

OUTDOOR SCIENCE FIELD TRIPS: INVALUABLE OR INEFFECTIVE?

by

KERRIE ANNE THERESE LOYD

(Under the direction of Malcolm B. Butler)

ABSTRACT

The purpose of this study was to assess the cognitive and affective values of an outdoor science field trip. Participants were 28 fifth grade students, studying earth science, from a large southeastern US city. Knowledge about local geology and attitudes related to science and the outdoors were evaluated before and after a three hour field trip experience on Stone Mountain. Data were collected using a combination of quantitative and qualitative methods, with participants' cognitive and affective changes interpreted via statistical analyses. Significant gains in cognitive achievement were evident though no significant affective gains were identified. The findings of this study lend support to a popular notion recognizing science field trips as important educational tools. Results suggest that isolated outdoor experiences can facilitate learning. The implications of this study are important to formal educators organizing science field trips, as well as nonformal educators providing these opportunities to school groups.

INDEX WORDS: Science field trips, outdoor education, learning outdoors, science outside, Earth Science trip, nonformal education

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CHAPTER 1

Introduction

Principals, parents, formal and nonformal educators perceive educational field trips to be learning tools that enhance classroom instruction by providing a means for students to observe and interact with science in a hands-on manner. Each year, thousands of science teachers organize field trips to parks, science centers and museums with hopes that the trips will be productive and inspirational learning experiences.

Outdoor science field trips can be appreciated as a form of experiential learning, or “learning by doing”, by using resources not available in the classroom. The Association for Experiential Education defines experiential education as: a process through which a learner constructs knowledge, skill and value from direct experience (Ford, 1986). Local outdoor environments have the potential to provide the best demonstration of some science concepts. In-the-field-learning uses nature’s ecological and geological creations as tangible evidence of the science discussed in textbooks and classroom lectures. Students have different preferences for learning and many may prefer these active opportunities rather than the more common passive strategies (Broda, 2002). The multi-sensory nature of many field trips may also aid students who don’t prosper in the traditional school environment.

The authors of the National Science Education Standards (NRC, 2000) incorporate field trips in their program standards stating, “good science programs require access to the world beyond the classroom” (p. 220) and declaring these experiences critical for students in secondary school. For decades, field trips have completed the science curriculum for students across the country. Three early studies reviewed by Falk and Balling (1979) indicate that educators view science trips as significant, proving clear cognitive and affective benefits, and that trip settings can inspire or influence student attitudes and learning.

Conversations with teachers participating in outdoor programs have helped me conclude that science teachers have a variety of motives for including field trips in their curriculum. Cognitively, field trips may be used as enrichment following a science unit, promoting more concrete understanding of certain science concepts, or as an introduction to a science unit. Affectively, field trips may initiate new interests in science, a renewed motivation to learn, and increase student aspirations towards science careers. Krepel and Duvall (1981) note that field trips are undertaken for educational purposes in which the students go to the place where the science material may be observed and studied directly in its functional setting. Hofstein and Rosenfeld (1995) agree that the visits are “standard practice” within science education because they provide students with objects and experiences unavailable in the science classroom.

Most of the research on science field trips and outdoor education programs has focused on the effective use of field trips (Disinger, 1987); how to make the most of the experience through structuring the curriculum to properly insert them (Howie, 1974); and providing optimal amounts of preparation and follow-up in the classroom (Falk & Balling, 1982). Some consider student preparation in regard to field trips essential (Hofstein, Orion, Tamir & Giddings, 1996). Though these suggestions may demonstrate the most effective way to use the field trips, in reality, I have found (through conversation with participating teachers over years of working in nonformal education settings) that often the experiences are conducted independent of any preparation or postwork relevant to the science concepts.

Research Goals and Purpose

This study examined a particular outdoor field trip to evaluate its educational and affective significance. It will contribute new knowledge to a limited research base and help educators decide if field trips can stand alone as effective educational tools. There has been a recent increasing emphasis on Earth Science throughout science curriculum nationwide (Knapp & Barrie, 2001). This implies a need for assessing different modes of teaching geological concepts.

The goal for this study is to expand knowledge about using outdoor science education field trips as contextually rich learning environments. It explored what a trip offers to individual students and identified if learning occurred specifically as a result of the outdoor experience. The research is significant to formal educators who take their students on educational trips during the school year and to nonformal educators who provide these opportunities to school groups. It may also be of interest to science teacher educators who focus on alternative teaching methods and learning strategies. Specifically, the research questions were: 1. What specific knowledge is learned by fifth graders during a three- and one-half-hour outdoor Earth Science field trip? 2. Are there significant attitude changes regarding Earth Science or the field trip site as a result of this outdoor experience?

CHAPTER 2

Review of the Literature

A nationwide survey of teachers, administrators, science teacher educators and nature center professionals found an overwhelming agreement that field trips are useful educational tools with clear benefits for students (Falk & Balling, 1979). Research on the topic of science field trips generally supports their use to benefit students both cognitively and affectively. Cognitive gain represents intellectual knowledge and abilities of students. Significant cognitive gains have been noted through testing of participants of different outdoor education trips: geology (Fokomer, 1981), forest ecology (Howie, 1974), plant biology (Knapp, 2000) biology and ecology (Bogner, 1998; Lisowski & Disinger, 1991). There is little research to support the idea that students learn more on field trips than they do in the classroom, but field trips can be an important asset if they are properly integrated in the science program. Koran and Baker (1979) conducted a review of early studies on field trips and concluded that trips are only significant when carefully constructed and employed for appropriate outcomes.

Cognitive Value of Field Trips

Cognitive value in this study is defined as contributing to knowledge and intelligence. Cognition involves the act of obtaining, storing and remembering knowledge and increases students' ability to comprehend a topic. Several models have been suggested for successful implementation of field trips in the science curriculum (Orion, 1993). Orion (1989) reported learning achievement through development of a biology course based on the use of field trips. He and others view the field trip as an integral part of the learning process. He also structured a high school geology course around field trips sandwiched between a preparatory unit and a summary unit on the topics (Orion, 1989). The importance of optimal preparatory activities and lessons is noted by Orion and others (Orion & Hofstein 1994; Orion, Hofstein, Tamir & Gidding,

1996). Farmer and Wott (1995) found cognitive value after conducting a follow-up activity after a fourth grade outdoor field trip. Crompton and Sellar (1981) conclude that the outdoor environment provides a more stimulating learning environment than the classroom if the subject area is closely associated with the outdoors.

Several studies explored the significance of setting orientation in guiding educators towards the most effective use of field trips (Falk, 1983; Falk & Balling, 1979, 1982). Reducing the novelty of the setting (the students' perceptions of novelty) helped students to focus on the learning tasks of the field trip and eliminated time wasted looking around and getting familiar with the surroundings. Students who were accustomed to the site due to the extent of trip preparation exhibited better performance on the tasks assigned and on evaluations of topics discussed on the trip (Martin, Falk & Balling 1981; Orion & Hofstein 1994).

Because of evidence of cognitive gain due to the combination of classroom and in-the-field instruction, most relevant studies have been designed with this in mind and few researchers have examined the use of field trips as a self-sufficient means of teaching some science concepts. Knapp (2000), however, looked at the effect of a single forest hike and activity on elementary students' long-term memories. He found no support of cognitive memories due to the trip but a lot of positive memories of the experience and an overwhelming (80%) desire to return to learn about more plants. In another study, Knapp and Barrie (2001) compared two treatments, a single ecological based program and a program oriented towards environmental issues, neither involving introductory preparation or debriefing follow-up lectures or activities. Quantitative analyses (MANOVA) showed science knowledge gain as a result of both treatments with the most benefit a consequence of the ecology-based program. Fokomer (1981) conducted an early outdoor education study and compared classroom treatments to an outdoor geology field trip. He found the most improvement in conceptual knowledge (regarding weathering, erosion, deposition, folding, faulting and igneous intrusions) to be a result of the field trip.

The results of this study suggest students' outdoor experiences may help to correct science misconceptions they hold. Science misconceptions were originally defined as unfounded beliefs which may arise from faulty reasoning; recent papers on this topic suggest that erroneous ideas may come from strong word association, confusion or lack of knowledge (Blosser, 1987). This author acknowledges that science educators use a variety of terms to describe childrens' alternative understanding of a topic (in contrast to scientists' understanding); these include: preconceptions, naïve conceptions or theories and alternative frameworks (Blosser, 1987). Naïve theories or preconceptions are often developed through everyday experiences with the physical world and successful confrontation must involve experience-based instruction (Bruning, Schraw & Ronning, 1999).

Affective Value of Field Trips

In contrast to the cognitive domain that is concerned with intellectual knowledge and abilities, the affective realm describes an individual's interests, attitudes, moral and ethical values. It includes emotions and feelings. Environmental and outdoor educators have thought for decades that experience and education in the outdoors leads students to develop more appreciation of the topics learned in the field and more environmentally conscience behavior. Shepard and Speelman (1985) suggest in their findings that outdoor education programs in which the child learns about the environment through direct experience with it ought to produce positive attitude changes and possibly even behavioral changes. The authors measured attitude in regards to nature walks, trash, wildlife, the environment and the woods and concluded there is a relationship between program length and attitude development. Crompton and Seller (1981) completed an evaluative study of literature that summarized the impact of outdoor education experiences on attitude towards learning outdoors and towards school. They reviewed several studies which measured attitude change towards the outdoors as a learning environment and toward school, the longer 5 day programs produced more significant positive results whereas shorter programs provided little support for the notion that there is transfer of attitude related to

perceptions of the outdoors and towards school after an outdoor education experience (1981). Bogner (1998) measured the influence of an outdoor education experience on variables of environmental perspective and also found positive shifts toward more environmental behavior after a five day program at a national park. Orion and Hofstien (1994) completed an investigation into student attitudes toward the field trip and reported that most high school participants had positive attitudes towards geology and the field trip site, and viewed the field trip as a learning tool.

