-visit surveys for subjects immediately prior to and following their participation in a Stone Laboratory workshop.
That is, the students received the pre-visit survey the last school day prior to their Stone Lab experience, and they received the post-visit survey the first school day after returning from the experience. The same surveying technique was followed for each of the groups, with their instructors administering the instrument. Therefore, the students were exposed to the survey for approximately the same amount of time prior to and following the Stone Lab experience. The teacher who administered the surveys was also asked to assign a confidential number to each student. This prevented the researchers from connecting specific students to their responses, and also provided the teacher with the ability to assign the same number to each student for the post-visit survey. Because of this error in data collection, an original intent to do a panel study of the data, looking at individual change for students, was unable to be completed since it was difficult to ensure that the match up between pre- and post-test surveys was entirely accurate.

Survey data were analyzed using the Statistical Package for Social Sciences (SPSS) using paired samples t-tests. Demographic characteristics (e.g. gender, age and self-defined ethnicity) were used as independent variables for comparing student responses regarding their feelings about science.

**Phase Two**

*Instrument*

The second phase of the study used a questionnaire developed from collective statements from both the ATSSA and the SAI attitudinal surveys. It used both closed- and open-ended questions. The questionnaire was designed to examine whether there is a long-term change in student’s affect toward science as a result of participation in the
Stone Lab workshop. Many of the questions were written in an open-ended format, allowing students to provide detailed answers addressing their overall feelings toward science. Other questions focused on science-related choices that students made in their studies and career ambitions. The questionnaire was pilot-tested among Central Ohio area high school students to ensure that all questions were understandable and would provide useful information.

Subjects

The students selected to receive the Phase Two questionnaire were seventh graders (11-13 years old) who participated in the Stone Lab workshop during the previous spring (and were surveyed in Phase One of this research). Questionnaires were also administered to students in the ninth and twelfth grades in the same school district. The rationale behind this part of the study is that since all sixth graders from this school district attend Stone Laboratory, all of the students in the higher-level grades (except new transfers) will also have had the experience. Responses from the previously participating students were sought to account for progressively longer periods of science affect development building on the Stone Lab experience.

One question inquired whether students had attended Stone Laboratory in the past. This enabled the researcher to distinguish between students who participated in Stone Laboratory activities with this school district in the sixth grade, and those students who did not (for example, if they transferred into the school district after the sixth grade).

Parent letters and permission slips were sent in September 2002 to the high school for distribution to ninth and twelfth grade students in their homerooms. The school’s
principal selected the homerooms that were sampled. Only students who returned completed permission forms were eligible to complete the questionnaire. Copies of parent letters and permission slips are included in the Appendix. Seventh grade participants were selected from the students who returned permission slips in Phase One of the study.

Data Collection and Analysis

Questionnaires were administered and collected during the fall quarter of 2002. Students in the seventh grade (those students who participated in Stone Laboratory programs the previous spring) received the questionnaire, as well as students in the ninth and twelfth grades. By collecting responses from ninth and twelfth grade students, the researcher could investigate whether students report a long-term influence on their affect toward science following the Stone Laboratory experience over differing time periods (one summer versus two and four years). School administrators collected the completed questionnaires and mailed them back to the researcher.

The qualitative nature of Phase Two data, along with a relatively low response rate, required a descriptive summary. Frequency reports were first calculated for quantitative items or portions of items on the questionnaire. Then, qualitative analysis of student comments was completed by use of general coding for each question. To identify themes in student responses, the researcher used a method of coding called pattern coding. Pattern coding, as defined by Miles and Huberman (1994), is a method of qualitative analysis where reoccurring themes are identified and comments are grouped within them. By grouping comments in this method, it is easier to summarize
overarching themes within the students' comments. Very few codes were identified in this research because of the brevity of students' responses in the qualitative portion of the questionnaire. Coding comments in this phase was difficult because of this lack of detail provided by the students in their answers.

Where possible, the general codes of Education, Enjoyment, Experience (Hands-on), Difficulty and Other were used in this analysis. For example, if a student gave a justification for liking science that emphasized they found the topic to be interesting, this answer was coded as education (because it related to the content of the subject). If students said, "Science is fun," the remark was coded as enjoyment. Figure 3.3 summarizes the codes used in the analysis of each question, along with a brief description of how the codes were defined by the researcher. Some questions also had subdivisions within the code to illustrate whether responses were framed in a positive, negative or neutral way. For example, if a student said "science is hard" and that is why they do not like it, then this would be a "negative" remark about difficulty. However, if students said they enjoyed science because it challenged them, then this would be a "positive" remark about difficulty. Comments in Figure 3.3 are representative of a student response that would fall in that code category. Actual comments from students were not used in order to minimize bias within the inter-raters. These are the definitions that were used in data analysis and in attaining inter-rater agreement.
<table>
<thead>
<tr>
<th>Codes</th>
<th>Positive</th>
<th>Negative</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>Positive comments about the educational experience at Stone Lab or science in general, such as, “I learned a lot”</td>
<td>Negative comments about the educational experience at Stone Lab or science in general, such as, “We already knew everything” or “All we do in science is read”</td>
<td>Neutral comments about the educational experience at Stone Lab or science in general, such as, “We learned stuff”</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>Positive comments about how the students enjoy science or Stone Lab, such as, “I like science” or “Stone Lab was fun”</td>
<td>Negative comments about how the students enjoy science or Stone Lab, such as, “I do not like science” or “Stone Lab was boring”</td>
<td>Neutral comments about how the students enjoy science or Stone Lab, such as, “Sometimes it’s fun, sometimes it’s not”</td>
</tr>
<tr>
<td>Experience</td>
<td>Positive comments about the experience of participating in science or at Stone Lab, such as, “I liked dissecting the fish” or “We do fun experiments”</td>
<td>Negative comments about the experience of participating in science or at Stone Lab, such as, “Birding was boring” or “We don’t do many experiments”</td>
<td>Neutral comments about the experience of participating in science or at Stone Lab, such as, “The experiments are okay” or “The boat trip was okay”</td>
</tr>
<tr>
<td>(Hands-on)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty</td>
<td>Positive comments about the difficulty or challenge of participating in science or at Stone Lab, such as, “I like science because it challenges me”</td>
<td>Negative comments about the difficulty or challenge of participating in science or at Stone Lab, such as, “Science is hard”</td>
<td>Neutral comments about the difficulty or challenge of participating in science or at Stone Lab, such as, “Sometimes it’s hard and sometimes it’s easy”</td>
</tr>
<tr>
<td>Other or</td>
<td>Any positive comment about science or Stone Lab that does not fall under any of the other categories, such as, “I just do”</td>
<td>Any negative comment about science or Stone lab that does not fall under any of the other categories, such as, “I don’t really do science”</td>
<td>Any neutral comment about science or Stone Lab that does not fall under any of the other categories, such as, “Because”</td>
</tr>
<tr>
<td>Ambivalent</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 3.3: Coding definitions for qualitative analysis of student responses on the questionnaire.
If a student comment fell into more than one code, it was rated both ways. For example, if a student said that he/she liked science and felt that he/she had learned a lot, then this comment would fall under both the positive educational code and the positive enjoyment code. For the Other/Ambivalent code, if a student responded positively on the multiple choice portion of the question, and then justified qualitatively with a comment such as “I just feel that way,” then the comment was rated as a positive other/ambivalent response. The same followed if the student answered negatively. This allowed for the researcher to accurately sort out the numerous “because” and “I just do” comments that the students provided. This coding system was used on the qualitative portions of the following questionnaire items:

#2 Please circle the statement that describes how you feel about science. (I like science/I like science a little bit/I don’t really like or dislike science/I dislike science a little/I do not like science). Why?

#12 Did you enjoy your Stone Laboratory Workshop? (Yes/No) Why or Why not?

#21 Do you feel you learned more, less or the same amount of science at Stone Lab than you do in the same amount of time at school? (More/Less/Same) Why do you feel this way?

A few of the qualitative questions needed to be described in a different manner. For example, when students identified their career ambitions in science, comments were summarized using the most common responses. These instances are evident in Chapter Four.

Inter-rater agreement was achieved using three separate colleagues, who coded a portion of student responses on each question. Miles and Huberman (1994) suggest that a researcher attain at least one (if not more) additional researcher to review coded
comments to assure that there is reliability in the researcher’s interpretations and subsequent coding of responses. Miles and Huberman did not stress that inter-rater agreement on all of the data be achieved, but rather that the additional researchers code a portion of the data. The reliability of inter-rater agreement for codes used on this data was found to be 73%.

Consent/Participant Protection

Human Subjects Research Protocol # 02E0129

Permission slips and parent information letters (see Appendix) were sent home to all students who participated in the study. Surveys and questionnaires were provided to those students who consented, and whose parents have consented, to their participation in either of the two phases of the study. Working with the school district’s administration, a letter of introduction was sent to each student accompanying the permission slips. Complete anonymity from the investigator was outlined in the parental letter. Anonymity was implemented with the use of coded student numbers, instead of names, identifying the individual students on both survey and questionnaire. The researcher numbered each of the surveys and distributed them to the teachers. It was the responsibility of the teachers to provide the students with their own numberd survey, and keep a record of which student received each number (so that they receive the same number for both pre- and post-tests). Therefore, the researcher did not know the source of any of the students’ individual responses and the subjects’ numbers and names were kept confidentially by the school administering the survey and/or questionnaire. Correlated numbering between
pre- and post-test, as well as questionnaires, enabled the researcher to compare
differences between student responses and feelings across time.

Some teachers disregarded the instructions accompanying the Phase One survey
by sending signed permission slips back to the researchers. To maintain student
anonymity, slips were sealed and removed from the researchers’ possession. To survey
these students in Phase Two of the study, a person unrelated to the research compiled the
names of Phase One participants for mailing to the seventh grade school. This was the
best way to keep the students’ identities anonymous and still continue the study.
CHAPTER 4

RESULTS

Phase One – Short Term influence of Stone Lab (Overall and by demographic group)

Administration of the survey prior to and following the students’ Stone Lab experience yielded a total of 90 completed pre- and post-test surveys from the sampled population. Since a census of all Stone Lab participants was attempted (~280 students), the response rate was 32%. In both phases of the study, the researcher was dependent upon students to return parental permission slips in order to participate in the study. The fact that this makes the sample essentially self-selecting is an unavoidable occurrence for these types of studies since non-respondents cannot be followed-up because of the lack of parental permission. Therefore, this factor should be taken into consideration when reading the results for both phases.

The first analysis of the resulting data was an overall paired samples t-test ($\alpha=0.05$, $t=2$) on students’ responses for the instrument as a whole. Mean response on the pre-test was 3.58 (on 5 point scale), whereas the mean response on the post-test increased to 3.67. Change between the mean values from pre- to post-test was 0.086, and the t-value for this change was 2.442 ($df=89$, $p=0.017$, 2-tailed). Overall, there was a significant positive change in students’ feelings toward science for the entire instrument.
For data split by gender on responses on the instrument as a whole, change for male students was more noticeable than change for female students. The paired samples t-value for male students was significant at 2.625 (df=35, p=0.013, 2-tailed) whereas females had a much smaller t-value of 0.709 (df=50, p=0.482, 2-tailed) which was not significant. Mean scores for females were lower on the pre-test (and the post-test) and showed less change between surveys than males.

When data were split by ethnicity, the only group showing significant change at a 90% confidence level was the white ethnic group with a t-value of 1.825 (df=50, p=0.074, 2-tailed). African Americans and Other ethnic groups did not show significant change with calculated t-values of 0.087 (df=16, p=0.932, 2-tailed) and 0.672 (df=9, p=0.518, 2-tailed) respectively. There was more than 0.6 of a point difference between means for White respondents and African American respondents for student pre-test results. Following completion of the post-test, African American students showed almost no change in their mean whereas White students had a significant level of positive change in their responses (at α=0.10) (Table 4.1). However, the difference in number of student responses between ethnicities could impact the significance of the results. Whereas there were 51 White students who completed the survey, only 17 African American students did so, and just 10 students of Other ethnicities completed the survey. Analysis with data split by ethnicity also showed that twelve respondents did not identify any particular ethnic group. Therefore, these students were not included in analyses. Given the small overall sample size, this could influence data analysis results. A summary of results for the survey instrument as a whole (all subjects, split by gender and split by ethnicity) is provided in Table 4.1.
<table>
<thead>
<tr>
<th></th>
<th>Pre-test Mean</th>
<th>Post-test Mean</th>
<th>Mean Diff.</th>
<th>Stand. Error</th>
<th>T-value</th>
<th>df</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Subjects</td>
<td>3.5842</td>
<td>3.6703</td>
<td>0.0862</td>
<td>0.0353</td>
<td>2.442</td>
<td>89</td>
<td>0.017**</td>
</tr>
<tr>
<td>Male</td>
<td>3.7210</td>
<td>3.8885</td>
<td>0.1675</td>
<td>0.0638</td>
<td>2.625</td>
<td>35</td>
<td>0.013**</td>
</tr>
<tr>
<td>Female</td>
<td>3.5053</td>
<td>3.5342</td>
<td>0.0289</td>
<td>0.0408</td>
<td>0.709</td>
<td>50</td>
<td>0.482</td>
</tr>
<tr>
<td>White</td>
<td>3.6948</td>
<td>3.7749</td>
<td>0.08</td>
<td>0.1414</td>
<td>1.825</td>
<td>50</td>
<td>0.074*</td>
</tr>
<tr>
<td>African American</td>
<td>3.1765</td>
<td>3.1832</td>
<td>0.0066</td>
<td>0.0764</td>
<td>0.087</td>
<td>16</td>
<td>0.932</td>
</tr>
<tr>
<td>Other</td>
<td>3.7654</td>
<td>3.8069</td>
<td>0.0415</td>
<td>0.0617</td>
<td>0.672</td>
<td>9</td>
<td>0.518</td>
</tr>
</tbody>
</table>

\( df = \) Degrees of Freedom; **Significant at \( \alpha = 0.05 \); *Significant at \( \alpha = 0.10 \)

Table 4.1: Paired T-Test values for analysis of responses to overall instrument. Data are presented for all subjects and also by gender and ethnicity.

