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This study proposed that student motivation and learning in Earth Science can be enhanced if students are given the opportunity to experience autonomy, competency, and relatedness in the classroom. The study addressed the following research questions: (a) If students are given an opportunity to experience autonomy, competence, and relatedness, how will it affect their learning?; and (b) Similarly, how will it affect their motivation? Nine students, who previously failed this course, were enrolled in a summer school Earth Science class at an urban high school. They completed a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ) that measured self-efficacy, intrinsic challenge, intrinsic importance, intrinsic interest, test anxiety, self regulation monitoring cognition, self regulation monitoring, self-regulation monitoring-planning, and self regulation-effort management persistence. One-on-one interviews were conducted to give students an opportunity to elaborate and to obtain further insights on their motivation and learning. Field notes were collected to triangulate data. The results indicated that the students were able to experience autonomy, competence, and relatedness as a result of the instructional strategies presented in the classroom. The discussion focused on the implications of these findings for science education and school reform, particularly as it relates to the needs of those African-American students who experience difficulties in this discipline.

THE EFFECTS OF SELF DETERMINATION THEORY ON LEARNING AND MOTIVATION OF REPEATING STUDENTS IN A HIGH SCHOOL EARTH SCIENCE CLASSROOM

by

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I want to dedicate this dissertation to, Sylvester and Bernice Jenkins, my daddy and mamma. Thanks for loving me unconditionally.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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CHAPTER I

INTRODUCTION

Background

In 1985 the North Carolina State Board of Education (NCSBOE) made a decision to remove Earth Science from the eighth grade curriculum and it was not placed in any other grade level (Watson & Tucci, 2002). Public school educators, university professors, a meteorologist from the National Weather service, and the director from the North Carolina Aggregates Association were the core of a pressure group to restore Earth Science back into the state's curriculum and ultimately make it a high school graduation requirement. In 1998, the NCSBOE approved making Earth Science and/or Environmental Science one of the three science courses required for high school graduation starting with the class of 2004 (Watson & Tucci, 2002).

In the past, Earth Science was a class that was recommended for students who previously failed a science class such as Biology, Physics, or Chemistry and needed another science course to graduate. According to Gilbert and Yerrick (2001), Earth Science was described as the lowest-level science course. Typically, students enrolled in Earth Science classes were unmotivated and were not able to see the relevance of the class other than for the science credit. The academic tasks that students were given were not relevant, useful, or essential for students to achieve the desired learning goals of the class (Yerrick, 2000). Teacher expectations in these classes were low and not clearly stated (Gilbert & Yerrick, 2001). The teachers who were assigned to teach Earth Science, had low expectations for students and did not feel that academic progress could be made with those students (Secker & Lessitz, 1999). Instructional strategies in an Earth Science class consisted of lectures and handouts. Students generally did not engage in laboratory exercises and if they did, it was very infrequent (Gilbert & Yerrick, 2001). Meaningful learning in a lower track science class was measured by the students' abilities to memorize and recall facts and follow instructions. Teachers in those classes used strategies that limited student input, diluted the curriculum and increased teacher control (Yerrick, 2000). Instructional strategies such as these are in direct contrast to what is recommended to increase students' learning and motivation (Brophy, 2004).

At Joseph LeConte High School (JLHS), the participating school, Honors level Earth Science courses were not offered based on this designation. The teachers at JLHS were not prepared to teach Earth Science (most of them had Biology degrees and Earth Science was not a required course in their course of study). Consistent with the research of Gilbert and Yerrick (2001), instructional strategies at JLHS in Earth Science consisted of handouts, in which the majority of the questions or activities were at the knowledge level, based on Bloom's Taxonomy, writing definitions, and/or lectures. At JLHS there were four teachers who taught Earth Science. Of those four teachers, only one of them had a formal Earth Science class in college and that teacher taught one class of Earth Science and two classes of Physical Science each semester. The teacher who had the majority of the Earth Science classes, was a lateral entry teacher (meaning that this individual had neither teacher licensure nor a content area education degree), whose major in college was biology. He previously hoped to attend dental school. This teacher was in a classroom that was not equipped to conduct laboratory experiments. His instructional strategies consisted of handouts, having students copy definitions, and lectures. This teacher conducted only one lab and it was on identifying rock types.

What can teachers do to improve learning and increase student motivation in Earth Science classes? How might this situation be reversed? The teacher's instructional strategies consisted of lectures and hand-outs which are strategies that are in direct correlation to the study done by Gilbert and Yerrick (2001) and contradictory to what Brophy (2004) identified as motivational strategies.

As the researcher, my main assumption is that students' performances can be improved when the classroom's instructional climate promotes both learning and motivation. Based on the research literature, quality and meaningful learning occurs when academic tasks engage students in behaviors that they naturally enjoy and are able to connect them to their lives (Brophy, 2004; Seiler, 2001). The unmotivated student often views current school work as making little or no sense to them or as something not useful for later in life (McPartland & Branddock II, 2001). Such students are not likely to learn when engaged in pointless or meaningless activities such as continuing to practice on isolated skills, memorizing lists for no apparent reason, looking up and copying definitions of terms never used, or working on tasks that are assigned to fill time rather than to accomplish worthwhile learning goals (Brophy, 2004). On the contrary, it has been found that when students are trusted and empowered in the classroom, their attitudes change, their work habits improve, they develop ownership or self-determination, and their learning and motivation improves (Gilbert & Yerrick, 2001; Seiler, 2000; Slattery, 1995).

Deci and Ryan (1994) identified three factors that promote self-determination in the classroom: autonomy, competence, and relatedness. First, for students to experience autonomy, the classroom needs to be managed so that choice is emphasized rather than control. Second, competence is perceived when students are given a rationale to understand the purpose and personal importance of each learning task and the tasks are presented at the students' level. Students perceive competence when their thoughts are acknowledged and given quality feedback on tasks assigned to them. Finally for relatedness to be perceived, students have to understand the relevance of the instructional task. Their feelings need to be acknowledged about the task when it is necessary to require them to do something that they do not want to do and they need to be given the opportunity to interact with their peers. The assumption is that students would be more motivated to learn if the classroom climate was more positive and inviting. Motivation is increased when students perceive autonomy, competence, and relatedness in the classroom.

Science Performances of African American High School Students

Since 1969, the National Assessment of Educational Progress (NAEP) has been the sole, ongoing performance indicator of what American students know and can achieve in major academic subjects (The Nation's Report Card, 2000). Over the years, NAEP has measured students' achievement in many subjects, including reading, mathematics, science, writing, history, Civics, Geography, and the arts. In 2000, NAEP conducted assessments in reading at grade 4 and in mathematics and science at grades 4, 8, and 12. In addition, NAEP conducted state-by-state assessments in mathematics and science in grades 4 and 8. The results of the 2000 NAEP science assessment showed no significant change in grades 4 and 8 and a decline in performance at grade 12 since 1996. Average scores on the NAEP science assessments were examined for five major racial/ethnic subgroups: White, Black, Hispanic, Asian/Pacific Islander, and American Indian. The results of the NAEP showed that African American students scored below all of the aforementioned subgroups. However, in the county where JLHS is located, biology, chemistry, physics, and physical science are the science classes that have an End-of-Course (EOC) tests attached to them. African American students as a whole in this county tend to score below Whites and in all other ethnic groups in the county of the tested science courses (see Table 1) (North Carolina Department of Public Instruction, 2005). The table does not list Earth Science because Earth Science is not a tested course; however, it is a graduation requirement. The chart shows that AA (African American) students scored below all students in this county as well as the other students in the state. As the Assistant Principal at JLHS High School in charge of evaluating the teachers in the science department, I observed the instructional strategies utilized in the Biology, Chemistry, Physics, and Physical Science classes as well as those in the Earth Science classes. The instructional strategies in those classes mirrored the instructional strategies found in the Earth Science classes, which consisted of handouts, lectures and very few labs being conducted. The students enrolled in the non-Honors' level classes, especially those in Biology and Physical Science, were given low level work that required students to give one or two word answers or to regurgitate facts and to complete tasks that they found uninteresting and irrelevant. For example, one on-going assignment in one of the

Table 1

Science EOG Scores (%) as Reported by the North Carolina Department of Public Instruction

	Subject			
	Biology	Chemistry	Physics	Physical Science
NC	63.0	76.6	86.1	68.8
CC	59.3	72.1	88.1	57.1
JLHS	45.2	63.9	71.4	31.5
NC AA	39.0	54.9	63.6	48.3
CC AA	35.7	54.9	69.2	38.1
JLHS AA	45.2	63.9	71.4	31.4
NC W	75.0	83.4	89.7	80.1
CC W	77.5	79.7	90.6	77.1
JLHS W	*	*	*	*
NC-JLHS AA	-17.8	-12.7	-16.9	-37.4
CC-JLHS AA	-15.1	-8.2	-16.7	-25.7

Note: NC=All students in North Carolina; CC=All students in this county; JLHS=Participating high school; AA=African American students; W=White students biology classes was for students to copy definitions that were listed at the end of each chapter. The student did not have to memorize or learn the definition. The only requirement was to write the word and look up the definition.

The non-Honors level classes consisted of a high number of students who were repeaters (those students who have failed a grade). At JLHS, the make up of a typical Earth Science class usually consisted of repeaters, low achievers, and those students who were not interested in attending college. From my observations, the instructional strategies that were the norm in the science classes consisted of handouts, lectures, and these strategies were presented by unprepared teachers, an observation that can be linked to the findings in the Gilbert and Yerrick (2001) study.

Historical Explanations for African American Performances

Ogbu (1974) conducted an ethnographic study that focused on the educational beliefs and practices of Burghersiders, a neighborhood in Stockton, California. For the purpose of this study Ogbu denotes people of color as Blacks. The study was conducted from 1968 to 1970. Ogbu's goal was to study how the people in Stockton, including Burgherside, conceptualized their educational system and their place in it and how these conceptualizations influenced the way they behaved within the institution. Ogbu lived in Stockton for first 16 months of the study and during the final months he visited the city every other week for interviews which lasted from two to three days. When he did not reside in Burgherside, he spent most of this time visiting families, interviewing, or just observing and participating in activities. He attended social events and religious services and exchanged dinner invitations to gain a better perspective of how the people lived.

He interviewed approximately 225 Burgherside students in the fifth through twelfth grade mainly by means of questionnaires that dealt with family background, educational and occupational goals, influence of parents, teachers, and peer groups as perceived by the children, and the extent to which the children saw themselves or others as responsible for the type of work they completed in school.

African American students were thought to perform poorly in school not because they lacked basic intellectual competence or specific skills, but because of how they felt as related to their membership in society and how that membership shaped their behavior. Ogbu (1974) identified two primary forces that contributed to the academic success or underachievement of minority students; the minority groups' members' incorporation into American society and the patterns of adaptive responses the minority groups exhibit in response to the discriminatory treatment they receive.

Ogbu (1974) classified minorities into three types: autonomous minorities or voluntary, immigrant minorities, and involuntary minorities. Autonomous minorities, such as Jews and Mormons, are minorities in the numerical sense. These groups may experience prejudice but their cultural frame of reference encourages academic success. Voluntary minorities were those people whose ancestors came to America in search of better economic opportunities. Voluntary minorities can experience initial problems of adjusting to school, but their problems are not characterized by persistent adjustment difficulties or low academic performance. Involuntary minorities are those peoples whose ancestors did not choose to become members of this society. They suffered slavery, conquest, or colonization and were historically denied true assimilation into American society. African Americans and Hispanics generally comprise the involuntary minority category.

Ogbu identified four cultural and structural consequences for the status of Blacks as an involuntary minority: (a) differential status mobility; (b) cultural and intellectual derogation; (c) interracial conflicts; and (d) adaptive responses of Blacks. Differential status mobility refers to the shared method of getting ahead in a society within a given population. Blacks in Stockton were not able to compete freely for desirable jobs above the designated job ceiling. This exclusion affected the way that Blacks responded to schooling, resulting in Blacks having low expectations for future success. The economic and social disadvantages that surrounded them led many Black students to believe that their efforts in school would have little payoffs in terms of social mobility. The parents' social class was associated with parental participation, quality of instruction, school peers, teachers, and other influences have considerable influences on a child's educational outcome (Kao & Thompson, 2003). The perceived barriers imposed by a society that perpetuates inequality along race and class lines further communicated to minority students that there is little or no relationship between their efforts and eventual outcomes (Graham, Taylor, & Hudley, 1998).

Cultural and intellectual derogation was the second barrier that Blacks were subjected to in Stockton. Because of their low socioeconomic status, the community viewed them as non-taxpayers. The community defined non-taxpayers as incompetent and dependent people who made little or no useful contributions to the city. Blacks in Stockton were regarded as immoral, dirty, selfish, and not willing to improve their situation. Because many Blacks were on welfare, the White people in Stockton did not think that Black parents were capable of raising their children.

As a result of both the Black and White conflicts, there was a distrust of White people by the Black people in Stockton which was indicative of the third barrier, interracial conflict. Finally the last barrier identified by Ogbu, was adaptive responses. In Stockton, Blacks developed survival techniques in order to adapt to what they perceived as institutionalized racism. Ogbu called these survival techniques collective struggles. Examples of these techniques included boycotts and civil right protests, Uncle Tomming, and hustling. Uncle Tomming placed Blacks in a position of taking on the characteristics of Whites in order to get ahead. Hustling was a technique used for exploiting interpersonal relationships for material and non material benefits. Because Black Stocktonians believed that there was a Black way and a White way, the way to get ahead was not the same for Blacks and Whites. Furthermore hustling was a way for Blacks to work for themselves and not for the "White Man." Blacks did not believe that they could succeed by following the rules of behavior that worked for Whites, such as going to school. In Ogbu's study, local officials attributed low performance of Black students to parents' rural backgrounds, social class differences, and children's background, ranging from limited English proficiency to poor home environments.

Since schools in Stockton were in neighborhoods that were segregated, Blacks were in racially segregated schools with very few Black teachers. In his study, Ogbu observed subtle ways in which the schools contributed to the low performance of Black students. Teachers had low expectations and attitudes about the students. The teachers characterized the students into two groups: those who could and wanted to learn and those who can not or did not want to learn. The teachers named the students who could learn the Conscientious Work students, and the students who could not learn were known as the Sunday school students. The parent teacher relationship was characterized by distrust and negative attitudes. Teachers did not accept the parents' diagnoses of their children and the parents did not trust the teachers' diagnoses of their children. Additionally, the teachers did not believe that the parents were capable of understanding the academic problems of their own children (Ogbu, 1974). This rejection was not conducive for a positive academic setting.

Ogbu (1974) found that when he looked at report cards, the children at the elementary school continued to receive the same average mark through grade six. In the interviews Ogbu conducted, students revealed that they felt that a "C" was doing average and it was what everyone else in the neighborhood received. Both the teachers and the students felt that the other was the blame as to why the students were failing. The teachers indicated that the students failed in school because they did not attempt to do the work and were not serious about schoolwork. The students felt that the teachers did not teach them anything and there was a lot of repetition of work that they had received in earlier grades. In a related study, Atwater (2000) observed teachers who believed that if Black students can regurgitate words and facts found in the text book, they were learning science and if the students did not learn with this method, the teachers assumed that they were incapable of learning.

Ogbu's study discussed ways students are evaluated and how evaluations have great influences on children's academic work orientations and performances. When children are not rewarded on the basis of their performance, ability, or effort, it causes them not to associate earning higher marks with making greater efforts. Students also fail to develop proper work habits and performance strategies that help them earn higher marks. In a later study by Atwater (2000), she indicated that assessments should stress what students are capable of doing. Assessments should be free of bias, reflect what is being taught, diagnose problems, identify misconceptions of individual students, and measure the effectiveness of a teacher and curriculum. In the same study conducted by Atwater (2000), it should be noted that testing has been used to categorize, rank, sort, and separate Black students and if they fail, it is attributed to the Black student's inability to comprehend; and the school takes no ownership in Black students' academic failure (Atwater, 2000; Ogbu, 1974).

Kao and Thompson (2003) reported that most Blacks, Asians, and Hispanic youth had much higher aspirations than would be expected given their socioeconomic status. Black children learned about the job ceiling early in life from their parents and the media. They lived the consequences of the limitations that their parents had in terms of jobs and economic mobility. Black parents and Black students believed that an education would "better" them but often found it difficult to get that betterment. Their job preferences and aspirations indicated that most of them desired jobs requiring a good education because education pays off. However, Black students did not match their wishes and aspirations with effort. They perceived that their chances of making it, according to the mainstream strategy of using school credentials, were not as good as their White peers. This perception affected how they behaved in school. As such, Ogbu (1974) found that even though parents expressed a wish for a good education for their children, they did not instill appropriate attitudes and behaviors in their children to help them do better in school and their lives. This type of behavior was modeled by their parents and the adults in their lives. This clearly sent a powerful message that the connection between school success and one's ability to get ahead was weak. In a different study conducted by Graham (1994), it was revealed that Black parents were more likely to believe tht their children were doing well in school and would continue to do well even when their grades indicated otherwise. These actions resulted in parents placing fewer demands on children for extracurricular activities and in school academic activities and tended not to scrutinize children's day to day progress in school.

Ogbu's (1974) study revealed that teachers had low expectations for the students in Stockton. They were given low-level work that consisted of handouts and work that students were already exposed to. The students were not rewarded for effort or hard work as indicated by the grades that the students received. More specifically, low expectations and low work level was characterized in a study conducted in an Earth Science class Yerrick (2000).

Ogbu's study (1974) concluded that African American students want to do better in school, but structures within the school acted as barriers to achievement, which were low expectations and attitudes, low quality instruction, unfair testing and tracking and biased curriculum and textbooks. Ogbu also cited structures outside the school that acted as barriers to achievement. They were racially segregated schools, very few Black teachers, and inadequate resources. Although Ogbu's study was conducted in 1974, several studies have found the same conditions such as a lack of resources, unprepared teachers, low expectations from the teachers and inadequate facilities (Singer, Hilton, & Schweingruber, 2005).

Students who have been placed in low-level science courses faced many of the obstacles documented by Ogbu (low teacher expectations, handouts, teacher directed learning, and low level work). As a result, it is imperative for educators to use those instructional practices that promote learning and motivation, such as cooperative groups, allowing for choice, student centered instruction and tasks that provide challenges and practices that do not appear to be occurring in many Earth Science courses.

Learning Styles

Learning styles differences between cultural and school values might also explain poor performance reasons for African American students. Nichols (1976) theorized that in the African cultural group, learning is achieved through interpersonal relationships, which he termed Man-Man, whereas the European focus is on Man-Object, which dictates that the highest value lays in the object or in the acquisition of the object (land, work, time, etc.). According to Nichols (1976), Africans learn through symbolic imagery and rhythm and Europeans know through counting and measuring. From the European perspective, information is presented with parts numbered sequentially until the whole is presented. African American students must first see the whole, then the parts.

As cited by Nichols (1976), African American students need to be able to talk and socialize during classroom instruction to foster of interpersonal relationships. They need to be able to have the ability to make choices and take ownership of what they are learning. Choice and relationships are two tenets of the self-determination theory. Based on the axiology of Man-Man, a teacher of Black children must realize the importance of having a personalized relationship with each student. Teachers must be friendly and know the students in and out of school (Atwater, 2000; Brophy, 2004). If the child is not made to feel important to the teacher, then an environment for learning will not exist (Nichols, 1976). Similarly, Atwater (2000) stated that successful teachers of Black students believed that these students have great potential and that they expect them to achieve in the classroom.

In our schools, it appears that instruction that is more conducive to student learning is not occurring in the classroom. The structure of the typical classroom is passive, rigid, slow paced, and quiet. They consist of lectures; students are not allowed to interact with each other in the classroom, and learning is done in isolation, which is in contrast to how African American students learn (Gilbert & Yerrick, 2001). Furthermore, Singer et al. (2005) stated that students, regardless of their backgrounds, learn more when concepts are presented a variety of formats.

As it relates to this study, Atwater (2000) indicated that for African American students to be successful in science they must be allowed to disagree with each other in order to confirm their scientific understanding or to discard their ideas for a better understanding. Social interaction, allowing students to ask questions and generate solutions, are strategies that are cited by Graham (1994), Nichols (1976), and Gilbert and Yerrick (2001). These strategies promote academic achievement in African American students and are the same strategies that the National Science Education Standards (NSES) use to define inquiry (National Science Education Standards, 2000). Unfortunately, research evidence to support these learning styles assertions are lacking, however, a research base exists to support its recommendations as positive for all students, regardless of their ethnic background or achievement level. The next section will examine these instructional practices.

Research Based Instructional Practices

Inquiry. The National Science Education Standards (2000) defined inquiry as a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena. In doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories. Sandoval (2005), with the help of the scientific community, stated that inquiry refers to a process of asking questions, generating and pursuing strategies to investigate those questions by generating data, analyzing and interpreting and drawing conclusions and present their findings to the community. In summary, effective inquiry occurs when teachers say very little about the meanings of the concepts; the teachers use indirect rather than direct approaches; the students discover a large proportion of school science on their own and the students figure out for themselves how to come to terms with problems and construct knowledge while engaging in problem-based activities (Holiday, 2004).

Therefore inquiry, in part, is a state of mind of inquisitiveness and our challenge as educators is to create an educational system that exploits the natural curiosity of children so that they maintain their motivation for life-long learning (National Science Education Standards, 2000). The standards, which promote inquiry-based instruction, call for a pedagogical shift from teacher-centered instructional strategies to student-centered instructional strategies. Student-centered instructional strategies, which include collaborating with peers, discussing options, and formulating questions, engage students in socially interactive scientific inquiry and helps them to acquire a desire for life long learning.

Instruction that is characterized by inquiry and discussion of open-ended questions should provide academically challenging experiences, regardless of ability motivation, and academic track of the individual student. (Von Secker & Lissitz, 1999). If teachers are to successfully implement inquiry methods in their classroom, they need to provide a supportive learning environment where students receive help in generating questions that are important and interesting to them and guidance on how to develop strategies for investigating their questions. Brophy (2004), Graham (1977), and Nichols (1976) identified these strategies as effective in promoting learning and motivation. Engaging in inquiry helps students develop a deeper understanding of knowledge. Inquiry encourages students to build on knowledge and an understanding of what they already know.

Additionally, inquiry based learning is very beneficial to students in lower track classrooms. The teacher is moved from the position of total authority to one of a helper

(Yerrick, 2000). Inquiry also gives more control to the student with the teacher acting as a facilitator (Deboar, 2004). Inquiry based lab exercises have the potential to enable students to form collaborative social relationships as well as positive attitudes toward science and cognitive growth (Singer et al., 2005). When students are allowed to interact with their peers, it helps them to reflect and discuss their results. As such, valuing student experiences and questions conveys to them that their participation is important to the classroom discussion (Yerrick, 2000). Relationships and collaboration with peers and providing and receiving feedback are two of the components of the self-determination theory.

Two essential features of classroom inquiry are that learners learn to formulate explanations from evidence and to connect those explanations to scientific knowledge while promoting higher level and critical thinking skills (Songer, Lee, & McDonald, 2003). When we encourage students to create and build their own tentative working theories for problems being investigated, they are guided to trust their own voices rather than rely on the teachers' cognitive authority (Vermans, Lallimo, & Hakkarainen, 2005). By doing this, students are given choices and autonomous behavior is promoted. Deboar (2004) states that students learn more when they discover the learning themselves. Furthermore, the learning is more meaningful when students are allowed to have informal conversations with the teacher and other students. This process gives the student the opportunity to test and change thoughts and to assimilate what they have learned, which promotes competence. Allowing students to talk and interact and be social was also discussed by Brophy and Pintrich, (1996) and Nichols (1976), as effective motivational practices. Incorporating these strategies in the classroom allows students to experience autonomy, competence and relatedness, components of the self-determination theory.