Instruments Used in this Study

Interviews, surveys and concept maps were used for data collection. The students' preinterviews and postinterviews were scored using a scoring rubric. "Concept map" is a term used to describe the written representation of what we believe to be the organization of concepts in a student's cognitive structure (Novak & Gowin, 1984). Concept maps were used in this study to reinforce oral responses in the interviews; it is widely believed that they can help students externalize their thoughts. Concept maps provide a summary of students' thoughts on a topic (Novak & Gowin, 1984). Novak and Gowin (1984) support the use of concept mapping in evaluation, suggesting teachers can use maps as a valid "simple tool for assessing where students are in learning" (p.101). The use of concept maps in evaluation is also congruent with the changing emphasis in assessment outlined by the authors of the National Science Education Standards (NRC, 2001). Rye and Rubba (2000) claim using concept maps as an assessment tool can provide both quantitative and qualitative measures of understanding and have considerable potential for revealing change in knowledge over time. I used students' concept maps in a similar manner, to compare interview transcripts to a second piece of cognitive data.

In order to provide a more concrete comparison between each student's cognitive and affective interviews before and after the field trip, I scored the students' cognitive knowledge using a rubric. Scoring rubrics are a descriptive scoring scheme developed to guide the analysis

of the students' product efforts (Moskal, 2000). They can help judge the quality of a broad range of subjects and activities and are commonly used within the field of science education. Rubrics contain a series of categories, each of which describes characteristics of a response that would elicit the particular score for that category. Rye and Rubba (1998) successfully used rubrics to score knowledge (identified through interviews and concept maps) of 8th graders about chlorofluorocarbons (CFCs) and their effect on the atmosphere. The categories of rubrics are developed by teachers or evaluators and based upon objectives for a lesson; each category describes a level of understanding of those objectives.

Importance of this Study

There is very little relevant research pertaining to the impact of a particular program content associated only with a science field trip. The studies reviewed in this context have conflicting results. It is important to evaluate field trips as they are commonly used today, as a unique learning experience. Gottfried (1981) reported that a majority (62%) of teachers he studied viewed field trips as an "enrichment", they did not plan preparatory or follow-up activities for the experience. Orion (1989) agreed that field trips are generally used for enrichment and has stated that the trips themselves do not guarantee higher cognitive gains. Regardless of how many suggestions educators make about the proper way to integrate field trips into the curriculum to make them most beneficial, schoolteachers do not always find the additional lectures and activities feasible options. Due to the popularity of science field trips, teachers often do not have much of a choice of when they are scheduled. The topics covered may be concepts the students learned months ago in the classroom or have not yet heard mentioned. Some non-formal science education facilities (zoos, nature centers, museums, parks etc.) provide optional activities to introduce students to ideas which will be covered but many are not used on a consistent basis. If provided, it is up to the teacher if and how the preparation and follow-up are conducted. Communication with numbers of teachers who participate in school

field trips has led me to believe many of the aforementioned limitations do affect their use of field trips in the curriculum.

If we are to continue to value field trips as teaching tools, then research must investigate what the trip can teach independent of any other intervention. Orion (1993) has stated that the trips themselves do not guarantee higher cognitive gains. Often, the reality is that students come to a field trip site with very minimal, if any, introduction to the site or relevant concepts. Will they learn anyway? Will their attitudes be influenced by their experience? I hope to provide answers to these questions through the evaluation of a fifth grade class on an outdoor field trip.

CHAPTER 3

Research Methodology

This was a multiple method research study that used quantitative and qualitative components to explore the cognitive and affective contributions of a science field trip. Qualitative research regarding outdoor education and science field trips is extremely rare within studies completed. Innovative research methods including or combining constructivist tools and conversation analyses such as those used were suggested for assessing informal learning at a recent conference on developing an agenda for advancing research in this field of science education (Rennie, Feher, Dierking, & Falk, 2003). I used this unique research design to evaluate the site and content knowledge that students bring to a science field trip and what they learned as participants of a field trip. Changes in understanding of science concepts and attitude were identified through use of interviews, concept maps and responses to an attitudinal survey.

Project Site and Participants

This study was conducted on Stone Mountain, in Stone Mountain Park, Stone Mountain, Georgia. Stone Mountain is a unique and well-known geologic feature that rises 800 feet above the surrounding landscape 15 miles from downtown Atlanta. It was formed 300 million years ago during the continental collision that formed the Appalachian mountain chain along the east coast of North America. Stone Mountain granite crystallized underground from melted magma that resulted from the tremendous heat and pressure as North America and Africa collided. It was exposed millions of years later as time and weathering wore away all the above-lying and surrounding land. The durability and resistance of the granite contributes to its prominent stance above the landscape today. This information is agreed upon by numerous geologists which have documented the geologic history of the Stone Mountain-Lithonia area, including: Atkins,

R.C. & Joyce, L.G. (1980); Whitney, J.A., James, L.M., & Walker, R.L. (1976) and Size, W.B. & Khairallah, N. (1989).

Data were also collected in the students' classroom, at an elementary school located in a large southeastern city. The study included 28 fifth grade students. This grade was chosen because the designated field trip covers topics outlined in the state curriculum for fifth grade science. The participants were a mix of students from two fifth grade homerooms. Fifteen girls and 13 boys participated; the students were middle-class, and the majority (82%) Caucasian. The Stone Mountain field trip was an ideal opportunity for the study participants; the location was nearby, familiar and the program relevant to their science studies.

The three and one half hour trip included a discussion of igneous rocks, how the Stone Mountain granite formed and why it is such a major feature on the landscape. Students completed a two and three quarter mile hike all the way to the top of Stone Mountain and back, stopping eight times along the way. At each stop, students discovered different geological features, minerals, effects of physical and chemical weathering, erosion, or plant and animal communities on the mountain. The learning objectives of the field trip at Stone Mountain are as follows: students will understand how the mountain formed, students will recognize unique features on mountain and realize their origin, students will identify the rocks and minerals found on the mountain, students will recognize the life forms found on the mountain, students will comprehend the granite outcrop ecosystems and their succession. Concepts were emphasized as they relate to Stone Mountain and learning of topics was assessed through study evaluation. Teaching strategies on the field trip stressed learning through exploration. The instructor guided activities and discourse was encouraged among the students and with the instructor. The notion of the physical Earth as a continuously changing landform was stressed throughout the program.

Design and Procedure

To assess the impact of the field trip on students, I first measured their initial knowledge of the site and related Earth Science topics. I visited the participants' classroom and met with individual students to conduct semi-structured interviews on the topics of Stone Mountain and learning science. This information was later compared with that collected after the field trip. Postdata collection took place almost two weeks later as it has been suggested that posttests and interviews completed immediately after a program are not conclusive (Bogner, 1998).

There are both quantitative and qualitative elements to the design of this study. Since interviews were scored and given a numeric value, the insight they provided became a quantitative contributor to study results. Concept maps were analyzed qualitatively. Significant portions of the students' interviews were also examined and discussed in the qualitative sections.

Each interview had two portions; the first portion gathered data on their preconceived notions of Stone Mountain and related Earth Science concepts, and the second portion questioned the students about their attitudes regarding science class and outdoor field trips. Interviews were my main source of information. Using only written responses in a pre- and posttest design would not have allowed an accurate assessment of their knowledge because of students' lack of writing skills at this age. Fifth grade students may be more descriptive in oral responses and can provide a deeper understanding of their knowledge, perception and feelings through interviews. Some questions were based on students' responses initiating further explanation of their thoughts or opinions. Science knowledge interviews were evaluated using a scoring instrument, Appendix F, and interview notes and transcripts. Each student received a number score assessing their science knowledge. Attitudes were scored using a rubric, Appendix G, during the interviews; also, body language, facial expression and verbal cues were taken into consideration as students answered.

In addition to interviews, several documents were also collected and analyzed for triangulation with interviews and as additional evidence of change. Each student was asked to complete a “concept map,” or “brainstorm” on the topic of Stone Mountain. An attitudinal survey was also used. These data were used to assist in knowledge and attitude assessment and were examined and transferred into points on the scoring rubrics designed for this study. This same methodology was used after the field experience for comparison and identification of cognitive gain and attitudinal change.

The field trip to Stone Mountain took place one week after the preinterviews were completed. Thirty-two students (two classes) participated in the experience; those not part of the study (without parental permission) could not be excluded from the activity. The trip took three hours and 30 minutes; the children had a short snack break and ten minutes of free time at the top of Stone Mountain. Most stops along the trail were almost equal in length and all included science material.

Description of Instruments

Two Earth Science instructors at Fernbank Science Center, Dekalb County Public Schools, reviewed the study instruments for face validity purposes. An additional evaluator scored 11 cognitive and affective interviews, attitude surveys and concept maps. Though the second evaluator scored students just on the basis of interview transcripts (facial expressions and cues were not taken into account), scores were consistent with the researcher’s scores.

Cognitive Interview Protocol (Appendices A & B):

The interview questionnaire consisted of 12 questions and was developed based on the conceptual focus of the field trip, a mixture of geology and ecology concepts relevant to granite outcrops. The interview made use of photos of Stone Mountain and its flora, as well as rock samples representing the three major groups of rocks (igneous, metamorphic and sedimentary). Students were encouraged to tell me as much as possible about each photo or sample. Interview audio was recorded for later use of transcripts and notes were made as the students

answered each question. The postinterview protocol eliminated one question, then irrelevant, but all others remained the same.