Data analysis was also conducted using subscales for a clearer picture of the areas of the survey that showed the greatest amount of change in student feelings. Subscales were identified as follows: students' general feelings toward science (GSF), students' feelings toward science in class (SCL), students' feelings toward science as a career (SCR) and students' feelings of the value of science (VS) (Table 3.1). Paired samples t-tests were conducted on the pre- and post-test values of these subscales for all subjects (Table 4.2). Significant change occurred between pre- and post-test for the GSF and VS subscales illustrating a positive change in student affect between tests for items included on them. Although not significant, a positive increase in students' mean responses was found on both of the other subscales as well.
<table>
<thead>
<tr>
<th></th>
<th>Pre-test Mean</th>
<th>Post-test Mean</th>
<th>Mean (diff.)</th>
<th>Stand. Error</th>
<th>T-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Science Feelings (GSF)</td>
<td>3.5825</td>
<td>3.7371</td>
<td>0.1546</td>
<td>0.0507</td>
<td>3.049</td>
<td>0.003*</td>
</tr>
<tr>
<td>Science in Class (SCL)</td>
<td>3.4991</td>
<td>3.5677</td>
<td>0.0686</td>
<td>0.049</td>
<td>1.401</td>
<td>0.165</td>
</tr>
<tr>
<td>Science as a Career (SCR)</td>
<td>3.4033</td>
<td>3.4431</td>
<td>0.0398</td>
<td>0.0543</td>
<td>0.817</td>
<td>0.416</td>
</tr>
<tr>
<td>Value of Science (VS)</td>
<td>3.7107</td>
<td>3.8372</td>
<td>0.1265</td>
<td>0.0488</td>
<td>2.329</td>
<td>0.022*</td>
</tr>
</tbody>
</table>

*Significant at α=0.05

Table 4.2: Means and paired T-Test values for analysis of responses in each subscale for all subjects (df = 89).

Partial correlation coefficient analysis was conducted to determine the extent of correlation for subscales between pre- and post-tests when gender was held constant. Analysis of the subscale correlation coefficient results illustrated that responses on the pre- and post-tests for each subscale were strongly correlated to one another. As shown in Table 4.3, the pre-test responses for GSF subscale had a correlation coefficient of 0.8345 (p=.000) with the post-test responses on the same subscale. For the other three subscales SCL (pre/post) was 0.8493 (p=.000), SCR (pre/post) was 0.8375 (p=.000) and VS (pre/post) was slightly less correlated at 0.6881 (p=.000) (Table 4.3). Other subscale responses with particularly high correlations were between GSF (post) and SCL (post) at 0.8900 (p=.000), GSF (pre) and SCL (pre) at 0.8242 (p=.000), and GSF (pre) and SCL (post) at 0.8184 (p=.000). This indicates that responses on different subscales changed at similar rates to those on other subscales.
<table>
<thead>
<tr>
<th></th>
<th>GSF (pre)</th>
<th>SCL (pre)</th>
<th>SCR (pre)</th>
<th>VS (pre)</th>
<th>GSF (post)</th>
<th>SCL (post)</th>
<th>SCR (post)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSF (pre)</td>
<td>0.8242</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>p=0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCL (pre)</td>
<td></td>
<td>0.6259</td>
<td>0.6402</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p=0.000</td>
<td></td>
<td>p=0.000</td>
<td>p=0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCR (pre)</td>
<td></td>
<td></td>
<td></td>
<td>0.5591</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VS (pre)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.6048</td>
<td>0.5591</td>
<td>0.5880</td>
</tr>
<tr>
<td>p=0.000</td>
<td></td>
<td>p=0.000</td>
<td>p=0.000</td>
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<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
</tr>
<tr>
<td>GSF (post)</td>
<td>0.8345</td>
<td>0.7686</td>
<td>0.6436</td>
<td>0.5583</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>p=0.000</td>
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<td>p=0.000</td>
<td>p=0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCL (post)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.8184</td>
<td>0.8493</td>
<td>0.6919</td>
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<tr>
<td>p=0.000</td>
<td></td>
<td>p=0.000</td>
<td>p=0.000</td>
<td></td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
</tr>
<tr>
<td>SCR (post)</td>
<td>0.6331</td>
<td>0.6747</td>
<td>0.8375</td>
<td>0.4600</td>
<td>0.7398</td>
<td>0.7795</td>
<td></td>
</tr>
<tr>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td></td>
</tr>
<tr>
<td>VS (post)</td>
<td>0.4248</td>
<td>0.5239</td>
<td>0.4818</td>
<td>0.6881</td>
<td>0.5651</td>
<td>0.6006</td>
<td>0.5569</td>
</tr>
<tr>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
<td>p=0.000</td>
</tr>
</tbody>
</table>

Df=84; coefficient/2-tailed significance

Table 4.3: Partial correlation coefficients for each of the pre- and post-test subscales. Corresponding subscales for pre- and post-test are shaded.

The amount of student affect varied between gender and ethnic groups. Paired samples t-tests using α=0.05 and tailed t=2, showed more significant change for males (n=36) than for females (n=51). In fact, males showed significant change with a 95% confidence level in two subscales (GSF and VS), whereas females did not show significant change in any of the four subscales (Table 4.4). Using α=0.10, males also had significant positive change for the SCL and SCR subscales. In addition, pre-test means were higher for males than for females across all subscales (male means were also higher for the instrument as a whole). For the two subscales where males showed significant change at α=0.10 (SCL and SCR), female means actually decreased slightly between pre- and post-test. These were also the same subscales where there was the largest overall
difference between male and female mean responses. All pre-test means for both genders were over 3.0 (3=neutral) suggesting that most students started out with slightly positive affect toward science. A summary of these results can be found in Table 4.4.

<table>
<thead>
<tr>
<th></th>
<th>Pre-test Mean</th>
<th>Post-test Mean</th>
<th>Mean Diff.</th>
<th>Stand. Error</th>
<th>T-value</th>
<th>Signif.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Science Feelings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3.7024</td>
<td>3.9668</td>
<td>0.2644</td>
<td>0.0764</td>
<td>3.460</td>
<td>0.001**</td>
</tr>
<tr>
<td>Female</td>
<td>3.5000</td>
<td>3.5742</td>
<td>0.0742</td>
<td>0.0693</td>
<td>1.071</td>
<td>0.289</td>
</tr>
<tr>
<td><strong>Science in Class</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3.6262</td>
<td>3.7976</td>
<td>0.1713</td>
<td>0.0940</td>
<td>1.822</td>
<td>0.077*</td>
</tr>
<tr>
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<td>3.4289</td>
<td>3.4231</td>
<td>-0.0058</td>
<td>0.0523</td>
<td>-0.111</td>
<td>0.912</td>
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<tr>
<td><strong>Science as a Career</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
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<td><strong>Value of Science</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>3.7972</td>
<td>3.9764</td>
<td>0.1792</td>
<td>0.0839</td>
<td>2.136</td>
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<tr>
<td>Female</td>
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<td>0.1046</td>
<td>0.0747</td>
<td>1.399</td>
<td>0.168</td>
</tr>
</tbody>
</table>

**Significant at α=0.05; *Significant at α=0.10

Table 4.4: Means and paired T-Test values for analysis of responses by gender. Male df=35; Female df=50.

Table 4.5 shows the results of a paired samples t-test focusing on the differences between ethnic groups. As with the other t-tests, this also used α=0.05 and t=2. Predominant ethnic groups in the sample were White (n=50) and African American (n=16) with remaining ethnic groups categorized as Other (n=9). Eleven respondents did not list an ethnic group and were excluded from this analysis. Within the ethnic groups, only GSF was found to have a significant change in the Caucasian ethnic group with at
α=0.05; no significant change was found in any subscale for the African American group or Other ethnic group between the pre- and post-tests (Table 4.5).

<table>
<thead>
<tr>
<th></th>
<th>Pre-test Mean</th>
<th>Post-test Mean</th>
<th>Mean Diff.</th>
<th>Stand. Error</th>
<th>T-value</th>
<th>Signif.</th>
</tr>
</thead>
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<td><strong>General Science Feelings</strong></td>
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<tr>
<td>White</td>
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<td>3.7969</td>
<td>0.1327</td>
<td>0.0611</td>
<td>2.172</td>
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</tr>
<tr>
<td>African American</td>
<td>3.1502</td>
<td>3.2458</td>
<td>0.0956</td>
<td>0.1519</td>
<td>0.629</td>
<td>0.538</td>
</tr>
<tr>
<td>Other</td>
<td>3.8125</td>
<td>3.9643</td>
<td>0.1518</td>
<td>0.0917</td>
<td>1.656</td>
<td>0.132</td>
</tr>
<tr>
<td><strong>Science in Class</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>White</td>
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<td>0.0669</td>
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<tr>
<td>African American</td>
<td>3.0962</td>
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<td>-0.0152</td>
<td>0.0969</td>
<td>-0.157</td>
<td>0.877</td>
</tr>
<tr>
<td>Other</td>
<td>3.7032</td>
<td>3.6722</td>
<td>-0.0310</td>
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<td>-0.392</td>
<td>0.704</td>
</tr>
<tr>
<td><strong>Science as a Career</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>White</td>
<td>3.5471</td>
<td>3.5288</td>
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<td>0.0523</td>
<td>-0.350</td>
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<tr>
<td>African American</td>
<td>2.8971</td>
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<td>0.1304</td>
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<tr>
<td>Other</td>
<td>3.5650</td>
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<td>0.669</td>
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<tr>
<td><strong>Value of Science</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>White</td>
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<td>0.1550</td>
<td>0.1212</td>
<td>1.279</td>
<td>0.233</td>
</tr>
</tbody>
</table>

*Significant at α=0.05

Table 4.5: Means and paired T-Test values for analysis of responses by ethnicity. Eleven individuals did not identify a race and were therefore omitted from analysis. White df=51; African American df=17; Other df=10.

Again, similar to results found between genders, almost all means on the pre-test scores for the varying ethnicities were greater than 3.0 (3.0=neutral) indicating an initial slightly positive affect for students. However, African American students had a slightly negative score (pre-test mean = 2.8971) on the pre-test for one subscale, Science as a Career (SCR). Although this subscale did increase (mean diff. = 0.1304) between the
pre- and post-test scores for African American students, the change was not significant at either the $\alpha=0.05$ or 0.10 levels.

In addition to the t-test analyses of survey data, descriptive analyses of student reports of favorite and least favorite subjects and best and worst grades were also performed (Table 4.6). It is important to note that these results are frequencies and do not indicate a significant change in student feelings. More students listed science as their favorite subject following their Stone Lab experience than prior to it. Accordingly, fewer students listed science as their least favorite subject on the post-test compared to the pre-test. The same trend occurred in student responses in the best and worst grade categories. For the frequency reports in the best and worst grade categories, it should be kept in mind that these are not true reflections of the students' actual grades in school. Rather these are self-reports of how students perceive their grades in each subject. Therefore, it would perhaps be more realistic to say this reflects not an actual change in grades but a change in student perception.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Science</th>
<th>Math</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Test</td>
<td>Post-Test</td>
<td>Pre-Test</td>
</tr>
<tr>
<td>Favorite Subject</td>
<td>30</td>
<td>34</td>
<td>26</td>
</tr>
<tr>
<td>Least Favorite Subject</td>
<td>17</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Best Grades</td>
<td>10</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Worst Grades</td>
<td>23</td>
<td>20</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 4.6: Frequencies of student reported favorite and least favorite subjects and best and worst grades for pre- and post-test survey responses in Phase One.
Phase Two -- Long Term influence of Stone Lab (Overall and by demographic group)

Students in the seventh, ninth and twelfth grades completed eighty-nine questionnaires for this second phase of the study. Seventh graders (n=73) comprised the majority of the completed questionnaires, whereas only 6 questionnaires were collected from ninth graders and 10 from twelfth graders. Because students in the higher grades did not return parental permission slips, fewer questionnaires were administered to the students. This phase of the study is purely descriptive and relates frequencies of student responses to quantitative questionnaire items along with comments provided by the students for the qualitative questions. The quantitative results will be presented first, followed by student responses to qualitative questions.

At the beginning of the questionnaire, students identified their favorite and least favorite subjects, along with the subjects in which they received their best and worst grades. Science was identified by 18% (n=16) of students as their favorite subject whereas 20% (n=18) identified it as their least favorite subject. In terms of grades, 16% (n=14) of students said that they got their best grades in science and 20% stated that they received their worst grades in science.