All of these definitions have a central theme of engaging students in answering a question about a natural phenomena and developing a method to answer that question by engaging in scientific process skills of observation, inference, and experimentation. These practices should provide academically challenging experiences regardless of ability, motivation, and the academic track of the individual student.

The ability to formulate questions requires certain cognitive skills. Engaging students in inquiry requires accessing prior knowledge. It is found that students have trouble formulating questions because they lack prior knowledge or background related to what is being studied. They are confused about cause and effect events and lack the necessary skills to discern what is important or irrelevant when analyzing and interpreting data (Flick, 2004). It is essential that we provide opportunities to help develop cognitive skills in our students. The cognitive demands of inquiry include understanding the concepts as well as the processes of science (Flick, 2004). Sandoval (2005) felt that in order for students to understand inquiry as a science they needed to know that scientific knowledge is constructed by people in order to explain observations of the real world, that scientific methods are different depending on what is being studied, that there are different forms of scientific knowledge and that scientific knowledge changes as new observations or new competing ideas surface. This requires students to do more than to comment facts to memory. Franklin Bobbit, at the beginning of the last century, said that students need not only to remember facts but must develop the power to think and that their success in their ability to ask questions depends on their prior knowledge of the topic to be studied (as cited in Cuevas, Lee, Hart, & Deaktor, 2005).

If teachers are to successfully implement inquiry methods in their classroom, they need to provide a supportive learning environment where students receive assistance in generating questions that are important and interesting to them and guidance on how to develop strategies for investigating their questions. Dunbar (1993) found that by letting students generate their own explanations from their data instead of verifying a given hypothesis, they were better able to evaluate data more critically. Targeted instruction is needed for students to be able to synthesize their knowledge in order to give them a knowledge base to be able to engage in inquiry. One method is the explicit and reflective approach. Khishfee and Abd-E-Khalick (2002) recommended that students be introduced explicitly to the concept and provided with opportunities to analyze the activities from different perspectives; they should then map connections between their activities and draw generalizations. In this method the students are given background information and engaged in activities to reinforce that information. Students need practice in generating questions and opportunities to support cognitive skills important for understanding and using inquiry. Therefore inquiry methods that encourage students to formulate questions, build explanations, and make predictions lead to a strong and lasting conceptual understanding of scientific concepts (Songer et al., 2003).

In summary, inquiry based learning requires students to interact with one another, to formulate their own questions, to make predictions, and to develop strategies for investigating their questions. In other words, inquiry based instruction provides a shift from teacher-centered instruction to student-centered instruction. This shift suggests that classroom instruction practices should enable students to experience autonomy, competence, and related in the content area, all of which correlate to the tenets of self-determination theory.

Self-Determination Theory

The desire to master and be competent in interactions with the environment defines the self-determination theory (Cokley, 2003). There are three basic needs: autonomy, competence, and relatedness that motivate students (Deci & Ryan, 2000). Satisfaction of the three basic needs provides the necessary conditions that allow people the freedom to engage in a self-determined activity. Self-determined learning also promotes intrinsic motivation. The self-determination theory specifies that social settings promote intrinsic motivation when they satisfy the psychological needs of autonomy (self-determination in deciding what to do and how to do it), competence (developing and exercising skills for manipulating and controlling the environment), and relatedness (affiliation with others through pro-social relationships) (Brophy, 2004).

Autonomy. Student autonomy, according to Pintrich and Schunk (1996), refers to the degree of choice that students have about tasks and when and how to perform them. Brophy (2004) inferred that students experience autonomy when their input is valued and encouraged. In an autonomy supported classroom, the environment is one that facilitates independent thought and an understanding that there are multiple ways to solve a problem. The teachers in autonomy supportive classrooms, according to Valas and Solvik (1993), encourage students to solve problems in their own ways. They promote student initiative for asking questions and suggesting ideas for individual learning projects. Brophy (2004) suggests that autonomy is supported by creating opportunities for choice and encouraging students rather than being demanding. These teachers allow students to work in their own way, encourage questions, and help students understand the value, purpose of tasks, and activities that they have to participate in or complete.

Autonomy supportive teachers endorse responses that involve investigating and working from the student's perspective. They involve students in the process of learning by providing them choices. These teachers believe that it is important for students to learn to solve their own problems and provide opportunities for them to engage in such activities. Problem-solving techniques are promoted by encouraging student discussions. These are also characteristics of inquiry (Von Secker & Lissitz, 1999). Students tend to show more curiosity, desire for challenge, and confidence in their academic abilities when they have choice and are encouraged to define and solve their own problems. Brophy (2004) summarized that when teachers support autonomy, they promote intrinsic motivation by understanding the students' perspectives, support their initiatives, create opportunities for choice, be encouraging rather than demanding, and allow students to work in their own way. Giving students choices that are structured in a way that the students' choices are guided by interest promotes ownership. Feelings of self-determination are enhanced when there is support for selecting and planning activities (Ames, 1992). More specifically classroom structure and instruction that emphasizes choice rather than control enhances feelings of self-determination theory (Brophy, 2004).

In summary, autonomy supportive teachers tend to endorse responses that involve investigating and working from the students' perspectives. Autonomy supportive teachers see their role as facilitating independent thought by giving students choices. Students are, therefore, encouraged to solve problems in their own ways rather than insisting on a single method. Teachers listen more to their students about instructional materials, ask questions, and act on the students' wants. Teachers promote autonomy in students by promoting problem-solving techniques through the encouragement of students' discussions.

Competence. Competence needs are met when students can effectively deal with the environment and master and control things around them (Brophy, 2004). Students' competence needs can be supported by making sure that learning activities are well matched to the current level of the students' knowledge and skill. The learning activities should provide challenge in order to increase student motivation. The academic tasks should be designed to address various learning styles and provide opportunities for students to make active responses and receive immediate feedback. The learning activities should feature skill variety, task identity, task significance and components that make the activity enjoyable (Brophy, 2004).

When students expect themselves to do well, they tend to try harder, persist, and perform better. These students are much more likely to be motivated in terms of effort, persistence, and behavior than those students who believe they are less able academically and do not expect to do well (Linnenbrink & Pintrich, 2002). These confident students will be more cognitively engaged in learning and thinking than those students who doubt their capabilities. If students are consistently overestimating their capabilities, it is hard for them to change their behavior in the face of feedback that provides them with information about their weaknesses (Linnebrink & Pintrich, 2002). Students who believe they have more personal control of their own learning and behavior are more likely to do well and achieve at higher levels than students who do not feel in control. (Linnebrink & Pintrich, 2002). Inquiry learning promotes competence when students can formulate their own questions and desire to learn about particular phenomena. Furthermore, competence is enhanced in inquiry based learning when students are encouraged to use a variety of skills which also signals that there is no set way of solving a problem.

Finally, students are able to experience competence when students get frequent opportunities to respond actively, meaning they can interact with each other, manipulate materials, or do other things besides listening and reading. Competence is experienced when questions are posed so that students will be stimulated to discuss or debate issues, offer opinions about cause-and-effect relationships, speculate about hypothetical situations, or think creatively about problems (Brophy, 2004).

Relatedness. Relatedness reflects a need to belong or be attached to a group. These needs are assumed to be innate for all humans in all cultures and apply across all situations. The desire for affiliation reflects a need for attachment to others, paralleling the need for relatedness (Deci & Ryan, 2000). The need for relatedness can be satisfied in the classroom by allowing students to collaborate and interact with peers. Brophy (2004) suggested that teachers can respond to a students relatedness needs by establishing the classroom as a learning community. When the classroom is viewed as a learning community, there are opportunities for students to collaborate with their peers and to work in cooperative groups. In this setting, they tell and retell their ideas, solutions, and methods to their peers and receive and give feedback (Brophy, 2004). This discourse allows them to refine and adapt their thinking about the activity/question. Collaboration responds to the students' relatedness needs. These methods promote friendships and pro-social interaction among students who differ in achievement, gender, race, ethnicity, and handicapping conditions. In addition, they have positive effects on self-esteem and academic self-confidence.

When classrooms promote an interpersonal climate of collaboration, students are likely to experience enhanced intrinsic motivation while they participate in learning activities that allow them to positively interact with their classmates. Cooperative learning activities offer potential motivational benefits because they respond directly to students' relatedness needs, as well as potential learning benefits because they engage students in the social construction of knowledge. Brophy (2004) identified that classrooms should be structured as learning communities to promote relatedness needs. In doing so, relatedness can be experienced by students if they are provided opportunities that allow them to collaborate with each other and work in groups such as small groups or pairs. Students need opportunities to discuss and critique each others' ideas.

Intrinsic Motivation

To the extent that students experience classrooms that promote competence, autonomy, and relatedness, they are more likely to become intrinsically motivated (Deci, Vallerand, Pelletier, & Ryan, 1991). Intrinsic motivation reflects the behavior that the task is undertaken for the sake of doing it (Pintrich, 2003) and extrinsic motivation reflects on behavior or an activity that is done because of some external value or reward. This transition from extrinsic to intrinsic motivation occurs in stages. The first stage is external extrinsic motivation. This type of motivation is controlled by others or by external constraints such as rewards. The second stage on the continuum is referred to as introjection. At this stage, internalization of values starts to occur, but control is still external because the individual seeks approval from others. In identification, the third stage of extrinsic motivation, there is more internal control and self-endorsement of values and goals at this level. The final type of extrinsic motivation is called integration, which reflects high internal control and a high correlation with self, values, and goals.

In conclusion, inquiry learning and teaching satisfies the psychological needs of autonomy, competence, and relatedness. These three needs are considered critical to learning and motivation by the self-determination theory (Ryan & Deci, 1994). Promoting problem solving techniques by encouraging student discussion promotes autonomy and inquiry. When students are engaged in inquiry, they are encouraged to choose how to solve problems as well as determine what problems they wish to solve. Inquiry learning promotes autonomy because inquiry encourages students to create their own investigations about a particular phenomenon. Mirroring competence and relatedness are collaboration with one's peers and voicing and critiquing others' ideas (Dunbar, 1993) two major components of inquiry.

Inquiry encourages collaboration because students work together to solve problems. In an inquiry based classroom where the self-determination theory is being promoted, there are opportunities for students to collaborate and have input in what is being discussed. Therefore instructional strategies that are embedded in self-determination theory provide an avenue for enhanced learning and motivation.

Additional Related Research

Carole Ames (1992) identified six facets of the classroom that were conducive to student learning; (TARGET): task, authority, recognition, grouping, evaluation, and time. The academic task refers to the assignment, activity, or the work that students are asked to participate in or complete the assignment of their teacher. Academic tasks are what students are evaluated on and an indicator of mastery of the learning goals related to a particular subject. What students are asked to do (academic task) and how students perceive these tasks has a direct correlation to their motivation to participate in those academic tasks (Ames, 1992). Also, what students believe about their ability to complete a task is directly correlated to their performance.

In order to enhance motivation, Brophy (2004) emphasized that the task should be relevant, essential' and useful in attaining the desired learning outcome. The task should be challenging enough to extend learning but not so difficult to cause frustration or confuse the student. The task should be able to engage the student in critical thinking, inquiry, problem solving, and decision making, not just regurgitating facts and definitions (Brophy, 2004). Additionally, the task or tasks should be feasible enough to implement within the constraints of the classroom in which one must work. Tasks that are relevant, on the students' levels, and engage the students in problem solving are strategies the promote competence.

The authority structure of the classroom refers to whether or not the student has opportunities to assume leadership roles, make choices, and participate in decision making. Authority also refers to allowing students to engage in developing skills that help students to take responsibility for their learning (Ames, 1992). Allowing students to have a voice in establishing the priorities in task completion, method of learning, or pace of learning helps them establish responsibility. The classroom routines of teacher-lecture and student-listener can be replaced by learning activities where students take initiatives and play an active role. It has been found that when students are trusted and empowered in the classroom, their attitudes change, their work improves, and they develop ownership (Gilbert & Yerrick, 2001, Seiler, 2001; Slattery, 1995). Providing choices, leadership roles, and giving students an opportunity to set priorities in their methods of learning or the pace of learning also promotes autonomy.

The way students are recognized and grouped in the classroom sends clear messages to them about what is valued in the classroom. Positive feedback has been generally found to increase intrinsic motivation because it enhances perceived competence. Students benefit when they are recognized for noteworthy progress (Brophy, 2004). When students work in pairs or small groups, they can engage in the social construction of knowledge (Brophy, 2004), which is a factor of relatedness. This process allows students to have their ideas heard, challenged, and/or critiqued by their peers.

Evaluation in the classroom should focus on providing positive feedback to the students and not be a distinct aspect of the classroom life. This type of feedback or getting feedback is an integral factor of competence. Acknowledgement of the students’ progress or lack of progress on the task has a direct effect on their learning. Evaluation is accomplished by using a variety of criteria and methods. Students should have enough time to collaborate, interact and reflect with each other (Brophy, 2004). Finally, time should be flexible enough to allow students the full opportunity to complete tasks (Brophy, 2004).

Brophy (2004) emphasized that teachers should teach concepts that are worth learning in ways that the students appreciate the value of the activity. Students are not likely to be motivated to learn when engaged in pointless or meaningless activities such as continued practice on skills that have already mastered, memorizing lists for no apparent reason beyond a test, looking up definitions and copying definitions of terms never to be applied to more authentic situations, and working on tasks that are assigned to fill time rather than to accomplish worthwhile learning goals. These unmotivating strategies were found in Yerrick's (2000) study and Ogbu's (1974) study.

Research Questions

The National Science Education Standards (2000) indicate that if students are engaged in inquiry, they will learn science. Self-determination theory indicates that if autonomy, competence, and relatedness are satisfied, motivation will increase and cognitive learning can be achieved. Inquiry based learning satisfies those needs. If a science classroom is structured to utilize inquiry, students will have the opportunity to make choices, interact with one another, and utilize their autonomy.

Based on self-determination theory and inquiry, the following questions are asked:

1. If students are given an opportunity to participate in those activities that are thought to promote autonomy, competence, and relatedness, how will it affect their learning?
2. If students are given an opportunity to participate in those activities that are thought to promote autonomy, competence, and relatedness, how will it affect their motivation?

This study was designed to determine if students were placed in an environment that supported the tenets of the self-determination theory and inquiry, would they demonstrate positive learning and motivation profiles**.** The learning profiles included grades, a pre-test and a post-test on the Earth Science content and the Motivated Strategies for Learning Questionnaire (MSLQ) survey items on self regulation (monitoring, cognition, and planning) on the pre-survey and the post-survey. The motivation profiles included effort management persistence, test anxiety, intrinsic, challenge, importance, interest, and self efficacy survey items.

CHAPTER II

METHODS

Research Setting

Located in the southeastern region of the United States and founded in mid-1900s, Joseph LeConte High School (JLHS) was built during the time of segregation. It was built for the sole purpose of being the “colored or Negro” high school in the school system. Despite many efforts of the school system to integrate JLHS, the school during the time of the study had a 98% African American student population. JLHS is full of traditions and pride. Annually, thousands of alumni and friends attend the homecoming festivities, including the football game. There is a major homecoming parade in which various community organizations participate. The marching band is considered one of the best bands in the county. The football and basketball teams have made it to the state championships and the basketball team has won several state titles; the chess team won a state tournament. Many successful graduates serve in a variety of professional capacities internationally, nationally, and locally. The Alumni organization is very active with chapters scattered across the United States. Once a year the alumni gather at the campus for a national meeting. Nonetheless, despite its legacy and history, when it comes to academics, JLHS is among the lowest performing schools in the school system according to accountability measures.

Summer school at JLHS, as with all the high schools in the county, is offered to those students who failed a course during the regular school year, specifically biology, Chemistry, Algebra I, and /or English 9. Because of the time constructs and structure of summer school, students are eligible to take one class. The year that this study was conducted, JLHS offered Earth Science to its students. The summer session was held during the month of July and the students met Monday through Friday from 8:45 am until 1:30 pm. During that time they were given a 15-minute break and a 45-minute lunch.

Participants

Out of ten students enrolled in the Earth Science class, nine consented to participate in the study. All of the students enrolled in the class had taken Earth Science during the regular school year and failed (See Table 2). Two of the students had taken the class at least twice. The grade point averages (GPA) of the students enrolled in the class were in the range of 1.9-2.5. There were three males and six females, all of whom were African American except for one; he was a Hispanic student. Attendance of the students during the previous school year ranged from six days to 46 days absent. However, during the previous school year, all of the students except for two, indicted they skipped Earth Science three to four times a week. Three of the students were absent from school more than 40 days and two other students missed more than twenty days the previous school year. Three of the students were to be considered as freshmen when the 2006-2007 school year begins. The other six students would be sophomores. However, one student would probably be a junior, but because she failed many classes, she would not have the required credits to be a junior. Another student should be entering into her senior year; however, she only had enough credits to be a freshman.

Table 2

Student Information

Name	GPA	Class Rank	Membership*	Absent	Tardy	Total # of Credits	# of Times in ES	Age of Students	Grade 06-07
MC	.667	440/475	180	22	0	3	2	15.5	9
SH	1.5	420/524	180	22	2	4	2	15	9
TS*	.579	383/383	81	43	3	4	3	17	9
BS	2.0	354/524	180	6	10	6	2	15	10
HM*	1.3	452/524	180	6	10	10	3	15.5	10
LS	1.4	439/524	180	45	0	5	2	15	10
BR	2.5	228/524	180	0	9	7	2	15	10
DC	1.2	455/524	179	46	1	6	2	16	10
JS							2		10

*Membership is defined as the days that the student was enrolled in the school. The school year consists of 180 days.

All but two of the students had a class rank in the bottom 20%. One of the two students' ranking was in the bottom 38%, and the other one was in the bottom 57%. In order to be classified as a sophomore, students would have to have earned seven out of eight credits.

TS was a very angry student at the beginning of the course. Her membership at JLHS during the 2005-2006 school year was only 81 days and she missed 43 of those days. TS was ranked last in her class. Of the 43 days she attended, TS admitted skipping most of her classes. An African American female who would be classified as a sophomore when the 2006-2007 school year started, TS indicated she ran away from home and enrolled in several different schools; however, this information was not indicated on her transcript. She had only four academic credits, meaning she only passed four classes. She had not passed any of her required classes in order to be admitted into college. Her ambition was to "do hair", but she clearly did not understand what the requirements were in order to "do hair". TS said that she couldn't pass earth science in the past because the teacher did not teach the way she learned. She also indicated that the class was hard; therefore, she changed schools. This was the fourth time she had taken earth science. TS indicated in order for her to pass the earth science class, she needed for the teacher to help her learn and to teach her.

Having failed Earth Science twice, HM was taking the course for the third time. Still a sophomore, HM indicated she failed because she neither liked the teacher nor the class and she did not understand the work required. Her solution for passing the course this time was for the teacher to take it easy on the work. However, she did say that she was going to, "Try to try," this time. Though she just went through the motion, HM was very respectful and cooperative. In essence, she only wanted to finish high school. She never indicated any goals that she had for her life beyond secondary school. She just wanted to work or as she said, "get a job".

SH, an African American female who would be in the ninth grade again in the 2006-2007 school year, had a GPA of 1.5 out of 4.0. Her class rank was 420 out of 524.

SH had a total of five credits. Absent from school 22 days of school year, SH indicated she skipped school. SH also took ownership of her failure. While she offered no explanation as to what she needed from me in order to pass this class except, “I don’t know,” SH completed her work and academically was quite capable. She was very social and the other students in the class were easily influenced by her even though she constantly belittled them. In fact, she had no trouble completing assignments and would help her classmates with their work even though she did not treat them well. She had a very nasty attitude and was quite disrespectful to everyone in the class including me. SH did not view school as a necessity, for she believed that school was boring and that the teachers were more boring.

DC was a student who needed a lot of attention. At the time of the study, DC lived with her grandparents and three sisters. Her mother left her and her sisters because she was addicted to crack-cocaine; her father died two years ago. She failed two of her classes during the 2005-2006 school year and according to her, she failed because the teacher was boring and did not do anything but talk. DC demonstrated her disengagement by skipping school at least three times a week. Moreover, she was absent forty-six days during the school year. DC said in order for her to be successful in the earth science class, she needed a teacher who would help her with everything in the course and stay on her because sometimes, “I may slack off a little.” She also indicated that she was going to come to class this summer and give me her attention and try to understand. DC was very social about non-school related activities. School was not important to her and she would have rather been somewhere else instead of school. Even with her school disengagement, she had very high goals in life. More specifically, she wanted to become a forensic pathologist. While she enjoyed watching the television show CSI (Crime Scene Investigation), she did not fully comprehend the academic preparation required to work in the field of forensics.

BS failed earth science during the school year because she did not attend class. She attended school regularly, having only six absences for the entire year. With a 2.0 G.P.A., BS took sole ownership for her failure and said there is nothing that the teacher could do to help her pass the course this time because she stated the she has to do it herself. Very talkative especially on topics unrelated to earth science, BS was usually on task with the lesson, able to communicate her thoughts, and passionately defend them. Her ambition was to be a lawyer, but like DC, she did not fully understand the academic requirements of entering law school. She believed however, that she could be a lawyer because she liked “to talk.” BS lived with her grandmother and mother and other siblings.

LS, a sophomore African American female with five credits, a GPA of 1.4, and a class rank of 439 out of 524, had a total of 45 absences during the previous school year. She failed two classes during the 2005-2006 school year. Lacking academic focus, LS admitted that she did not contribute to passing her earth science course or other courses for that matter. She also stated that the teacher was boring; therefore, she skipped class. LS recalled that the teacher told the students in the class all the time that they were failures and that she had her education and they needed to get theirs.

BR is one of three males in the class. A sophomore whose GPA was 2.6 and class rank was 228 out of 534, BR admitted he failed earth science because he kept falling asleep in class and did not pay attention. He enjoyed reading and would read the textbook instead of focusing on the tasks in the summer earth science course. BR was the only student in the class who participated in extracurricula activities during the school year. He played football and looked forward to doing so again in the coming school year. BR wanted to become an artist if he did not make the National Football League. He interacted well with the other members of the class and all of the students felt that he was smart. In fact, they thought BR was the smartest one in the class. He contributed to class discussions and completed all tasks assigned.

With only three credits and still classified as a ninth grader, MC had a GPA of 0.667. He skipped all of his classes often according to the assistant principal. He had many discipline problems and was suspended several times during the school year. He had a total of 22 absences. MC is not ranked in his class. He has not been identified as an exceptional children's program student, but his skills in reading and writing skills were low. It was hard for him to focus when he had to take notes and he would get very frustrated when working on tasks that required him to write. MC wanted to become a professional basketball player. Ironically, he was not on the basketball team and was rather short in stature. Nevertheless, he indicated that he was so good that he would be recruited from the streets.

JS, a Hispanic student who was very quiet, was not formally enrolled at JLHS. He only attended summer school. This was his second time taking earth science. He was reluctant to work with the students at first but eventually came around. He completed all tasks and was very capable of doing the work. He participated and contributed to the class discussions and group discussions.