Affective Interview Protocol (Appendices C & D):

Students were asked to respond to questions such as “Do you like going outdoors?” “How do you feel about science?” “Do you like school field trips?” Interviews were recorded and special attention was given to the expression on the child’s face and the tone of their voice as he or she responded to these questions. Students were scored according to the attitude rubric as they answered interview questions. The postinterviews included two additional questions regarding the students’ attitudes about learning outdoors and their most prominent memory of the field trip.

Attitude Survey (Appendix E):

Simple Likert-type attitudinal surveys were administered before and after the field trip. This survey was created specifically for this study. The brief statements included on this survey were fairly similar to those of the Likert-type attitude assessment used by Bogner (1998) with 12 year olds and that used by Shepard and Speelman (1984) with 9-14 year olds. Bogner’s study (1998) outlined all “psychometric guarantees” including reliability and validity in a table that displayed acceptable Cronbach’s alpha numbers. Shepard and Speelman’s (1984) assessment was derived from a number of other tested and published instruments. Rather than have students circle the number that most represented how they felt about a statement, participants were asked to read each statement and circle the face icon that most expressed how they felt.

Concept Map (Appendix F):

After students’ preinterviews, I explained the notion of a concept map, showed them an example and had them complete one focusing on the topic of “Stone Mountain.” The students referred to the maps as “brainstorms,” similar to brainstorm activities they sometimes used in class. See Appendix E for an example of a student concept map. For comparison, each student was asked to make a new concept map after the field trip. These maps could be compared with

the interview transcripts as a second cognitive data source for each child and helped more thoroughly represent their knowledge of the topics. Rye and Rubba (2002), who also used concept maps as an assessment tool, found that students with the highest concept map score on a topic also provided more critical information on that topic during their interview session. In this study childrens' concept maps were used in qualitative analysis to look for changes and improvements in the concepts listed the science words used to describe Stone Mountain.

Cognitive Assessment Rubric (Appendix G):

For comparative and analytical purposes, an assessment rubric was completed to reflect the depth of each student's knowledge of science topics before and after the field trip. The Stone Mountain field trip objectives dictated what was to be evaluated and present in the rubric. Audio recordings of the interviews were used to assign a point score on the rubric for each topic addressed during the experience.

The development of the scoring rubric before use for assessment helps make the evaluation more of an objective process. The preset descriptive categories of scoring rubrics increase the chance that two independent evaluators would assign the same score to a student's work (Moskal, 2000). This notion of consistency of assessment scores is referred to as "rater reliability". The rubric development process used was suggested by Moskal and Leydens (2000) for ensuring that the scoring rubric was an appropriate assessment: 1- Clearly state the purpose and objectives of assessments 2- Develop the scoring criteria to address each objective 3- Reflect on the following: Are all objectives measured through the scoring criteria? Are any of the scoring criteria unrelated?

The validity of both the cognitive and affective assessment rubrics was achieved through this careful planning. Four descriptive categories were used to rank students' knowledge. Category one (and a score of one for that topic) was chosen if the child knew nothing about the topic, if they did possess some knowledge a higher category (two or three) was chosen to

represent their understanding. A score of four for a topic was assigned if the student could give me a thorough correct answer to the questions related to those topics.

Affective Assessment Rubric (Assessment H):

This assessment rubric evaluated data collected in the affective portion of the interview. It identified a point score used to compare and easily recognize change in emotional regard to science, field trips and the outdoors. The categories described represent strength of emotion (negative to positive) expressed through answers to the affective questions. For example, a student who said they really liked science and smiled and enthusiastically shook their head and explained why would receive a score of four for that affective topic. An emotionless “yeah” would receive a lower point score, and a student with a negative response would receive a score of one. Validity and reliability concerns of this rubric were also addressed through the well-defined evaluation categories. Independent evaluators of the students’ affective interviews should achieve the same score on the affective scoring rubric.

Appendix I illustrates examples of some photos used in the students’ cognitive interviews. Appendices I, J, K and L display some of the childrens’ concept maps. Appendix M is the guideline for the Stone Mountain fieldtrip.

Data Analysis

Quantitative data analysis included scoring cognitive and affective interviews using the appropriate scoring rubrics developed for this study. The pre-field-trip and post-field-trip data, (numbers derived from scoring interviews) were then statistically analyzed using SSPS 12, predictive analytic software. Wilcoxon Signed Ranks tests were utilized to see if members of each pair differed in size. This test is appropriate for nonparametric, related, nominal data that were measured before and after a treatment. Qualitative data analysis included examination of concept maps and interviews, interpretation and assessment of change.

CHAPTER 4

Presentation of Findings

The research questions answered through examination of the data analysis are:

What specific knowledge is learned by fifth graders on a three and one-half hour outdoor Earth Science field trip?

Are there definite attitudinal gains regarding Earth Science or the field trip site as a result of this outdoor experience?

Results are organized in four sections: Quantitative Cognitive, Quantitative Affective, Qualitative Cognitive and Qualitative Affective.

Quantitative Results

Cognitive Data

A Wilcoxon Signed Ranks analysis was performed (95 % confidence interval) to evaluate the change in mean scores from pre-field-trip cognitive interviews to post-field-trip cognitive interviews for each topic and the total. Table one, "Difference in Mean Scores of Students' Cognitive Interviews", indicates very significant positive change in scores for each individual science topic addressed on the field trip and the total science knowledge gain.

The Wilcoxon Signed Ranks test was used to accept or reject the following null hypotheses.

Table 1
Difference in Mean Scores of Students' Cognitive Interviews

TOPIC	PreInterview vs. PostInterview (n= 28)	
Origin of Stone Mountain		
- ranks	1	
+ ranks	23	
ties	4	
z-value	-4.12	
one-tailed significance		.000*
Rock Identification		
- ranks	1	
+ ranks	17	
Ties	10	
z-value	-3.86	
one-tailed significance		.000*
Weathering on St. Mt.		
- ranks	1	
+ ranks	12	
ties	15	
z-value	-2.95	
one-tailed significance		.002*
Changes on Earth's surface		
- ranks	0	
+ ranks	18	
ties	10	
z-value	-4	
one-tailed significance		.000*
Granite Outcrop Ecosystem		
- ranks	1	
+ ranks	21	
ties	6	
z-value	-3.95	
one-tailed significance		.000*
Total		
- ranks	0	
+ ranks	28	
ties	0	
z-value	-4.63	
one-tailed significance		.000*

* $p < .025$

Null Hypothesis: There is no difference in cognitive achievement of fifth graders after participating in an outdoor science field trip.

Alternative Hypothesis: There is a change in cognitive achievement of fifth graders after participating in an outdoor science field trip.

The Wilcoxon Signed Ranks test shows that the difference in mean scores representing cognitive achievement is significantly different from zero, leading to a rejection of the null hypothesis in favor of the alternative hypothesis. Total cognitive scores increased by 45.7 % from 9.375 to 13.661. The greatest possible total score was 20.

Null Hypothesis: There is no difference in concept knowledge of fifth graders related to the origin of Stone Mountain after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in concept knowledge of fifth graders related to the origin of Stone Mountain after participating in an outdoor science field trip.

The Wilcoxon Signed Ranks test shows that the difference in mean scores representing cognitive achievement of the formation of Stone Mountain is significantly different from zero, leading to a rejection of the null hypothesis in favor of the alternative hypothesis. Knowledge assessment scores on the topic of the origin of Stone Mountain increased by 76.2 % from an average of 1.500 to 2.643. The greatest possible total score was four. Preinterviews found only one student scored a three or four (showing accomplished or exemplary knowledge) on this topic, postinterviews revealed 19 students with a score of three or four out of four on this topic.

Null Hypothesis: There is no difference in concept knowledge of fifth graders related to rock identification (igneous, metamorphic, sedimentary) after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in concept knowledge of fifth graders related to rock identification (igneous, metamorphic, sedimentary), after participating in an outdoor science field trip.

The Wilcoxon Signed Ranks test shows that the difference in mean scores representing cognitive achievement of rock identification is significantly different from zero, leading to a rejection of the null hypothesis in favor of the alternative hypothesis. Knowledge assessment scores on the topic of the origin rock identification increased by 34.7 % from 1.750 to 2.357. Preinterviews found only three students scored a three or four on this topic, postinterviews revealed 11 students with a score of three or four out of four (showing accomplished or exemplary knowledge) on this topic.

Null Hypothesis: There is no difference in concept knowledge of fifth graders related to the weathering of rocks after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in concept knowledge of fifth graders related to the weathering of rocks after participating in an outdoor science field trip.

The Wilcoxon Signed Ranks analysis shows that the difference in mean scores representing cognitive achievement of weathering of rocks is significantly different from zero, leading to a rejection of the null hypothesis in favor of the alternative hypothesis. Knowledge assessment scores on the topic of the origin of weathering increased by 22.1 % from 2.339 to 2.857.

Preinterviews found only two students scored a three or four on this topic (showing accomplished or exemplary knowledge), postinterviews showed dramatic improvement with 23 students receiving a score of three or four out of four on this topic.

Null Hypothesis: There is no difference in concept knowledge of fifth graders related to changes on Earth's surface after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in concept knowledge of fifth graders related to changes on Earth's surface after participating in an outdoor science field trip.

The Wilcoxon Signed Ranks test shows that the difference in mean scores representing cognitive achievement of changes on Earth's surface is significantly different from zero, leading to a rejection of the null hypothesis in favor of the alternative hypothesis. Knowledge assessment scores on the topic of changes on earth's surface increased by 38.2% from 1.964

to 2.714. Only two students received a high score of three or four (showing accomplished or exemplary knowledge) on this topic pre-field- trip, this improved to 20 students after the trip.