When students were asked how they feel about science, more than half of responding students had at least slightly positive feelings. Of all students (n=89), 36% stated that they like science, 24% of students said that they liked science a little bit, 21% responded that they did not like nor dislike science, only 12% of students said that they disliked science a little and 4% said that they do not like science at all. When data were divided by gender and ethnicity, it followed similar trends in responses. However,
females seemed to have slightly less positive feelings about science than males. Whereas 46% of males said that they like science, only 29% of females stated this (Figure 4.1). In addition, for analysis by ethnic group, while 39% of white students said they like science, 27% of African Americans and 47% of students from Other ethnic groups expressed this feeling. However, African American students answered "I like science a little bit" at a much higher percentage (40%) than either white students (25%) or students from Other ethnic groups (6%) (Figure 4.2).

![Graph showing the percentage of respondents who do not like science, dislike science a little, don't like or dislike, like science a little bit, like science, and missing by gender and overall.]

Figure 4.1: Frequencies of student self-reports of how they feel about science (Overall responses and by gender).
Figure 4.2: Frequencies of student self-reports of how they feel about science (by ethnic group).

Students identifying subjects other than science as their favorite subject still, in general, had positive feelings toward science. At least 40% of respondents in each subject stated that they either liked science or liked science a little bit (Figure 4.3). Students naming science as their least favorite subject, perhaps not surprisingly, showed poor overall feelings toward science. However, 6% of respondents stating that science was their least favorite subject still said that they liked science, and 11% said that they liked science a little (Figure 4.4).
Students described their feelings toward science with a wide range of comments. For students who did not like science or disliked it a little, reasons included that science was boring or they did not understand it. In addition, several students listed their teacher as the reason they did not like science. Students who said they did not like or dislike
science were also ambivalent in their description of why they feel that way. Some of the reasons they provided included:

"There are some things I enjoy and some things that I dislike"
"Because we don't do experiments all the time"
"I'm not sure, I just don't have any feelings about it"
"It depends on the teacher if their (sic) nice or not"

Students who said they liked science gave reasons such as, they think science is fun and interesting and/or they got to do experiments. Some of the students who said they only liked science a little emphasized that they sometimes felt it was boring or hard.

When all of the comments were coded using the system described in Chapter 3, students responding that they like science had more positive comments to offer than those students stating that they were ambivalent about or did not like science. Table 4.7 quantitatively summarizes the number of comments falling in each category. Students who stated that they like science identified qualities of the educational experience, hands-on activities or experiments and enjoyment of the subject as reasons for their feelings. Students stating that they neither like nor dislike science were, subsequently, also ambivalent about why they felt that way. Negative comments about science included comments focusing on the educational qualities and students' enjoyment of the topic.

Along with this, a few students also focused on the difficulty of the topic.
Answers: I like science & I like science a little (n=53)

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
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<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
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<td>0</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>12</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
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<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
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<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
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<td>2</td>
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</table>

Answer: I don’t like or dislike science (n=19)

<table>
<thead>
<tr>
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<th>Neutral</th>
</tr>
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</tr>
<tr>
<td>Enjoyment</td>
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<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Difficulty</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

Answers: I dislike science & I dislike science a little (n=15)

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
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<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>0</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.7: Quantitative coding analysis of student comments regarding why they feel the way they do about science. The coding system used here was defined in Chapter 3.

Student responses were overwhelmingly positive for the question focusing on students’ enjoyment of the Stone Lab experience. Out of all respondents (n=89), 74% (n=66) replied “Yes” they enjoyed their experience at Stone Lab. When divided by gender, 81% (n=30) of responding male students and 69% (n=36) of female students answered positively (Figure 4.5). In analysis using ethnic groups, 76% (n=51) of white students, 73% (n=15) African American students and 88% students of Other ethnicities also responded in the affirmative (Figure 4.6). However, 21% of females and 28% of
African Americans stated that they did not enjoy Stone Lab, whereas only 5% of males, 16% of white students and 6% of students of Other ethnicities felt this way.

Figure 4.5: Frequencies of student self-reports of whether students enjoyed their Stone Laboratory workshop experience (Overall responses and by gender).

Figure 4.6: Frequencies of student self-reports of whether students enjoyed their Stone Laboratory workshop experience (By ethnic group).
Figure 4.7: Frequencies of self-reports of whether students enjoyed their Stone Laboratory workshop experience, divided by students' favorite subjects.

Figure 4.8: Frequencies of self-reports of whether students enjoyed their Stone Laboratory workshop experience, divided by students' least favorite subjects.
When analyzed using students' favorite and least favorite subjects, a higher percentage of students naming science and math as their favorite subject stated that they enjoyed the Stone Lab experience than those responding with different favorite subjects. This may have been influenced, however, by sample size in each group. The number of students listing science or math as their favorite subject was higher than those students listing some other subject (Figure 4.7). Analysis using student's least favorite subject also showed that students overwhelmingly enjoyed the Stone Lab experience (Figure 4.8).

Students who answered that they did enjoy their Stone Lab experience provided the following comments for reasons why:

"It was fun."
"Because I learned more about science."
"I liked that I learned a lot more. Also was more fun than school science."
"It was interesting and you learned something"
"Because we got to do a lot of different things."
"We got to look at fish and animals"
"It was fun because we did experiments instead of listening to someone lecture."

The overwhelming themes in all student responses to this question were that students found Stone Lab to be fun, interactive and different than their regular science class.

Some of the students who did not enjoy the Stone Lab experience provided the following reasons when asked why:

"Because it was cold, and the birdwatch was boring and the fish smelled, also it was dead and I don't like blood"
"Because it stunk and it was really nasty, and the birdwatch was boring."
"It was boring"
"Because I had to cut the fish"
"I don't know I just didn't enjoy it"
"Don't like dissecting animals"
The most prevalent reasons that students gave for not liking the experience were that they found it to be boring. In addition, some students had problems with the fish dissection activity that is part of the workshop.

Along with inquiring whether they enjoyed the Stone Lab experience, students were also asked to identify the most memorable activity that they participated in at Stone Lab. Overwhelmingly, students identified the fish dissection as the most memorable. Although some students listed this activity as being memorable because they felt it was “gross” or “nasty,” the majority of students listing the dissection said it was “fun” or “cool.” Other activities that were listed as memorable were the birdwatch, microscopes, “going out on the boat,” and looking at insects and plankton.

Analysis of student comments using the coding method described in Chapter 3 showed that of students who reported enjoying the Stone Lab experience, the majority listed how much fun they had there (Enjoyment) (Table 4.8). Other top reasons included education and other aspects of the experience of participating in activities at Stone Lab. All comments provided by these students were positive. Of the students stating that they did not enjoy the Stone Lab experience, most of them noted that they either did not have a good time or just did not like the activities or other elements of the experience. None of the students made any negative observations about the quality of the education provided at Stone Lab.
Students who stated that they did enjoy the Stone Lab experience (n=56):

<table>
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<tr>
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</tr>
</thead>
<tbody>
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</tr>
<tr>
<td>Enjoyment</td>
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</tr>
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<td>Experience (Hands-on)</td>
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</tr>
<tr>
<td>Difficulty</td>
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<tr>
<td>Other or Ambivalence</td>
<td>4</td>
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<td>0</td>
</tr>
</tbody>
</table>

Students who stated that they did not enjoy the Stone Lab experience (n=12):

<table>
<thead>
<tr>
<th></th>
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<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
</tr>
<tr>
<td>Enjoyment</td>
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<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>0</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.8: Quantitative coding analysis of student comments regarding why they did or did not enjoy their Stone Lab workshop. The coding system used here was defined in Chapter 3.

When students were asked if they felt that they learned more, less or the same amount of science at their Stone Lab workshop compared to what they learned in the same amount of time in their regular science classes, most students answered that they felt they learned more at Stone Lab (Figure 4.9). The second most popular answer was that they felt they learned the same amount of science. Only 9% (n=8) of students in the overall sample responded that they felt they learned less, whereas 49% (n=44) of students felt they learned more and 27% (n=24) of students felt they learned the same amount.

When data were analyzed by grade levels, results followed the same trend. Gender analysis, however, showed a slightly different division of results. For females, 48% (n=25) answered that they learned more at Stone Lab, 33% (n=17) answered that they learned the same amount and 4% (n=2) felt they learned less. More than half of males
answered that they learned more at Stone Lab, however more males (compared to female responses) also felt they learned less. Fifty-one percent (n=19) of responding males said they learned more at Stone Lab, 19% (n=7) answered that they learned the same amount of science and 16% (n=6) responded that they learned less at Stone Lab than in the same amount of time at school (Figure 4.9). In analysis by ethnic group, the White and African American students predominantly reported learning the same or more at Stone Lab compared to their classroom. Respondents from the Other ethnic category overwhelmingly (71%; n=17) felt that they learned more science at Stone Lab than in school. Within this ethnic group, only one individual reported learning the same amount of science, two individuals answered that they learned less and two did not answer.

![Bar chart showing frequencies of student self-reports of learning more, less or the same amount of science at Stone Lab compared to the amount of science they learn in the same amount of time at school (Analysis by all students and by gender group).](image)

Figure 4.9: Frequencies of student self-reports of learning more, less or the same amount of science at Stone Lab compared to the amount of science they learn in the same amount of time at school (Analysis by all students and by gender group).
Figure 4.10: Frequencies of student self-reports of learning more, less or the same amount of science at Stone Lab compared to the amount of science they learn in the same amount of time at school (Analysis by ethnic group).

Students listing gym and health or social studies as their favorite subjects were more likely to say they felt they learned the same or less science at Stone Lab compared to school. However, of the students listing some other subject as their favorite, the majority felt they learned more science at Stone Lab (Figure 4.11). When data were analyzed using student’s least favorite subject, students naming social studies or gym and health again responded differently. Students disliking social studies were evenly split among whether they learned more, less or the same amount of science; students answering gym and health were evenly split between more and the same; none of these students felt they learned less at Stone Lab (Figure 4.12).
Figure 4.11: Frequencies of student self-reports of learning more, less or the same amount of science at Stone Lab compared to the amount of science they learn in the same amount of time at school (Analysis by favorite subject group).

Figure 4.12: Frequencies of student self-reports of learning more, less or the same amount of science at Stone Lab compared to the amount of science they learn in the same amount of time at school (Analysis by least favorite subject group).
Students who felt they learned more science at Stone Lab than in a regular classroom session made the following comments in the second portion of this question:

"We did more activities"
"I did not know that there was that much things in the water"
"Cause I learned as much as I do in school in a week in 2 days"
"Because they made it funner (sic)"
"I never dissected a fish before"
"It was more hands on"
"I am a visual learner and I learned more from experience in Stone Lab than I did from textbooks"

Of the students who replied they learned the same amount of science, almost all of them commented they already knew the information that was presented. Other comments from these individuals included that they felt science was boring or that they did not like science. Only a few students felt they actually learned less at Stone Lab than in their regular classroom. They explained their feelings by stating they only covered a few topics, felt they didn’t have enough time or stated that Stone Lab made science more confusing for them.

Of students stating they learned more at Stone Lab compared to in school, coding of comments showed that they emphasized the educational and experiential aspects of the workshop even over their own enjoyment of it (Table 4.9). There were few comments accompanying the responses of students who felt they learned less, but the majority of these comments were negative. Students who felt they learned the same amount of science were, in general, vague and/or ambivalent about why they felt that way.
Students who felt they learned more at Stone Lab (n=41):

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
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</table>

Students who felt they learned less at Stone Lab (n=5):

<table>
<thead>
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<th></th>
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<tbody>
<tr>
<td>Education</td>
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<td>0</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
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<td>1</td>
<td>1</td>
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</tbody>
</table>

Students who felt they learned the same amount of science at Stone Lab (n=21):

<table>
<thead>
<tr>
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</thead>
<tbody>
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<td>Education</td>
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<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>0</td>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 4.9: Quantitative coding analysis of student comments regarding whether they felt they learned more, less or the same amount of science at Stone Lab compared to the same amount of time in school. The coding system used here was defined in Chapter 3.

Although a large percentage of respondents said they learned more science at Stone Lab compared to the same amount of time at school, students were split on whether their Stone Lab experience actually helped them understand science better. Forty-three percent (n=38) of responding students indicated they were unsure whether Stone Lab helped them understand science more fully (Figure 4.13). Of the remaining subjects, 22% (n=20) stated that Stone Lab did help them understand science better whereas another 22% (n=20) replied that Stone Lab did not help them understand science better.
Similar trends were followed when the data were broken down by gender. In analysis by ethnic group, a lower percentage (13%) of African Americans felt Stone Lab helped them understand science compared to responses from white and Other ethnic groups (Figure 4.14). This may have been influenced by the smaller number of African Americans (n=15) in the sample compared to other ethnicities. However 25% of white students and 29% of students in the Other ethnic group (n=17) felt they understood science better because of Stone Lab. The sample size of the Other ethnic group in the study was not much higher than representation of African American students.