Format of the Course

Introduction of the Course

To begin with, on the first day of class the researcher conducted an introductory activity that was designed to introduce the students and teacher to one another and to introduce the topic of Earth Science. The students created a bubble map with Earth Science in the middle bubble; the four other bubbles surrounding were filled in as the class progressed. In a brainstorming session, the students had two minutes to discuss what they thought Earth Science was. After the time was up, the students took Post-It notes and listed as many descriptive words on the post-it notes to describe what Earth Science was. The students categorized their Post-It notes and placed them on the poster boards under the correct branch of Earth Science. Four poster boards each with a different branch of Earth Science were placed around the classroom. Each group was given a completed poster board to facilitate a discussion with the class. At that point, the students had to introduced themselves orally and tell what they knew about Earth Science. The students spoke about what was on their poster board and if what was there was on the appropriate board or if it was better suited to be on one of the other boards. Once that activity was completed, the students as a whole group filled in the rest of their bubble map as the class discussion continued.

After the introductory activity was completed, I explained that they were going to satisfy the requirements of Earth Science and I invited them to participate in the study. I explained to the students what motivation was and the self-determination theory in terms of autonomy, competence and relatedness. As participants in this study, I explained to the students what I needed from them in terms of their honesty and cooperation. Meanwhile, Mr. Shirley came in and read the assent to act as human subjects (see Appendix A). Mr. Shirley gave each of the students a copy to sign. Once Mr. Shirley completed the protocol, the students completed a data sheet (see Appendix B).

The purpose of the data sheet was to provide demographic information and give insight on the following questions: Why they did not pass Earth Science previously; and what is it that I can do as their teacher to help them pass this time. The students were given permission slips to take home and get their parents to sign and return the next day (see Appendix C).

When the introductory activity was completed, the pre-test was given (see Appendix D). I explained to the students why they were taking the test and how the results would be used. I strongly stressed to them that they would not be penalized and the results would be used to help structure the class and determine at the end of summer school if they learned and how much they learned as a result of this class. Afterwards, the students and I looked at the standard course of study (SCOS) and the textbook to collaboratively choose the order of the topics they wanted to focus on during the summer school class (see Table 3).

Finally, the students were given a copy of the Motivated Strategies for Learning Questionnaire (MSLQ) survey. I explained to the students what the instrument was and how to mark their answers. I answered questions about the students’ understanding of the questions before they started. The students were given as much time as needed during the class period to complete the instrument.

Table 3

Students' Chosen Topics

Topic		
Minerals	Earth's Resources	Weathering
Wind	Earthquakes	Glaciers
Ocean Life	Earth's History	Deserts
Volcanoes	Solar System	Climate
Sea Floor	Clouds	

Note. Topics were chosen at random.

Daily Format of the Course

The course was designed to provide opportunities for students to experience autonomy, competence and relatedness. In every class, the concepts, chosen by the students (see Table 3), were introduced in the form of a demonstration, story, and/or some type of activity. The lessons were introduced in a variety of methods. Each day the students engaged in some form of note-taking. The methods consisted of role playing situations that the students could relate to, demonstrations, and observations. The students' notes could be in the form of a graphic organizer or the traditional method. As the students completed their note-taking, the concepts were discussed in small groups as well as with the whole class.

Also, part of the daily format was that the students participated in an activity that required them to be partnered or in a group. Assessments were done in a variety of ways. Assessments were given to determine if the students had developed understanding and mastery. Students were assessed orally during class discussions. Their written work which was in the form of quizzes, tests, lab write ups, and lab completion was formally assessed where they received a numerical grade and graphic organizers/notes were informally assessed where they received a check or check minus. I made a point to ask specific questions to each individual student during every class. The labs and activity sheets were graded as individual work and group work. As the researcher, I evaluated daily participation and classroom input by giving students tally marks.

Measures

Self-Determination Measures

The self-determination theory addresses students' autonomy, competence, and relatedness. The need for autonomy reflects a desire to be in control or to feel autonomous or self-determining in terms of one's own behavior. Student autonomy refers to the degree of choice that students have about the tasks and when and how to perform them. Competence occurs when activities are matched to the students' current level of knowledge and skill. Competence is supported when students get frequent opportunities to respond actively, meaning they can interact with each other, manipulate materials, or do other things besides listening and reading. Relatedness occurs when students have opportunities to interact with their peers in the classroom for the purpose of refining and rethinking information presented to them. It is also promoted when students can work in cooperative groups or pairs.

To measure these three connections-autonomy, competence, and relatedness-the students were given a set of autonomy, competence, and relatedness (ACR) cards in which contained questions under each dimension, to respond to after completing the instructional activity each day. Table 4 lists the questions for each of the dimensions. The students' responses to the ACR cards the students' gave perspective on the activities, classroom structure and their learning. Student responses to the ACR cards provided evidence to the extent to which students believed that they had opportunities to demonstrate autonomy, competence, and relatedness.

Learning and Motivation

Motivated Strategies for Learning Questionnaire (MSLQ). The students completed a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991) (see Appendix E). This instrument was originally designed to assess college students' motivational orientation and their learning strategies. The two scales on the survey, learning and motivation strategies were scored on a seven-point Likert scale, from 1 (not at all true of me) to 7 (very true of me) (see Table 5).

The learning strategy section of the MSLQ addressed the students' use of different cognitive and metacognitive strategies. There are three general processes that comprise metacognitive self-regulatory activities: cognition, monitoring and planning. Regulating refers to the fine-tuning and continuous adjustment of the students' cognitive

Table 4

Autonomy, Competence, Relatedness Cards

Question	Autonomy	Competence	Relatedness
1	What choices were I given in class?	What did I learn today?	What did you feel about the assigned tasks?
2	What type of input did I have in class today?	What type of feedback did I receive today?	Describe your interaction within the group or partner.
3	How was I encouraged to complete the tasks assigned today?	How were my thoughts acknowledged?	I like working with another student . . .
4	What contributions did I make to the day's discussion?	How was I able to demonstrate in class what I learned?	What is the importance of your peers' input?
5		Did you enjoy working on the assigned tasks? Why or why not?*	How would you interpret the feedback that you received today?
6		Explain how the tasks done today were relevant for this class.	

*Not used in the scoring

activities. As such regulation activities are assumed to improve performance by assisting learners in checking and correcting their behavior as they proceed on a task. Monitoring activities include tracking of the students' attention to what they read, self testing and integrating it with prior knowledge. The planning activities help activate or prime relevant aspects of prior knowledge that make organizing and comprehending the material easier.

Table 5

MSLQ Instrument

Construct	Survey Items
Self Efficacy	2. Compared with other students in this Earth Science class, I expect to do well. 6. I'm certain I can understand the ideas taught in this Earth Science course. 8. I expect to do very well in this Earth Science class. 9. Compared with others in this class, I think I'm a good student. 10. I am sure I can do an excellent job on the problems and tasks assigned for this Earth Science class. 12. I think I will receive a good grade in this Earth Science class. 13. My study skills are excellent compared with others in this class. 15. Compared with other students in this class I think I know a great deal about Earth Science. 16. I know that I will be able to learn the material in this Earth Science class
Intrinsic/ Challenge	1. I will prefer class work that is challenging so I can learn new things in Earth Science.
Intrinsic / Importance	4. It is important for me to learn what is being taught in this Earth Science class. 7. I think I will able to use what I learn in this Earth Science class as well as in my other classes. 18. Understanding Earth Science is important to me.
Intrinsic/ Interest	5. I like what I am learning in this Earth Science class 14. I think that what we are learning in this class is interesting
Test Anxiety	3. I get so nervous when I have to take a test I cannot remember the facts I have learned in this class 11. I have an uneasy, upset feeling when I take a test in Earth Science. 17. I worry a great deal about tests. 19. When I take a test I think about how poorly I am doing.
Self Regulation/ Monitoring-Cognition	20. I ask myself questions to make sure I know the material I have been studying. 27. When I'm reading I stop once in a while and go over what I have read.
Self Regulation/ Monitoring	25. I often find that I have been reading for class but do not know what it is all about 26. I find that when the teacher is talking I think of other things and do not really listen to what is being said
Self Regulation/ Monitoring-Planning	24. Before I begin studying I think about the things I will need to do to learn.
Self Regulation/ Effort Management Persistence	21. When work is hard I either give up or study only the easy parts. 22. I work on practice exercises and answer end of chapter questions even when I do not have to. 28. I work hard to get a good grade even when I do not like the class.

The motivation section assessed the students' intrinsic goal orientation, which included intrinsic challenge, intrinsic importance and intrinsic interest, task value, self-efficacy, effort management persistence, and test anxiety.

Intrinsic goal orientation refers to the students' perception of challenge, interest, and importance of the task in relation to the course as a whole. Its emphasis is on the degree to which students perceive themselves to be participating in a task for reasons such as challenge, curiosity, and mastery. It answers the question, "Why am I doing this?" Having intrinsic goal orientation towards an academic task indicates that the students' participation in the task is an end all to itself, rather than participation being a means to an end.

Task value or importance refers to the students' evaluation of how interesting, how important, and how useful the task is. It answers the question, "What do I think of this task?" Task value refers to students' perceptions of the course material in terms of importance, interest, and utility. Importance or attainment value refers to how important it is for students to do well (Pintrich & Schunk, 1996) and how important it is for students to attain success in order to affirm their self concept or fulfill their need for achievement power or prestige (Brophy, 2004).

Interest value is defined as the enjoyment people experience when doing a task (Pintrich & Shunk, 1996). Attention to a learning activity because the learner values or has positive affective responses to its content or processes is a focus of interest value. Interesting activities provide learners with opportunities for responses that they find rewarding and wish to continue (Brophy, 2004). Interest is enhanced when applications or connections are made between the content and the students lives (Brophy, 2004).

Brophy (2004) identified two types of interest; situational interest and individual interest. Situational interest emerges when something in the situation catches one's attention and motivates one to focus on it and explore it further. In contrast, individual interest refers to an enduring disposition to engage in a particular task or activity whenever the opportunities arrive. It is directed at a specific activity or topic in contrast to curiosity (Pintrich & Schunk, 1996). Motivation is increased when instructional goals include strategies that incorporate content that students find interesting or activities that they find enjoyable (Brophy, 2004).

Self-efficacy perceptions are defined and assessed with reference to the capabilities needed to succeed in particular achievement situations (Brophy, 2004). Bandura (1997) defined self-efficacy as "people's" judgments of their capabilities to organize and execute courses of action required to attain designated types of performances. The self-efficacy component of the survey assessed two aspects of expectancy. They were expectancy for success, which refers to performance expectations, and relates specifically to task performance, and self-efficacy, which includes judgments about the students' abilities to accomplish tasks as well as the students' confidence in their ability to perform the tasks.

Effort regulation falls under the heading of effort management persistence, which is self management and reflects a commitment to completing one's study goals, even when there are difficulties or distractions. Effort management is also important to academic success because it not only signifies goal commitment but regulates the continued use of learning strategies.

Test anxiety is thought to have two components. These components are a worry or cognitive component, and an emotionality component. The worry component refers to students' negative thoughts that disrupt performance, while the emotionality component refers to the affective and physiological arousal aspects of anxiety. Also the worry component refers to the students worrying about failing a test, or the consequences of not doing well, or thinking about being embarrassed about the low grade. In contrast, the emotional component refers to the actual physiological and emotional arousal that individuals experience as they take a test, such as sweaty palms, upset stomach, faster than usual heartbeats, or fear and a general uneasiness (Schunk, 1996). Depending on the level of the anxiety, it can prevent students from trying. Schunk (1996) indicates that test anxiety is more likely to occur in low achieving students but does occur in average- or high-achieving students as well. It is important that teachers use strategies such as announcing the test in advance, avoid time pressures, stress the feedback functions rather than the evaluation or grading functions of tests, be friendly and encouraging when administering the test, and teach students stress management skills and effective test taking skills and attitudes (Brophy, 2004).

Interview—Pre-Survey

Each of the students who completed the MSLQ survey participated in a one-on-one interview. The interviews were conducted in locations of the students' choice. Some of the students chose restaurants while others chose the school. The interview questions were taken directly from the MSLQ survey. I asked the students to explain why they ranked themselves on the MSLQ the way that they did and explain why they answered the question the way that they did. The students’ responses were recorded and the questions were assembled according to the subtopics (see Appendix F).

Field Notes

I manually recorded students’ conversations and interactions related to autonomy, competence, and relatedness during class sessions. I later summarized the classroom activities and how they related to the research study at the end of each day. The field notes were coded by using a tally to mark if what I observed or heard was related to autonomy, competence and or relatedness. For example, my summary for the first day included a statement made by one student She indicated that she wished that her other teachers would have let them choose what they wanted to learn. I coded that as autonomy.

Content Assessment

To measure the students’ learning, they were given a pre-test and a post-test (see Appendix G) on content learning. The pre-test, developed by the writers of the textbook *Earth Science* (Tarbuck & Lutgens, 2006), was administered on the first day of class. The textbook writers referred to the pre-test as a screening assessment. It was designed to identify students’ weaknesses and skills in basic science knowledge. I used it to determine what the students retained from being previously enrolled in Earth Science. The pre-test consisted of sixty questions that correlated to the three content standards set forth by the National Science Education Standards (NSES) as well as the Standard

Course of Study for Earth Science (see Appendix H). The NSES content standards are Science as an Inquiry, Physical Science, and Life Science. Table 6 lists the standards that were covered on the assessment.

Table 6

Earth Science Content Standards

Standards	Questions
Content Standard A: Science as Inquiry	
• Abilities necessary to do scientific inquiry	1,4,18,21
• Understandings about scientific inquiry	4,31,32
Content Standard B: Physical Science	
• Structure of Atoms	5
• Structure and properties of matter	6,7,39,43
• Chemical Reactions	48
• Motions and forces	11, 12, 13, 36,37,44, 46,56
• Conservation of energy and increase in disorder	45,50.58
• Interactions of energy and matter	15,25,26,30
Content Standard C: Life Science	
• Interdependence of organisms	29, 33
• Matter, energy and organization in living systems	19, 20
• Behavior of organisms	52,53
Content Standard D: Earth and Space Science	
• Energy in the Earth Science	2,9,22,27,38
• Geochemical cycles	10,40,41,51,60
• Origin and evolution of the Earth system	3,8,28,34,49,54,57
• Origin and evolution of the Universe	17,23,24,35,47
Content Standard E:	
• Understandings about science and technology	42,55,59
Content Standard F:	
• Environmental quality	16

Chart: National Science Education Standards

The questions on the test consisted of questions on knowledge (17 questions), comprehension (18), application (17), and synthesis level (6) as defined by Marzano, (Communities Resolving Our Problems., 2001). Seventeen of the questions required students to refer to a diagram, pictures, and/or a chart/graph. An answer key was provided and the questions were marked either right or wrong and the correct score was converted to a 100-point scale.

Since this was a summer school class and the students were already exposed to the Earth Science content, there was some latitude in what was taught. Initially, the students chose the curriculum topics which were to be covered in class. However, because of time constraints, we only covered minerals, earth's resources, and weathering (see Table 7).

Table 7

Topics Covered

Main Topic Chapter	**Introduction to Earth Science (Chapter 1)**	**Minerals (Chapter 2)**	**Earth's Resources (Chapter 4)**	**Weathering, Soil, and Mass Movement (Chapter 5)**
Sub-Topics	What is Earth Science? A View of the Earth What is Scientific Inquiry?	Matter Minerals Properties of Minerals	Energy and Mineral Resources Alternate Energy Sources Water, Air, Land Resources Protecting Resources	Weathering Soil Mass Movement

The post-test served as the students' final examination and was created from a test bank. The test bank was supplied with the textbook supplemental materials (Tarbuck &

Lutgens, 2006). The exam consisted of only questions that came from what was taught in class. The final exam consisted of 108 questions. Eighty of the questions were multiple-choice; specifically, 21 were completion, and seven were short-answer questions. Sixty of the questions were on the knowledge level, 42 of the questions were at the comprehension level and 13 of the questions were at the application level. The students were given the entire class period to complete the test. The test was scored by marking the questions correct or incorrect according to an answer key. The correct answers were converted to a 100-point scale.

Procedure

Throughout the summer school course, students participated in activities that were intended to promote the students' sense of autonomy, competence, and relatedness. In order to determine if the students were experiencing autonomy, competence, and relatedness the students completed autonomy and competence cards at the end of class each day and the relatedness cards were completed approximately three to four times each week. The students answered the questions based on the activities, discussions, and topics that were covered/completed in class that day. Daily instruction was modified based on their response as well.

A total of 86 autonomy/competence (AC) cards were completed and a total of 59 relatedness (R) cards were completed by the students. When coding the autonomy, competence, and relatedness (ACR) cards, if students gave positive responses, it demonstrated that they had the opportunity to perceive that activity as providing them with autonomy, competence, and/or relatedness. If students gave a negative response to the questions, it demonstrated that the students did not perceive the activity as providing them with autonomy, competence, and/or relatedness. For example, a positive coded response was cited as the following: SH said, “I learned about mechanical, chemical weathering, how to make chalk melt down, and I learned about frost wedging. On the other hand, a comment that was coded as negative was as follows: When students were asked what choices they were given in class, BS wrote, “I wasn’t” (given any choices). DC wrote, “Not really” (given any choices).

To determine inter-rater reliability, an external auditor and I coded 50 responses and were in agreement 95% of the time. The researcher completed coding the other responses. There were 99 responses on the ACR cards per each dimension; autonomy, competence, and relatedness. Overall, students responded positively in 85%, 89%, and 87% of those questions respectively. All of the students responded positively at least 75% of the time.

Role of the Researcher

I, as the researcher, have played many roles at JLHS. My first encounter at JLHS was that of a volunteer in a Biology class during the 1991-1992 school year. At that time, I was in the process of becoming certified as a Biology teacher and it was suggested that I volunteer in Mr. Jones’ biology classroom at JLHS. As a mother of three children, all of whom attended and graduated from JLHS from 1993 until 2000, I was active in the PTA as president, vice president, and PTA membership chairperson. In 1998, I became a faculty member at JLHS in the role of the Director of the Math, Science, & Technology Academy and held that position until the end of the 1999-2000 school year. At that point, I became an assistant principal and remained in that position for two years. The graduating class of 2005 consisted of the last group of students with whom I would have the professional opportunity to interact. My first contact with the students in this study was on the first day of the summer session.

During the time the study took place, my role as teacher and researcher were explicitly delineated as much as possible. It is important to note that while I intentionally and consciously attempted to remain objective during the time of the study, I could not totally detach myself from the participants; after all, I was their teacher. As the teacher, I taught the class using instructional strategies designated as part of the study. While class was in session, I made mental notes which were later transcribed into field notes and I made talley marks that noted if questions asked by students and portions of conversations with students provided clear evidence that students perceived autonomy, competence, and relatedness relative to the assignment given. During breaks, lunch periods, and immediately after school, I recorded in my field notes observations made by students and me, as well as conversations with students pertaining to the study. During the analysis of the data, I played the role of researcher, carefully triangulating the data to assure correct interpretations.

Trustworthiness of the Study

The trustworthiness of the study is based on the quality of the investigation and the credibility, transferability, dependability, and the conformability of the inquirer's interpretation of the data collected (Stake, 2005). In this study, the following techniques were used to ensure trustworthiness: triangulation and member checks.

Triangulation is a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation. It checks the inferences that are drawn and uses multiple data sources, multiple theoretical perspectives or multiple methods (Schwandt, 2001). Data in this study was obtained from a survey, a one-on-one interview with individual students, classroom observations, classroom assignments, ACR cards, and oral and written products. The one-on-one interviews were conducted in order to give meaning to survey responses. Classroom observations were used to provide additional clarity to ACR cards and how students were learning.

Member check is a procedure for corroborating or verifying findings and of ensuring that the findings are valid and meet criterion of conformability. Member check was used throughout the study in order to clarify students' responses on the survey as well as the ACR cards. Although students did not read my summary notes, I did ask students to further explain or change the wording to convey their true feelings or thoughts.

CHAPTER III

RESULTS

The purpose of this study was to determine if students' learning and motivation would improve if they were placed in an environment supported by the tenets of the self-determination theory and inquiry. The following research questions were addressed: (a) If students are given an opportunity to participate in those activities that are thought to promote autonomy, competence, and relatedness, how will it affect their learning? and (b) If students are given an opportunity to participate in those activities that are thought to promote autonomy, competence, and relatedness, how will it affect their motivation? The first section focuses on what I did to establish the instructional context where students had frequent opportunities to experience autonomy, competence, and relatedness.

Instructional Context: Autonomy, Competence, and Relatedness

The summer school class consisted of 15 daily sessions that lasted 4.5 hours each day. To provide opportunities for autonomy, competence, and relatedness in each class, per day there were approximately two hands-on activities, a teacher presentation, and opportunities for discussion and some form of assessment. Depending on the topic or activity, the students were assessed orally by quizzes and/or written products such as lab write ups, graphic organizers, and activity sheets. In the following paragraphs, I will give examples of how autonomy, competence, and relatedness were promoted when I taught alternative forms of energy, weathering, and the protecting of natural resources.

Alternative Forms of Energy

To help the students understand the concepts associated with alternative forms of energy, the students completed a graphic organizer, created games, and made a solar cooker. The class started with an introduction of the different forms of alternative energy sources (solar, nuclear, wind, hydroelectric, geothermal, and tidal). I listed the six different alternative forms of energy on the board and the students completed a flow map. The students gave examples /information about each form of alternative energy and students were asked individually to tell the class their thoughts about each form. This was done to determine what they thought they knew and if what they knew was accurate knowledge. As the discussion continued, all of the students completed a flow chart on the different alternative forms of energy. Afterwards the students chose to create jeopardy and a hangman game. Because the students worked in groups using their graphic organizers to create questions for both of the games, their choice to create games help to support competence and relatedness.

Under autonomy, the students indicated on the ACR cards that they enjoyed making the games and choosing the topics to be discussed. The students enjoyed doing anything that allowed them to talk and associate with their peers. Most of the students made contributions to the discussions and helped with the activities by helping their peers in their groups. Even though the students put on a façade of toughness, they thrived on affirmation and encouragement. It was essential for me to tell them that they did a good job and that they could do better or that they had more knowledge about Earth Science than they previously thought. The students voluntarily made contributions to the activity by answering questions and giving their own opinions about the tasks.

Competence was promoted in this activity because the students demonstrated their knowledge when they created the questions for the game and participated in the games. From field notes, I observed that the students were very competitive but they were encouraging of each other to answer questions. The students wanted a winner and a loser and would become very upset if they thought I was ruling unfairly. They wanted to answer the questions. The students worked very well together as they encouraged the members on their team. The students would become upset, however, if the team member who was to answer the questions provided the incorrect answer. While preparing for the game, as a group the students set their rules and decided who would be team captain and game host. The students agreed they learned about fossils, tar sands, alternative energy, oil, natural gases and petroleum. The students also perceived their thoughts were positively acknowledged. One student, SH, described how she believed the teacher recognized what she was saying by stating, “because of my responses to the answers they gave.”

There were several opportunities for the students to experience relatedness. They worked as a group to create questions for the game. As the game progressed, each team collaboratively worked to come up with the answer. The students expressed that working with a partner was good because they did not have to work in isolation. They also demonstrated that their peers' input was important especially if the students perceived their partners knew what they were doing.