Null Hypothesis: There is no difference in concept knowledge of fifth graders related to the granite outcrop ecosystem after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in concept knowledge of fifth graders related to the granite outcrop ecosystem after participating in an outdoor science field trip.

The Wilcoxon Signed Ranks test shows that the difference in mean scores representing cognitive achievement of the granite outcrop ecosystem is significantly different from zero, leading to a rejection of the null hypothesis in favor of the alternative hypothesis. Knowledge assessment scores on the topic of the granite outcrop ecosystem increased by 69.6 % from 1.821 to 3.089. Three students scored a three or four (showing accomplished or exemplary knowledge) before participation in the field trip in contrast to 21 students after the experience.

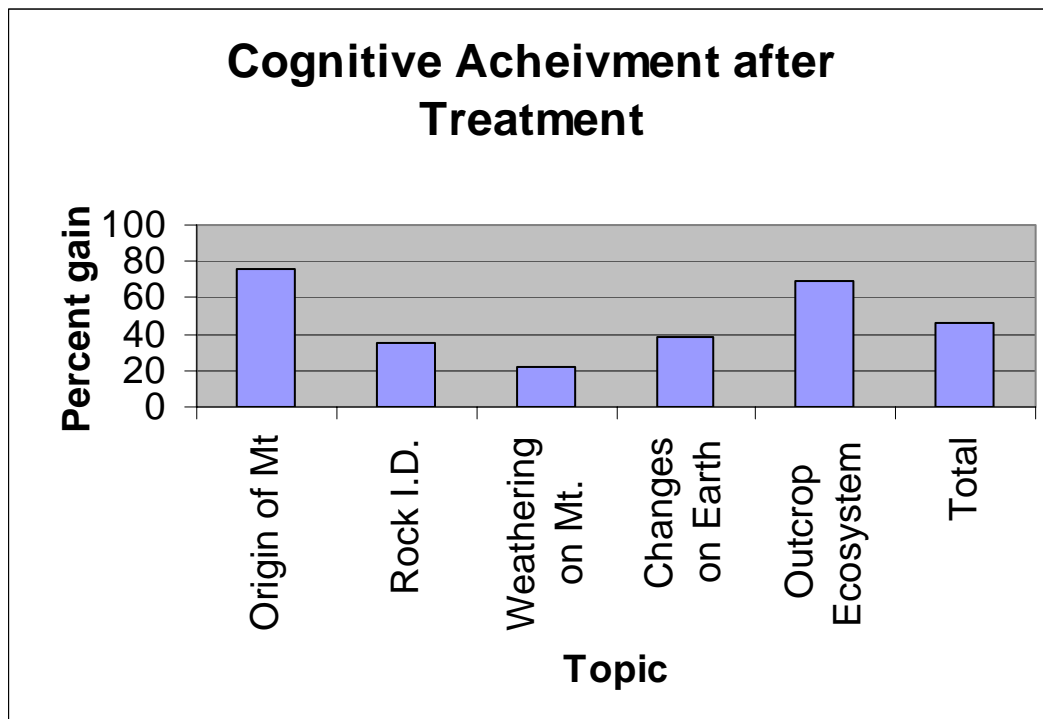


Figure 1. Percent gain in cognitive achievement after a science field trip

Affective Data

A paired Wilcoxon Signed Ranks analysis was run (95 % confidence interval) to evaluate the significance of the change in mean scores from pre-field-trip affective interviews to post-field-trip affective interviews for each topic and the total. Table two, "Difference in Mean Scores of Students' Affective Interviews" describes the results. There was no significant change in mean score for any of the attitude topics.

Table 2
Difference in Mean Scores of Students' Affective Interviews

TOPIC	PreInterview vs. PostInterview (n= 28)	
Science Class		
- ranks	9	
+ ranks	8	
ties	11	
z-value	-.836	
one-tailed significance		.202
Nature and the Outdoors		
- ranks	9	
+ ranks	8	
Ties	11	
z-value	.000	
one-tailed significance		.500
Learning Earth Science		
- ranks	9	
+ ranks	10	
ties	9	
z-value	-.250	
one-tailed significance		.402
Educational Field Trips		
- ranks	8	
+ ranks	10	
ties	10	
z-value	-.900	
one-tailed significance		.184
Stone Mountain		
- ranks	1	
+ ranks	21	
ties	6	
z-value	-.494	
one-tailed significance		.301

($p < .025$)

The results of the statistical analyses were used to determine whether the null hypothesis can or can not be rejected.

Null Hypothesis: There is no difference in attitude of fifth graders related to learning science after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in attitude of fifth graders related to topic one learning science after participating in an outdoor science field trip.

The results of the Wilcoxon Signed Ranks test confirm that there is no significant change in attitude about learning science after participating in an outdoor science field trip. The null hypothesis can not be rejected.

Null Hypothesis: There is no difference in attitude of fifth graders related to nature and the outdoors after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in attitude of fifth graders related to nature and the outdoors after participating in an outdoor science field trip. The results of the Wilcoxon Signed Ranks test confirm that there is no significant change in attitude about nature and the outdoors after participating in an outdoor science field trip. The null hypothesis can not be rejected.

Null Hypothesis: There is no difference in attitude of fifth graders related to learning Earth Science after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in attitude of fifth graders related to learning Earth Science after participating in an outdoor science field trip. The results of the Wilcoxon Signed Ranks test confirm that there is no significant change in attitude about learning Earth Science after participating in an outdoor science field trip. The null hypothesis can not be rejected.

Null Hypothesis: There is no difference in attitude of fifth graders related to educational field trips after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in attitude of fifth graders related to educational field trips after participating in an outdoor science field trip. The results of the Wilcoxon Signed

Ranks test confirm that there is no significant change in attitude about educational field trips after participating in an outdoor science field trip. The null hypothesis can not be rejected.

Null Hypothesis: There is no difference in attitude of fifth graders related to visiting Stone Mountain after participating in an outdoor science field trip.

Alternative Hypothesis: There is a difference in attitude of fifth graders related to visiting Stone Mountain after participating in an outdoor science field trip.

The results of the Wilcoxon Signed Ranks test confirm that there is no significant change in attitude about Stone Mountain after participating in an outdoor science field trip. The null hypothesis can not be rejected.

Table 3
Number of Students with Scores of Three out of Four or Four out of Four on Attitude Topics

TOPIC	PreInterview (n= 28)	PostInterview
Science Class	25	27
Nature and the Outdoors	26	28
Learning Earth Science	24	22
Educational Field Trips	27	25
Stone Mountain	27	27

Sixteen participants returned their attitude surveys on the same topics as those addressed in the interview. A Wilcoxon Signed Ranks analysis was completed to evaluate change in these scores. No significant difference was found among pre-field-trip and post-field-trip scores on any topics of the attitude survey or on the total scores. In contrast to attitude interview results (see Table 2) that showed two slight decreases in affective score, the attitude survey scores all showed positive percentage change in means.

Table 4.
Analysis of Students' Attitude Survey Scores

TOPIC	PreInterview vs. PostInterview (n= 16)	
Science Class		
- ranks	1	
+ ranks	2	
ties	13	
z-value	-577	
one-tailed significance		.282
Nature and the Outdoors		
- ranks	0	
+ ranks	2	
Ties	14	
z-value	-1.41	
one-tailed significance		.079
Learning Earth Science		
- ranks	2	
+ ranks	3	
ties	11	
z-value	-.707	
one-tailed significance		.240
Educational Field Trips		
- ranks	1	
+ ranks	1	
ties	14	
z-value	.000	
one-tailed significance		.500
Stone Mountain		
- ranks	0	
+ ranks	2	
ties	14	
z-value	-1.41	
one-tailed significance		.079

($p < .025$)

Qualitative Results

Cognitive

Eleven of the 28 participants completed and returned concept maps before and after the field trip. Examination of the words and phrases on those maps shows an overwhelming increase in science language related to topics of the field trip. Most students (73%) included new descriptive scientific words and phrases in their post-field-trip concept map, examples include: (a) “granite” (students 4, 7, 8, 9, 10, 18, 19),

(b) “igneous” (students 7, 17, 20),

(c) “shallow soil” (student 24),

(d) “cooled slowly” (student 8),

(e) “yellow daisies” (students 8, 18),

(f) “used to be magma” (students 8,19),

(g) “three hundred million years ago” (students 7, 20, 24, 10),

(h) “formed underground” (students 4, 7, 8, 10, 19, 20),

(i) “cold and heat weathering” (student 17),

(j) “lichens” (students 8, 18),

(k) “weathering causes cracks” (student 19),

(l) “unique animals” (students 7, 18, 21, 24).

Most students included many more words in their post-field-trip maps and six of the eleven wrote much more about the Life Science aspects of the field trip (the plants and animals on the mountain).

During preinterviews, I became aware of the many misconceptions the fifth graders had about Stone Mountain. All but one student had visited the mountain on several occasions and were quite familiar with the site and the park, but had to guess about the mountain’s origin or were fairly sure their erroneous interpretation was correct. Some of the most commonly heard

misconceptions were: "it was a volcano" or that it formed through the action of water, for example that "water washed it up" or "built the rock up there."

Other answers included: (a) "not sure...asteroids maybe?", (b) "I'm thinking that water dripping how it forms caves...that that happened", (c) "it might have been a chunk of rock that fell from space and broke into a lot of pieces and then grew back together", (d) "rocks piling up over years".

The misconceptions extended to their assessments of the age of the mountain. All but four students of the 28 gave me very low estimates when asked about the age of Stone Mountain. Most replies were around 100-300 years old but two children answered only 60 years and a few guessed several thousand. This is especially notable since their expectations as to the origin of the mountain were lengthy happenings requiring hundreds or thousands of years to occur.