![Bar chart showing frequencies of student self-reports of whether participation at the Stone Lab workshop influenced how much they understand science.](chart.png)

**Figure 4.13**: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced how much they understand science. (All students and by gender).
Figure 4.14: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced how much they understand science. (By ethnic group)

While “Not Sure” was the most popular answer for students regarding whether Stone Lab actually helped them to understand science better, analysis by students’ favorite subject showed that 46% of students choosing language arts felt that Stone Lab did help them understand science better (Figure 4.15). Furthermore, in analysis of students’ least favorite subjects, 46% of those choosing social studies also felt that Stone Lab helped them (Figure 4.16). For students listing science as their favorite subject, 25% felt that Stone Lab did not help them understand science better, whereas 19% said that it did. Of the students listing science as their least favorite subject, very few (6%) students felt Stone Lab helped them understand science better, and 33% stated it did not help them at all.
Figure 4.15: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced how much they understand science. (Analysis of students divided by their favorite subject).

Figure 4.16: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced how much they understand science. (Analysis of students divided by their least favorite subject).
Within student comments for this section, students who said the Stone Lab workshop did influence how much they understood science provided some of the following reasons:

"Because I got to do different experiments hands on"
"Cause I know a lot and it made me understand better"
"They showed me things step by step"
"I know the parts of fishes better"
"They taught me stuff I never knew about"
"It brought what we learned in the textbooks and brought it to life"
"Because we didn’t just learn about it we actually did it too"

Overall, these students emphasized the hands-on and experience-based teaching style of the Stone Lab workshop. This is evident in the coding analysis of student responses as seen in Table 4.10. Students who said Stone Lab did not help them understand science better made the following statements of why it did not:

"Because I don’t like it"
"I have always had a pretty good understanding of science"
"Made more things confusing"
"It just showed the fun side of science again"
"I still don’t get science"
"I knew about everything they talked about because we had to learn it in science class before we went"

These students seemed to emphasize more their dislike of and confusion about science. Another common response was that that they already understood science. Most of the students who answered that they were “Not Sure” if Stone Lab had helped them understand science better did not provide any comments to accompany their answer. Of the students who did provide a comment, some of them were:

"Cause they didn’t give enough info"
"Because I learned some things but I don’t know if it helped me understand science better"
"I kind of did learn something"
"Because I kind of already understood science"
"I really did not like science"
"Because I don't really remember what we did at Stone Laboratory"

Most of the comments from the “Not Sure” students were also ambiguous, either they just were not sure of what they did or learned, or they could not reconcile whether they actually understood science better now because of Stone Lab.

Students who felt that Stone Lab helped them understand science better (20 Comments):

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Students who felt that Stone Lab did not help them understand science better (19 Comments):

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>1</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>0</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Students who were unsure whether Stone Lab helped them understand science better (15 Comments):

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
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</tr>
<tr>
<td>Enjoyment</td>
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<td>0</td>
</tr>
<tr>
<td>Experience (Hands-on)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Difficulty</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
<td>0</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 4.10: Quantitative coding analysis of student comments regarding whether they felt that participating in the Stone Lab workshop helped them to understand science better. The coding system used here was defined in Chapter 3.
When students were asked whether their Stone Lab experience affected their success in science at school, more students responded that there was “no change” in their success that they attributed to Stone Lab. Upon analysis of the data across all subjects (n=89), 16% responded that they were doing better in science because of Stone Lab, 6% responded that they were doing worse, 13% said that they were doing better but not because of Stone Lab, 3% said they were doing worse but not because of Stone Lab, and 48% reported no change in their success (Figure 4.17). In data analysis by gender, 11% of all male students (n=37) felt that they were doing worse in school because of Stone Lab, whereas only 2% of all female students (n=52) felt that way. However, 19% of males and 13% of females thought they were doing better in science because of Stone Lab.

![Bar chart showing the distribution of responses by gender and overall.]

Figure 4.17: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced their success in science at school. (All students and by gender).
The White and African American ethnic groups showed trends similar to that seen in analysis of all subjects (Figure 4.18). For Other ethnic groups there were a couple of differences. First, none of the students in this group reported doing worse in science now because of Stone Lab. In addition, 35% of respondents in this group felt they were doing better in science now because of Stone Lab.

![Bar chart showing frequencies of student self-reports](image)

Figure 4.18: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced their success in science at school. (By ethnic group).

Responses about student success in science because of Stone Lab, when divided by student’s favorite subject, did not show any major trends (Figure 4.19). However, 29% of students listing social studies as their favorite subject and 33% of students listing gym and health as their favorite subject felt that they were doing better in science because of Stone Lab. Conversely, 18% of students listing language arts subjects as their favorite subject felt that they were doing worse in science now because of Stone Lab.

Of students listing science as their least favorite subject, 17% of them felt that they were doing better in science now because of Stone Lab (Figure 4.20). In addition,
23% of students listing language arts as their least favorite subject and 23% of students listing social studies as their least favorite subject felt that they were also doing better in science now because of Stone Lab.

![Graph showing frequencies of student self-reports of whether participation at the Stone Lab workshop influenced their success in science at school. (By student's favorite subject).](image1)

Figure 4.19: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced their success in science at school. (By student's favorite subject).

![Graph showing frequencies of student self-reports of whether participation at the Stone Lab workshop influenced their success in science at school. (By student's least favorite subject).](image2)

Figure 4.20: Frequencies of student self-reports of whether participation at the Stone Lab workshop influenced their success in science at school. (By student's least favorite subject).
In terms of Stone Lab’s effect on student motivation, responses for how Stone Lab influenced students to work in their science classes almost mirrored student answers for whether Stone Lab impacted their success in science at school. As in the previous analysis for science success, the majority of students (37%, n=89) stated that there was no change in how hard they work in their science classes. In the second most popular answer, 24% of students responded they did work harder in science now but it had nothing to do with their participation in a Stone Lab workshop whereas 12% of students said they were working harder in their science class now because of Stone Lab. Very few students replied that they worked less hard at science regardless of whether it was because of Stone Lab (2%) or not (3%). Data splits for this question showed similar response trends between gender and ethnicity. However, within responses from students in the Other ethnic group, 24% of them stated they work harder now in science because of Stone Lab (Figure 4.22). A summary of this analysis is provided in Figures 4.21 and 4.22. These same trends also followed in analysis by students’ favorite and least favorite subjects (Figures 4.23 and 4.24).
Figure 4.21: Frequencies of student self-reports of how the Stone Lab experience encouraged them to work in their science classes. (All students and by gender).

Figure 4.22: Frequencies of student self-reports of how the Stone Lab experience encouraged them to work in their science classes. (By ethnic group).
Figure 4.23: Frequencies of student self-reports of how the Stone Lab experience encouraged them to work in their science classes. (By students’ favorite subject).

Figure 4.24: Frequencies of student self-reports of how the Stone Lab experience encouraged them to work in their science classes. (By students’ least favorite subject).
When asked whether participating in a Stone Lab workshop influenced how much they liked science, three questions were posed (two quantitative questions with a qualitative follow up for students to explain their answers). In the quantitative portion, students were almost equally split on their responses, both for the whole sample and by gender (Figure 4.25). In analysis, 44% of students said that Stone Lab did influence their feelings, whereas 43% of students said it did not. There were slight differences between males and females where 38% of males said “Yes,” 48% of females said “Yes.” In analysis by ethnic group, a higher percentage (53%) of students in the Other ethnic group felt that Stone Lab did not influence how much they like science, compared to the responses of white and African American students (Figure 4.26). Responses from white and African American students followed the same trends as when subjects were analyzed as a whole. Figures 4.25 and 4.26 merely show reported change, the corresponding qualitative responses in text details the way in which they were influenced.

![Bar Chart]

Figure 4.25: Frequencies of whether students felt that Stone Lab influenced how much they like science. (All students and by gender.)
Figure 4.26: Frequencies of whether students felt that Stone Lab influenced how much they like science. (By ethnic group).

This question also had a second part that provided students with a number of options to choose to elaborate on what, specifically, their feelings toward science are and how Stone Lab did or did not influence them. Of these options (summarized in Figure 4.27), 42% of students who indicated that Stone Lab did influence their feelings toward science responded that Stone Lab showed them that science could be fun. This was the most common of all responses for this question. The second most common response showed that 17% of students liked science but indicated that Stone Lab in particular did not influence this feeling. Eight percent of students (n=7) said Stone Lab showed them that science was harder than they thought, and 7% (n=6) said Stone Lab didn’t influence their feelings at all, they had always disliked science and they still did.
Figure 4.27: Student self-reports of how they feel about science and whether Stone Lab contributed to their feelings (n=80). Multiple responses were accepted. Nine students did not respond.

Eleven percent of students (n=10) chose the “Other” option to provide their own explanation for how Stone Lab influenced them. A sample of student comments for this selection is below:

“Stone Lab is cool”
“I don’t like or dislike”
“Stone Lab was boring, but not all science is boring”
“Science seems a little more interesting now”
“Taught me females could play dominating roles in science careers”

Students who chose the “Other” option seem to have either wanted to express ambivalence toward science or the Stone Lab experience. A few gave negative statements about Stone Lab, and others used the option to elaborate on their positive feelings toward Stone Lab.
Of the students responding that Stone Lab showed them science could be fun (n=39), 38% of these were male and 62% were female. Between ethnic groups on the same question, 67% of students responding in the affirmative were white, 18% were African American and 15% were members of Other ethnic groups. Some of the comments that accompanied this answer were as follows:

"It helps you learn about the world"
"More get out and do something thing, other than sit down and read"
"I didn’t know it was so interesting"
"I think it’s fun because of the hands-on experience"
"The labs at Stone Lab were challenging, yet I enjoyed them tremendously"

The fact that Stone Lab provides hands-on science learning experiences was a common observation from students.

Students responding that Stone Lab did not influence their feelings (since they already liked science and always would) provided more general corresponding comments emphasizing, for example, the importance of science and how much fun the students think it is. Samples of these comments were:

"Because I love science and I love learning."
"Cause science is very important"
"Because science is fun"
"I just like science"

Students registering negative feelings toward science, by choosing answers such as “Stone Lab didn’t really change anything. Always disliked science – always will” and “Stone Lab showed me that science is boring” provided these follow-up comments:

"Because it’s boring"
"I don’t like science"
"Because I don’t get it"
"You don’t get to do fun stuff"
"Not so interested in organisms"
The feeling of science as a boring discipline was very prevalent among students demonstrating negative feelings toward science. The statement that science was boring was made several times in the follow-up comments for these individuals. A tabulation of all comments provided for this question using the codes discussed in Chapter 3 is provided in Table 4.11.

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Neutral</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Enjoyment</td>
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<td>15</td>
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<tr>
<td>Experience (Hands-on)</td>
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<td>Difficulty</td>
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<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Other or Ambivalence</td>
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<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 4.11: Quantitative coding analysis of student comments regarding reasons why Stone Lab did or did not influence how much they like science. The coding system used here was defined in Chapter 3.

When students were asked in general if they planned a career in science, the majority of students stated they did not. However, 19% of students (n=17) stated they did want to pursue a career in sciences. This was also the case data were analyzed by demographic group. Twice as many females expressed a desire to pursue a career in science than male students (Figure 4.28).

In analysis by ethnic group, a higher percentage of students in the Other ethnic group planned on pursuing a career in science than students in the white or African American groups (Figure 4.29). For students who noted they did want to pursue a career in science, the following specific jobs were mentioned:

"I would like to become a doctor"
"Veterinarian"
"Archeologist because it looks very fun"
"A forensic pathologist"
"Dentist"
"An engineer"
"Meteorologist because I want to chase storm"
"I want to be a basketball player, pediatrician, lawyer, record producer, and rap artist. Those are things I am interested in."

The most common science jobs mentioned by students were those in the medical field, such as doctor and veterinarian.

Figure 4.28: Student self-reports of whether they plan to pursue a career in science. (All students and by gender.)

Figure 4.29: Student self-reports of whether they plan to pursue a career in science. (By ethnic group.)
When data were analyzed using student’s favorite subject, 31% of students identifying science as their favorite subject and 36% of students naming language arts as their favorite subject said they planned on pursuing a career in science. In addition, 21% of students listing math as their favorite subject also said they wanted to pursue a career in science (Figure 4.30). When this analysis was done using students’ least favorite subject, only 6% of students naming science as their least favorite subject wanted to pursue a career in it (Figure 4.31). Of students listing language arts as their least favorite subject, 32% stated they wanted to pursue a career in science and 23% of students naming social studies as their least favorite subject want a career in science.

Figure 4.30: Student self-reports of whether they plan to pursue a career in science. (By student’s favorite subject).
Figure 4.31: Student self-reports of whether they plan to pursue a career in science. (By student’s least favorite subject).

When students were asked whether Stone Lab influenced their feelings about whether to work in science, the majority of students (70%; n=62) said Stone Lab did not influence them on this feeling (Figure 4.32). Trends were relatively stable for student responses on this question across demographic groups. However, twice as many females as males did say that Stone Lab influenced their feelings. For students who replied that Stone Lab did influence their feelings in this area (18%; n=16), the majority of them answered (on the second part of the question) that they were either planning a career in science, thinking seriously about or possibly considering a career. Only one student stated they would never choose a career in science and a few students replied they were unsure. A summary of student responses regarding whether Stone Lab influenced their feelings about pursuing a career in science is provided in Figure 4.32 and 4.33.
Figure 4.32: Student self-reports of whether participating in a Stone Lab workshop influenced their feelings about whether to work in science. (All students and by gender).

Figure 4.33: Student self-reports of whether participating in a Stone Lab workshop influenced their feelings about whether to work in science. (By ethnic group).