To further promote autonomy, students were given a choice as to which alternative form of energy they would like to explore further. The students were very interested in solar energy and wanted to find evidence that would show usage of the sun as an energy source. I gave them several examples of solar energy usage and asked the following question, "Have you ever heard the old folks say, "It is so hot outside you could cook an egg?" The students agreed they had heard the statement and wanted to do or make something that could actually use the sun's energy to cook something. As a result of the class discussion, the students decided to make a solar cooker. They wanted to use the solar cooker to cook hotdogs. In preparation for the activity, they decided to bring chips and drinks to go with the hotdogs. The students perceived autonomy as a result of their choices of the activities.

To evaluate student competence, different questions were asked to determine their knowledge of solar energy and the other alternative forms of energy. A quiz and their graphic organizers/notes were checked for completion. Relatedness was supported because the students collaborated in groups about what and how they needed to construct the solar cooker as well as helping each other to complete their individual solar cookers. On the day that we used the cookers, students were given opportunities to experience competence because they had to know how to position their cookers to get optimum sun rays. They experienced autonomy and relatedness because they helped each other and decided to experiment with different areas of the school campus to place the solar cookers.

From the results of the ACR cards, the students perceived autonomy. One of the questions that the students were asked for autonomy was to describe what contributions they made to the day's discussion. One student's (BS) response to the solar cooker activity was, "I talked out loud and showed my peers the difference between my box and theirs." Talking out loud meant that she was able to explain how she constructed her solar cooker to her peers while she physically helped them complete theirs. The students were very excited about making their solar cookers. BS, another student, was able to construct her solar cooker on her own. She took the lead and helped the other students who were having difficulty. MC had to redo his solar cooker and became very frustrated at the process; BR stepped in to assist him and kept encouraging him. Another student, TS, responded, "Played with the hot dogs." Her playing was manipulating her solar cooker to the right angle for optimum sun exposure.

A competence question based on the feedback that they received that day elicited positive responses from the students except from BS. She indicted none. I asked her why she indicated none; her reply was "I do not know." I asked her if her classmates thanked her for her help? I asked her if she remembered that I said she was doing a good job and that I needed her to be my helper. Her response was "Yea, that's right." TS stated, "Good job. The sun is hitting the spot." TS's hotdog was showing evidence of sweating and blistering. TS smiled. In fact, TS was amazed at this process and that the sun was really cooking the hot dog. TS was not used to success in the classroom, but not because of her inability to succeed. Other responses were “positive” and “a good job.”

The students were asked to respond to their interactions within the group or with a partner to judge their perception of relatedness. Their responses (HM, SH, LS) to this as it related to the solar cooker activity was, “It was fun,” “We worked well,” and “Good.” When I asked HM about her statement, “It was fun to”, she elaborated that it was fun to be able to be outside, work with everyone and make sure that everyone was able to get their hotdog cooked. Another question; What is the importance of your peers’ input? yielded the following responses from TS, “Because you should want to hear their input” and “to help understand the information better.” SH indicated that “sometimes the people in your group can say things that you forgot or wasn’t thinking about.” TS further explained that “your friends talk the same language as you and can break it down to your level.”

Weathering

Another topic that was chosen by the students was weathering. To introduce this topic, the students were given pieces of sandstone to touch. Once they touched the stones, they had to pay close attention to what happened as a result of handling the stones. As a whole-group, we discussed their observations and I related what happened as a result of them touching the stones to weathering. As a result of this activity, I was able to introduce the two types of weathering- chemical and mechanical. To further promote an understanding of chemical and mechanical weathering, the students completed two labs and a neighborhood walk to observe chemical and mechanical weathering in the natural environment. In all three of these activities, the students were provided opportunities to take notes, engage in hands-on activities, collaborate with their classmates, participate in a class discussion, and present their completed tasks to the group.

For the first lab, students created a simulated form of mechanical and chemical weathering. To simulate mechanical weathering, students were given a Ziploc bag, two graham crackers, and vinegar to simulate chemical weathering. They were instructed to place the graham crackers in the Ziploc bag and shake it. The students took notes on what they observed and answered questions connecting what they did to mechanical weathering. For the second part of this lab, the students were given another graham cracker and vinegar. They used a medicine dropper to drop vinegar on the cracker. Again they recorded their observations and answered questions relating their actions to chemical weathering. The students worked with a partner to complete the lab and the lab activity sheet. They took notes and completed a graphic organizer after a brainstorming activity. According to the ACR cards, all of the students experienced autonomy as a result of this activity. SH felt she contributed to the discussion and said, “It was a good one. I talked about the graham crackers and about all different types of soil.” HM indicated that she was able to put in her opinion. BS said her contribution was that she was able to help LS with her questions, where as LS said her contribution was to “answer questions and did [do] my work.” Classroom observations revealed that the students were excited about working in the lab. The students made remarks such that they would have done better in their old class if their teacher would have done things like this. Students were also able to correlate the breaking up the graham crackers to that of mechanical weathering in the real world.

In addition, the students responded positively to the competence questions. When questioned on what they learned in class about weathering, HS replied that he learned “about the characteristics of mineral, soil, the composition, texture, slope, organism, formation, time and climate.” All of the students related that they received positive feedback except DC who indicated, “I do not know.” It was essential for the students to be praised and encouraged because the student would get off task. It was apparent that they were not in other classes. DC indicated that in her other Earth Science class, the teacher told them that “She did not care if they learned or not, because she “had hers.” The students sought out approval from their classmates and me. I was essential that I provided immediate feedback and validation.

The students perceived relatedness as a result of the weathering activity. They worked with a partner to complete the labs. They felt that it was important to work with a partner. However, the students had to be redirected and focused, because they were easily distracted. Overall, the students enjoyed working with a partner, because, as SH and HM agreed, “I felt that my work gets done faster when you work with a partner.” LS reiterated more when she explained why she like working with a partner. She said, “We get to see and find a little more about what they [the partner] know and learn.”

The second lab simulated chemical weathering. This activity provided the students with the opportunity to evaluate a project long term, because on one day they did the preparation and the next day, they observed the results. The students made predictions as to what would happen and discussed their observations and predictions as a group. In this activity the students had to carve a piece of chalk and place it in a petri dish. Vinegar was used to simulate acid rain, and was poured over the carved chalk. The students did the preparation in one class and the observations in the next class. The vinegar which is a weak acid represented acid rain and the chalk represented buildings. After a lengthy discussion about weathering, students completed graphic organizers and a lab activity.

The final activity the students completed to help with their understanding of weathering was the neighborhood walk activity. Students went on a walk around the school and the surrounding neighborhood for the purpose of collecting soil samples in order to physically see the different types of soil and observe chemical and mechanical weathering. They had to draw what they saw and collect different soil samples to be used in another activity. As indicated on the ACR cards, overall, the students perceived autonomy as a result of this activity. Students indicated they had great deal of input in the class that day. More specifically, they indicated that they “helped people”. When relating to choice, an aspect of autonomy, the students were not sure about their choices. When asked what choices were they given in class, two students made statements such as “to do a project” (HM) or “to work on the assignment” (LS). However, the students were provided an opportunity to display their samples in their own way as well as how they would present their completed project. They received immediate feedback from their peers as well as from me. More specifically, the students were able to distinguish between the two types of weathering as they observed weathering in the neighborhood. Their thoughts were acknowledged and their thinking was challenged and redirected.

Competence was perceived by all of the students as a result of the walk activity. Two students indicated they learned that “there is (are) different types of soil” (JS) and that “everywhere there is (are) different kind of texture of dirt” (TS). TS later explained she was able to demonstrate what she learned “by putting different soils in a bag and telling about them.” SH stated that, “I learned about different types of dirt that’s outside and different types of chemical and mechanical weathering that is outside.” She further elaborated that she “never paid this stuff any attention” and when I go home, I will look around my house.”

Related to whether students experienced competence, they identified the teacher feedback they received as positive and encouraging. On one occasion, MC recalled the teacher’s feedback to him was, “keep working.” He liked that comment. LS agreed when she wrote she enjoyed “a good feedback” comment given to her by her teacher. The students had to collect the samples and record their observations in pairs. However, they interacted as a whole group when looking for examples of weathering. The students valued their peers input and several times they debated on some of the examples that they found.

The students’ responses to relatedness questions indicated that the walk activity gave them the opportunity to experience relatedness. SH noted how she related to the activity when she recognized the value of student input. She explained, “Because their [our] input works in the class and because they [we] are human, their [our] opinion counts”. BR chimed in when he said, “Anything ‘she’ [his project partner] says can be important and helps." The students' responses also indicated that it was important for them to have input from their peers and to be recognized by their peers.

Environmental Energy

This final activity was done to help students realize the importance of preserving natural resources and how the effects of certain choices and human actions can destroy or damage them. The students were placed into teacher-selected groups. They choose an environmental issue and took on a specific role in order to provide solutions to the problem. The environmental topics were: clearing a wooded area for a construction site, pesticide spraying near a school playground; and dumping toxic waste near a body of water. The students discussed in their groups' solutions related to their specific environmental issue and using the identity of a specific community person who had to solve the problem in beneficial way for the whole community. Excited about this activity, students engaged in some heated debates. They were able to draw on information presented in previous lessons. The students came up with several solutions with coherent facts to support their solutions. In answering a question on autonomy about what choice students were given in the activity, JS said, "I was given a choice to choose my partner." DC said her choice was "to state my debate on the environment." BR stated, "Good, positive, choices." The students learned that the environment is important. The students made various contributions to the day's discussion. BR said his contributions were, "about waste in the stream, lake, basically drinking water. TS said, "That pollution is bad for children and our health."

Competence was perceived by the students as a result of the activities. The students were able to demonstrate what they knew because they effectively debated their issues in their groups and with the class. They provided supporting details for their arguments that they presented in that day. The opportunity to discuss their issues solidified their learning. Openly discussing it allowed the students to receive feedback and their ides where challenged, corrected and refined. The students were very clear about what they learned. SH wrote, “I learned about mechanical, chemical weathering. How to make chalk melt down and I learned about frost wedging. TS wrote, “I learn that the environment is important.” Both MC and BS indicated that they learned about geology and a person who looks for fossils. They were able to demonstrate their knowledge because they “did a presentation with the group, wrote and talked about it” (SH). DC clarified further that “by putting [us] into four way groups and becoming a career type person and becoming something” was beneficial to her. LS found her learning came when “we did a class group paper and presented it in class.” The students responded positively to their perception of feedback as related to competence. JS was happy when the teacher told him “I did a good job.” DC liked “people’s opinion” when her classmates, during the discussion, thought what she said was good. To further show how the students perceived competence, JS wrote that the “task helped us understand the environment.” MS wrote “because we all learned something.” Finally TS wrote that “Earth Science and talked about the air, coal, effecting archeological substance.”

In summary, overall the students were able to perceive autonomy, competence, and relatedness as a result of the instructional strategies and classroom activities that I provided. In the first couple of classes, the students wanted the notes on the board in order to just copy them. The students preferred to write what was put on the board but not talk about it. The students were not used to completing graphic organizers or collaborating with their classmates about the lessons or activities, but as a result of the classroom structures, students were given numerous opportunities to interact with their peers, have their ideas challenged, and receive feedback. However, the students had no problems socializing with each other. I on the other hand had to provide structure to their thinking and conversation and redirect them to focus on the task at hand. The students did not mind completing the ACR cards, but they did not always provide elaborate answers. Because of their unwillingness to write, I would follow up with the students in order to clarify what they would write in order to get a clearer understanding. Still their notes only reflected what was on the board.

Table 8 represents the results of the ACR cards. Please note that activity # 11 was the day that the students took the final exam. The first activity was a plastic lab and the students were having trouble completing the ACR cards because of the vocabulary they did not understand. Table 8 indicates that overall the students perceived autonomy, competence, and relatedness as a result of the instructional strategies/activities. However, when I probed students for more clarification, they were able to make comments that led me to believe that they perceived autonomy, competence, and relatedness. The students were assessed daily and continuously and verbally and by written products. I employed various measures to assess them while attempting to stay away from traditional methods.

Table 8

ACR Results (Percent)

Activity/Construct	**Autonomy**	**Competence**	**Relatedness**
1	55	100	NA
2	71	100	71
3	86	100	88
4	88	100	88
5	78	100	89
6	78	100	89
7	100	100	71
8	86	100	88
9	100	100	67
10	100	100	67
11	29	86	29

Effect of Self-determination Earth Science Instruction on Students' Learning

Formal Measures

The first research question explored how students' learning would be affected if they were given an opportunity to experience autonomy, competence, and relatedness. Table 9 represents data on the four learning indices.

Table 9

Learning Measures

	Earth Science Content Test		Self Regulation Monitoring		Self Regulation Monitoring Cognition		Self Regulation Planning	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Mean	37.44	74.55	4.92	4.42	4.28	3.92	5.57	5.42
SD	10.30	15.77	1.45	1.27	1.77	12.42	1.61	2.37

The first measure was the Earth Science content test. On the Earth Science content analysis, significant differences where found favoring the post-test over the pre-test [t(1,8) = 8.606; p=.000)]. Evaluation of test scores by individual students revealed their student performance gains by eight of the nine students demonstrated gains in all of the topics as indicated on the pre-test and the post-test.

On the monitoring measure analysis, there was no significant differences [t(1, 6)=.866, p=.420]. The third measure, self-regulation monitoring cognition analysis, also showed no significant differences on the pre-test over the post–test [t(1, 6) = .376; p=.720)]. The final measure, self-regulation planning analysis, demonstrated no significant differences [t(1, 6)=.213; p=.838)].

The self-regulation measures had a total of nine questions and three sub-categories: (a) metacognition monitoring, (b) metacognition monitoring cognition, and (c) metacognition monitoring planning. Metacognition refers to the awareness, knowledge and control of cognition. The metacognition monitoring cognition measure focused on the students' ability to monitor activities which would include tracking one's attention span while reading, self-testing, and questioning. These activities help the learners understand the content and integrate new knowledge with prior knowledge. Metacognition monitoring planning learning measure looked at the students' ability to monitor their ability to monitor their cognition when studying. The final measure, planning, dealt with how students' planning of activities helped them to activate prime relevant aspects of prior knowledge which helped the students organize and comprehend the content better.

Student survey responses on the three self-regulation measures were far more positive than observed behaviors in the classroom. The following information from field notes might explain this lack of differences. The ratings were all above 4 except for one, which was at 3.92 in the post-survey. The behaviors in the classroom as they pertained to the ratings were in total opposite. First of all, the students did not study in advance for this class or in their previous classes. For example on one occasion, the students were given a worksheet to complete. This worksheet was part of the supplemental materials that came with the textbook to be used as students read the text. As the student read the section in the textbook, they were to complete the worksheet. The students became very frustrated because the wording on the handout was different from the wording in the textbook. The questions required students to make inferences and apply prior knowledge. In order to alleviate the frustrations, I had to show them that the information was the same but presented in a different format with different words but it all meant the same. It was difficult to get the students to read and if they did read, it was only to find an answer to a specific question or they would just read the words. I observed that if there were words or concepts that the students did not understand, they would continue to read even though they did not understand what they were reading. The students' idea of reading was silently pronouncing the words even if they did not understand what they read. If they were told to read a certain passage in the book, they would read the passage but were not able to explain what they had read. The students' idea of reading was pronouncing the words; it was not clear to the students that they needed to know and understand what they read. The actual comprehension was not there. This contributed to their frustration when given an assignment that required them to read. To combat this problem, it was important to review the questions and ask specific questions such as, "Do you understand what demonstrate means?" in order to get an understanding if they comprehended what they were read. I encountered this behavior initially when the students were completing the ACR cards. Students did not understand what the word "acknowledge" or the word "interpret" meant. Once they understood what those words meant, they were able to effectively answer the questions.

The students did not take any work, assignments, etc. home at the end of the day or asked if they should. According to the students, this is the same behavior that they exhibited during the regular school year. They said that they did not have time to do it in this class or their previous classes.

During the summer school course, if students were in the middle of completing an assignment or activity and it was time for the class to end, they stopped what they were doing and left. I had to provide them with constant probing and encouragement. By doing so, the students completed all the assigned tasks in class. There was much redirection, and refocusing the students in order for them to remain on task.

Overall, there was no change in the survey items from the pre-survey to post-survey. However, classroom observations revealed students' increased ability to do work in the classroom under my supervision but unwillingness to do the work at home. Even though the students rated themselves high on the measures, their behaviors in the class were contradictory to their ratings. The students indicated they asked themselves questions about what they had been studying, but in class they did not read for comprehension, they just read the words and attempted to complete the reading as soon as possible, if they, even read it. If they did not understand a word, they continued to read so that they could say "I read it." If the students were not involved in the discussion/lecture, meaning they had a task to complete or were required to provide input, they quickly became off task and did not pay attention to what was occurring in the class. They would have sidebar conversations that pertained to what they were doing the night before with each other.

The students' idea of studying was to remember key words a few minutes before the test. What I observed with the students in this study was that they did not have study skills, or the self-regulation skills tht aided them to study. They did not possess the reading skills or the vocabulary background necessary for the successful completion of Earth Science. Because I was able to redirect them when they were off task and not change my expectations, the students completed the class assignments. Towards the end of the summer session, students did not require as much re-directing. Thus, they started meeting my expectations or their own.

Informal Measures

In addition to the pre-test and post-test, I gathered informal data on their graphic organizers/notes, student participation, lab/activity assignments, and quizzes. The first informal measure was the graphic organizers/notes (Appendix I). Each student was given a notebook in which to keep his/her notes. The students took notes daily from my lectures. Even though they were given choices in their method of taking notes, I designed them in the form of a graphic organizer on the board. Although the students did not receive a letter grade for this measure, they received a check for completion. If they received a check (✓), it indicated that the graphic organizer/notes were complete and the check minus (✓-) meant that the graphic organizer/notes were incomplete. On any given day of the course, eight out of the nine students received a check on this measure. One student, who did not receive checks, could not write well, he had very poor penmanship.

Students did not have a problem with copying the notes from the board. In fact, a suggestion from the students was that they wanted me to have the notes already written on the board when they came in the class and let them copy what I wrote on the board. Once they finished copying off the board, they asked me to lecture or discuss the day's content material. However, in order to make sure that the students remained on task, I drew a graphic organizer on the board with key words and as we discussed the topic, the students and I completed the graphic organizer together. What I learned through trial and error was if I put all the notes on the board, once they finished copying them, the students would not pay attention to any discussion. If I followed their suggestion, the students would not pay attention to what was being said. When checking their notes, I noticed they did not add to the notes, even though they provided input to the discussion. They just wrote what eventually was placed on the board. For example, when we were discussing tidal energy, we discussed it in detail; the students provided input and they gave examples of how they understood it. However, their notes were verbatim of what was on the board. The students written output was very low level. When they had to answer a question in the written form, they would write only one word or very short answers, often not enough to fully answer the question. Nevertheless, if I questioned them for more clarification, they orally demonstrated their competence. The practice of questioning the students for more information ensured students' participation in the class discussion. It demonstrated to me whether students were following the lesson, what questions they might have, and it served as an indicator of their understanding of the course content.

The second informal measure was participation. My goal in the class was to create an environment where all of the students would want to provide input in the class discussions, participate in and complete the activities. During classroom discussions, students were first given opportunities to volunteer answers or provide input. However, for those students who did not readily volunteer to answer questions or provide input, I called on them specifically. Students received tally marks to indicate if they provided input, answered a question or asked a question and the type of questions they asked. The students attempted to give correct answers and towards the end of the course, the students were helping each other answer questions. The level and relevance of their questions increased; therefore, I did not have to call on students specifically. They were eager to answer questions, ask questions, and were open to being corrected. Interesting to note even though their knowledge level was limited, I had to explain to them why the answers were wrong. It was essential that I thoroughly explain to them the process of correcting answers step by step.

All of the students were eager to provide input and participate in class. I observed a general willingness to learn while they were in the class; however, it took a lot of probing and being firm with them to get them to complete the activities. At first, Earth Science was a course for which they had to begrudgingly attend summer school. As time went on, the students became more than willing to express themselves orally. Although, the students' oral output was not always grammatically correct, it was appropriate to what we were discussing. Their oral participation gave them opportunities to share their understanding of the course content in their own words and allowed me to see if they comprehended the material.

The grades on the third informal measures, lab/activities, ranged from 50% to a few students with 100% consistently (SH, BR, LS). Producing the products or completing the labs/activities and receiving the desired outcomes were not difficult for the students. They worked well with their group/partner. Each of them provided input and was able to teach/help one another.

All of the labs/activities had a written component in which the students had to complete during and after the labs/activities was completed. The written component consisted of questions pertaining to the labs/activities. Although the students were able to effectively demonstrate their understanding of the activity and could verbally speak their knowledge of the concept, it was difficult for them to express themselves in the written form. Students enjoyed and looked forward to the hands-on activities that we did in class. Often they would make suggestions of ways to broaden the experiment. Students asked relevant questions and demonstrated an understanding of what was expected. However, they did not want to complete the written questions. What I concluded from my observations was that if the students were actively engaged and occupied, they were learning, but, they did not want to express themselves in a written form. I attributed this behavior to the students' inability to write in a narrative form. Looking at the students English grades on their transcripts, I discovered that only one student passed the class with a grade higher than a "C". The labs provided the opportunity for the application of the course's ideas and allowed me to check for their understanding of the content.

The final informal measure consisted of quizzes (Appendix J). The students took three written quizzes throughout the course. The first quiz was worth 10 points. Eight students took this quiz and the students' scores ranged from 3.5-9.0. The average score was 6.6. Eight students took the second quiz, which was worth 4 points. The scores ranged from 2.0- 5-4. The average score was 3.0-27. Three students scored a 4.0, and two students scored 2.5 on this quiz. The final quiz was worth a total of 6 points. The ranges of scores were 3.0-6.0 with one student scoring a 3.0. The average was 5.18. The first quiz was announced to the students at the beginning of class. The students found it difficult to focus on what we were doing in class. They panicked, and immediately went into an anxious mode. They would constantly question what's going to be on the quiz and how many items would be on the quiz. No matter what we were discussing, they wanted to know if I they needed to memorize a particular piece of information for the quiz. Because of this behavior, I found that I needed to complete the discussion/activity and announce that we were going to have a quiz right before they took it. During the time the students took the quiz, I would provide constant reassurance to the students in the form of encouragement and context clues. The scores on the quizzes should have indicated how well they understood the information and informed me on what to re-teach. However, when I asked the students to verbally answer the questions, they were able to answer the questions. It was a matter of them being clear on my expectations of them.

The informal measures; graphic organizers/notes, student participation, labs/activities/assignments, and quizzes- were graded daily. The students received immediate feedback on their progress. Overall, the students achieved the desired outcomes of the tasks that were expected from them. Nonetheless, the students achieved these outcomes with much teacher-driven prodding, encouragement, and voicing high expectations of them. While the students liked doing the labs/activities assignments, they did not want to go the extra step as far as writing up the labs or answering the questions with more than one word. They worried about their grades and questioned me if they did not think their grade was fair, or did not understand how the grade was assigned. For them, the idea of a good grade was a “C” and all students earned at least this grade.