Postinterviews revealed a definite dismissal of the previous misconceptions about age and origin of Stone Mountain in favor of more correct knowledge. Though no student attempted to tell me the entire scientific theory behind the formation of Stone Mountain, most knew that it formed from magma underneath the surface of the Earth and was later exposed. Typical post interview answers (not all representing an equal score) included: (a) "It used to be under the ground as magma, it cooled from the outside in and the dirt on and around it washed away", (b) "The heat melted rock and igneous rock came out of it", (c) "It formed from magma and it was here before the dinosaurs were", (d) "Hot molten rock formed it and all the stuff surrounding it went away".

Only two students still insisted that it had something to do with a volcano. Two others developed two new misconceptions which included pieces of scientific information presented on the trip: "it got here over billions of years from underground, an earthquake probably pushed it up" and "it was formed by a volcano erupting and dirt and stuff was eroded away."

Participants' concepts of the age of the mountain were also affected. Students acknowledged a much older number when asked the age of the mountain. Very few students answered with the correct age of 300 million years, but all answers exceeded one million years in the postinterviews.

During postinterviews, the first question asked was, "What can you tell me about Stone Mountain?" A majority of students' responses to this question included science information, usually that it was made out of granite, but predominantly answers focused on Life Science aspects of the information presented and discussed on the field trip. Even though the trip focused primarily on Earth Science concepts, students' most prominent memories involved the trees, lichens and "desert plants" growing on the mountain and for some the Granite Grasshopper. The children found and observed one of these camouflaged (green and gray) insects on the trip. Examples include: (a) "There's a lot of vegetations...Prickly Pear cactuses", (b) "The trees grow in very little soil, there are some bugs that live on Stone Mountain, there's gray spiders", (c) "There's green stuff that grows on it, its lichen", (d) "The trees that grow on there, they are shorter than normal because they don't have enough nutrients", (e) "There are grasshoppers that blend in to it and cactus grow on it, there's lichens". Qualitative cognitive results indicate a shift toward understanding and support the quantitative analysis and evidence of field trip value.

Affective

Most fifth graders responded positively to my attitude questions during the preinterview sessions, many were so enthusiastic about several topics that they received the highest scores possible on the scoring rubric. Science was the favorite subject of many of the participants and all but one child greatly enjoyed spending time outside and exploring nature. A few students admitted that their attitudes about science class varied yearly, that it depended on the teacher and what they do. Many expanded on why they liked science over other school subjects: (a) "I

like experiments”, (b) “I like when we do fun activities”, (c) “I only don’t like it when we do worksheets and stuff”, (d) “I think it’s really fun when we get to do projects and experiments”. Some children told me about their favorite place or thing to explore outside. There did not appear to be any change in attitude regarding science and the outdoors after participating in the field trip.

When asked about learning Earth Science, some children favored this science because it is “interesting to learn about how our Earth is formed,” others enjoyed learning about volcanoes and mentioned rock experiments they were doing in class. During the postinterviews, I noticed some children did not appear to have the same enthusiasm to learn more Earth Science, they admitted they were kind of bored with it after the long unit on rocks and the Earth.

For the postinterviews, I included several additional related questions about learning on field trips and memories of the field trip. Interestingly, an overwhelming majority of students (89%) thought they could learn Earth Science better outside on trips such as this one. Descriptions of why they preferred learning outside included: (a) “It’s much better when you can see the stuff in real life”, (b) “I like learning on field trips where I can actually see and touch what you’re talking about”, (c) “Outside is better because in the classroom we just see pictures of stuff; outside we see the real source”, (d) “Outside, because you can explain the reason why it has cracks and you can actually see the cracks”, (e) “I like learning about things outside because I could see it firsthand instead of reading about it in a book”. Since interviews revealed that students held field trips in high regard because they were “fun” or they “get out of school”, I expected students to describe the hike, the view or even lunch when asked what they remembered most about the field trip. Instead, most students (68%) included some science related fact or phrase in their response. Examples include: (a) “probably the mineral crystals we collected”, (b) “its very old”, (c) “probably that it was formed millions of years ago or that it is granite”, (d) “that it was made underground”, (e) “the trees up near the top”, (f) “the weathering”, (g) “the animals, like the grasshopper”.

CHAPTER 5

Conclusions and Implications

Discussion

Study results definitely support the notion that isolated science experiences, like field trips, can facilitate learning. Data analysis revealed significant changes in understanding of Stone Mountain and related topics and gain in cognitive achievement after the field trip was greater than 50% for most topics evaluated. Student interviews provided additional insight as students described what they learned. Both the quantitative and qualitative aspects of this research study provide sufficient evidence to justify the use of field trips in science curriculum even when coursework is not designed to provide introduction and follow-up on the trip topics or site. Diverging from a popular belief that students would not learn or retain knowledge on field trips without such preparation and reinforcement, this study suggests that field trips have instructive value as unique experiences. There may (of course) be additional value to including activities before and after a field trip but these findings do not reject the common use of trips as their own educational tool.

Observations within this study are consistent with one aspect of other projects on this topic, that familiarity with the site alleviates distraction due to novelty (Falk, 1983; Falk and Balling, 1979, 1982). All participants but one had been out to Stone Mountain on several occasions. When they arrived, I noticed most were very attentive and showed interest in the discussions and activities. Questions were related to the topic we were focusing on. These aspects contribute to the environment most likely to show more affirmative learning results as substantiated in the study.

Positive results on the statistical analysis showing highly significant gain in science knowledge were thoroughly supported by a number of other data collected and evaluated during

the study. Though some advance was expected, the high percentage increase in knowledge is noteworthy. Students' concept maps showed incredible improvement in the science aspect and responses to questions of the attitude interview even reflected science knowledge gain.

Students with lower preinterview knowledge scores improved to the greatest extent showing the largest achievement gains. Lisowski and Disinger (1991) found similar gains in their evaluation of ecological knowledge learned outdoors.

Interestingly, two topics addressed on the field trip, the formation of Stone Mountain and the granite outcrop ecosystem, had considerably larger gains in knowledge achievement by participants. Post-field-trip scores showed great improvement on these topics and the concept maps attributed considerable space to them after the field trip. Students showed more interest in learning about these, preferring them to other field trip topics like weathering, rocks and minerals, and geological features. The same topics surfaced frequently in the affective postinterviews as the students described what they most remembered about the field trip. Some students professed their love for learning about plants and animals after stating their disinterest in Earth Science during the affective postinterview.

Analyses of these results recognize a number of theoretical science education possibilities: Are some topics of greater interest to a particular age group? Did students' extensive classroom experience with Earth Science lead to boredom, resulting in a lower score on the affective postinterview? Was there more visual connection with the science of the geological formation and ecosystem?

Repetition of new terms and ideas are another possibility contributing to success in cognitive gain. Throughout the study very few things were repeated or emphasized frequently, but had they been, the cognitive percentage gains might have been even more impressive.

The observations and results regarding highly successful topics should be influential in leading field trips guided by or related to their most obvious interests. The childrens' interests in certain topics may be used to positively affect their knowledge in topics they may not be inclined

to take an interest in. At Stone Mountain, the uniqueness in geology and ecology are intimately related and these observations invite suggestions of combining Earth and Life Science at each learning station along the field trip to keep students interested. The topics most cognitively valuable to the students, the formation of Stone Mountain and the granite ecosystem are more abstract topics, difficult to thoroughly understand from books. They are also very specific topics that the students had little or no previous experience with.

In addition to evidence of strong conceptual gain, the implication of rejection of previous misconceptions about Stone Mountain through the trip experience is of eminent significance. It is often hard for children to correct science misconceptions (Bruning, Shaw & Ronning, 1999) and many misconceptions are highly resistant to change or alteration by traditional teaching methods (Blosser, 1987). The observations in this study may suggest that outdoor trips can provide the environment necessary to overcome some conceptual discontinuities. Additional research exploring this subject may be beneficial to science education.

While conceptual knowledge was certainly affected, attitudes were not. However, students' attitude scores were so high during the pre-field-trip assessments that room for change was minimized. The lack of significant change in attitude due to the field trip experience was not predicted but it is consistent with some research findings. Shepard and Speelman (1985) acknowledged that program length does have an effect on development of more positive science and environmental attitudes. Their study found significant results from a five-day residential program, but not from a one-day trip. Knapp and Barrie (2001) reported results that did not support the notion that a science trip could improve student attitudes. Bogner (1998) stated that nature experiences could foster more positive attitudes but did not find shifts in attitude towards a more environmental perspective after a one-day program at a National Park. Knapp and Barrie (2001) also reported results that did not support the notion that a science trip could improve student attitudes.

The experience in this study lasted only three and one half hours. Attitudes take a long time to become established and may require longer periods of time to change. In addition, most students expressed positive opinions of the topics questioned before participating in the field trip and scored very high in the first place leaving little room for improvement on the assessment instruments. Students' interest in a topic may be related to how much time they spent on it in class and the scope of the lessons and activities involved. These students had a four-week unit of physical Earth Science (rocks, plate movements, earthquakes, volcanoes), which they finished up after the field trip, shortly before I returned to conduct the follow-up interview. This interview was almost a month after the preinterviews that reflected the higher Earth Science attitudes. Attitude change may be better observed and measured over a series of field trips and site visits.

The attitude evaluations did reveal a common perception among the children in regards to preference of learning methods. Almost all students believed they could learn and comprehend more Earth Science outdoors where they could see and touch the objects under discussion. Broda (2002) implied that children of this age prefer more active learning and usually exhibit positive responses to learning field trips. Interviews and surveys from this study support his analysis even though they may illustrate minimal change. Falk and Balling (1982) reported similar affective data in fifth graders, observing that students chose a forest over classrooms, a park, a greenhouse and outside the school for learning about trees.