When asked if they are currently involved in a hobby related to science, most students said no. Only 21% (n=19) of students stated that they did have a hobby related to science and listed what that hobby was. Some of the hobbies mentioned included various sports (football, basketball, skateboarding & snowboarding), chemistry sets,
collecting rocks, rockets, building, models, and "collecting blacklight, electric shock balls."

Students who replied that they read magazines or watch television shows related to science were also in the minority. Of all responding students, 29% (n=25) replied that they watched a television show of some kind related to science. Some of the programs they specifically mentioned included *Discovery Channel*, *Bill Nye the Science Guy*, *Zoom*, *Travel Channel*, *Health Channel*, and *Animal Planet*. *Discovery Channel* and *Bill Nye the Science Guy* were the most mentioned programs.

When asked if they read magazines related to science, 19% (n=17) of students said that they did. Some of the magazines that they named were *Science World*, *Time*, *Life*, *Discovery*, *Scope*, *Science*, and *Popular Science*. *Science World* and *Popular Science* were mentioned more than any other particular magazine, but no particular magazine was mentioned a large number of times, probably because of a low n.

As mentioned earlier in this chapter, analysis on student response by grade level was conducted to a limited degree. Because of exceptionally low response rates for the ninth and twelfth grade respondents, little credence should be given to these results, however, for the sake of future research these results for a few of the questions are summarized in Table 4.12 and 4.13.
<table>
<thead>
<tr>
<th>Grade</th>
<th>Like Science</th>
<th>Like Science a Little</th>
<th>Do not like or dislike science</th>
<th>Dislike science a little</th>
<th>Do not like science</th>
<th>Missing Data</th>
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</thead>
<tbody>
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<td>17</td>
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<td>4</td>
<td>2</td>
</tr>
<tr>
<td>9th grade (n=6)</td>
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<td>3</td>
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<td>2</td>
<td>2</td>
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</tr>
</tbody>
</table>

Table 4.12: Student responses by grade level of how much they like science.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Did students enjoy the Stone Lab experience?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>7th grade (n=73)</td>
<td>61</td>
</tr>
<tr>
<td>9th grade (n=6)</td>
<td>1</td>
</tr>
<tr>
<td>12th grade (n=10)</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 4.13: Student responses by grade level of whether they enjoyed the Stone Lab experience.

At the end of the questionnaire, space was provided for students to leave any additional comments that they had about Stone Lab or science in general. Comments ranged from the positive to the negative, some comments were ambivalent and others were more like suggestions. Positive comments were defined as those offering a positive view of science or the Stone Lab experience. Samples of the positive comments received are available below:

"You should keep on doing it because it may change some children's minds on what they're interested in as a career when they get older"
"It taught me some new things"
"It let me see that science can be fun"
"Stone Lab is a wonderful program and definitely should be continued in the future!"
"It should be hands on that was the fun part because in 6th grade and before it wasn't (sic). So it was a new and fun experience."

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Negative comments were defined as those portraying a negative view of science or Stone Lab. If students said they were unaffected or did not enjoy the Stone Lab experience they were identified as leaving the experience with a negative feeling about it. Negative comments provided by students included:

"It didn't change my feelings because I never really like science that much and if it isn't hands-on I'm not going to like it."
"I did not like science because it is boring"
"It was kinda boring"

Most of the ambivalent comments included statements such as "Nothing" and "I don't know." Another ambivalent comment was "It didn't change my feelings about it I feel the same" but the student did not identify in the comment what these feelings were.

Suggestions provided by students focused on the Stone Lab workshop itself and, specifically, the fish experience portion of the workshop. These were:

"Getting to catch more fish and be able to go fishing with a fishing pole"
"Get more fish and more tools"

These results and their implications for education and Stone Lab workshops are discussed in Chapter Five.
CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

Summary of Results

This study looked at students’ affect or feelings toward science prior to and following participation in a Stone Lab workshop, to investigate the degree to which the workshop influenced these feelings. The theory background to this study consisted of environmental education, place-based learning and attitude theory, and results contribute to those areas of research. As a case study, generalizations to other populations are limited and results can only be reflective on the school district and workshop experience involved in the research.

The study consisted of two phases. Phase One used a survey instrument to assess pre- and post-visit students’ feelings toward science. This instrument was based on a pre-existing survey developed and tested by Germann (1988). Slight revisions by the researcher consisted of additional questions that were based upon those developed for the Science Attitude Inventory (SAI) (Moore & Sutman, 1970; Moore & Foy, 1997). T-test analysis was used to determine whether significant change occurred for students between pre- and post-test completion of the surveys. Subjects in the analysis were sixth grade students from a northern Ohio school district who participated in a one and one-half day
program at Stone Lab during the spring of 2002. From the 244 students participating in
the workshop, the researcher obtained ninety complete pre- and post-test survey packets.

In Phase Two, seventh, ninth and twelfth grade students who returned research
consent forms completed a questionnaire that focused on their experiences at Stone Lab
and provided an opportunity for them to self-report any effects that they believed the
Stone Lab experience had on them personally. The subjects in this portion of the study
had all participated in Stone Lab workshops during their sixth grade year and were from
the same northern Ohio school district as the subjects in Phase One. The questionnaire
was administered in the fall of 2002. Analysis occurred in two ways, both of which were
descriptive. Frequency statistics were calculated for the quantitative questions.
Qualitative questions were described using quotations and a coding scheme to identify
themes in student responses. Completed questionnaires were obtained from 73 seventh
graders, 6 ninth graders and 10 twelfth graders.

Results from this study help answer the following research questions:

- To what extent does participation in a Stone Laboratory workshop influence
  (in short-term and/or long-term) the affect component of attitude toward
  science?

- To what extent is the level of affect response to the Stone Laboratory
  experience related to demographics such as expressed interest in science,
  gender or ethnicity?

In addition, the results also indicate Stone Laboratory’s level of attainment of their stated
goals by influencing student interest in science. Discussion of the results along with
recommendations for future research is provided in conjunction with the appropriate research question.

Discussion of Findings by Research Question

*Question: To what extent does participation in a Stone Laboratory workshop influence (in short-term and/or long-term) the affect component of attitude toward science?*

For Phase One, student responses on the Likert-scale survey were converted into a numerical score for each item. In analysis, with the most negative answer from students scored as a one to the most positive answer scored as a five. Neutral answers were scored as threes. Scores for students were averaged on the instrument as a whole and then for each of four subscales: General Science Feeling (GSF), Science as a Class (SCL), Science as a Career (SCR) and Value of Science (VS).

When the instrument was analyzed as a whole, students showed significant change. The student mean on the pre-test was 3.5842 and their mean on the post-test was 3.6703. It is evident that although students started out slightly positive in their feelings toward science, they became more positive following their participation at Stone Lab. This was a change that was significant with a 95% confidence level. Although, practically, the change is very small, the fact that it is a significant change indicates that the Stone Lab experience has some influence on students’ feelings.

An additional factor to consider when reviewing these results, which could have affected the amount of change in affect for students, is the poor weather that was experienced during the Stone Lab workshop for this school district. This factor would contribute to responses from all students in Phase One and the seventh grade respondents
in Phase Two. Because of this poor weather, students did not experience their Stone Lab workshop to the fullest extent. In the case of inclement weather, outdoor activities are affected, particularly the science cruise. Whereas the science cruise boat typically leaves the Put-in-Bay harbor and goes into deeper waters, in poor weather, the boat must stay in the shallower water. This keeps the students from being able to complete all of the activities that they would have in the deeper waters (e.g. fish trawl).

Results from subscale analysis showed significant positive change for all students on two subscales. GSF and VS showed positive change that was significant with a confidence level of 95%. These subscales included questions that looked at how students felt about science in general (GSF) and the level of importance that they place upon science in our world (VS). Much as when the instrument was analyzed as a whole, these subscales showed small but consistent positive change in student responses between pre- and post-tests. The GSF subscale showed more change than the VS subscale with a pre-test mean of 3.5825 and a post-test mean of 3.7371. Student scores on the VS subscale had a pre-test mean of 3.7107 and a post-test mean of 3.8372. This suggests that students already had a positive view of the importance of science and positive feelings about science in general. However, participating in the Stone Lab workshop still influenced these feelings even if only to a small degree.

As for the other two subscales, Science in Class (SCL) and Science as a Career (SCR), student responses did show positive though not significant change given the distribution of responses. SCL had a pre-test mean of 3.4991 with a post-test mean of 3.5677 and SCR had a pre-test mean of 3.4033 and a post-test mean of 3.4431. It is possible that these two subscales are more easily influenced by other outside experiences.
than perhaps GSF or VS would be. This could result from intervening variables, such as students thinking about their traditional science courses in school. Furthermore, some students may simply not plan to pursue a career in the science field regardless of their feelings toward the subject itself. It is the opinion of this researcher that because of these extraneous factors (classroom experiences and other outside interests) it is perhaps less likely that Stone Lab would have a significant influence on these subscales than it might on the other (more general) subscales.

On the Phase One instrument, students also identified their favorite and least favorite subjects. A noteworthy result of these reports is that more students identified science as their favorite subject following their Stone Lab workshop than prior to it. Of all students, 33.3% identified science as their favorite subject on the pre-test and 37.8% identified it as their favorite subject on the post-test. In addition, fewer students listed science as their least favorite subject on the post-test compared to the pre-test. Whereas 18.9% listed science on the pre-test, 15.6% listed it on the post-test. Therefore, although these results are not significant, students did seem to feel that the liked science a little better after Stone Lab in terms of their favorite subjects.

The results suggest that participation in a Stone Lab workshop does have a positive influence on how students feel about science in the short-term. Whether this statement can be extended to describe long-term benefits of participation is more ambiguous. In Phase Two, when the seventh, ninth and twelfth grade students were asked if they liked science, the majority (60%) stated that they liked science at least a little bit. Furthermore, most students (74%) said that they enjoyed the Stone Lab experience. This is notable considering the majority of respondents in Phase Two were
seventh graders – the same group who experienced exceptionally poor weather during their workshop. Forty-four percent of students felt that Stone Lab actually influenced how much they like science. Of students providing this response, 42% of students said that Stone Lab showed them that science could be fun. Therefore, while students did, in general, feel that they like science and that they like Stone Lab, they were divided on whether Stone Lab influenced how they feel about science. Since one of Stone Lab’s key objectives is to increase student interest levels in science, it is evident here that they have achieved this objective for at least some of the workshop attendees. One possible reason why students who experienced the same workshop were split so evenly on how the workshop influenced them is the different learning styles of students from different demographic groups, as well as additional societal factors (Cavallo & Laubach, 2001). This will become more evident in discussion of the second research question focusing on differences between demographic groups.

In terms of other long-term influences that students attribute to their participation in a Stone Lab workshop, almost half (49%) felt that they learned more at Stone Lab (compared to in school) and 22% stated that Stone Lab actually helped them understand science better. Sixteen percent of students said that they were doing better in science at school because of Stone Lab and 12% stated that Stone Lab inspired them to work harder in their science classes at school. Positive student comments about the Stone Lab experience focused primarily on its educational value, students’ enjoyment of the workshop and the hands-on experience that they gained there.

From all of these results, it is easy to see that some students feel that Stone Lab had an impact on their feelings about science. However, these results seem to be rather
inconsistent in some areas. For example, less than a quarter of all students feel that Stone Lab helped them understand science better, however, almost half of all students noted that they felt they learned more at Stone Lab. Future research about the relationships between these feelings should be completed in order to develop a more conclusive statement of the influence Stone Lab has on students in the long-term.

Two factors that could have impacted the long-term influence of the Stone Lab workshop on students is the quality of in-class reinforcement that students receive following the experience and developmental changes that the students are going through as they age. The school district involved in this research indicated that they use some activities from the OEAGLS curriculum in preparation for the students’ visit to Stone Lab and as follow up. It would be interesting, however, to see exactly what is involved in the lessons that teachers use for reinforcement of the activities that the students participate in at Stone Lab. Past research showed that in-class reinforcement can have a great influence on how much students retain from environmental education and outdoor programs like the Stone Lab workshop (Dettman-Easler & Pease, 1999; Keen, 1991). In terms of development change in long-term results, perhaps Stone Lab is just occurring too early in the students’ academic careers to have a long-lasting effect on them. Eagles and Demare (1999) stated that most attitudes for students solidify during the high school years and Simpson and Oliver (1985) noted that students’ attitudes toward science decrease between middle school and high school. Therefore, it seems reasonable to consider that, in order to have a longer impact on students, Stone Lab should try to offer more programs to high school age students and hopefully help to foster better feelings toward science when the students are at more advanced age in addition to their current
program offerings. One additional suggestion as well, might be for Stone Lab to encourage participating schools to bring their students back for additional workshops. This would serve, not only as reinforcement of lessons taught at Stone Lab, but would also have the additional purpose of reaching students at older ages and levels of attitude and affect development.

**Question:** To what extent is the level of affect response to the Stone Laboratory experience related to demographics such as expressed interest in science, gender or ethnicity?