From my observations and the students’ responses, I gathered that for the students to achieve, they needed to be able to provide input into the discussion. Their opinions and answers needed to be acknowledged and corrected if needed. If their thinking was not completely correct, it needed to be re-directed and corrected immediately. The students' participation grades were positive but in order for them to stay focused, the students needed to be actively involved at all times. Students were easily distracted and their discussions would include other topics that did not pertain to Earth Science. Their written output was often not indicative of high school students. They would write only one word answers without further elaboration; however, when questioned for more clarification, they expressed themselves better verbally. Despite these difficulties, all students demonstrated progress on the informal learning measures.

Effect of Self-determination Earth Science Instruction on Students' Motivation

The second research question examined how students' motivation would be affected if they are given an opportunity to experience autonomy, competence, and relatedness? Table 10 represents data on the seven learning indices.

From pre-test to post- test, students showed no significant differences on five of the seven measures: self efficacy expectancy [$t(1,6)=.687$;$p=.518$]; self efficacy ability [$t(1,6)=1.19$; $p=.278$]; intrinsic importance [$t(6,1)=-.587$;$p=.579$];; effort management persistence [$t(1,6) = .439$, $p= .676$]; and test anxiety [$t(1,6)=-2.66$;$p=.325$]. Two measures, intrinsic challenge [$t(1,6)=2.489$;$p=.047$] and intrinsic interest survey item [$t(1,6)=2.914$;$p=.027$ showed difference from the pre-survey to the post-survey.

Similar to the responses on the learning items, the students tended to overestimate their motivation. This was particularly true considering what their classroom behaviors were. For example, on one hand, students rated their efficacy high yet they scored low on the content pre-test. They thought they would do well because they had taken the class

Table 10

Pre and Post Mean and Standard Deviations on Motivation Measures

	Mean		SD	
Motivation Measure	Pre	Post	Pre	Post
Self Efficacy Expectancy	6.07	5.67	1.01	1.07
Self Efficacy Ability	5.59	5.04	.805	1.35
Intrinsic Challenge	4.42	5.57	1.98	1.39
Intrinsic Importance	5.33	5.66	1.24	1.00
Intrinsic Interest	3.50	5.07	1.60	1.23
Effort Management Persistence	3.92	4.17	.909	1.53
Test Anxiety	4.03	4.25	1.14	2.21

before. On the other hand, if any of the tasks required them to access prior knowledge or infer, they became frustrated. With persistence, they only showed this behavior in class when supervised. If I did not monitor them, they would stop that activity or not do the best that they could do on it. During class, I would have to constantly check on student progress and provide input or ask questions. They were easily distracted. Although they lacked the persistence in class on their own, they ranked themselves highly on the survey.

Students also ranked themselves high on the intrinsic importance items. They explained that the class was important to them because they needed it in order to graduate. However, with the several topics that we covered in class, the students became involved for the sake of learning because they were interested in the topic and was able to see the application to their daily lives.

The final measure, test anxiety, measured the students' negative thoughts that disrupted their performance on tests and their physiological arousal aspects of anxiety. There were four test items which measured their emotional reaction to the task. They indicated that taking tests did make them nervous but they attributed it the fact that they did not study. Though, the students did not have adequate study skills, their idea of studying was to attempt to memorize immediately before the test certain concepts and key words. The students did not set aside adequate time to study. Most of the time their preparation for a test was done the morning of the test in the classroom before the teacher passed the test out. In this class, if I said we would have a quiz, the students' focus would only be on when and what the quiz would cover. This would go on until they took the quiz. From informal conversations in the class, the students did not want to take the time to study, get materials ready to study, or take class work, notes or books home in order to prepare to study. During this class, the students never took a book or any course material home from class. Overall, the students did not worry about actually taking a test but they did worry about passing it. The students anxiety was attributed to the fact that they did not prepare to take the test.

Two differences were noted, regarding, intrinsic challenge and intrinsic interest. Students' behaviors in class were consistent with their higher ratings on the post-survey measures for these two constructs. In the beginning of the class, the students did not want to be challenged because they did not want to expend the effort. They only wanted to do the bare minimum. Also, at the beginning of the class, the students did not view the work that they assumed we would do in the class as interesting; they strongly expressed their dislike of Earth Science. Nevertheless, as a result of the activities and assignments in which the students participated, their rankings on the intrinsic challenge and intrinsic interest increased. For example, the students were given choices in the class, received frequent feedback on their performances, and had numerous opportunities where they had to work together. Given these experiences, the students experienced the components of the self-determination theory which are autonomy, competence, and relatedness.

CHAPTER IV

DISCUSSION

Overview of the Study

The purpose of this study was to look at the relationship of the self determination theory and student learning and motivation. The study addressed two questions: (a) if students were given the opportunity to experience autonomy, competence, and relatedness, how would it affect their learning? and (b) if students were given the opportunity to experience autonomy, competence, and relatedness, how would it affect their motivation? In order to answer these questions, I taught a summer school session of Earth Science to 10 students who had previously failed the class. Nine of the students consented to participate in the study. The structure of the class consisted of instructional strategies that were designed to allow students to experience autonomy, competence, and relatedness, are the three basic needs that allow people the freedom to engage in a self-determined activity (Deci & Ryan, 1994). Self-determination theory promotes intrinsic motivation when it satisfies the psychological needs of deciding what to do, and how to do it (autonomy); developing and exercising skills for manipulating and controlling the environment (competence), and affiliation with others through pro-social relationships (relatedness) (Brophy, 2004).

To measure learning, students took a content test, rated survey items measuring self-regulation monitoring, monitoring cognition, and monitoring planning, and participated in note-taking exercises, lab activities, and quizzes. To measure motivation the students rated survey items assessing self-efficacy ability and self-efficacy – expectancy, intrinsic challenge, intrinsic importance, and intrinsic interest, effort management persistence, and test anxiety.

In addition to classroom observations, graphic organizers/notes, quizzes, and lab/activities, supported by my classroom observations, the students completed autonomy, competence, and relatedness (ACR) cards to provide evidence of students' recognition of the instructional strategies as providing autonomy, competence, and relatedness.

Learning

When evaluating their learning, differences were found on the content tests and the informal measures. On the content test, there were significant gains from the pre- to the post-test. There was a 36% increase from the beginning of the summer school session until the end of the summer school session. Every student, except one, showed dramatic gains on this measure. I attributed this gain to the fact that the students had the opportunity to select the topics that they wanted to explore; they were encouraged to provide input during the class discussions or activities, and they worked in groups and were able to rethink and redefine their learning when needed. These situations promoted autonomy, competence, and relatedness (Brophy, 2004). With the note taking, the students eagerly discussed and asked questions as they studied various topics. During the lab/activities, the students interacted with each other, and, quite often, they redefined how the activity was structured. Grades on student's quizzes confirmed their improved performances in these areas.

On the other hand, differences were not found on the survey learning responses from the beginning of the summer school session to the end of the summer school session. The student responses on the survey, however, differed from their classroom behaviors. On the survey, the students tended to overestimate their abilities. This was evident in the students' content pre-test. For example, the students did not score above 40% on the content pre-test. They had trouble comprehending what they read and they could not communicate in formal writing what they learned. I had to closely monitor their performances so that they would do what was required of them. Classroom behaviors gave a more realistic view of the current performance levels versus the survey. The students were able to perform to a certain degree with my monitoring, but they could not maintain their performances outside the classroom.

From my informal conversations with and observations of students, they demonstrated poor reading and study skills. Often they would just read words and not know what the words meant and therefore, they could not comprehend what they read. Initially, the students would only do what was asked of them, but it required much prodding from me and re-focusing by them. While students have experienced success with my supervision, they could not transfer the skills learned to outside school situations.

Motivation

When evaluating their motivation, differences were found on two of the measures- intrinsic challenge and intrinsic interest. In the beginning of the class, the students were not interested in Earth Science and did not want to be challenged academically in Earth Science or their other classes as indicated by them. Even though they indicated in the beginning they did not want to be challenged, the students enjoyed completing the labs and hands-on activities.

Differences were not found on five of the motivation measures: self-efficacy ability and self-efficacy expectancy, intrinsic importance, effort management persistence, and test anxiety. The students overestimated their abilities on all of these measures. They believed that they were going to do well in the class and that they had the ability, but they scored below 40% on the content pre-test. They all expressed that they were just as smart as their peers because they were all repeaters. However, they identified one student in the class as being smart and often remarked that they personally, were not as smart.

The class was important to them because it satisfied a graduation requirement. Initially, they did not see any need for Earth Science or how it related to them; nonetheless the students were able to relate to the topics of weathering and solar energy. Through classroom discussions, I observed them asking relevant questions and giving real life examples on the aforementioned topics.

While the students rated themselves highly on the effort management measure, the students' classroom behaviors did not correlate with their ratings. What I observed was that the students did not have the required study skills in order to study effectively.

They lacked the ability to read for understanding. More specifically, they would read words regardless if they understood what they meant. The students would only do what was asked of them initially, and it required much prodding and redirecting from me. While students were successful with the activities, once again, they were not able to transfer these skills to encounters outside of the classroom/school.

The students experienced a great deal of test anxiety when it came to taking a test/quiz. I attributed their behavior to the fact that they did not adequately prepare during class, study after class, or have effective study skills. The students' idea of studying was to memorize a few key words, usually the morning of the test, while the teacher passed out the test. I observed that if I told the students that they were going to have a quiz, that was all, on which that they focused. They wanted to know what the questions were, and no matter what we discussed that day; they also wanted to know if it what I shared was going to be on the quiz. The students' biggest fear existed because they did not study effectively or prepare for tests.

The results of the ACR cards indicated that the students perceived autonomy, competence, and relatedness as a result of the instructional strategies. Because of their low writing skills, the students provided very short answers to questions, but they were more than willing to verbalize their thoughts. They were given choices and encouraged to contribute to the discussions and to complete the assigned tasks. They were also given daily opportunities to demonstrate what they learned through individual and group presentations. Finally the students collaborated with their peers and were able to re-define and further develop their understanding of concepts they studied.

Ogbu's (1974) study determined that Blacks were not learning because of their membership in this society and how their membership shaped their behavior. He identified Blacks as members of the involuntary minority group in which they were denied true assimilation into American society. As a result of this membership, the belief is maintained that they are denied certain jobs and often there is a limit on their ability to advance. Given who they are and the demonstrations of culture, they are viewed as incompetent and dependent on the system. In order to survive, they have developed survival techniques to cope with what they perceive as institutional racism. With these perceptions, Blacks see no relevance of school because they are unable to see the relationship between their efforts in school and the eventual outcomes.

The students in my study had similar beliefs. All of the students except for one did not affiliate with school. They were not in any extra-curricular activities; however, they did attend the games and dances. All but one student had parents that had been in jail or in jail. Only one student had a parent with a college degree. The rest of the students' parents worked at low paying jobs that did not require any formal skill.

Ogbu (1974) and Yerrick (2000) both identified classroom and school environments where teachers had low student expectations and negative attitudes about the students. There was not a positive relationship between teacher-student or teacher-parent. The instruction was teacher-centered and work was repetitive of what they had in earlier grades. As evidenced in this study, students did not understand why they needed to take this Earth Science and although they had high aspirations of becoming doctors, lawyers, etc. they neither felt they could achieve their goals nor did they engage in activities that would help them achieve their professional goals. To help alleviate this, the students received constant encouragement, relevant work, and standards of high expectations. The environment in my class was structured so students were encouraged and expectations were high. In addition, students were provided opportunities to develop positive relationship with their classmates and me. As a result of these interactions, the students openly communicated in class and knew that they would not be criticized or humiliated by what they said.

Concerning low teacher expectations, negative teacher-student relationships, irrelevant work, and students' beliefs of school effort equating to job success also a falsehood, the experiences of the students in my study mirrored those of Ogbu (1974) and Yerrick (2001). They were in classes where teachers' expectations, according to their descriptions, were low and this was reflected in the assignments they were given. Handouts, worksheets, lectures, and no opportunities to experience autonomy, competence, and relatedness were their reality. Brophy (2004) and Yerrick (2000) indicated that students can learn and succeed through collaboration with the teacher and their peers. The instructional strategies needed to be student-centered where students know the expectations and how to meet them. Both researchers also stressed that students should be accepted as an individual and teachers should model what is expected. Collaboration among their peers is essential and what is taught should be worth learning. During the study, students were given those opportunities to have control over what they were learning, have relevant and challenging work and to collaborate with their peers.

McPartland and Braddock (2001) identified four sources of motivation: (a) opportunities for success, (b) relevance of school work, (c) caring and supportive environment, and (d) help with social problems. Additionally, Ladson-Billings (1994) identified four methods that teachers who teach African American students should do in order for them to be successful. The first one is a positive teacher-student relationship that extends outside of the classroom. The second one is that the teacher demonstrates a connectedness with all the students and the third method is that the teacher encourages a community of learners and finally, the teacher encourages student collaboration. These methods also define autonomy, competence, and relatedness. In this study, I gave work that students could relate to and provide meaning and relevance to their lives. Evidence of this was the weathering and the solar energy exercises. I structured the classroom so that there were many opportunities for students to be successful. The students were assessed in a variety of ways in order for them to communicate their understanding of the subject in ways that was best for them. The students were also able to collaborate on a daily basis with their peers and me. Thus students were encouraged and their contributions were acknowledged. I provided immediate feedback and kept my expectations high.

Black students, according to Nichols (1976), need to be able to talk and socialize during classroom instruction, and there needs to be a teacher–student connection which was reiterated by Atwater (2000) and Brophy (2004). In this study, I put in place things in order to build personal relationships with all the students by taking them to lunch and allowing time at the end of class to talk about themselves. The students responded to encouragement and needed it as was indicated in my field notes and their responses on the ACR cards. Opportunities to socialize during instruction were provided daily. As a result of the students having those experiences in the classroom, their intrinsic challenge and intrinsic interest motivation increased and their learning increased as demonstrated on the post-test.

The students often expressed that their previous Earth Science class was boring. They indicated that the teacher did not make the class interesting and that all she did was talk about things that did not pertain to earth science. She belittled them and did not care if they learned or not, because as they said, she had “hers.” What these students described was a teacher who had very low expectations, no opportunities for positive teacher-student interaction or student-student interaction. As a result of this, the students were not used to the instructional practices that I incorporated in the class. Although they were repeaters and had low reading and writing skills, they could learn and wanted to, but needed a lot of pushing, prodding, and for me to not accept inferior work.

The students experienced autonomy, competence, and relatedness. They made progress in their learning and completed assigned tasks. Initially, there was much needed pushing and prodding to keep students engaged but as the class progressed, they did not require as much pushing. However, the students did not transfer this attitude outside of the classroom. One student indicated that she would look for signs of weathering when she got home, but she did not report back to me. Working with a partner or in a group was beneficial to the students because they were able to realize that they had valuable contributions and were able to accept their peers correcting them.

Special Considerations

It is important to note special considerations of this study. The study took place during a concentrated period of time – a summer school session which lasted for seventeen consecutive days for four and one half hours per day. Such a setting was unlike a traditional seven-period day or one block-scheduled period of time (90 minutes). The extended time per day spent with the students could have had an effect on my ability to build stronger relationships with them. After all, to them, they had me for themselves. Additionally, the small class size (n=9) may have had an impact. Traditionally, Earth Science class sizes at this particular research site were approximately 25 students and above per individual class. With such a small number of students with whom to work, I was able to interact with them more personally, support them more often when they required assistance or entered the zone of proximal development, and I was more aware and could act more quickly when issues of discipline and disengagement arose. However, I believe strongly that if the components of self-determination theory – autonomy, competence, and relatedness – are effectively implemented in the regular classroom setting, similar results are possible.

Future Studies

All of the students were enrolled in this class, except one, were students who failed not only Earth Science during the regular school year, but also other classes as well. Two of the students who were initially classified as freshmen should have been a junior and a senior respectfully. The students could not determine the relevance of school, especially, Earth Science. Previous teachers neither held them to high expectations nor expected them to do well. Additionally, the students had low writing and reading skills and were not held accountable for their actions at home or the school. All of them expressed that they were given no consequences at home for failing the class. The instructional strategies that these students were previously exposed to did not allow them to define and solve their own problems or provide opportunities for feedback except on formal measures, such as tests. On the same note, they were not given opportunities to collaborate with their peers, or having relevant assignments. According to them, their previous classes did not promote autonomy, competence, or relatedness. Thus, the students were not successful. While I noted improvement in the students learning and motivation, I believe that more time would have produced even better results.

To further explore the effects of self-determination on learning and motivation, several studies can potentially be conducted. A longitudinal study that involves teachers structuring their instructional strategies to include opportunities for students to experience autonomy, competence, and relatedness starting with students in the third grade and continue until the end of the students' ninth-grade year which would provide opportunities for students to have high expectations on a continuous basis. I think that if students are exposed to these strategies on a continuous basis they will become more intrinsically motivated and would learn science and other subjects because they want to. So school would be more interesting and relevant to them because teachers would provide opportunities for them to have choices. If these opportunities are incorporated, there could possibly be a significant drop in students' failure rate. I attribute student failure to a lack of a strong academic foundations; this basis also includes low teacher expectations and the practice of pedagogy of poverty (Hodges, 2001).

This study was completed in summer school with repeating students who needed to pass this class. Conducting this same study with students who had not failed the class, using the same measures and format during the regular school year, is another possible future study. One could use the same measures, as well as compare the class with one that is not implementing self-determination theory. The researcher would have more time to form relationships with the students and could provide long term activities where students could explore their own interests. An additional component to this study would be to compare a class with the measures and a class not receiving the measures. Although this study was completed in an Earth Science class, autonomy, competence, and relatedness should be provided in all content areas. This same study could be conducted in other disciplines using the same measures.

Implications

As an administrator of a school that is 98% African Americans, the results of this study are very promising. The research states that if motivation is enhanced, then learning will improve. In order for this to occur, teachers need to provide those opportunities that enhance motivation. In this case, providing opportunities for students to experience autonomy, competence, and relatedness on a daily basis would increase their motivation. However, in order to do this, a dramatic shift from the traditional method of teacher-centered learning to student-centered learning needs to occur. Teachers must be willing to modify and adapt instruction in order to meet the needs of all students.

To accomplish this, first, teachers need to have opportunities to learn self-determination theory and how it can enhance learning. They need on-going staff development and administrative and district support as well as both financial and human support. More importantly, this should start at the elementary level. As with the students in this study, they were not accustomed to being challenged, given choices, or given the opportunities to effectively work with their peers. The research states that such opportunities are essential for learning to occur. Second teachers need staff development on implementing strategies such as engaging in cooperative learning, creating and using graphic organizers, and developing learning communities.

In addition to staff development, teachers need to believe that students can learn and attain desired outcomes regardless of home/parent or community influences. Teachers need to have high expectations and hold students responsible for classroom participation, homework, and completing assignments. They need to develop and sustain the self-efficacy about positively relating to students and the dispositions that they believe their students can learn.

Conclusion

I had success with my students, but there are things that I could have done differently. I don’t think that the success will be long term because the class was only three and half weeks. I wish that I would have been afforded more time in order to incorporate more reading and writing because of their low skills. However, while I saw evidence of learning, it would be interesting how much they retained when school starts. They had low reading skills as well as poor study skills. I would have liked to have taught the students cooperative learning skills and how to interact with their peers because they had not been exposed to cooperative learning. The students who I had in my study were those not accustomed to being successful and it was difficult at first for them to try. More time would have allowed us to do more long term assignments, reading activities, and incorporate more writing.

We are failing a generation of students and I believe that this can be stop by utilizing the tenets of self-determination. The students are asking for those opportunities to have choice and do things in class to make learning interesting and relevant to what they can relate to. They want to be challenged and not have to sit in a classroom and listen to the teacher lecture the entire time. Finally there is an innate need to be social and allowing students talk about what they are learning will have positive results. Providing students with opportunities to experience autonomy, competence, and relatedness will increase their motivation and thus have an impact on learning.

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APPENDIX A

ASSENT TO ACT AS HUMAN SUBJECTS

ASSENT TO ACT AS A HUMAN SUBJECT: ORAL PRESENTATION

(For student participants)

You are invited to participate in a study conducted by Ms. LaToy Kennedy. You will engage in instructional strategies that will enhance your learning and motivation to do and understand Earth Science. This study will examine the themes, products, interactions, and attitudes that develop as a result of your participation.

Information will be collected by Ms. Kennedy in the following ways:

- You will be audiotaped during sessions
- Field notes will be written during and after sessions, which will detail observations that cannot be captured on audiotape.
- You will be interviewed before and at the end of the project.
- You will complete daily and weekly response cards so that Ms. Kennedy can evaluate your reactions to the course.
- You will complete a pre-test and post-test that will cover Earth Science content.

You will do all of these activities, except for the interviews, which will be conducted outside of class and will take no longer than 30 minutes, as part of the requirements of the class. You may feel that you have to participate in this project because Ms. Kennedy is your teacher. But, be assured that your decision to participate or not participate will not affect your grade. Ms. Kennedy is asking your permission to use the information for her study.

By doing this study Ms. Kennedy hopes to see how we might make Earth Science more interesting to more students. Your participation in this study will give you a voice in what motivates you to learn science.

You will encounter minimal risk by being involved in this study. Your name will not be used in any notes, publications, etc. Ms. Kennedy will use a pseudonym (false name) in order to keep anything that you and she discuss private. All information will be kept in a locked file in Ms. Kennedy's office. All hard copies of the data will be shredded and destroyed after 3-5 years.

At any time you have the right to ask questions about the project and how the information will be used. Even though your parents have given their permission for you to participate in the study, you can decide on your own to withdraw at any time.

Signing this paper means that you have read this or that someone has read it to you and that your want to be in the study. If you don't want to be in the study, don't sign the paper. Remember, being in the study is up to you, and no one will be mad if you don't sign this paper or even if you change your mind later.

______________________________ ______________________________

Signature of participant Date

______________________________ ______________________________

Signature of Investigator Date

APPENDIX B

STUDENT DATA SHEET

Name: ____ Grade:__________

Address: ____

Phone # _________________________ GPA: __________________

1. What did you think caused you to not pass Earth Science?

2. What are you going to different this time so that you can pass?

3. What can I do to help you pass this class?

APPENDIX C

PARENT INFORMED CONSENT

UNIVERSITY OF NORTH CAROLINA AT GREENSBORO
PARENT INFORMED CONSENT

Your child is being invited to participate in a study entitled, "If African American Students are placed in an Earth Science course based on the principles of self-determination theory, how will it affect their learning and motivation?"

The purpose of this study: The purpose of this study is to give students responsibility in their learning, participate in developmentally appropriate curriculum and curriculum that relates to real world applications and to measure how these instructional strategies affects students' learning and motivation.

The benefits of this study: Your child will benefit from the best practices that will be used in this class in addition to providing insight on instructional strategies that enhance your child's motivation and learning in Earth Science.
Society will benefit because the results of this study will inform science educators of best practices on motivating Earth Science students.

Methods/Procedures – Your child will be asked to participate in the following activities:

1. Pre and post test on the Earth Science content. (40 min) This information will be compared with their previous work and that of their peers.
2. Survey that will measure their perception of motivation and learning (30min)
3. Interviews that will be conducted outside of class that will allow them to elaborate on their answers on the survey (30 min). Interviews will be audio-taped.
4. Complete daily feedback cards that evaluates the students perception of autonomy and competence (5 min)
5. Complete weekly feedback cards that evaluates the students perception of the effectiveness of their social interactions in the class (relatedness) (5 min)
6. The classes will be audio-taped if all parents provide consent.