Affective characteristics are complex and decidedly difficult to measure. More extensive interview questions and surveys would better examine emotional changes and possibly reveal more significant attitude change. In their review of literature, Knapp and Barrie (2001) declared that many authors believe attitude evaluations following short-term outdoor experiences are very difficult to accurately assess. The lack of attitudinal change reflects other research done on this subject and may be attributed to the positive beginnings and the duration of the trip.

Summary

This study explored what students can learn during a short outdoor science experience and considered whether childrens' attitudes about science, the outdoors and the trip site were influenced through participation in the experience. Though topics evaluated within the study were somewhat different from those examined in previous related studies, the concept of using nature as a classroom and nature's geological and ecological creations as teaching tools remained the focus of my investigation. The attitude attributes measured in this study were similar to others in the existing body of research and included student perspectives on earth science, learning outdoors and the field trip site. The project was unique in its examination of the field trip experience itself. It also answers a call among researchers interested in this topic to apply qualitative research techniques and alternative learning assessments to research in the nonformal science education realm.

Results of quantitative and qualitative analyses discovered specific knowledge learned by fifth graders on an outdoor science field trip included Earth Science concepts related to Stone Mountain, rocks and weathering, and ecological concepts associated with granite outcrops. Cognitive achievement can be attributed explicitly to the field trip experience as students received no introduction to or reinforcement of the subject matter. This evidence lends support to the perception that science field trips are an invaluable educational tool that can complement classroom instruction, or be used independently to teach certain subject matter.

Though there was no evidence of attitudinal gains as a result of this experience it should not discourage teachers or nonformal education professionals. Affective gains may still be expected from longer, more extensive outdoor science programs or from repeated visits.

The findings of this project suggest the effective use of field trips is not limited to a curriculum designed around the trip. Its value as an independent learning experience is heartening for teachers today who often plan trips with the hope that the trip itself will do the teaching. Implications extend to professionals in the nonformal education sector- museum, park

and nature center instructors for example who believe in the value of how they teach but literature justifying it is uncommon. The results of this project should contribute to the limited knowledge and understanding of learning in the outdoors, as a representation of what can be achieved. Science educators today are continuing to explore and confirm what some conservationists of the past have told us:

“Why must we always teach with books?

Let them look at the mountains and the stars above.

Let them look at the beauty of the waters

And the trees and the flowers of the earth.

Then they will begin to think, and to think

Is the beginning of a real education.” – David Polis, 1970

Future research may justify this commonly preferred teaching and learning strategy through affirmation of the outdoors as one of the most effective settings for teaching certain Earth Science concepts. Field trips can cover a variety of science subjects using the environment as a classroom, studies focusing on the success of teaching different topics outdoors and on the affective results of short-term outdoor field trips would be helpful to further extend findings of this study.

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APPENDIXES

Appendix A

Cognitive Preinterview Protocol

Show photo of Stone Mountain

1 "Have you been here before?" (Eliminate in post)

2 "What can you tell me about this place?"

3 "What about the science behind it- what kind of rock is Stone Mountain?"

4 "How do you think it formed?"

5 "How long ago?"

Show examples of 3 types of rocks

6 "Can you tell me which rock is an example of each an igneous rock?" (Do you know the other types?)

Show Stone Mountain granite

7 "Do you know recognize this type of igneous rock?"

Show photo of weathered surface of Stone Mountain

8 "Why do you think the surface of Stone Mountain is so uneven, with so many cracks and depressions?"

9 "Is the surface of Stone Mountain changing?"

10 "What are some examples of weathering that can break down rocks?"

Show photo of lichens

11 "Have you seen this before, what is it?"

Show photo of tree on mountain

12 "Can you tell me anything about the trees on Stone Mountain?"

Appendix B
Cognitive Postinterview Protocol

Show photo of Stone Mountain

1 "What can you tell me about Stone Mountain?"

2 "What about the science behind it- what kind of rock is Stone Mountain?"

3 "How do you think it formed?"

4 "How long ago?"

Show examples of 3 types of rocks

5 "Can you tell me which rock is an example of each an igneous rock?" (Do you know the other types?)

Show Stone Mountain granite

6 "Do you know recognize this type of igneous rock?"

Show photo of weathered surface of Stone Mountain

7 "Why do you think the surface of Stone Mountain is so uneven, with so many cracks and depressions?"

8 "Is the surface of Stone Mountain changing?"

9 "What are some examples of weathering that can break down rocks?"

Show photo of lichens

10 "Have you seen this before, what is it?"

Show photo of tree on mountain

11 "Can you tell me anything about the trees on Stone Mountain?"

Appendix C

Affective Preinterview Protocol

- 1-How do you feel about science class?
- 2-Do you enjoy spending time outdoors and exploring nature and stuff?
- 3- Do you like learning about Earth Science? Why?
- 4- Do you enjoy learning field trips?
- 5- Do you like visiting Stone Mountain?

Appendix D

Affective Postinterview Protocol

- 1-How do you feel about science class?
- 2-Do you enjoy spending time outdoors and exploring nature?
- 3- Do you like learning about Earth Science? Interested in learning more about rocks, earthquakes and mountains?
- 4- Do you enjoy learning field trips?
- 5- Do you think you learn some science better in the classroom or outside on fieldtrips?
- 6- Do you like visiting Stone Mountain?
- 7- What is the thing you remember most about the Stone Mountain field trip?

Appendix E
Attitudinal Survey

Please circle the face which most expresses how you feel about each statement.



How I feel about Science:



I like being outdoors:



Earth Science is interesting:



School field trips are fun:



Stone Mountain is a neat place:



Appendix G

Cognitive Scoring Rubric

Concept Knowledge	Beginning 1	Developing 2	Accomplished 3	Exemplary 4	Score 1,2,3,4
The formation of Stone Mountain	No knowledge of what Stone Mountain is or how it got there. OR serious misconception about the mountain	Knows Stone Mt is very old Has no major misconceptions	Knows Stone Mt formed underground a very long time ago and was later exposed	Aware that Stone Mt formed underground from melted magma during the creation of the Appalachian mts and was exposed through erosion	
Rocks and Minerals	Can not pick out igneous rock or granite from choices	Knows Stone Mt. is granite but can not correctly chose 1 of the samples (igneous or granite)	Can identify both the igneous rock sample and granite	Knows Stone Mt is granite, an igneous rock formed from magma, can identify all rock samples by type	
Weathering of rocks	Does not recognize the context of weathering	Shows understanding that weathering affects rocks and breaks them down	Shows understanding of weathering on Stone Mt and can recall one of the types of weathering	Accurately describes what weathering looks like and names examples of physical and chemical weathering	
Changes on Earth's surface	Not sure if or how the surface of Earth is changing	Realizes Earth's surface changes over time	Realizes Earth's surface changes over time and can describe some changes	Realizes that change occurring on Earth's surface (mountain building, erosion) is a result of the forces acting on it	
The mountain ecosystem	Does not acknowledge the different environment on the mountain	Realizes that Stone Mt. supports a different kind of ecosystem but is not sure why or what lives there	Understands that Stone Mt. supports a special system of plants and animals	Can describe the environment on Stone Mt and name several plant or animal species that are adapted to life on it	

Appendix H

Affective Scoring Rubric

Attitude about:	Negative 1	Indifferent 2	Slightly Positive 3	Very Positive 4	Score 1,2,3,4
Science	Strong statements about their dislike of science	Response indicates he/she believes science is ok but isn't excited about learning science	Science is pretty cool and interesting to them	Shows great interest in science class, enjoys it greatly	
The Outdoors and nature	Not fond of going outdoors, even to play, would always rather stay in	Goes outdoors sometimes but not too much interest in it	Enjoys being outdoors, especially in natural areas	Loves nature and being outdoors, explores it at every opportunity	
Learning Earth Science	Not excited about this subject at all shows obvious disinterest	Earth science is not of great interest to student or student doesn't know what this subject is	Response indicates Earth science is pretty interesting to them, they are excited to learn more	Shows extreme interest in topic, that they even explore Earth science on their own	
Educational Field Trips	Shows dislike of educational field trips they've had bad experiences in the past	Shows little opinion on participating in such trips	Shows enjoyment of past field trips, would like to attend more	Great enthusiasm for educational field trips, no matter what the site	
Stone Mountain	Not fond of the mountain, maybe scared of heights	Never been to Stone Mountain, not too excited about visiting	Shows interest in the mountain and/or may have fond memories of past visits	Ecstatic at mention of Stone Mountain a favorite place theirs or somewhere they've always wanted to visit	