It has already been established that the Stone Laboratory workshop experience has a positive influence on student attitudes toward science when data are analyzed for all students. However, does this hold true when data are analyzed for different demographic characteristics? In Phase One, analysis based upon gender groups showed that male students had significant change on the instrument as a whole and on all of the subscales whereas females showed no significant change for any of the analyzed units. For the instrument as a whole, males had a pre-test mean of 3.7210 and a post-test mean of 3.8885. Females had a lower pre-test mean of 3.5053 and a lower post-test mean of 3.5342. Change for male respondents was significant with a 95% confidence level. This trend maintained itself through subscale analyses. Male students showed significant positive change with a 95% confidence level for the GSF and VS subscales and significant positive change with a 90% confidence level for SCL and SCR. Therefore, Stone Lab workshops seem to have a greater influence on male students than females. The gender of each student’s instructor could be a factor here. While Stone Lab instructors tend to be males, for this group, students were exposed to both male and
female instructors (all of White ethnic background). There are no data available for
which students were with each instructor, though it would be interesting to see if the level
of change in feelings about science for females is different depending upon the whether
they had a male or female instructor. However, societal influences may also be a factor
here. This data seems to reinforce previous research that suggests that males tend to have
more positive feelings toward science than females (Simpson & Oliver, 1985; Steinkamp

Analysis by ethnic group on Phase One data showed that there were differences
between white students and students of African American and Other ethnicities. For
analysis on the entire instrument, only White students showed significant change (90% confidence level). Neither students of African American heritage nor Other ethnicities showed significant change on the instrument as a whole. This could be influenced by the lack of ethnic diversity in Stone Lab instructors. However, one characteristic of student responses that was noticeable was the fact that African American students' feelings about science tended to start out much lower (more negative) when compared to those of White and Other ethnicities. African American students had a mean of 3.1765 on the pre-test and a mean of only 3.1832 on the post-test. White students had a pre-test mean of 3.6948 and a post-test mean of 3.7749 and students of Other ethnicities had a pre-test mean of 3.7654 and a post-test mean of 3.8069. Therefore, African American students started out almost an entire half point lower on their mean feeling about science than White students and even more so for students of Other ethnicities. This suggests that there are probably some type of societal influences affecting how African American ethnic groups feelings about science. This is converse to Atwater et al.'s (1995) findings
that African Americans showed more positive attitudes toward science than students of other ethnic groups. In addition, it also refutes Catsambis’ (1995) claim that African Americans tend to have a high affect toward science even when they exhibit low achievement levels. But it does support Hill, Pettus and Hedin’s (1990) assertion that minority students tend to have lower levels of interest in science. Conflicting research results on how ethnicity affects students’ feelings toward science show that further research needs to be done in this area to determine what scholastic or societal influences may be causing these discrepancies. One additional factor to consider is that when the data are split along these lines, sample sizes become very small, limiting the researcher’s ability to make any conclusive statements about the practical significance of these results.

In Phase Two (long-term effect), much as when data were analyzed for the sample as a whole, analysis by demographic group is somewhat questionable because of the small sample sizes within each group. However, there are some gender and ethnic trends to note. When asked whether they like science, a much higher percentage of males answered affirmatively compared to females. In addition, fewer African American students answered positively compared to White students and students from Other ethnic groups. When asked about liking Stone Lab, male students and students of the White and Other ethnicities seemed to enjoy the workshop more than females and African American students. This trend persisted through much of the analysis. This is contrary to Cavallo and Laubach’s (2001) assertion that females tend to become more positive toward science when they are exposed to highly interactive and hands-on programs. While the females and African American students did seem to enjoy Stone Lab, though not as much as others, it begs the question of what other factors might be causing the disparity between
demographic groups. This question will be answered in discussion in the following paragraphs.

Divergence also occurred in student responses on whether Stone Lab influenced how much they like science. Here, a higher percentage of females than males responded that Stone Lab did have an influence on them. On the same question, when asked to elaborate how Stone Lab influenced them, a higher percentage of females also noted that Stone Lab showed them that science could be fun. This seems to be somewhat in conflict with the results based upon gender differences as seen in Phase One where females showed no significant change in feelings toward science (whereas male students did show significant change). However, past research has shown females to be more attuned to the biological sciences and males more interested in the physical sciences (Jones, Howe & Rua, 2000). Perhaps the high biological content of the Stone Lab experience appealed to the female students’ sense of enjoyment more than the males. It is also possible that females were more able to express their feelings toward Stone Lab and science in the open-ended questionnaire than the Likert-scale survey. In addition, the instrument in Phase Two uses items that pose questions focusing primarily on Stone Lab, and the instrument in Phase One speaks more to science in the general sense (Stone Lab is not mentioned). It could be that females are not thinking of the Stone Lab experience necessarily in their Phase One responses. Because females have been shown in other studies to respond more positively in science learning environments that more interactive and hands-on (Cavallo & Laubach, 2001), if they were thinking of the conventional science classroom in Phase One and about the generally more hands-on Stone Lab workshop in Phase Two, this could account for differing responses on seemingly similar
questions between the two instruments. This is certainly an inconsistent finding that would be valuable to consider in future research. In addition, when asked about the amount of science they learned at Stone Lab, an extremely high percentage of students from Other ethnic groups answered that they felt they learned more. Seventy percent of this group answered more, compared to only about 45% of White and African American students. Moreover, 35% of students in Other ethnicities reported that they were doing better in science at school because of Stone Lab.

Analysis for students’ reported favorite and least favorite subjects was undertaken in both Phase One and Two of this research. While there did seem to be some small variation in how students answered questions between identified favorite and least favorite subjects, the sample sizes for these groups were so small that the researcher cannot put much weight on the results. One finding was noteworthy, however. Not surprisingly, students who named science as their least favorite subject were hesitant to say they liked science even a little. Only 17% of these individuals reported positive feelings toward science. However, even for students who named science as their least favorite subject, over 60% of them stated that they enjoyed the Stone Lab workshop. Additional research with a larger sample size is desirable to make more reliable conclusions from this data.

In general, it seems that Stone Lab has a larger influence on male and white students (and students of Other ethnic groups in some cases). Once again, sample sizes should be considered here, but it is the opinion of the researcher that societal influences are affecting how students of different demographic groups are responding to these questions. It would be beneficial to develop a study that identifies different socio-
economic groups, along with demographic groups, in order to see what components of demographics have an influence on students. The county where this school district resides is, on average, slightly more affluent and better educated than the rest of Ohio as a whole (U.S. Census, 2002). Perhaps this has an impact on how students are responding to the activities. For example, a study could be designed which investigates what percentage of each ethnic group falls into different socio-economic levels and how each of these groups responds to the Stone Lab experience.

Moreover, Hill, Pettus and Hedin (1990) noted in their research that females and non-White students tend to have a lower level of interest in science. They stated further that in order to overcome these biases against science, it is important to reduce the stereotype that science is a male-dominated field. One way that they suggested doing this was by emphasizing the importance of ensuring science role models of both genders and diverse ethnicities are provided in the classroom. These suggestions cause this researcher to wonder if the instructors at Stone Lab could also be affecting how students respond to the experience since the majority of them belong to the White ethnic group. It would probably be beneficial if Stone Lab were to diversify the demographics of their instructors. In addition, sampling students who are sent to Stone Lab in single sex or single ethnic groups might also be a good route when investigating whether interaction with other students is influencing the workshop experience. Häussler and Hoffman (2002) noted that when females were exposed to single sex physics classes, they responded more positively to the subject on both cognitive and affective levels. Therefore, there may be an argument for conducting science programs and workshops
such as the one offered at Stone Lab in single sex groups. This is certainly worthy of future study.

**Recommendations for Future Research**

A number of results within these data are indicative of larger scale trends for particular demographic groups of students. The following are suggestions for future areas of research that might be undertaken to address these new questions:

- While this study has confirmed that programs in environmental education and place-based education can have some influence on student affect, there is still much that needs to be done. In some areas, this study is contrary to what other researchers (e.g. Atwater et al., 1995) have identified in terms of outdoor programs’ influence on student feelings and attitudes (especially between demographic groups). Therefore, additional studies about Stone Lab’s impact on learners should be completed to further describe the influence that its workshop has on participants’ attitudes and feelings toward science.

- Phase One data demonstrate that Stone Lab does have an impact on its learners. However, this impact seems to be stronger for male and White students than any other groups. Additional research should be conducted investigating why this is the case. By conducting studies with higher sample sizes for females and ethnic groups (other than White) researchers might be able to pinpoint why these differences exist.

- When conducting studies focusing on demographic differences between students’ feelings toward science and Stone Lab’s influence on them, future researchers may wish to sample from single sex schools or look at schools with higher percentages of
one demographic over another. By separating out the demographics in this manner, researchers might obtain a better idea of Stone Lab’s influence on demographic groups without the confusion of addressing societal influences. Studies such as this would also be beneficial to add to the literature surrounding place-based education. There seems to be a lack of research focusing on how these types of programs influence different demographic groups (e.g., gender and ethnic differences).

- In terms of identifying long-term trends, it would be more beneficial to follow one group over a number of years to see how their feelings about science and Stone Lab’s influence on those feelings change over time. Time constraints prevented this study from doing so. Ideally, this study would be used as a starting point for conducting research on whether Stone Lab does have a demonstrable long-term impact on students.

- Along the lines of life experience research (e.g., Chawla, 1999), it would be beneficial to conduct a study that would feature interviews of older students who report a significant change in their career options or interest in science that they attribute to their Stone Lab experience. Conversely, a concurrent study examining the reports of students who state that Stone Lab had no influence or actually made them feel worse about science should also be investigated. This might help identify the components of the Stone Lab workshop that have a long-term influence on students, as well as the activities that have a opposite effect on learners.

- Finally, it might be desirable to conduct studies on groups that complete an overnight at Stone Lab compared to those who do not. Perhaps, there are other mitigating factors that are influencing the level of enjoyment that students experience
at Stone Lab that colors their perception of the entire experience. For example, if a student has issues with completing an overnight, that might influence how much (s)he enjoyed the workshop and what lasting changes accrue.

**Recommendations for Stone Lab**

- Students seem to enjoy the Stone Lab workshop and the educational experience that they gain there. Furthermore, a number of them leave the program with more positive feeling about science and an enhanced interest in the subject. Therefore the program seems to be effective and Stone Lab seems to be achieving a portion of the goals set out in their strategic plan.

- It may be in the best interest of Stone Lab and its students to create a follow-up workshop to encourage students to revisit their experience there. Research in advertising shows that repetition in a message can often times help to reinforce its impact on the recipient (Malaviya, Meyers-Levy & Sternthal, 1999). It could be a worthwhile venture to investigate the impact of multiple sessions at Stone Lab for students to see if it has a larger influence on student feelings toward science than a single workshop.

- In terms of instructors, Stone Lab may want to consider infusing additional diversity into their staff. It is evident that male students and White students take more away from the experience than others; perhaps having more females and minorities as instructors could change this trend.

- Given that there seems to be little difference in how Stone Lab influences students already interested in science versus those without an initial interest, Stone Lab
coordinators may want to consider encouraging school districts to send students other than those who are already have a predisposition to enjoy science. It might be that, in the end, the Stone Lab experience is actually more beneficial for students who do not already enjoy or like science, but need an experience outside of the classroom to understand its benefits and importance. Many of the comments from students who enjoyed Stone Lab emphasized that they liked it for being hands-on and different from the experience that they gain in the regular school classroom.

Recommendations for Methodological Changes

- Whereas student responses on the outdoor-based questions in this study were possibly influenced by the poor weather that students experienced during their trip to Stone Lab, creation of a subscale that would focus primarily on this aspect of the environmental and place-based education experience would be beneficial to future studies. Additional questions regarding outdoor experiences and field education should be added to the Phase One survey instrument in order to create a reliable subscale.
- If this study is recreated, students in Phase One should also complete the questionnaire from Phase Two. It was hard to identify changes over time since there was not a clear way to compare data collected in Phase One with data collected in Phase Two.
REFERENCES


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Ohio Sea Grant College Program. (2002). Stone Laboratory 2001: Program Review. Report from Ohio Sea Grant, Columbus, OH.