Choosing to participate or not: There are minimal risks associated with this study. Your child may feel obligated to participate in this study because I am going to be their instructor. All of the activities, except for the interviews, which will be conducted outside of class, and take no longer than 30 minutes, are part of the class requirements. However, be assured that your child's grade in this class will not be affected negatively should you or child decide not to participate, nor will your child's decision to participate affect his/her grade positively.

You or your child may ask to withdraw from the study at anytime. Your child may also ask to withdraw from the study at anytime. Doing so will in no way affect your child's standing or grade in the class. If you wish to withdraw your child from the study, simply contact me at the address below.

How privacy is protected: False names will be used on all written documents. Audiotapes and all documents will be locked in a file cabinet. Electronic data will only be stored on my personal computer which is password protected. Data will be kept for 3-5 years beyond the completion of this study and at that time audiotapes will be cut and shredded, electronic data will be erased and paper copies will be shredded.

The University of North Carolina at Greensboro Institutional Review Board, which insures that research involving people follows federal regulations, has approved the research and this consent form. Questions regarding your rights as a participant in this project can be answered by calling Mr. Eric Allen at (336) 256-1482. Questions regarding the research itself will be answered by LaToy Kennedy. You can contact me at: kennedl@gcsnc.com, at Bluford Communications Magnet (1901 Tuscaloosa, right behind Dudley High School), or by phone at 336-370-8120 (w) or 336-4516450 (cp). Any new information that develops during the project will be provided to you if the information might affect your willingness to continue participation in the project.

By signing this form, you are agreeing to participate in the project described to you by LaToy Kennedy.

Custodial Parent(s)/Guardian Signature(s) Date

If you don’t agree for your child to participate in this study, please sign below.

Custodial Parent(s)/Guardian Signature(s) Date

APPENDIX D

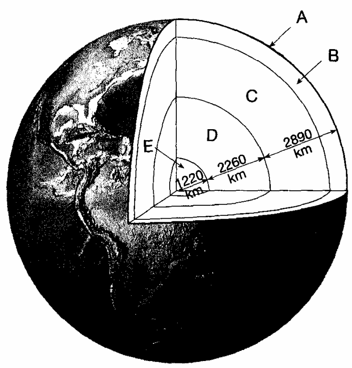
PRE-TEST

Name ______________________ Date __________ Class ______________

SCREENING TEST

1. Latitude is the distance
- **A** between two meridians.
- **B** north or south of the equator.
- **C** north of the international date line.
- **D** east or west of the prime meridian.

2. One source of energy for the Earth system is the sun. What is the other source?
- **A** Earth's interior
- **B** Earth's surface
- **C** Earth's atmosphere
- **D** Earth's hydrosphere



3. What part of the geosphere is indicated by the letter C?
- **A** crust
- **B** outer core
- **C** lower mantle
- **D** upper mantle

4. Which of the following is an example of a scientific question?
- **A** Which elements are classified as metals in the periodic table?
- **B** How tall is Mount Rainier?
- **C** What is the scientific definition of light?
- **D** Does a 5-minute daily workout lower cholesterol levels in males?

5. An atom is defined as
- **A** the smallest particle of matter.
- **B** an ion composed of electrons.
- **C** an element made up of only protons.
- **D** a substance that cannot be broken down.

Directions: *Use the information below to answer questions 6 and 7.*

Properties of Minerals

Properties can be used to identify minerals. **Color** is one property. Another property of minerals is streak. **Streak** is the color of a mineral in its powdered form. **Luster** is used to describe how light is reflected from the surface of a mineral. The visible representation of a mineral's internal arrangement of atoms is its **crystal form.** A mineral's **hardness** is determined by the Mohs scale. Whether a mineral has a tendency to break along flat surfaces (termed **cleavage**) or to easily **fracture** in uneven ways are two other properties. Another property that can be used to identify minerals is density. **Density** is the ratio of an object's mass to its volume.

6. Any sample of pure gold with a volume of one cubic centimeter will have a mass of 19.3 grams. What constant value does this provide to help identify a mineral?
- **A** density
- **B** color
- **C** streak
- **D** luster

7. The mineral mica breaks into thin sheets. Which property is being used to identify mica?
- **A** luster
- **B** fracture
- **C** harness
- **D** cleavage

GO ON

Name ______________________________ Date ________ Class ________________

SCREENING TEST *(continued)*

8. Igneous rocks form when

A sediments are compacted.
B magma or lava cools and solidifies.
C sediment is changed by pressure.
D lava is heated.

9. Geothermal energy is harnessed by

A splitting uranium nuclei into smaller nuclei.
B building large solar installations in the desert.
C using falling water to drive turbines.
D tapping underground reservoirs of steam and hot water.

Directions: *: Use the information and the table below to answer question 10.*

Land heats more rapidly and to higher temperatures than water. Land also cools more rapidly and to lower temperatures than water. Water accounts for 61 percent of the Northern Hemisphere. In the Southern Hemisphere, 81 percent of the surface is water. The table shows the range in annual mean temperatures (°C) at various latitudes located in the Northern and Southern Hemispheres.

Variation in Annual Mean Temperature Range (°C) with Latitude

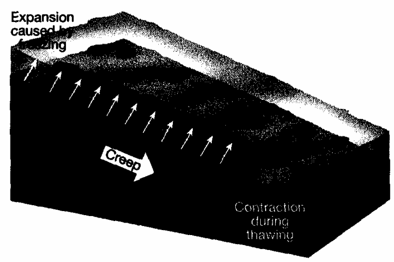
Latitude	Northern Hemisphere	Southern Hemisphere
0	0	0
15	3	4
30	13	7
45	23	6
60	30	11
75	32	26
90	40	31

10. What question were the scientists most likely trying to answer by gathering the information shown in this table?

A Are there snow storms at the equator?
B Do different locations sharing the same latitude also have the same temperature variations?
C What is the highest temperature ever reached in the Northern Hemisphere?
D Is there a relationship between precipitation and mean temperature?

11. Which of the following is an example of chemical weathering?

A a metal barrel rusting in an open field
B plant roots growing into the cracks in rock
C igneous rock exposed as the result of uplifting
D freezing water breaking large rocks into fragments



12. Creep is the repeated expansion and contraction of the soil on a slope. Creep results in the gradual downhill movement of the soil. In the diagram, the expansion is caused by freezing. What is causing the contraction?

A erosion
B uploading
C weathering
D melting

GO ON

Name ______________________ Date __________ Class ______________

SCREENING TEST *(continued)*

13. An example of deposition is

A a water table.
B a drainage basin.
C sediment at the mouth of a stream.
D glaciers moving along a valley floor.

14. A topographic map

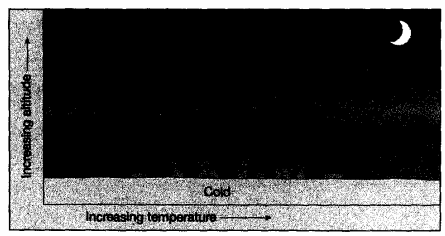
A shows the age of rocks at specific points.
B shows elevation by means of contour lines.
C has a specific projection to show longitude.
D is used to determine the distance between points.

15. The ocean's surface water temperature is higher at the equator than at the Arctic Circle. Which of the following affects this temperature variation?

A the water's salinity
B the oceanic mineral content
C density of the water
D solar radiation received

Directions: *Use the information and the diagram below to answer question 16.*

The quality of air is greatly affected by wind and temperature. If the atmosphere is unable to scatter pollutants, then air quality diminishes. Often on a clear night, air close to the ground will cool faster than the air higher in the atmosphere. This causes a temperature inversion where a blanket of warm air prevents upward movement.



16. What is happening to the pollutants coming from the factories in the diagram?

A They are being warmed by the air close to the ground.
B They are escaping into the upper atmosphere.
C They are being trapped near the ground.
D none of the above

17. Lunar phases are the result of the moon's motion and the sunlight

A that reaches the moon before Earth.
B that is reflected from Earth's surface.
C that is reflected from the moon's surface.
D that is blocked because of the moon's position.

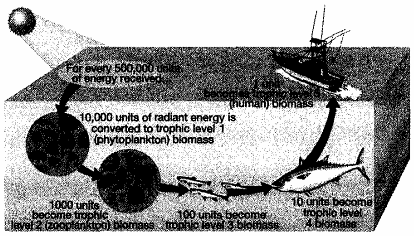
GO ON

Name ______________________ Date __________ Class __________

SCREENING TEST *(continued)*

18. Sonar works to map the ocean floor by

A taking photographs.
B using satellite images.
C transmitting sound waves.
D taking samples of sediment.



19. What does the oceanic feeding relationship in the diagram show?

A an ecosystem
B feeding stages called trophic levels
C the transfer of energy
D all of the above

20. The energy humans receive from eating seafood originates with

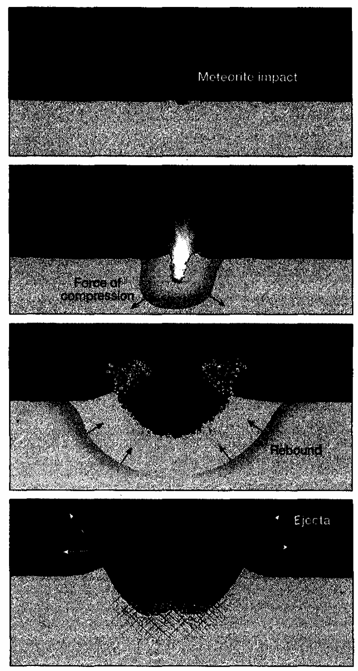
A the sun.
B large fish.
C phytoplankton.
D schools of fish.

21. Which of the following graph types would be *most* useful in showing a gradual change over time?

A bar graph
B data table
C line graph
D circle graph

22. Which of the following statements *best* describes what happens when solar radiation enters Earth's atmosphere?

A Most of the radiation is reflected from clouds.
B Most of the radiation is absorbed by the atmosphere and clouds.
C Most of the radiation is absorbed by land and sea.
D Most of the radiation is reflected from land and sea.



23. The energy of the rapidly moving meteoroid shown in the diagram is transformed into

A heat energy.
B chemical energy.
C electrical energy.
D mechanical energy.

GO ON

Name ______________________ Date __________ Class ______________

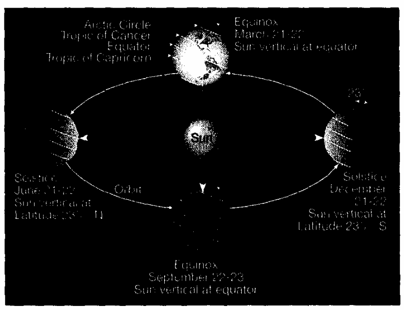
SCREENING TEST *(continued)*

24. Which of the following describes part of the process of lunar crater formation?

A volcanic eruption
B soil erosion moving rock
C rebounding rock ejecting debris
D weathering from rain

25. One of the main effects of wave action is

A the building of a delta.
B the fracturing of granite.
C erosion of the shoreline.
D changes in tidal patterns.



26. According to the diagram, when are the sun's vertical rays north of the equator?

A summer solstice
B spring equinox
C winter solstice
D autumnal equinox

27. Three mechanisms of energy transfer as heat are conduction, convection, and

A radiation.
B absorption.
C scattering.
D reflecting.

28. The main two motions of Earth are rotation and

A apogee.
B wave.
C revolution.
D haphazard.

29. What first released oxygen into Earth's atmosphere?

A plants
B snails
C trilobites
D cephalopods

30. Which of the following is ***not*** related to earthquakes?

A energy
B barometric pressure
C foreshocks
D surface waves

GO ON

Name ______________________ Date __________ Class ______________

SCREENING TEST *(continued)*

Directions: *Use the information below to answer questions 31 and 32.*

> Tasha designed an experiment on wind erosion. Tasha hypothesized that dry material is more prone to wind erosion than wet material. To create her experiment, Tasha obtained sand, cardboard, and water. On the cardboard she made two mounds of sand each weighing 1 kilogram. On one mound she sprinkled 10 milliliters of water. Tasha then blew across both mounds of sand for ten seconds each. She then recorded her observations. Tasha repeated her experiment with sandy soil, silty soil, and clay soil.

31. What was the manipulated variable in Tasha's experiment?

A the water **C** the amount of soil
B the type of soil **D** the amount of air

32. What would Tasha use to confirm or refute her hypothesis?

A the wet, silty soil **C** the size of the cardboard
B her observations **D** the amount of water left

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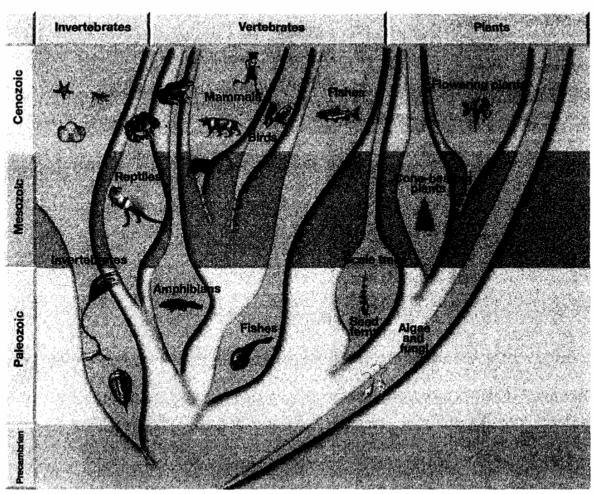
33. According to the diagram, in which era did reptiles first appear?

A Paleozoic **C** Cenozoic
B Mesozoic **D** Precambrian



34. The side-to-side cutting of a stream eventually produces a flat valley floor called a

A delta.
B levee.
C bed load.
D floodplain.

35. Most meteoroids originate from one of the following sources ***except***

A interplanetary debris.
B terrigenous sediment.
C solid remains of comets.
D material from the asteroid belt.

GO ON

Name ______________________ Date __________ Class ____________

SCREENING TEST *(continued)*

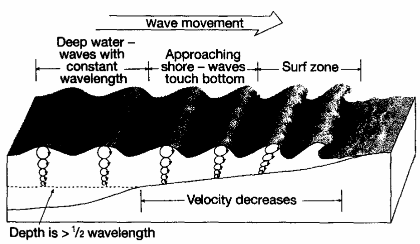
36. The dissolving action of groundwater creates

A wells. **C** geysers.
B caverns. **D** hot springs.

Directions: *Use the information and the diagram below to answer question 37.*

Breaking Waves

Changes occur as a wave moves onto shore. As a wave touches bottom, its speed decreases. Then, with a decrease in wave speed and in wavelength, there is an increase in wave height.

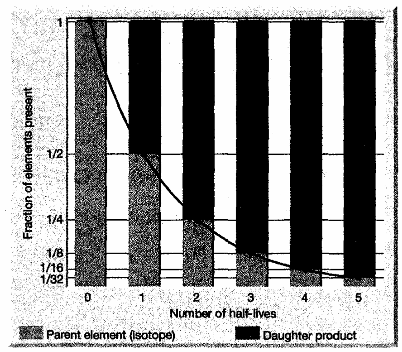


37. What happens to waves as they near the shore?

A They grow higher.
B They increase in speed.
C They increase in length.
D all of the above

38. Air masses are classified according to the surface over which they form and their overall

A shape.
B height.
C speed.
D temperature.



39. Half of the radioactive parent remains after one half-life in the radioactive decay curve shown. How much of the parent remains after a second half-life in this graph?

A one third
B one eighth
C one quarter
D one sixteenth

40. The type of precipitation that reaches Earth's surface depends on the temperature profile in the

A upper stratosphere.
B bottom of the mesosphere.
C upper limit of the thermosphere.
D lower few kilometers of the atmosphere.

41. Natural processes that can cause a climate to change include volcanic eruptions, solar activity, ocean circulation, and

A hurricanes.
B tidal patterns.
C Earth motions.
D thunderstorms.

GO ON

Name ______________________ Date __________ Class ______________

SCREENING TEST *(continued)*

Relative Humidity (percent)

Depression of Wet-bulb Temperature
(Dry-bulb Temperature − Wet-bulb Temperature = Depression of the Wet Bulb)

Relative Humidity Values

Dry-bulb Temperature (°C)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
−20	28																					
−18	40																					
−16	48	0																				
−14	55	11																				
−12	61	23																				
−10	66	33	0																			
−8	71	41	13																			
−6	73	48	20	0																		
−4	77	54	43	11																		
−2	79	58	37	20	1																	
0	81	63	45	28	11																	
2	83	67	51	36	20	6																
4	85	70	56	42	27	14																
6	86	72	59	46	35	22	10	0														
8	87	74	62	51	39	28	17	6														
10	88	76	65	54	43	33	24	13	4													
12	88	78	67	57	48	38	28	19	10	2												
14	89	79	69	60	50	41	33	25	16	8	1											
16	90	80	71	62	54	45	37	29	21	14	7	1										
18	91	81	72	64	56	48	40	33	26	19	12	6	0									
20	91	82	74	66	58	51	44	36	30	23	17	11	5	0								
22	92	83	75	68	60	53	46	40	33	27	21	15	10	4	0							
24	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4	0						
26	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9	5						
28	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12	8	2					
30	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16	12	8	4				
32	93	86	80	73	68	62	56	51	46	41	36	32	27	22	19	14	11	8	4			
34	93	86	81	74	69	63	58	52	48	43	38	34	30	26	22	18	14	11	8	5		
36	94	87	81	75	69	64	59	54	50	44	40	36	32	28	24	21	17	13	10	7	4	
38	94	87	82	76	70	66	60	55	51	46	42	38	34	30	26	23	20	16	13	10	7	5
40	94	89	82	76	71	67	61	57	52	48	44	40	36	33	29	25	22	19	16	13	10	7

42. According to the table, what is the relative humidity when the dry-bulb temperature is 8 and the depression of wet-bulb temperature is 3?

A 6 percent
B 13 percent
C 62 percent
D 72 percent

43. One mineral found in seawater is sodium chloride or

A processed white sugar.
B baking soda.
C household bleach.
D common table salt.

44. According to the plate tectonics theory, the lithosphere is a strong, rigid layer composed of the uppermost mantle and overlying crust. The lithospheric plates

A remain stable for many years until they suddenly shift.
B never change their shape or size.
C move relative to each other at a very slow but continuous rate.
D move through the ocean floor.

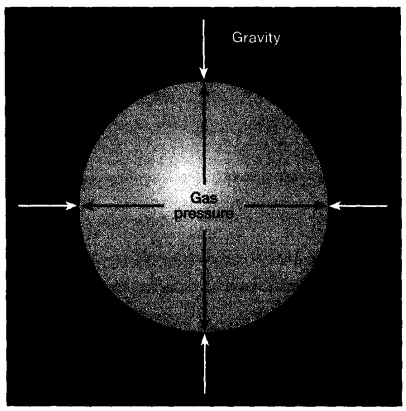
45. When two air masses meet, they form a front. An occluded front occurs when

A a warm front slides over a cold front.
B warm fronts collide, creating thunderstorms.
C an active cold front overtakes a warm front.
D a front does not move but remains stationary.

GO ON

Name ______________________ Date __________ Class ______________

SCREENING TEST *(continued)*

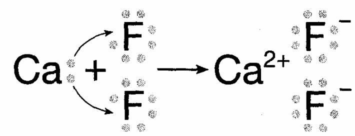


46. The diagram shows the forces acting on a star. Once the forces balance, the star becomes a stable main-sequence star. Which of the following describes the forces at work on the star?

A Gravity and gas pressure are trying to expand it.
B Gas pressure is trying to expand it while gravity is trying to squeeze it.
C Gas pressure is trying compress it.
D Gravity is trying to force it outward while gas pressure is trying to contract it.

47. Hubble's law stating that more distant galaxies have greater red shifts indicates that the universe is

A orbiting.
B shrinking.
C expanding.
D collapsing.



48. The diagram shows what happens when fluorine and calcium react to form the ionic compound fluorite. The dots represent electrons. What happens when fluorite forms?

A Two calcium atoms double their number of electrons.
B Two atoms of fluorite lose eight electrons to calcium.
C One atom of calcium loses two electrons to two atoms of fluorine.
D One atom of fluorine gains one electron from two calcium atoms.

49. Which rock type forms when existing rocks are changed by heat and pressure?

A sedimentary
B igneous
C metamorphic
D none of the above

50. Convergence refers to air in the lower atmosphere flowing together and

A lifting up.
B moving sideways.
C returning to Earth.
D becoming stagnant.

51. One factor that influences seawater density is salinity. What is the other factor?

A depth
B sea life
C atmospheric pressure
D temperature

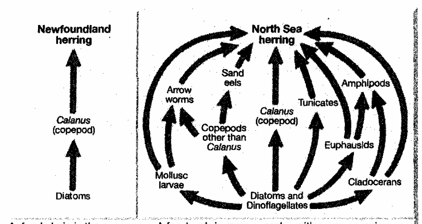
GO ON

Name ______________________ Date ________ Class ____________

SCREENING TEST *(continued)*

Directions: *Use the information and diagram below to answer questions 52 and 53.*

A food chain is the passage of energy along a single path. A food web is a complex series of feeding relationships with many organisms interacting and depending on each other. Animals that feed through a food web rather than a food chain are more likely to survive because they have alternative foods to eat should one of their food sources diminish or disappear.



A food chain is the passage of energy along a single path. A food web is more complex with many organisms interacting and depending on each other.

52. Newfoundland herring eat only copepods. What would happen if copepods disappeared?

A Newfoundland herring would eat sand eels.
B Newfoundland herring's population would increase.
C Newfoundland herring's population would decrease.
D Newfoundland herring would find a new food source.

53. North Sea herring have a better survival chance than Newfoundland herring because North Sea herring are dependent on

A diatoms.
B sand eels.
C a food web.
D a food chain.

54. Which of the following does ***not*** result in mountain building?

A folding
B colliding plates
C weathering
D accretion

55. Which of the following instruments measures air pressure?

A seismograph
B wind vane
C barometer
D anemometer

56. Earth's rotation affects moving objects. All free-moving objects or fluids, including the wind, are deflected to the right of their path of motion in the Northern Hemisphere. In the Southern Hemisphere, they are deflected to the left. This is known as

A Pangaea.
B plate motion.
C the Coriolis effect.
D continental drift.