Appendix I

Photos Used in Cognitive Interviews

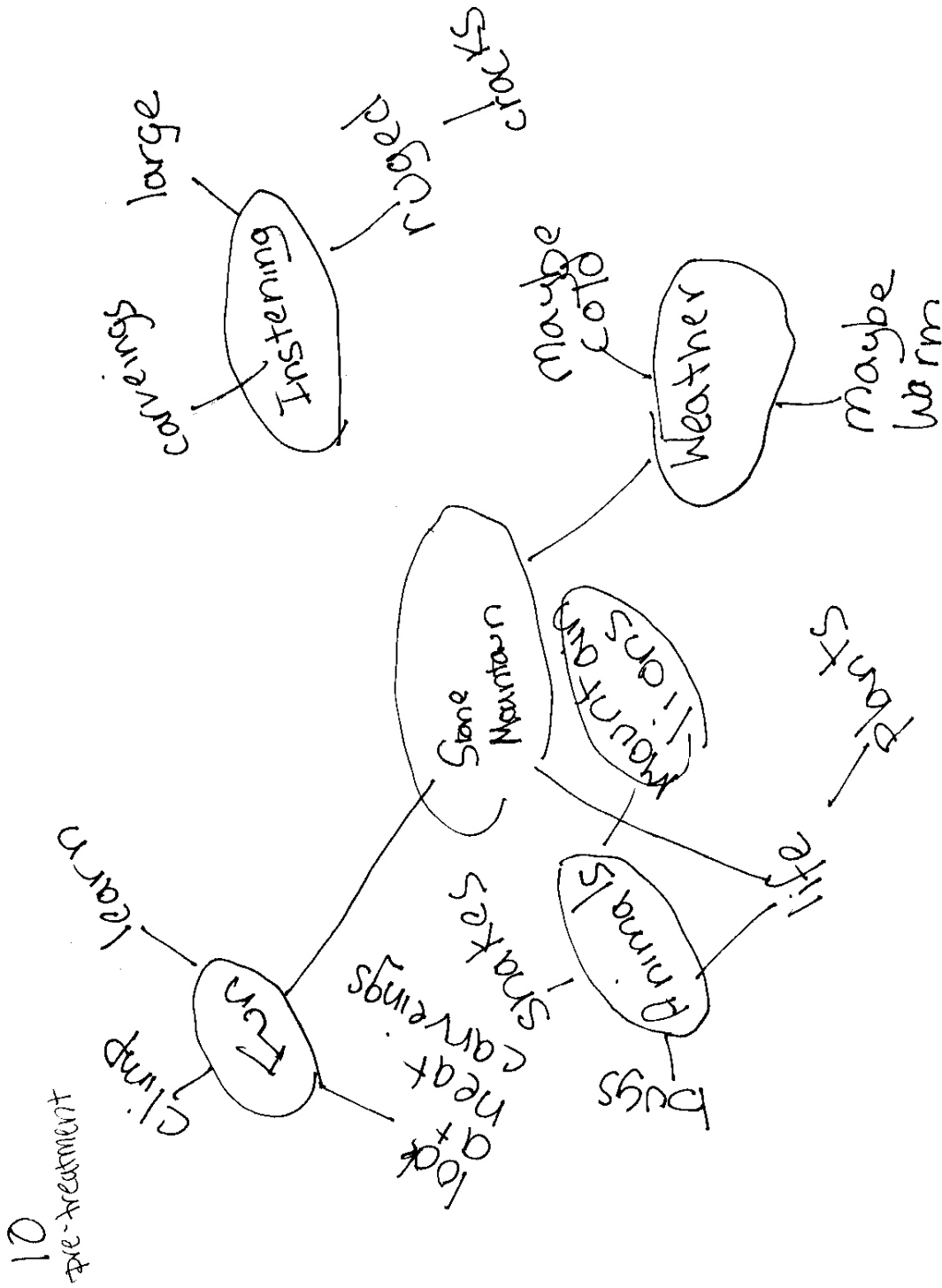


Appendix I Continued



Appendix J

Student 10 Concept Map Pre-field-trip

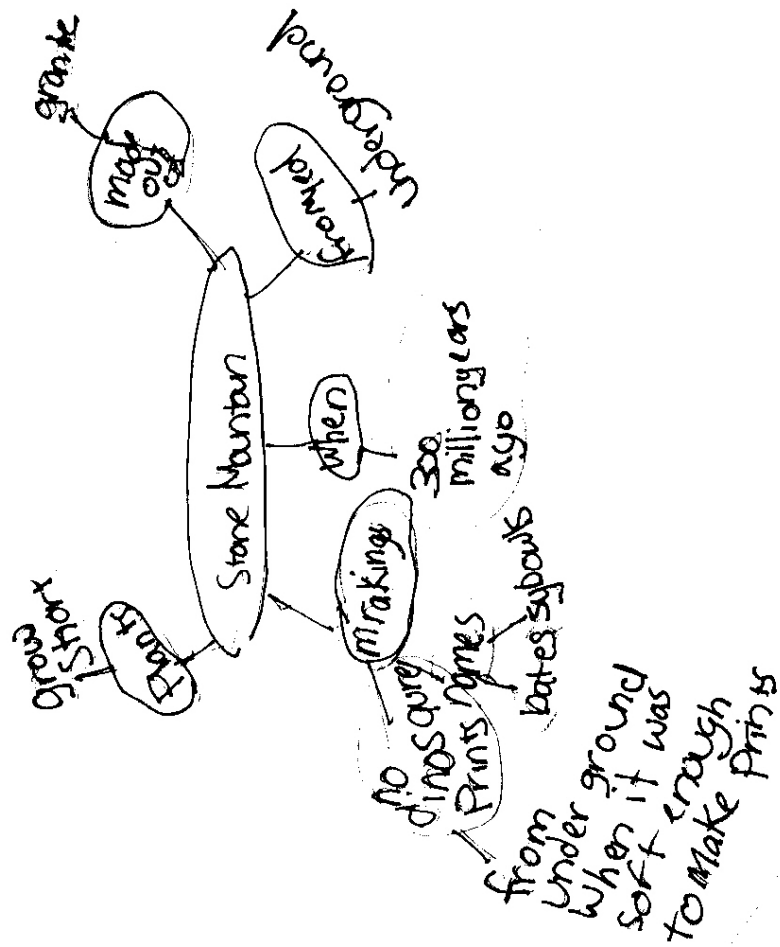


10
pre-treatment

Appendix K

Student 10 Concept Map Post-field-trip

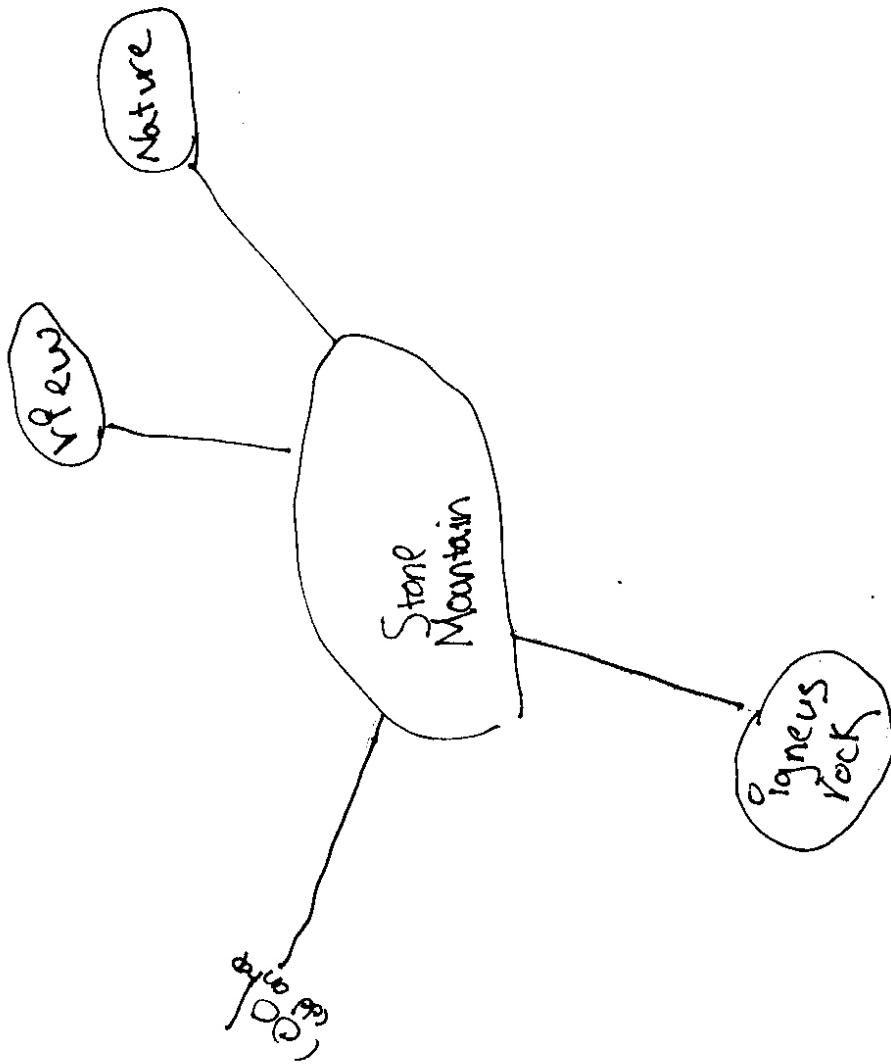
10
post-treatment



Appendix L

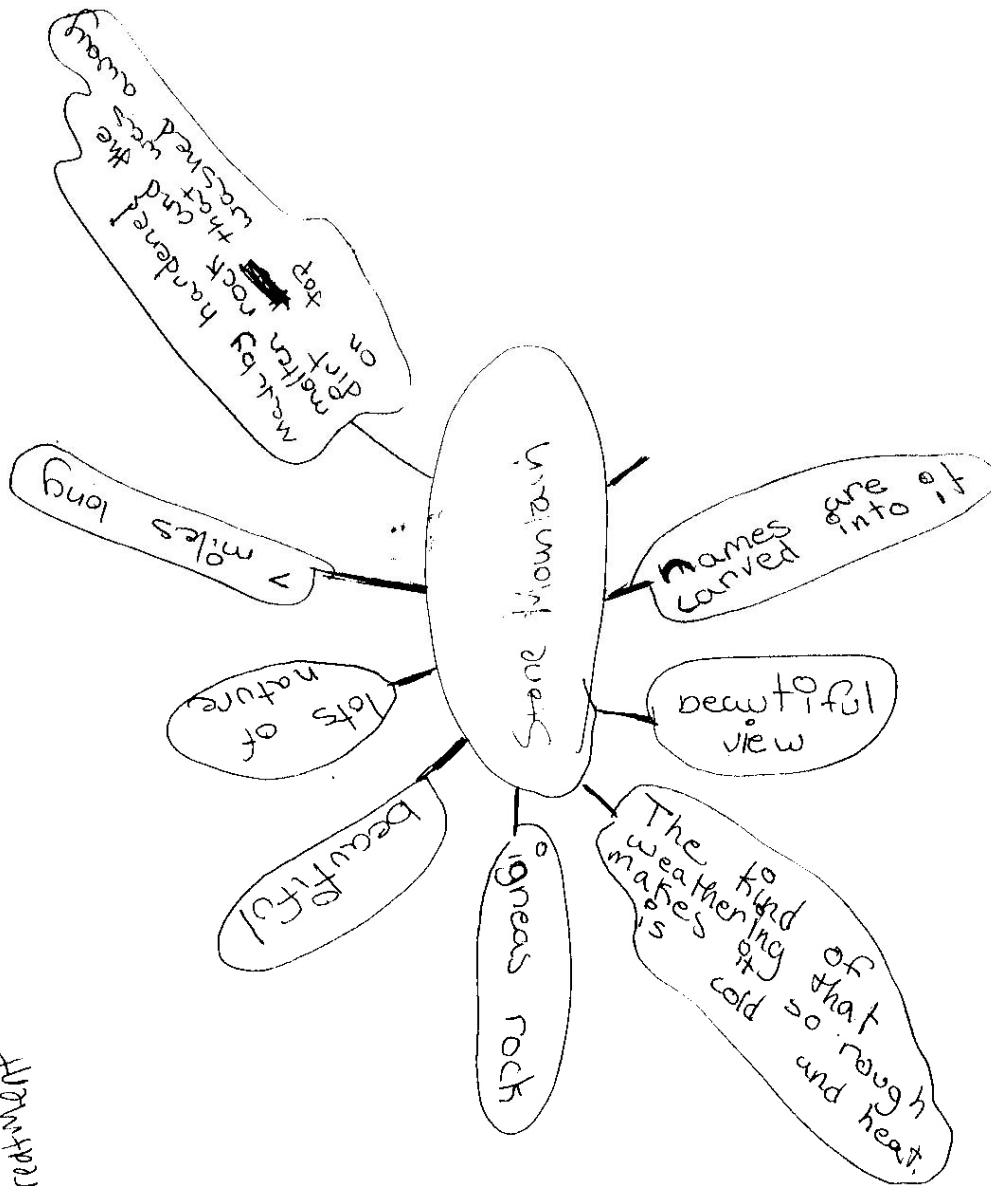
Student 17 Concept Map Pre-field-trip

#17
Pre-treatment



Appendix M

Student 17 Concept Map Post-field-trip



17
Post-treatment

Appendix N

Stone Mountain Field Trip Lesson Guide

The Geology and Ecology of Stone Mountain

3.5 hour program including hike to the top of Stone Mountain

Objectives met in all programs:

- students will understand how the mountain formed
- students will recognize unique features on mountain and realize their origin
- students will identify with different rocks and minerals found on the mountain
- students will recognize the life forms found on the mountain
- students will comprehend the granite outcrop ecosystems and their succession

Materials:

Laminated maps & pictures, stress ball, cracked marbles, examples of quartz, mica and feldspar, first aid kit

Basics:

The elevation we are currently at is 900 feet...the elevation at the top of Stone Mountain is 1686 feet. The mountain stands above everything in this fairly flat piedmont area...How many feet will we climb in elevation today?

MOUNTAIN FORMATION AND HISTORY (use graphics to explain formation)

- Does anyone know how long ago Stone Mountain formed? A few hundred years ago? Thousands? A million?

The mountain formed 300 mya- this was even before the dinosaurs were on earth! Earth looked very different at that time, long ago, the continents were in different places on earth because they move slowly along the Earth's crust (they still do today- causing earthquakes). 300 MYA North America and Africa actually collided and pushed land up to form the Appalachian Mountains! Below the earth's surface, the movement and shifting of the earth's continental crust created lots of pressure and friction (example of pressure- push hands together, example of friction- rub hands together) heat was the result of this action- this friction and pressure warmed and melted a large mass of rock below earth's surface to a liquid –do you know what melted rock is called? Magma!

The magma hardened into granite underground.

- What kind of rock is granite? Igneous, sedimentary or metamorphic?

We call it an igneous rock because it was formed by crystallization (hardening) of magma

- At the time in history when the mountain formed do think it looked similar to the way it looks today?

Nope, in fact you wouldn't have been able to see the mountain- it was 8 miles underground!

- Do you know why we can see the mountain now?

Layers of land on top of the dome washed away with lots of time and weathering – the surrounding land wore away to uncover the mountain, the surrounding rock is softer, less resistant (metamorphic rock) than the granite and wears away more quickly. The only reason Stone Mountain stands here today higher than anything else in this area is because the granite is so tough and resistant

Appendix N Continued

■ Can we see all of Stone Mountain?

Nope, the mountain is kind of like an iceberg - we only see the very tip of it. There are miles of Stone Mountain below our feet and it spreads out about 7 miles to the east of here. Stone Mountain is not underneath all of Georgia like many people think!

As we walk up the mountain today, we will stop several times to look at features on the mountain as well as the plants- can introduce unique plants at this area- prickly pear cactus, hairy cap moss, lichens etc.

STOPS

Cover “veins “ in the mountain at first large one if desired or wait till one by “gum rock” area.....

■ 1 In this area we can see how Stone Mountain is weathering today- if older explain **physical** and **chemical** weathering....

The depressions you see on the mountain are areas where seasonal weather and chemicals (organic acids) from plants weaken and wear away the granite

The depressions become the beginning of the plant communities on Stone Mountain.

The main cause of Physical weathering is actually the heating and cooling of the rock with the seasons, this causes the granite to expand and contract, weakening the rock and cracking it. Show cracks and depressions.....Chemical weathering occurs because of acidic rain or plant acids actually changing the composition of the granite making it weaker and less resistant.