APPENDIX A

PHASE ONE INSTRUMENTATION
Science Attitude Survey

Student #: _______ Gender: Male / Female (Circle one) Age: _______ Ethnicity: _____________

Favorite Subject: ___________________ Least Favorite Subject: ___________________

Subject I get my best grades in: ____________________________________________________________________________

Subject I get my lowest grades in: ____________________________________________________________________________

Instructions:
Please circle the level (strongly agree, disagree, no opinion, agree, strongly agree) that most closely resembles your opinion on each of the statements below.
Thank you for taking the time to complete this survey.

| 1. Science is Fun. | SD | D | N | A | SA |
| 2. I have good feelings toward science. | SD | D | N | A | SA |
| 3. It bothers me to study science. | SD | D | N | A | SA |
| 4. Most people can understand science. | SD | D | N | A | SA |
| 5. I would like to learn more about science. | SD | D | N | A | SA |
| 6. I would feel sad if I never had science class again. | SD | D | N | A | SA |
| 7. Science is interesting to me, and I enjoy it. | SD | D | N | A | SA |
| 8. It is important to understand science. | SD | D | N | A | SA |
| 9. Science is fascinating and fun. | SD | D | N | A | SA |
| 10. Studying science makes me impatient. | SD | D | N | A | SA |
| 11. I would like to be a scientist. | SD | D | N | A | SA |
| 12. I do not like science. | SD | D | N | A | SA |
| 13. Science is a topic that I enjoy studying. | SD | D | N | A | SA |
| 14. I feel at ease with science and I like it very much. | SD | D | N | A | SA |
| 15. Science is important. | SD | D | N | A | SA |
| 16. Science is boring. | SD | D | N | A | SA |
| 17. During science class, I am usually interested. | SD | D | N | A | SA |
| 18. Science makes me uncomfortable. | SD | D | N | A | SA |
| 19. It is hard for me to understand science. | SD | D | N | A | SA |
| 20. I feel a definite positive reaction to science. | SD | D | N | A | SA |
| 21. Science is hard. | SD | D | N | A | SA |
| 22. I would enjoy studying science in the future. | SD | D | N | A | SA |
| 23. Working in a science lab would be fun. | SD | D | N | A | SA |
| 24. Science is useful. | SD | D | N | A | SA |
| 25. Everyone should understand science. | SD | D | N | A | SA |
| 26. Working outside in science is boring. | SD | D | N | A | SA |
| 27. I am uncomfortable doing science outdoors. | SD | D | N | A | SA |
| 28. Science is not really related to my life. | SD | D | N | A | SA |
| 29. Scientists have exciting lives. | SD | D | N | A | SA |
| 30. Scientists don't contribute useful things to the world. | SD | D | N | A | SA |
APPENDIX B

PHASE TWO INSTRUMENTATION
Instructions: Please answer the following questions as completely and detailed as possible.
Grade Level: 7th 8th 9th 10th 11th 12th (circle one)

Gender: Male Female (Circle one) Age: _____

Ethnicity: __________________________

Favorite Subject: __________________________

Least Favorite Subject: __________________________

Subject I get my best grades in:

Subject I get my lowest grades in:

1. Have you ever taken any science classes since 6th grade that were not required?
   YES NO (circle one)
   If YES, how many? _______

2. Please circle the statement that describes how you feel about science:
   I like science.
   I like science a little bit.
   I don't really like or dislike science.
   I dislike science a little.
   I do not like science.

   Why? __________________________

3. My favorite activity ever in a science class was:
   __________________________
   __________________________

4. My least favorite activity ever in a science class was:
   __________________________
   __________________________

5. Do you have a hobby related to science? YES NO (circle one)
   If YES, what is the hobby? _______________________
   How long have you had this hobby? _____ Years

6. Do you want a career in science?
   YES NO NOT SURE (circle one)
   If YES, What do you plan to do and why?
   __________________________
   If NO, why not?
   __________________________

7. Do you regularly watch any television shows about science? YES NO (circle one)
   If YES, which ones? _______________________
   _______________________

1
8. Do you regularly read any magazines about science?  
YES  NO
If YES, which ones? __________________________

9. Did you attend a Stone Laboratory Workshop with Sandusky Schools in 6th grade?  YES  NO
If YES, please continue the questions below, starting with question #10.
If NO, please turn to page 9.

10. What do you remember most about your time at Stone Laboratory in 6th grade? Why?  


11. What was your most memorable science activity at Stone Laboratory in 6th grade? Why?


12. Did you enjoy your Stone Laboratory workshop?  
YES  NO (circle one)
Why or Why not? __________________________

13. Did the Stone Laboratory workshop influence how much you like science?  YES  NO (circle one)
How would you best describe how you feel about science now because of Stone Lab? (Please circle one or more)
   a. Stone Lab didn’t really change anything, always liked science- always will.
   b. Stone Lab didn’t really change anything, always disliked science - always will.
   c. Stone Lab showed me that Science could be fun.
   d. Stone Lab showed me that Science is boring.
   e. Stone Lab taught me that science is harder than I thought.
   f. Stone Lab taught me that science is easier than I thought.
   g. Other: __________________________
Why do you feel this way about science? __________________________

14. Do you think that participating in the Stone Lab workshop helped you understand science better?  
YES  NO  NOT SURE (circle one)
Why or why not? __________________________
15. How has the Stone Laboratory workshop influenced your success in science class at school? (as compared to your success in science before going to Stone Lab)
   a. Not at all - no change.
   b. I am doing better now in science because of Stone Lab.
   c. I am doing worse in science because of Stone Lab.
   d. I am doing better now in science, but it has nothing to do with Stone Lab.
   e. I am doing worse now in science, but it has nothing to do with Stone Lab.

16. How did your experience at Stone Lab encourage you to work in your science courses?
   a. No change - I work as hard as I always have.
   b. I work harder now in science because of Stone Lab.
   c. I work less hard in science now because of Stone Lab.
   d. I work harder at science now, but it has nothing to do with Stone Lab.
   e. I work less hard in science now, but it has nothing to do with Stone Lab.

17. Did the Stone Laboratory workshop influence your decisions about taking other science classes in school?
   YES   NO (circle one)

   If YES, how did Stone Lab affect your decisions about taking science classes?
   _____________________________________________________________________

   _____________________________________________________________________

   If NO, why do you think that Stone Lab did not affect your decisions about taking science classes?
   _____________________________________________________________________

   _____________________________________________________________________

18. Did the Stone Laboratory workshop experience inspire you to take extra science courses outside school, like through a community center, other special Stone Laboratory courses, or other facilities?
   YES   NO (circle one)

   If YES, where did you take these special science courses?
   _____________________________________________________________________

   _____________________________________________________________________

   How many extra courses did you take? _______
19. Did the Stone Laboratory workshop influence your choice of hobby?  YES  NO (circle one)
   If YES, How? ____________________________________________________________

__________________________________________________________

20. Have you ever encouraged other people to go to Stone Laboratory?  YES  NO (circle one)
   Why or Why Not? _________________________________________________________

__________________________________________________________

21. Do you feel you learned more, less or the same amount of science at Stone Lab than you do in the same amount of time at school?
   MORE  LESS  SAME (circle one)
   Why do you feel this way? ________________________________________________

__________________________________________________________

22. Did the Stone Laboratory workshop influence your feelings about whether to work in science?
   YES  NO (Circle one)
   If YES, How did it affect your choice?
   a. Planning a science career.
   b. Thinking seriously about a science career.
   c. Possibly considering a science career.
   d. Would never choose a career in science.
   e. I don’t know

What else would you like us to know about how Stone Lab changed or didn’t change your feelings about science?
Please use the blank space below.

Thank you for your time! Please do not complete the questions after this page. Please return this questionnaire to your teacher.
If you did not attend Stone Laboratory with Sandusky Schools in the 6th grade, please answer the following questions.

23. Please describe the most memorable moment you have had in any science class you have ever taken.
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

24. Please describe what you think is the most important environmental issue facing our world today.
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

25. Please describe the person who has had the biggest influence over your current feelings about science.
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________

26. Have you ever participated in any science classes or workshops at a zoo, nature center, metropark or other natural area?  YES  NO (circle one)

If YES, did you enjoy it and learn from it? Why or why not? ______________________________________________________________
_________________________________________________________________
_________________________________________________________________

Is there anything else you would like us to know about your feelings about or interest in science? If so, please use the blank space below.

Thank you for your time! Please return this questionnaire to your teacher.
APPENDIX C

COVER LETTERS AND TEACHER INSTRUCTIONS
Mr. John Smith  
Northern Ohio Middle School  
7000 Ohio St.  
Northern, OH 00000

April 6, 2002

Dear Mr. John Smith,

Enclosed you will find the parent information letters and permission slips for students to participate in the study. The letter outlines the basic purpose of the study and provides assurance of confidentiality of each student's identity from the study. In addition, the letter also provides the contact information for the researchers (Dr. Rosanne Fortner and Jennifer Dudley) in case the parents have any concerns or questions. The letter also assures the parents that the students’ Stone Laboratory experience will not be altered or affected by the completion of the surveys.

If possible, please provide these permission slips to each of the students’ teachers as soon as possible for dissemination to the students. Students not returning a parental permission slip will be unable to participate in the study. Surveys will be asked to be administered to the students the last school day prior to their departure for Stone Laboratory (pre-test) and the first school day after they return (post-test). Please ask teachers to have their students return the permission slips by April 23, which is the Tuesday prior to the first group’s pre-test survey administration day (which would be April 26).

I will be mailing you the survey packets within the next week. The surveys will be divided up into 7 packets, with about 45 pre-numbered surveys per packet. Each packet will include both the pre-test and the post-test (which will be separate from each other). Further instructions about the survey administration will be included in the Survey Packets.

Again, thank you very much for agreeing to participate in this study. I appreciate the work that you are willing to put into gathering the survey information. If you have any questions, please do not hesitate to contact me at 614-688-0285 or dudley.42@osu.edu.

Sincerely,

[Signatures]
Dr. Rosanne W. Fortner  
Professor

Jennifer E. Dudley  
Project Coordinator

enclosures
April 6, 2002

Dear Teachers and Instructors,

Enclosed you will find the parent information letter and permission slips for students to participate in the study. The letter outlines the basic purpose of the study and provides assurance of confidentiality of each student’s identity from the study. In addition, the letter also provides the contact information for the researchers (Dr. Rosanne Fortner and Jennifer Dudley) in case the parents have any concerns or questions. The letter also assures the parents that the students’ Stone Laboratory experience will not be altered or affected by the completion of the surveys.

Please pass these permission slips out to the students as soon as possible. Students not returning a parental permission slip will be unable to participate in the study. Surveys will be asked to be administered to the students the last school day prior to their departure for Stone Laboratory (pre-test) and the first school day after they return (post-test). Please have your students return the permission slips by April 23, which is the Tuesday prior to the first group’s pre-test survey administration day (which would be April 26).

Once you receive the signed permission slips from the students, please file them away and provide surveys only to those students who have returned a signed slip. Please do not return the permission slips to the researcher. The researcher may only collect surveys from students who received parental permission to participate in the study. I will be mailing you the survey packets within the next week. The surveys will be divided up into 7 packets, with about 45 pre-numbered surveys per packet. Each packet will include both the pre-test and the post-test (which will be separate from each other). Further instructions about the survey administration will be included in the Survey Packets.

I appreciate the work that you are willing to put into gathering the survey information. If you have any questions, please do not hesitate to contact me at 614-688-0285 or dudley.42@osu.edu.

Thank you for your time and effort.

Sincerely,

Dr. Rosanne W. Fortner
Professor

Jennifer E. Dudley
Project Coordinator

enclosures
April 8, 2002

Dear Parent/Guardian,

Your student(s) at Northern Ohio Schools is going [has been] to P.T. Stone Laboratory at Put-in-Bay, Ohio, with the school. Jennifer Dudley, a graduate student in the School of Natural Resources at The Ohio State University, is interested in studying the long-term effect students may gain as a result of participation in the Stone Laboratory activities.

I hope you will allow your student to take part in this research. Participation will in no way affect the student's eligibility to participate at Stone Lab, and no grade will be affected. Throughout the duration of this study, the student will be advised by Dr. Rosanne Fortner, who is a professor at Ohio State and the Associate Director of Stone Lab.

Our goal is to learn whether participation in the programs at Stone Laboratory changes student attitudes towards science. During the course of the research, students will answer two surveys (late April/Early May 2002) and/or one questionnaire (Fall 2002) about science interest and attitudes towards science in general.

At no time will individual student names be listed or revealed by the researcher. All responses will be kept confidential. If a student wishes to withdraw from the program at any time, he or she will be allowed to do so without any prejudice. Please feel free to call Dr. Fortner or Jennifer Dudley (614-292-9826 or 614-688-0285) at any time should you have any questions. Again, your child will be allowed to participate in the Stone Laboratory activities even if you do not consent to his/her participation in the research project.

We hope that you will allow your student to participate in the research project to help us better understand the effects of outdoor and environmental education programs on student attitudes toward science. If so, please sign in the space provided below and send your signed form with your student prior to their participation in the Stone Laboratory trip.

Sincerely,

Rosanne W. Fortner
Dr. Rosanne W. Fortner
Professor

Jennifer E. Dudley
Project Coordinator

enclosure
Protocol Title: A quasi-experimental investigation of the effect of participation in an experiential environmental education program at F.T. Stone Laboratory on students' attitudes toward science.

Protocol Number: 02E0129
Principal Investigator: Rosanne W. Forner

I consent to my child's participation in the research project conducted by Dr. Rosanne W. Forner and Jennifer E. Dudley of The Ohio State University and their associates. I understand the purpose of this study and any questions I have raised have been answered to my full satisfaction. Furthermore, the director and associates have explained the purpose of the study, the procedures that will be followed, and the amount of time it will take. I understand the possible benefits of my child's participation.

I know that I can (and/or my child can) choose not to participate without penalty to me (and/or my child). If I agree to participate I can (or my child can) withdraw from the study at any time and there will be no penalty.

I understand that my child's anonymity will be maintained in any report prepared from the data collected from my child.

I have had a chance to ask questions and to obtain answers to my questions. I can contact the investigators at (614-292-9826 or 614-688-0285). If I have questions about my rights as a research participant, I can call the Office of Research Risks Protection at (614) 688-4792.

I have read this form. I sign it freely and voluntarily. A copy has been given to me.

Print the name of the student attending Stone Lab:

________________________________________

Date:________________________

Signed __________________________ (student)

Signed __________________________ (parent/guardian)
Mr. John Smith  
Northern Ohio Middle School  
1000 Ohio St.  
Northern, OH 00000

April 6, 2002

Dear Mr. Smith,

Enclosed you will find the survey packets for both pre- and post-test administration. Included with the surveys are instructions for teachers for assigning numbers and distributing them.