GO ON

APPENDIX E

MSLQ SURVEY

MSLQ Survey

Student's Name: ___________________________
Date: _________________________

When I take the Earth Science class this summer,

1. I will prefer class work that is challenging so I can learn new things in Earth Science.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

2. Compared with other students in this Earth Science class, I expect to do well.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

3. I get so nervous when I have to take a test I cannot remember the facts I have learned in this Earth Science.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

4. It is important for me to learn what is being taught in this Earth Science class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

5. I like what I am learning in this Earth Science class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

6. I'm certain I can understand the ideas taught in this Earth Science course.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

7. I think I will be able to use what I learn in this Earth Science class as well as in my other classes.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

8. I expect to do very well in this Earth Science class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

9. Compared with others in this class, I think I'm a good student.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

10. I am sure I can do an excellent job on the problems and tasks assigned for this Earth Science class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

11. I have an uneasy, upset feeling when I take a test Earth Science.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

12. I think I will receive a good grade in this Earth Science class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

13. My study skills are excellent compared with others in this class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

14. I think that what we are learning in this class is interesting.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

15. Compared with other students in this class I think I know a great deal about Earth Science.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

16. I know that I will be able to learn the material in this Earth Science class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

17. I worry a great deal about tests.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

18. Understanding Earth Science is important to me.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

19. When I take a test I think about how poorly I am doing.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

20. I ask myself questions to make sure I know the material I have been studying.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

21. When work is hard I either give up or study only the easy parts.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

22. I work on practice exercises and answer end of chapter questions even when I don’t have to.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

23. Even when study materials are dull and uninteresting, I keep working until I finish.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

24. Before I begin studying I think about the things I will need to do to learn.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

25. I often find that I have been reading for class but don’t know what it is all about.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

26. I find that when the teacher is talking I think of other things and don’t really listen to what is being said.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

27. When I’m reading I stop once in a while and go over what I have read.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

28. I work hard to get a good grade even when I don't like a class.

Not at all True of me						Very True of me
1	2	3	4	5	6	7

APPENDIX F

STUDENT RESPONSES

7-26- USE THE SOLAR COOKERS AND START THE EXAM

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To do my work and let the hotdogs cook outside or take them to the lunch room and let them do it.	I had positive input	I encouraged myself.	I talked out loud and showed my peers the difference between my box and theirs
HM	To finish the whole exam or do it tomorrow	Positive	Because it was my final exam	None really
BR	Positive ones	None	Hotdogs- we used our solar cooker to cook the hotdogs	Learning
JS	My choices were if I wanted to eat a hotdog or not.	None	My tasks were easy	I participated in class today.
TS	To use my solar cooker pizza box to make hotdogs	That the hotdogs had started to cook, sweat brown	It was funny and creative and deas with Earth Science the sun	That the hotdogs was a nice experiment
BS	To move the hotdogs in the cafeteria	None	I DK how I was encourgaged	Played with the hotdogs
DC				
LS				
MC				

7-26- USE THE SOLAR COOKERS AND START THE EXAM

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned that the pizza boxes with making them hotdogs don't work using solar energy, I leaned it was hot outside, and I learned that we had to use books (IDK)	A good feedback	I spoke out loud and wrote down notes.	My showing/ comparing my boxes with my classmates and spoke out loud	It was okay time, went by faster	It was science
HM	How to make a hotdog in the sun	Positive	By telling them in the discussion	I didn't today	Yes it was kind fun.	Because it related to science
BR	How to cook hotdogs with solar power	Positive	I didn't have any	Cook hot dog with solar energy	Why, it was fun	IDK
JS	I learned about how to cook hotdogs by using solar power.	Ms. Kennedy said I did good on the first of the exam	I understood everything	I demonstrated by participating	Yes, because they are easy	It showed us how solar power is used
TS	That if it is hot enough outside with the right equipment you can cook a hot dog.	Good job – the suns hitting it on the spot	Spoke out (when outside)	On Test	Yeah, cause I was working with food	Earth Science – using the sun and energy
BS	Nothing took a test	None	The wasn't cause I had nothing to say	By making hot dogs	Sometimes when they are fun	Had to do with solar power
DC						
LS						
MC						

7-26- Use the solar cookers and start the exam

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay	We worked well	Work gets done quicker	Because you should want to hear their input	NA
HM	It was fun because we were outside	That was fun too	Sometimes	Important as mines. Just important as mine. We are on the same level	By using it in the future.
BR	They were cool	Good	Yes	Everything	Positive
JS	The tasks were easy	Didn't interact with a group	Didn't work with a student	To help understand the info better	That I did a good job.
TS	It was cool	Creative	Sure		great
BS	I didn't feel anything	We didn't work with a group or partner	Yes	IDK	Didn't receive none
DC					
LS					
MC					

7-27—The Final Exam

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To stay quiet while taking the test	A positive	I encouraged myself to stay focus, and take my time and do my best	We didn't have a discussion
HM				
BR	To finish my test	None	The last day of summer school and going out to eat	None
JS	I was given many choices on the test	None	The exam was easy so I did it	None
TS				
BS	None, we had a chance to finish our test	None completed my test	By reading over what I had learned	I did not make any today, because we didn't have a group discussion
DC	To take my test	None	Because I remembered some	None
LS	To complete the test and go over your answers	Positive	By the teacher, to stay on task	Completed my exam
MC	None but to do my test	Answer questions	Had to study for about 5 minutes	We didn't have one

7-27—The Final Exam

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	About Earth Science, everything you taught us.	A good one	On paper	On paper	No, took to long, got sleepy, and its boring to be quiet for a long time.	About Earth Science
HM						
BR	NA	NA	NA	By test	Yes, if summer school is almost over	NA
JS	I learned a lot about minerals, soil, weathering and more	I passed my exam	I understood everything	I passed the exam	Yes, because the exam was easy	Our exam is to what we learned today
TS						
BS	In order to past a test you must pay attention and study	None	They weren't because I none on today's assignment	By passing (hopefully)	No, it was sort of hard	We took a test on what we learned all the weeks we were here
DC	My test	None	On paper	My test	Yes, because my test	IDK
LS	NA	Positive	NA	By handing in my test and letting her read it	No, because it was too many questions	Because we had to complete the question on Ch. 1-2-4-5
MC	Different stuff	Good job	Not to play around	Put it in my head and use it for the test	Yes, because it was challenging for me because I acted up in class a lot	It taught me a lesson not to play in class not more

7-27—The Final Exam

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay, got a good one.	Didn't work in partners	Get my work done faster	Didn't hear nothing from my peers	I don't know, didn't get anyway feedback but good job
HM					
BR	It was crazy	NA	Yes	Everything	Important
JS	None	Didn't have group	Didn't work with another student	None of peers input	I felt good that I passed the class
TS					
BS	Nothing	Didn't have any	Didn't have any	IDK It is important to hear what everybody has to say	Did not receive any
DC	Fine	I didn't have one	Sometimes	To know what you know	IDK
LS	I felt it was okay because we didn't do to much writing we just did a lot of reading	NA	Because I don't have to complete all the work by myself	So they want get left out	Positive
MC	I felt real good	We did not have any partners today	Yes, I do like working with another student because it is fun	My peers input is really good	I will just keep being happy

7-10—LECTURE AND PREPARE A POSTER BOARD WITH MINERAL CHARACTERISTICS. PREPARED A JEOPARDY GAME.

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To do my work, and stay on task Oh I had conversation, has a group discussion	We got to do something we got a chance to teach her (teacher) and our classmates	She told us to stay on task, stay focus, she helped us out everything	I learned about the minerals and the different types of minerals. I also learned the properties and characteristics of a mineral. I also learned the mineral groups and the elements of a mineral.
HM	A lot	A lot	I wasn't but I did them	
BR	None	A lot	I wasn't	A little
JS	I was given different options to choose from like how I wanted to do my work		The tasks were easy and simple and I was encouraged by the teacher helping me start off	
TS				
BS				
DC	A lot	None	None	None
LS	To do the work or just get a F. to follow her rules and regulation and stay on task	Good input because I got to teach the class about minerals and the characteristics	The teacher said to stay on task and keep going you doing good	Talked and answered question
MC	None	Atom	Help	I DK

7-10—LECTURE AND PREPARE A POSTER BOARD WITH MINERAL CHARACTERISTICS. PREPARED A JEOPARDY GAME.

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned about the minerals and the different types of minerals. I also learned the properties and characteristics of a mineral. I also learned the mineral groups and the elements of a mineral.	NA	I DK	We presented a poster board	It was okay because I don't know - 4 want fun but at lest I got to make a poster and made it colorful	Because its was taking about minerals and minerals has to deal with Earth Science
HM	I learned a lot about the periodic table	A lot, notes helped		Because I understood it	Yes because it kept me up and it wasn't boring	It was Earth Science
BR	About minerals and rocks , also the Periodic Table	Positive feedback	Yes, I could contribute I was asked questions	Teach the class what I learned	Why not, it was way to much	Learning about minerals
JS	I learned that pure gold is very fragile and it can break if worn, that is why it is mixed with other metals	Different minerals were made3 in different areas with different climates and temperature	She helped me understand the information by correcting me	I wrote the information on a poster board to make an information timeline	I didn't enjoy class cause their was a lot of writing to do	
TS						
BS						
DC	The periodic table and rocks minerals	IDK	On a poster	Presented the information on the poster	We worked in groups	
LS	I learned about the row and periods in the periodic table. And different kind of minerals and characteristic and the properties of minerals	NA		Presented a poster board	Yes, because we got to do a group work and presented and so I felt like we did good	Because we were talking about minerals and matter and we did/t get off subject
MC	I learned about minerals	Notes	good	Answered question	Yes, because I learned good stuff today	Learned more

7-10—LECTURE AND PREPARE A POSTER BOARD WITH MINERAL CHARACTERISTICS. PREPARED A JEOPARDY GAME.

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	I felt it was okay, I learned something new today. Your suppose to learn something new everyday	We got along easy work - maybe cause we already cool or whatever.	Because if you work together as partners the faster you getting (the work goes faster)	They helped me out as well	NA
HM	I felt that they were fair and fun	Normal, we both did work about the same amount	Sure	Very important – we can learn from each other	
BR	It was crazy	We or all of us can talk	Yes		It was important to help us understand
JS	I felt the assignment was easy	My partners helped me out by explaining how to do my work	I liked working with a partner because he helped me out		
TS					
BS					
DC	Fine	Fun and confused	Yes	Somewhat important depending on what they say	IDK
LS	Kind of nervous because I don't like speaking out loud	Very calm because we know what they were doing	Cause we are on the same level. Also I get tired of working by myself	Language, because the audience might not understand what you saying	
MC	Yes, they were good and interesting	No	Yes	No	Yes, we had some that was good

7-17—Games and Graphic Organizers

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To do our work or you couldn't come back to summer school anymore	I helped out by answering questions	Because in a way she tried to make it interesting	Did my work answered questions helped out classmates
HM	To choose what I wanted to do in future lessons	A lot of inputs because I gave my own opinions	I wasn't, I just did	IDK
BR	To be quiet or get in trouble	None	New choices	IDK
JS				
TS	To read or get out	Fall back	I was told I can do it and had a talk for break	I didn't make any because I wasn't in the mood to be bothered
BS				
DC	To do games in class continuing to work	To make our own games	To perform in a group activity	Nothing, asked and answered questions
LS	To participate or leave	To play games	My teacher and peers	I answered questions
MC	Good	It was cool	yes	I told people they could do it.

7-17—Games and Graphic Organizers

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned about fossil fuels, tar sands, alternatives, how to make a game, types of resources, about coal, natural gases and oil.	NA	By the teacher asking questions	Saying the answers out loud and writing it down	Not really don't know the class just boring but making the games was okay	It s Earth Science talked about the environment
HM	I learned mostly about hydroelectric energy	None	I didn't want them to be	By the teacher asking questions	Yes because it was something I wanted to do	Because it was related to science
BR	Alternative energy sources	Positive	Perfectly	Make a game	Yes it was enjoyable	
JS						
TS	Resources – renewable and non renewable oil, coal, natural gases, petroleum	Negative and positive		Notes	It was okay, nobody know how they wanted learn	Talk about science how oil was made and petroleum
BS						
DC	Non renewable and renewable resources	IDK	IDK	In a game	Not really. They didn't catch my attention	IDK
LS	We learned about alternative resources, oil shale, tar sands		By the teacher asking questions	We did a project	No because I kept on talking and it was boring and I didn't want to do it	because we work on what we talking about the alternative energy sources
MC	Tar sands and when coal gets hot it make acid rain	Notes			Yes, because we got to do things (lab)	Because we learn something today

7-17—GAMES AND GRAPHIC ORGANIZERS

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay	We did good	Because get done faster	NA	NA
HM					
BR					
JS					
TS					
BS					
DC					
LS	Good	Good, because we got along an plus we had the same opinions	Because I don't have to do all the work by myself	So that they can get a grade and want be left out	
MC	Good	It was cool	yes	They know what they was doing	Keep it in my head

7-18—SPEAKER, SOLAR ENERGY—HANDS-ON—NOTES (GRAPHIC ORGANIZER) CLASS DISCUSSION

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	Just to do my work, pay attention, not to be rude be respectful, and stop talking and pay attention	Carved in the chalk took down some information	Play games and I guess by the teacher	Work together. talk out loud with the class
HM	To play and participate	A lot of input	Because I know it's a grade	By stating my opinions
BR	A lot	Positive	IDK	NONE
JS	We were given choices on what we had to do	I wrote the info down	I was encouraged by myself because I want to pass class	I mostly listened to what everyone said.
TS	To write notes and play games	Asked questions to the beautician- How her dregs started- do you have to learn everything-Pay-years you have to attend school	Games, good job	For people to shut up and listen and learn
BS	To play a game	Helped play a game	I wasn't	By given a letter when playing a game
DC				
LS	To work on the experiment we did	We carved in the chalk	By teacher	Work together talk out loud with the class
MC	Do hang man		Ms Kennedy kept telling me I could do it	I was smart and gave right answers

7-18—Speaker, Solar Energy—Hands-On—Notes (Graphic Organizer) Class Discussion

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned how long you have to do something that has to do with hair and I learned the solar energy	Positive	I spoke out loud and wrote on paper	Played jeopardy and hangman and said answers out loud	Yes, jeopardy because the time went by faster	Its Earth Science and we talked about science
HM	About cloroxide and dye and how they can break your hair off	Good feedback	By speaking out loud	By working in groups	Yes because we played games	Because they were related to science
BR	Ms. Kennedy, Hair, About acid Rain	Positive	IDK	Do an experiment	Why, it was enjoyable	I know a lot about acid rain
JS	I learned that groups are called columns	The teacher said she was proud of us for being respectful to the visitor		I wrote down the info in my notebook	I did because the task was easy	It helped us understand the info better
TS	Alternative energy sources- formation of mineral deposits	Positive, encouraging	Talking out loud	Answering questions and playing the games	It was okay, I wrote notes and listened	Earth Science, acid rain experiment and games
BS	Alternative energy sources	Positive good	By talking out loud	By playing a game	Yes, cause we played games	We played a game that had to do about what we learned and study
DC						
LS	We learned about the 6 alternative energy sources	Good	By speaking out loud	We played hang man and jeopardy	Yes, because we didn't do so much	Because they were related to Earth Science
MC	About alternative energy sources	Good	Good	IDK	Yes, because we got to have fun	We got to do other stuff

7-18—SPEAKER, SOLAR ENERGY—HANDS-ON—NOTES (GRAPHIC ORGANIZER) CLASS DISCUSSION

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay – want not biggei but its was okay in a way. It was fun cuz you got to joke around	We did good and got along	Because work gets done faster	So your other peers want get left out	NA
HM	It was kinda fun (games)	Good communication	Sometimes	Important as mines	It was positive
BR	Fun	Crazy, positive	Yes	Be respectful	It was positive, It helped
JS	They were easy	I was helped out	Because its easier to do my work with help		I would interpret the info by studying
TS	I didn't have an problem	Little not enough	I worked with Candice – she did not contribute	NA	Felt like I did a good job
BS	Nothing	Fun	Sometimes	A lot	It made me feel like I did a good job
DC					
LS	It was alright and we could of did better with the jeopardy game	Good	So we all could put in different stuff	So they want get left out	NA
MC	Good	Fun	Yes	They were smart	It made me feel like I did a good job

7-19—Problem Solving Within a Group With a Certain Issue

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To stop being smart or I'll go to Ms. Pinkett	Positive	The teacher told us to do our work and I encouraged my own self	I helped out, answered questions, and helped out classmates
HM				
BR	Good, positive choices	Good, positive input about my project	Food	About waste in the stream, lake, basically drinking water
JS	I was given the choice to pick my partner	I explained what I wrote down on my worksheet	Ms. Kennedy helped me out with my task	I was the recorder
TS	To play a game (guess who) – To write notes	I talked about the problem of pollution of school playgrounds	I was lead in the positive direction, good job, you can do it	That pollution is bad for children and our health
BS	Choose a problem we wanted to do	Help Saquon with ideas	I wasn't	Help tell what we can do not to pollute
DC	To state my debate on the environment	To our society of our community	By the working catching my attention and making me wanna know it	In the science way
LS	To do the work or leave	Positive	The teacher she said that I was very smart and I could do it	I help out answering question and other classmates
MC	Do my project	Answered question	I had help	About wood

7-19—PROBLEM SOLVING WITHIN A GROUP WITH A CERTAIN ISSUE

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned about mechanical, chemical weathering. How to make chalk melt down and I learned about frost wedging	A positive feedback	I got to talk about it and write them down	Did a presentation with the group not wrote talked about it	It was okay because time went by faster	We talked abut science and did an experiment
HM						
BR	Weathering (Chemical, Mechanical, rate of Weathering)	Positive feedback	In group work	In a group project	Why, I learn about Weathering	I learn what weathering can do
JS	I learn that the environment is important	I was on task	I shared my answers	I shared my thoughts	No because there was a lot of writing	The tasks helped us understand the environment
TS	That the vinegar (acid rain) destroyed the chalk (buildings)	Positive	We talked about the subject	Writing notes, answering questions	It was ok, I did my work	Earth Science and talked about the air, coal, effecting archeological substance
BS	Mechanical weathering	None	They wasn't	IDK	Yes	
DC	Mechanical and chemical weathering and a person who looks for fossils	People opinion	By me speaking out and my thoughts	By put into 4 way group and being a career type personal and becoming something	Some of them some I like doing, some I IDK	IDK
LS	Weathering, soil and mass movements	Positive	I got to talk about and give information	We did a class group paper and presented in the class	No because all of the people in my group didn't work	Because it was about Earth Science
MC	About geology	I did a good job	Getting smart	About good stuff	Yes because we was talking	Because we all learned something

7-20

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To do my work and be quiet	Positive because I did my work	Myself, I knew I had to get my work done	Helping out my classmates
HM	The choices everyone else had	I had a lot of input	By it being quiet	
BR	A lot, positive choices	Positive, input	By talk about weathering	A pizza box, and a good attitude
JS	I didn't have any choices	None	I was encouraged to finish because I want to finish my project	I shared my answer
TS	To explain what mechanical weathering is and to make a solar cooker	Help classmate, did the project show them how it is done, answered questions	A little help and encouragement	Help classmates with their solar cooker
BS	Make a solar cooker	I helped other people with their project	I wasn't	I helped people
DC	Not really	To say what I knew about mechanical weathering and chemical weathering	I really wasn't encouraged, I just really wanted to know all the effects on earth	I didn't make any
LS	To do the work and get a grade or just don't participate	Positive	By the teacher	I did a pizza box and answered questions
MC	To do a project	Answered question	People told me I could do it	Helped people

7-20

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned about the mechanical and chemical weathering and the 3 processes which are frost wedging, unloading , biological	Good	I talked about them and I wrote them down	On paper and out loud	It was okay time went by faster	Talked about science
HM	I learned mostly about mechanical weather	A lot	By people answering question	By showing what I did (project)	Yes, because it wasn't much bookwork	Because they were related to science
BR	How to make a solar cooker	Positive feedback	By discussing them	Discuss about different weathering	Why, it was fun and enjoyable	About alternate energy source
JS	I learned about mechanical weathering	Ms. Kennedy was proud of us because we were on task	They were shared	demonstrated what I learned by finishing my project	Yes, because it was fun working on the project	They were relevant cause it helped us understand
TS	How to make a solar cooker	Positive, a helpful greeting	When I read my paper on what I thought mechanical weathering was	Helping and answering questions	Sure did it was something amusing	Earth Science- we are using aluminum foil to cook
BS	How to make a solar cooker	Thanks for helping	IDK	Took notes	Yes, because it was educational	Solar energy
DC	All about weathering (chemical and mechanical)	What were the 3 steps to chemical weathering	By speaking out loud	By taking notes	Yes, because I was active and using my mind to something that had caught my attention	The solar oven is a way to use things without electricity and all. Mechanical and chemical weathering is something you see everyday
LS	I learned about the three mechanical weathering and chemical weathering	Positive and negative	We presented well - we worked on a pizza box	We worked on a pizza box	Yes, because we didn't really have nothing to do. Time went by fast	Because we were learning how to do solar cook activity in Earth Science
MC	About mechanical weathering	I did a good job	I did okay	I can do it now	Yes, because It was fun but hard	Because It had to deal with the subject

7-20

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay making the solar thing with the pizza boxes	Did well	Because I get done faster	Do their work I guess	NA
HM	I thought it was alright	I helped a lot of people and it was cool	Sometimes	Important as mines	
BR	It was enjoyable	NA	Yes	Directions	It was helpful
JS	I feel that we have a lot of work to do everyday	I was helped on my project	I like working with another student cause I get help	I was helped out.	That I was on task
TS	Fine, I was cool with it. I had no problems	Okay we helped each other	Briana, Candice, Mick	They helped me finish	Positive helpful
BS	I felt okay	It was good	Yes	A lot	Good
DC	I was happy and fine about it	We worked by ourselves	Sometimes	To see how he/she says and feels about the subject	IDK really
LS	I felt it was kind of bored cause we had to cut and paste on the boxes. Then I felt it was kind of fun because we didn't have a lot of work to do	Good, because we get along very well	Because I'm not use to working with other students, sometimes I like to be independent	Their work, and speech so we can understand them and they no what they are doing and talking about	NA
MC	Good	We both did a good job	Yes, because you have different opinions	I told him he did a good job	We all told each other how good they did

7-21—Lab Activity group Discussion – Observations – Predicted What Would Happen

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To stay on task and not talk so loud	A positive because I stayed focused. Talked about the graham crackers	I told myself to do my work	A good one. Talked about the graham crackers an about all different types of soil
HM	The teacher choices	I had input to the class discussion. I asked and answered questions gave my opinion	I was encouraged because it was a grade	Putting in my opinion
BR	Good choices	Asking questions about weathering and mass movement	What encouraged me was the computer and wanting to listen to my CD player	None today
JS				
TS	To eat and enjoy a project	The graham crackers broke into and the vinegar was shuck up and caused chemical weathering	Good job, that's right	That the rocks broke down into mud or dirt
BS	We got to either choose to work the whole time or get talking time	I got to tell about what happen to the graham crackers and vinegar	By doing an activity/experiment	Helping Lashawn with her questions
DC	None really	To say what I've learned in class about soil	Just by the fact I wanted to know more about it	None really. A little about the sand at the beach
LS	Stay on task and follow directions	Positive because we talked about the graham crackers	By the teacher to finish and stay on going	Answer questions, did my work
MC				

7-21—Lab Activity group Discussion – Observations – Predicted What Would Happen

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned what will happen when you put vinegar on the crackers. Learned about the soil and formation	Positive feedback	Wrote down on paper and had a group discussion with the class	By mouth	Yea because I learned something new	We talked about science
HM	I learned about soil formation, and the characteristics of soil	I received positive feedback	By telling them the students	By answering questions right	Not really, but it wasn't the worst	Because they were related to science
BR	About soil and mass movement	Good, positive feedback	By discussing them	Taking notes about the section	Why, because I had a motivation	Taking notes, I can study them
JS						
TS	How mechanical and chemical weathering changes the rocks composures	Good	I was answering questions and listened to	Putting in my input	Yea, cause it was fun	Showed us the way chemical and mechanical weathering works
BS	About soil and what happen when water falls into rocks	Did a good job	We had a group discussion	By doing an experiment	Yes, cuz it was nice how it ended up	We did an experiment with graham crackers and vinegar and it show us what happens when water falls into cracks
DC	Soil different types and the formations	IDK	By me speaking aloud	On a sheet of paper	Yea, it attracted my attention and I wanted to know more about it	It involved Earth Science
LS	About the characteristics of mineral soil the composition, texture , structure slope, organism, formation , time, climate	Positive	By the teacher and by answering questions and doing my work	Answer question and look and preserve rocks and their cracks and formation	No, because we had a lot of reading and writing to do	Because we did experiment concerning how rocks form and crack
MC						