There are many different stages of life in the mountain ecosystem- young communities have only lichens or moss and older have trees...**lichens** are the greenish plant that sticks to the surface of the rock- its ½ fungus ½ algae(small plant)—the fungi absorbs moisture and the algae the sun’s energy and they share with each other. The lichen can produce a chemical when wet and can help weather the rock and make the depressions we talked about earlier.

The lichens are the first to grow on the bare rock, after some soil gathers in the pit, moss can grow and with more soil, flowers, plants, and some trees can grow- point out some plant species

Show some examples of succession on the mountain, have the students find representative communities of the different stages.

■2 Show “historical Graffiti” at first large carving you come across- usually the 7/4/98 one from 1898, explain how we aren’t allowed to carve on mountain today...

■3 Joints – area with lots of little cracksCan everyone find what looks like a crack in the rock?

As land eroded uncovering the mountain, the mountain expanded (because of less pressure/ weight on it) and these joints formed as the mountain’s surface cracked – use stress ball as example- it expands when you let off the pressure of your hand squeezing it These joints get bigger when water freezes in them or when tree roots grow in them.....large boulders can break off from the joints over time, break down into smaller stones and eventually contribute to soil formation on the mountain.

■ 4 Stone mountain consists of 3 kinds of minerals- feldspar, quartz and mica (pass around examples of these) You can find the quartz and mica showing on the surface in places in the mountain- and in this area you can often find chips of these separate minerals. Some pieces of granite which have been weathered for a long time are not so strong and can be broken with your hand- these are the pieces of whitish speckled rock- try this Rock discovery activity, and look for samples of granite and minerals of the granite and help them to identify what they’ve found .

Appendix N Continued

- 5 Does any one know what exfoliation means?

It means to take the surface off...this happens here on the mountain- the granite near the surface is layered, almost like an onion and weathering helps to shed off these layers over time- SHOW diagram....Do you think the large carving will be on the side of the mountain forever if Stone Mountain is shedding off its outer layers?

- 6 Large stripes in the granite like this white one are called dikes- they were formed by hot magma 300 mya when the mountain's outer shell had just begun to harden-, it cracked- cracks often form when rocks are heated than cooled –Magma welled up from below and filled the cracks, you can see the minerals which make up the granite concentrated in the cracks.

- 7 Plant communities- Lets name some living and nonliving things on the mountain involved in the ecosystem...

The granite outcrops are a harsh place to live- mention exposure and temperature extremes; there even are desert plants that live up here!

There are many different stages of life in the mountain ecosystem- young communities have only lichens or moss and older have trees....talk about the trees at this site- the stunted pines and cedars...the growth of these hardy trees is limited by the lack of soil and nutrients up here, many of these trees are growing in less than 6 inches of soil

Some animals have adaptations to live on the mountain- camouflaged granite grasshoppers are green and grey to match the granite and lichen, there are also lichen spiders with special color adaptations and fence lizards also blend into the rock very well. Clam shrimp live at the top of the mountain- briefly talk about their adaptations.

Have students look for these critters and go up and examine one of the twisted cedars.

TOP OF MOUNTAIN

- The view- explain what is where!
- Go see a vernal pool/solution pit if it's rained recently
- These pools could have formed in several ways- we already talked about how plant acids and rain can wear away the rock, also, because rock composition is not exactly the same all over the mountain some of the areas might be 'softer' rock and weather quicker than others leaving pits. Have students check out the vernal pools, look for clam shrimp if there is water in any of them.
- Point out endangered plants if they can be seen

Answer students' questions!