There are seven packets – one for each of the groups of students who will be traveling to the Stone Laboratory. Within each of these packets are two groups of surveys, 45 pre-test surveys and 45 post-test surveys. Each survey has a number assigned to it, and the same number is assigned to both a pre- and a post-test copy. Teachers will be asked to:

- record the number of the pre-test survey that they give to each participating student,
- ensure that they give the student the same post-test survey number,
- keep survey numbers confidential [the researcher does not need a list of numbers with student names],
- keep the numbers through the following school year, so that it might be possible for the students to receive the same numbered questionnaire (as the pre- and post-test) in the 7th grade for the second phase of the study.

Specific instructions for the time of administering each survey are included within each individual survey packet. I have asked the teachers to return the completed surveys to you. Once all surveys have been completed and collected (both pre- and post-test), please return them to me as soon as possible in the addressed, postage-paid manila envelope provided.

Thank you for your time and effort. As always, if you have any questions, please contact me at 614-688-0285 or dudley.42@osu.edu. As I mentioned over the telephone, due to a family matter, I will be in East Lansing, MI from April 30 – May 5. If you have any questions during that time, please contact me at 517-332-4504 or through the same email address.

Sincerely,

Rosanne W. Fortner  
Dr. Rosanne W. Fortner  
Professor

Jennifer E. Dudley  
Project Coordinator

enclosures
April 6, 2002

Dear Teachers and Instructors,

Thank you for agreeing to assist with this study. My Master’s thesis focuses on investigating attitudinal change toward science as a result of participation in a Stone Laboratory workshop. Data from the enclosed surveys is critical to answering my research question.

There are 90 surveys in this packet. Half of them are pre-test and the other half are post-test (they are different colors and are in separate folders). Please administer surveys ONLY to those students who have returned a signed permission slip that they are allowed to participate in the study. We ask for the pre-test surveys to be given the last school day before the students go to Stone Lab, and the post-test to be given the first school day back (please see accompanying schedule). Please record the dates when you actually give the surveys.

Each of the pre-test surveys has its own number assigned to it – with a correspondingly numbered post-test. Please do the following so we can compare tests from the same individual:
1. record the number of the pre-test that you give to each student,
2. ensure that the student receives the same numbered post-test.
Please do not send this numbered list to the investigator, but rather keep it for one year confidentially in your own files. Information will again be collected from the students in the fall, and we will use the same numbers when these students are in the 7th grade.

Once all surveys have been collected, please re-package them and give them to your school principal. They will return all surveys at the same time. If you have any questions, please contact me at 614-688-0285 or dudley.42@osu.edu. Due to a family matter, I will be in East Lansing, MI from April 30 – May 5. If you have any questions during that time, please contact me at 517-332-4504 or through the same email address.

Thank you for your time and effort.

Sincerely,

Rosalie A. Fortner
Dr. Rosanne W. Fortner
Professor

Jennifer Dudley
Jennifer E. Dudley
Project Coordinator

enclosures
SURVEY ADMINISTRATION SCHEDULE
If possible, please administer the surveys as according to this schedule:

<table>
<thead>
<tr>
<th>Stone Laboratory Trip Dates</th>
<th>Pre-test Administration Date</th>
<th>Post-test Administration Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 29 - 30</td>
<td>April 26</td>
<td>May 1</td>
</tr>
<tr>
<td>April 30 - May 1</td>
<td>April 29</td>
<td>May 2</td>
</tr>
<tr>
<td>May 1 - 2</td>
<td>April 30</td>
<td>May 3</td>
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<td>May 7 - 8</td>
<td>May 6</td>
<td>May 9</td>
</tr>
<tr>
<td>May 8 - 9</td>
<td>May 7</td>
<td>May 10</td>
</tr>
</tbody>
</table>
Mr. John Smith  
Northern Ohio High School  
1000 Ohio Ave.  
Northern, OH 00000  

September 26, 2002  

Dear Mr. Smith,  

Enclosed you will find the parent information letters and permission slips for students to participate in the study. The letter outlines the basic purpose of the study and provides assurance of confidentiality of each student's identity from the study. In addition, the letter also provides the contact information for the researchers (Dr. Rosanne Forner and Jennifer Dudley) in case the parents have any concerns or questions.  

As per our discussion, please choose two or three homerooms in both 9th and 12th grades to complete the questionnaires. We would like at least 60 students in each grade to complete the questionnaires. Please provide these permission slips to the participating homeroom teachers as soon as possible for dissemination to the students. Students not returning a parental permission slip will be unable to participate in the study. We ask that questionnaires be administered to the students in mid- to late October. Please ask teachers to request that permission slips be returned by October 31.  

I will be mailing you the questionnaires in a few weeks. The questionnaires will be divided up as we discussed with a packet of questionnaires for each participating homeroom. Further instructions about questionnaire administration will be included in the packets.  

Again, thank you very much for agreeing to participate in this study. I appreciate the work that you are willing to put into gathering the questionnaire information. If you have any questions, please do not hesitate to contact me at 614-688-0285 or dudley.42@osu.edu.  

Sincerely,  

Dr. Rosanne W. Forner  
Professor  

Jennifer E. Dudley  
Project Coordinator  

enclosures
September 20, 2002

Dear Parent/Guardian,

Your student(s) at Northern Ohio Schools has been to F.T. Stone Laboratory at Put-in-Bay, Ohio, with the school. Jennifer Dudley, a graduate student in the School of Natural Resources at The Ohio State University, is interested in studying the long-term effect students may gain as a result of participation in the Stone Laboratory activities.

I hope you will allow your student to take part in this research. Throughout the duration of this study, the graduate student will be advised by Dr. Rosanne Fortner, who is a professor at Ohio State and the Associate Director of Stone Lab.

Our goal is to learn whether participation in the programs at Stone Laboratory changes student attitudes towards science. During the course of the research, students will complete one short questionnaire about science interest and attitudes towards science in general.

At no time will individual student names be listed or revealed by the researcher. All responses will be kept confidential. If a student wishes to withdraw from the program at any time, he or she will be allowed to do so without any prejudice. Please feel free to call Dr. Fortner or Jennifer Dudley (614-292-9826 or 614-688-0285) at any time should you have any questions.

We hope that you will allow your student to participate in the research project to help us better understand the effects of outdoor and environmental education programs on student attitudes toward science. If so, please sign in the space provided on the bottom of the next page and send your signed form with your student back to school by October 11. Thank you for your time and cooperation.

Sincerely,

Rosanne W. Fortner
Dr. Rosanne W. Fortner
Professor

Jennifer E. Dudley
Project Coordinator
Protocol Title: A quasi-experimental investigation of the effect of participation in an experiential environmental education program at F.T. Stone Laboratory on students' attitudes toward science.

Protocol Number: 02E0129
Principal Investigator: Rosanne W. Fortner

I consent to my child's participation in the research project conducted by Dr. Rosanne W. Fortner and Jennifer E Dudley of The Ohio State University and their associates. I understand the purpose of this study and any questions I have raised have been answered to my full satisfaction. Furthermore, the director and associates have explained the purpose of the study, the procedures that will be followed, and the amount of time it will take. I understand the possible benefits of my child's participation.

I know that I can (and/or my child can) choose not to participate without penalty to me (and/or my child). If I agree to participate I can (or my child can) withdraw from the study at any time and there will be no penalty.

I understand that my child's anonymity will be maintained in any report prepared from the data collected from my child.

I have had a chance to ask questions and to obtain answers to my questions. I can contact the investigators at (614-292-9826 or 614-688-0285). If I have questions about my rights as a research participant, I can call the Office of Research Risks Protection at (614) 688-4792.

I have read this form. I sign it freely and voluntarily. A copy has been given to me.

Print the name of the student participating:

__________________________________________________________

Date: __________________

Signed ___________________ (student)

Signed ___________________ (parent/guardian)
Mr. John Smith
Northern Ohio Junior High
1000 Ohio Ave.
Northem, OH 00000

October 11, 2002

Dear Mr. Smith,

This package contains the questionnaires for students to complete as well as a sealed
manila envelope containing permissions slips and the names of students who are able to
participate. Only students who have a signed permission slip are able to participate in the
study. Please administer the questionnaire to them in whatever way is easiest for you and
your staff. Also enclosed in this package are some letters for the administering teachers.

A pilot test of the questionnaire has shown that it should only take the students about fifteen
minutes to complete it. After the students have completed the questionnaires, please collect
them from the teachers. Enclosed in this package are postage and a return address label to
enable you to return the completed questionnaires to the researcher.

The numbers on the questionnaires only exist to allow the researcher to distinguish them
from the 6th and 12th grade responses (700s = 7th grade). At no time will any student be
identifiable by any of these numbers. If you need any extra questionnaires, I have also
enclosed some unnumbered ones for your use. Please use them or make copies of them
as needed.

Thank you for your time and consideration. If you have any questions you may contact me
by mail at the address above, by phone at 614-457-4606 (home) or 614-688-0285 (office),
or by email at dudley42@osu.edu.

Sincerely,

Jennifer E. Dudley
Project Coordinator

enclosure

Rosanne W. Fortner
Dr. Rosanne W. Fortner
Professor

School of Natural Resources

221 Coffey Road
Columbus, OH 43210-1085

Phone 614-292-2265
TLX 243334
FAX 614-292-7432
Northern Ohio Junior High
1000 Ohio Ave,
Norwalk, OH 44056

October 11, 2002

Dear Teachers,

Thank you for agreeing to assist with this study. My Master’s thesis focuses on investigating attitude change toward science as a result of participation in a Stone Laboratory workshop. Data from the enclosed questionnaires is critical to answering my research question.

Your principal has provided you with a packet of questionnaires to provide to students. This questionnaire will only take about fifteen minutes of time for your students to complete. Please ensure that the questionnaire is only given to students who have a signed permission slip to participate in this study. Your principal has a list of names and permission slips for those students who are able to participate.

If you need any additional questionnaires, some unnumbered ones have been provided to your principal. The numbers on the questionnaires only exist to allow the researcher to distinguish them from the 9th and 12th grade responses (700s = 7th grade). At no time will any student be identifiable by any of these numbers. Once the students have completed the questionnaires, please return them to the principal.

Thank you for your time and consideration. If you have any questions you may contact me by mail at the address above, by phone at 614-457-4606 (home) or 614-588-0285 (office), or by email at dudley.42@osu.edu.

Sincerely,

Jennifer E. Dudley
Project Coordinator

enclosure

Dr. Rosanne W. Fortner
Professor
Northern Ohio High School  
1000 Ohio Ave.  
Northern, OH 00000  

October 11, 2002  

Dear Teacher,  

Thank you for agreeing to assist with this study. My Master's thesis focuses on investigating attitude change toward science as a result of participation in a Stone Laboratory workshop. Data from the enclosed questionnaires is critical to answering my research question.  

Your principal has provided you with a packet of questionnaires to provide to students. This questionnaire will only take about fifteen minutes of time for your students to complete. Please ensure that the questionnaire is only given to students who have returned a signed permission slip to participate in this study.  

If you need any additional questionnaires, some unnumbered ones have been provided to your principal. The numbers on the questionnaires only exist to allow the researcher to distinguish them from other grade responses. At no time will any student be identifiable by any of these numbers. 9th grade students should receive questionnaires numbered in the 900s, and 12th grade students should receive questionnaires numbered in the 1200s. Please ensure that you have the correctly numbered questionnaires before administering them to your students. Once the students have completed the questionnaires, please return them to the principal.  

Thank you for your time and consideration. If you have any questions you may contact me by mail at the address above, by phone at 614-457-4606 (home) or 614-588-0285 (office), or by email at dudley.42@osu.edu.  

Sincerely,  

Jennifer Dudley  
Project Coordinator  

Rosanne W. Fortner  
Dr. Rosanne W. Fortner  
Professor
Mr. John Smith  
Northern Ohio High School  
1000 Ohio Ave.  
Northern, OH 00000  

October 11, 2002  

Dear Mr. Smith,  

This package contains the questionnaires for students to complete. The questionnaires are in two different groups – the group with numbers in the 900s is for the 9th graders, while the group with numbers in the 1200s is for the 12th graders. Please provide the questionnaires to the appropriate homerooms. The numbers on the questionnaires only exist to allow the researcher to distinguish them from the other grade responses. At no time will any student be identifiable by any of these numbers. If you need any extra questionnaires, I have also enclosed some unnumbered ones for your use. Please use them or make copies of them as needed.  

As we discussed on the phone, I believe you have chosen three to four homerooms per grade to participate in the study. Only students who have returned a signed permission slip are able to participate in the study. The letters enclosed for the homeroom teachers also mention this requirement. A pilot test of the questionnaires has shown that it should only take the students about fifteen minutes to complete it. After the students have completed the questionnaires, please collect them from the teachers. Enclosed in this package are postage and a return address label to enable you to return the completed questionnaires to the researcher.  

Thank you for your time and consideration. If you have any questions you may contact me by mail at the address above, by phone at 614-457-4506 (home) or 614-688-0285 (office), or by email at dudley.42@osu.edu.  

Sincerely,  

Jennifer Dudley  
Project Coordinator  

Dr. Rosanne W. Fortner  
Professor  

enclosure