7-21—LAB ACTIVITY GROUP DISCUSSION – OBSERVATIONS – PREDICTED WHAT WOULD HAPPEN

Relatedness	**1. What did you feel about the assigned tasks?**	**2. Describe your interaction within the group or partner.**	**3. I like working with another student…**	**4. What is the importance of your peers' input?**	**5. How would you interpret the feedback that you received today?**
SH	It was okay got finished faster	Good we got along	Because I fell that my work gets done faster when you work with a partner	Positive input cause they knew what they was talking about as well	I feel happy when you say I am doing a good job. Makes me feel proud
HM	I felt they were o.k.	Its fun working with a partner sometimes	Because the work gets done faster when both of us are contributing	Important as mines	NA
BR	Okay	Nobody today	Yes	Everything	It was positive
JS					
TS	I liked it. Weathering mechanical and chemical weathering	Great, we observed the graham crackers then ate them	Yeah	We all thought the same about the cookies	Good
BS	I felt good about the task	It was fun cause we helped each other	Yes	A whole lot because you want people to listen to you	good
DC	Okay about it	I didn't have one	Sometimes	To see what they know	IDK
LS	I Felt that it was okay but we could have done less reading and writing	Good, because we stay focus and on task most of the time	Because to get see and find but a little more about what they know and learn	Working, skills, level	Good, because she was saying that we were doing good
MC					

7-24—Did a Walk Around the Neighborhood to Collect Soil Samples and Observe Weathering. Group Activity and Discussion about Observations

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	Wasn't given any choices today, I guess just do my work	A positive input	Myself: I told myself to do my work	We didn't have a discussion today. We just talked about RIB and rappers and famous people
HM	To do a project	A lot of input	By knowing it was a grade	Answering other people's questions
BR	Crazy choices	Good input	IDK	learning
JS	None	None	Ms. Kennedy helped me out	none
TS	To go outside and pick up dirt sample and look for chemical and mechanical weathering	That some dirt was thicker than others. Some brown, rocks	Keep examining the dirt's to find more	Doing my assignment
BS				
DC	None	None	I wasn't because I didn't complete it	None
LS	To work on the assignment	Positive	By the teacher, to do my work and stay on task	Nothing, just did a project
MC	To pick up rocks	Helped people	Good job	Asked questions

7-24—Did a Walk Around the Neighborhood to Collect Soil Samples and Observe Weathering. Group Activity and Discussion about Observations

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned about different types of dirt that's outside, and different types of chemical and mechanical weathering that is outside	A good feedback	Wrote down on paper and drew a picture	On a piece of paper and putting the stuff (soil) in a bag	Yea, because we got to do something different and more funnier even though it was not	Because it was science
HM	About horizons	Positive	By people saying my thoughts	By presenting it	Sure	Because they were related to science
BR	Chemical and mechanical weathering	Positive	I didn't have thoughts	Project	Why, I got some exercise	IDK
JS	I learned that there is different types of soil	None	I wrote down the info	I worked hard during class	Yes, because we walked around	It explained weathering
TS	That everywhere there is different kind of texture of dirt	Positive	I was called on	By writing down my example	Yeah, because we wasn't stuck in the class all day	Earth Science we were digging and experimenting in the dirt
BS						
DC	Bout different types of mechanical and chemical weathering outside and the different types of soil	About what we found	I didn't say anything	By putting different soils in a bag and tell about them	Yea it caught my attention	IDK
LS	Different types of dirt and soil	Positive	By the teacher	We did a project and drew pie	Yes cause we did a lot of drawing	Because we were talking about chemical and mechanical weathering
MC	About weathering	Keep working	Did not do so good	Do it again	Yes, it was fun	We knew how to do it

7-24—Did a Walk Around the Neighborhood to Collect Soil Samples and Observe Weathering. Group Activity and Discussion about Observations

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay because we got to do something different instead of read a book	Didn't work with a partner today	Get done faster	Because their input works in the class and because their humans and their opinion counts	
HM	It was kinda okay	Good when both are doing science	sometimes	Important as mines	By using it later for studies
BR	Okay	Good	Yes	Anything she says can be important and help	positive
JS	It was easy	I got help during our assignment	Cause I got help	None	Didn't get feedback
TS	It was cool something different	Alright nice finding different samples of dirt	It was okay	All our opinions counts	Positive
BS					
DC	Not very happy	We didn't have one	sometimes	What they know about that	IDK
LS	I felt it was good because we didn't do a lot of writing	Good	So I want have to do all the work by myself	So they want get left out	Good feedback it was good feedback
MC	Good	Fun	yes	Smart	We all did a good job

7-25—CONSTRUCTED A MODEL OF THE SOIL HORIZONS – EACH DID ONE WITH THE HELP OF EACH OTHER

Autonomy	1. What choices was I given in class?	2. What type of input did I have in class today?	3. How was I encouraged to complete the tasks assigned today?	4. What contributions did I make to the days' discussion?
SH	To do my work	I had a positive input	Myself I told myself to stay on task	A lot of contributions answered some of the questions
HM				
BR				
JS	We had the choice to make our project	I shared my work	I wasn't encouraged today	I shared my thoughts
TS	To make a model of the Earth's soil formation. Make my model the way I wanted	Talked about my model	By working by myself to do my model and write notes	Explained my model and what I did
BS				
DC	To do my presentation or get an F	Explain my picture	Coz, it attracted my attention	None
LS	To participate and complete the exercise	Positive	By the teacher	Answered question and complete the project
MC	To do a project	Answered a question	Help	Helped out

7-25—Constructed a Model of the Soil Horizons – Each Did One with the Help of Each Other

Competence	1. What did I learn today?	2. What type of feedback did I receive today?	3. How were my thoughts acknowledged?	4. How was I able to demonstrate in class what I learned?	5. Did you enjoy working on the assigned tasks? Why or Why not?	6. Explain how the tasks done today were relevant for this class?
SH	I learned the horizons, bed rock and about the soil formation	A good feedback, told me I am smart	On paper, did a project and I spoke out loud	On paper, did a project an spoke out loud	Yep, didn't do much book work today again	Because it is science
HM						
BR						
JS	I learned about the soil	None	I wrote down my thoughts	By doing my work	Yes, cause their easy	It helped us understand
TS	That there are steps in how the soil is formed	Positive, "my model is nice"	When I stood up to present my model	Presenting my model	Yeah, I got to cut and paste	Talk about the Earth's soil
BS						
DC	About soil formation	IDK	By me speaking	A picture	Yeap, it attracted my attention	IDK
LS	Soil formation, horizons	Positive	By the teacher to answer question	By presenting a project	Yes, because we didn't have nothing to do like writing and reading	Because we were talking about 3 soil horizons
MC	About soil formation	Good	Good	Getting smart	Yes, it was fun	We all had fun

7-25—CONSTRUCTED A MODEL OF THE SOIL HORIZONS – EACH DID ONE WITH THE HELP OF EACH OTHER

Relatedness	1. What did you feel about the assigned tasks?	2. Describe your interaction within the group or partner.	3. I like working with another student…	4. What is the importance of your peers' input?	5. How would you interpret the feedback that you received today?
SH	It was okay, because time went by fast	Good worked very well got along	Work gets done quickly	A good one because they didn't need to know I get left out	A good feedback
HM					
BR					
JS	They're easy	None interaction	Its easy work when working with a student	None	Didn't receive feedback
TS	It wasn't hard	Great, I'm a great help	Myself it's great	That all our models relate in some way	Positive
BS					
DC	I felt fine	We didn't have one	Fine	IDK	IDK
LS	I felt it was good	Good	Because we like to work together and work with each other on different stuff	So they won't get left out	positive
MC	Good	Smart	Yes	We all had the same thought	Everybody did something good

APPENDIX G

POST-TEST

Name: ________________

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Which of the following is NOT one of the main areas of Earth Science?

a. geology
b. oceanography
c. astrology
d. astronomy

____ 2. What is the study of the atmosphere and the processes that produce weather and climate?

a. oceanography
b. geology
c. meteorology
d. astronomy

____ 3. The area of Earth Science that examines the physical and biological changes that have occurred in Earth's past is called ____.

a. meteorology
b. oceanography
c. physical geology
d. historical geology

____ 4. According to the nebular hypothesis, our solar system formed from a huge rotating cloud made mostly of ____.

a. carbon and hydrogen
b. helium and hydrogen
c. oxygen and helium
d. nitrogen and oxygen

____ 5. Earth's four major spheres are the ____.

a. hydrosphere, atmosphere, geosphere, and biosphere
b. hydrosphere, atmosphere, lithosphere, and biosphere
c. hydrosphere, asthenosphere, lithosphere, and biosphere
d. hydrosphere, geosphere, lithosphere, and asthenosphere

____ 6. Which of Earth's spheres includes the oceans, groundwater, lakes, and glaciers?

a. the atmosphere
b. the hydrosphere
c. the biosphere
d. the geosphere

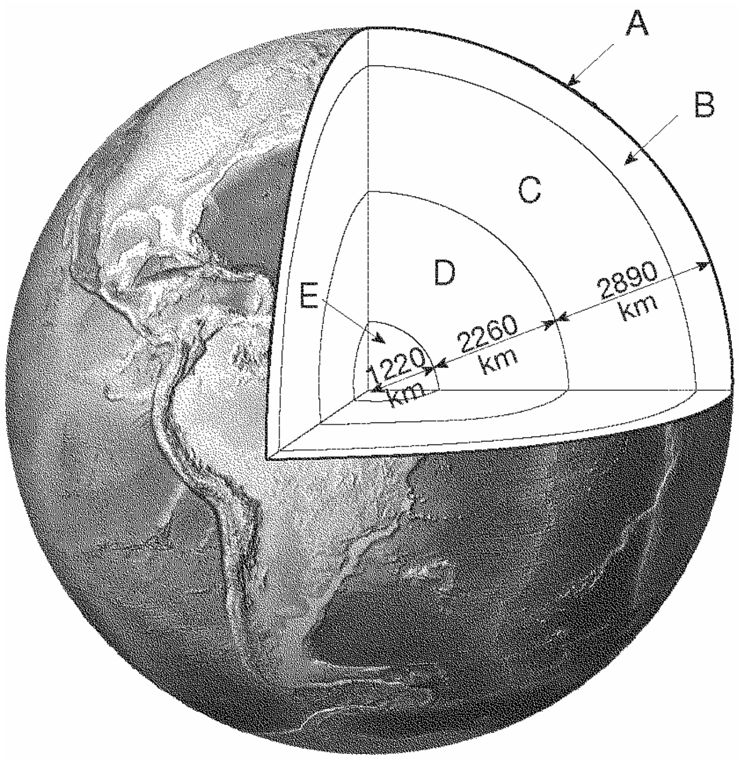


Figure 1-1

____ 7. In Figure 1-1, what layer of Earth's geosphere is labeled A?

a. inner core
b. outer core
c. upper mantle
d. crust

____ 8. In Figure 1-1, what layer of Earth's geosphere is labeled C?

a. crust
b. upper mantle
c. lower mantle
d. outer core

____ 9. What are the three main parts of the geosphere?

a. atmosphere, crust, core
b. crust, mantle, core
c. lithosphere, mantle, core
d. asthenosphere, lithosphere, atmosphere

____ 10. What are the two sources of energy for the Earth system?

a. lightning and the sun
b. the sun and Earth's interior
c. the sun and wind
d. Earth's interior and the winds

____ 11. Which of the following is an environmental hazard created by humans?

a. air pollution
b. flood
c. hurricane
d. earthquake

____ 12. Which of the following is NOT caused by human interactions with the Earth system?

a. air pollution
b. water pollution
c. mountain building
d. deforestation

____ 13. How could the building of a dam affect the Earth system?

a. A dam could cause the flooding of a nearby forest
b. A dam could destroy a fish species that needs swiftly moving water
c. A dam could block the migration of spawning fish
d. all of the above

____ 14. Which of the following is an example of a renewable resource?

a. iron
b. petroleum
c. energy from flowing water
d. coal

____ 15. Resources that can be replenished over a relatively short time span are called ____.

a. fossil fuels
b. renewable resources
c. nonrenewable resources
d. mineral resources

____ 16. Which of the following is NOT an example of a nonrenewable resource?

a. solar energy
b. natural gas
c. copper
d. oil

____ 17. Which of the following is NOT an example of a renewable resource?

a. cotton
b. lumber
c. chicken
d. iron

____ 18. A scientific hypothesis can become a theory if ____.

a. the entire scientific community accepts it
b. the hypothesis is tested extensively and competing hypotheses are eliminated
c. there are no other competing hypotheses
d. the hypothesis can be tested at least once

____ 19. A preliminary untested explanation that tries to explain how or why things happen in the manner observed is a scientific ____.

a. law
b. theory
c. fact
d. hypothesis

____ 20. A scientific idea that is well tested and widely accepted by the scientific community is called a scientific ____.

a. hypothesis
b. inquiry
c. theory
d. method

____ 21. In scientific inquiry, when competing hypotheses have been eliminated, a hypothesis may be elevated to the status of a scientific ____.

a. estimate
b. idea
c. theory
d. truth

Completion

Complete each sentence or statement.

22. The science of ____________________ is traditionally divided into two parts: physical and historical.

23. A group of sciences called ____________________ science deals with Earth and its neighbors in space.

24. The ____________________ hypothesis suggests that our solar system evolved from a huge rotating cloud of dust and gas.

25. Earth can be divided into four major spheres: the hydrosphere, the atmosphere, the ____________________, and the biosphere

26. Earth's weather and ocean circulation are powered by energy from the ____________________.

Short Answer

27. List the traditional subdivisions of Earth Science
28. What elements comprised the solar nebula from which our solar system formed?
29. What are the three major layers of the geosphere?
30. Describe what is meant by the phrase *the Earth system*.
31. What are the two major sources of energy for the Earth system?
32. Define the term *nonrenewable resource*.
33. What is the difference between a scientific hypothesis and a scientific theory?

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. What are the building blocks of minerals?

a. rocks
b. elements
c. isotopes
d. electrons

____ 2. The central region of an atom is called the ____.

a. proton
b. electron
c. nucleus
d. neutron

____ 3. The smallest particle of an element that still retains all the element's properties is a(n) ____.

a. compound
b. atom
c. isotope
d. mineral

____ 4. The mass number of an atom is obtained by totaling the number of ____.

a. electrons and protons
b. electrons and neutrons
c. protons and neutrons
d. neutrons and isotopes

____ 5. The main types of chemical bonds are ____.

a. ionic, covalent, and metallic
b. ionic, compound, and metallic
c. isotopic, covalent, and metallic
d. ionic, covalent, and nonmetallic

____ 6. Compounds with high melting points have ____.

a. covalent bonds
b. metallic bonds
c. ionic bonds
d. no chemical bonds

____ 7. Which of the following is NOT a characteristic of minerals?

a. crystalline structure
b. formed by inorganic processes
c. definite chemical composition
d. either liquid or solid

____ 8. Minerals are classified by ____.

a. color
b. composition
c. size
d. density

Completion
Complete each sentence or statement.

9. The smallest part of an element that still retains the element's properties is a(n) ____________________.

Short Answer

10. List the two most common elements, along with their chemical symbols, found in Earth's continental crust.

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Which of the following is an example of a renewable resource?
a. cotton
b. copper
c. natural gas
d. coal

____ 2. Renewable resources ____.
a. can be replenished over months, years, or decades
b. are all living resources
c. have finite supplies that will one day be used up
d. include iron, natural gas, and copper

____ 3. Which of the following is an example of a nonrenewable resource?
a. cotton
b. trees
c. cattle
d. uranium

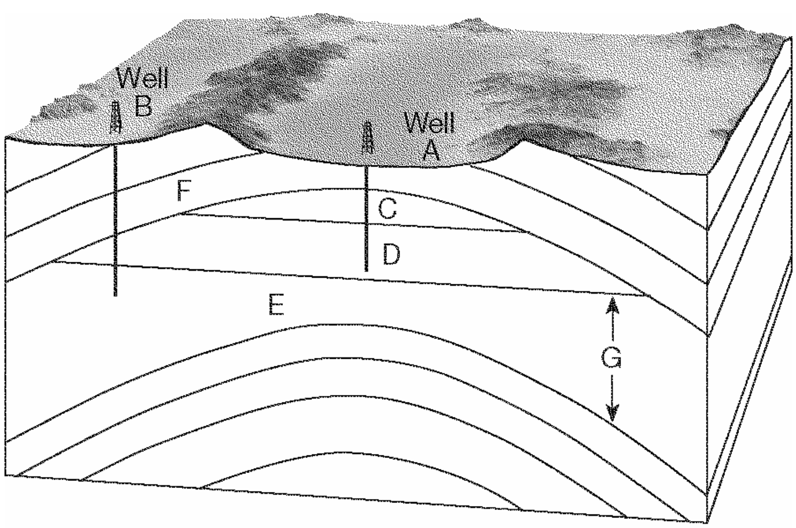


Figure 4-1

____ 4. In which layer will liquid petroleum be found in the oil trap shown in Figure 4-1?
a. layer F
b. layer C
c. layer D
d. layer E

____ 5. Which layer in Figure 4-1 forms the cap rock for the oil trap?
a. layer G
b. layer C
c. layer D
d. layer F

____ 6. Which of the following lists presents forms of coal in the correct order from the first stage of development to the last stage of development?

a. peat, lignite, bituminous, anthracite
b. bituminous, anthracite, peat, lignite
c. anthracite, bituminous, lignite, peat
d. peat, lignite, anthracite, bituminous

____ 7. Which of the following energy resources might replace dwindling petroleum supplies one day?

a. coal and natural gas
b. tar sands and uranium
c. oil shale and tar sands
d. wind and coal

____ 8. Which of the following is a drawback to the use of oil shale to produce energy?

a. Most of the world's oil shale occurs in politically unstable countries.
b. Processing, mining, and waste disposal are expensive.
c. Oil shale occurs only in areas with plentiful water resources for processing.
d. Oil shale can be mined only in arid regions.

____ 9. Placer deposits form when ____.

a. hot, metal-rich fluids cool underground
b. heavy eroded particles settle out of moving water
c. organic matter is compressed over millions of years
d. magma cools in underground chambers

____ 10. Vein deposits are usually produced by ____.

a. cementation and compaction
b. hydrothermal solutions
c. weathering
d. density sorting

____ 11. Which of the following nonmetallic mineral resources is used both as a building material and as an industrial mineral?

a. sulfur
b. limestone
c. graphite
d. corundum

____ 12. The advantages of solar energy include the fact that it is ____.

a. nonrenewable
b. non-polluting
c. expensive
d. absent at night

____ 13. Harnessing the sun's energy to produce heat or electricity is ____.

a. non-polluting
b. inexpensive
c. possible only in coastal areas
d. a major source of air pollution

____ 14. What is one of the drawbacks to the extensive use of solar energy?

a. It is nonrenewable.
b. Necessary equipment and installation are expensive.
c. It is available only at night.
d. It produces toxic pollution.

____ 15. The fuel for nuclear fission in nuclear reactors is ____.

a. petroleum
b. carbon
c. hydrogen
d. uranium

____ 16. Which of the following is a problem associated with the increased use of nuclear energy?

a. cost of building safe nuclear facilities
b. major hazards involved in nuclear waste disposal
c. concern over the possibility of a serious nuclear accident
d. all of the above

____ 17. It is estimated that, in the future, wind energy could produce what percentage of the nation's demand for electricity?

a. 80–85%
b. 5–10%
c. 70–75%
d. 25–30%

____ 18. Wind power generates ____.

a. noise pollution
b. air pollution
c. water pollution
d. soil pollution

____ 19. One problem with wind energy as a major source of electricity is ____.

a. it is nonrenewable
b. it causes major air pollution
c. it does not work during the night
d. the expense of large tracts of land in populated areas

____ 20. Hydroelectric power is produced by ____.

a. falling water that turns a turbine
b. tides that pour through a dam barrier
c. hot water that comes from deep underground
d. electric current that flows across a dam

____ 21. What is the source of geothermal energy?

a. sunlight heating surface waters
b. the splitting of atoms to release energy
c. natural underground reservoirs of steam and hot water
d. very hot minerals deep underground

____ 22. How is tidal power harnessed?

a. by building a dam across a swiftly flowing river
b. by bombarding uranium nuclei with neutrons
c. by building a dam across the mouth of a bay or an estuary in a coastal area
d. by tapping into underground steam reservoirs

____ 23. Fresh water is used for which of the following?

a. drinking
b. growing food
c. cooking
d. all of the above

____ 24. Which of the following is an example of a nonpoint source of fresh water pollution?

a. pesticide runoff from farm fields
b. leaking toxic waste landfill
c. sewage treatment plant
d. factory waste piped into a stream

____ 25. What amount of Earth's total water supply is usable fresh water?

a. 25%
b. less than 1%
c. 50%
d. 75%

____ 26. Which of the following is NOT a land resource?

a. soil
b. forests
c. iron
d. wind

Completion

Complete each sentence or statement.

27. Fossil fuels are ____________________ resources.

28. Coal, petroleum, and natural gas are ____________________.

29. Wind farms are used to produce ____________________.

30. Hydroelectric dams have finite lifetimes because ____________________ builds up behind them.

31. Humans use ____________________ for drinking, cooking, bathing, and to grow food.

Short Answer

32. Explain the difference between renewable and nonrenewable resources.

33. List two of the advantages of solar energy.

34. List the advantages and disadvantages of wind as a source of electricity.

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

____ 1. The process that occurs when physical forces break rock into smaller pieces without changing the rock's chemical composition is called ____.

a. differential weathering
b. chemical weathering
c. mechanical weathering
d. erosion

____ 2. Which of the following weathering processes involves the constant freezing and thawing of water?

a. unloading
b. frost wedging
c. exfoliation
d. spheroidal weathering

____ 3. Which of the following is NOT associated with mechanical weathering?

a. frost wedging
b. unloading
c. biological activity
d. reactions with oxygen

____ 4. What type of mechanical weathering is most common in mountainous regions in the middle latitudes?

a. frost wedging
b. biological activity
c. oxidation
d. unloading

____ 5. The gradual rounding of the corners and edges of angular blocks of rock is called ____.

a. exfoliation
b. unloading
c. spheroidal weathering
d. mechanical weathering

____ 6. Which of the following is the result of chemical weathering?

a. a rock that has been changed into one or more new compounds
b. a rock that has been broken into tiny pieces
c. a rock that has been split in two
d. a rock that has lost its outer layers

____ 7. What would cause the inscription on a marble gravestone to become harder and harder to read over time?

a. frost wedging
b. mechanical weathering
c. exfoliation
d. chemical weathering

____ 8. Which of these factors affects the rate of weathering?

a. climate
b. chemical composition of the exposed rock
c. surface area of the exposed rock
d. all of the above

____ 9. Which of the following is NOT a major component of soil?

a. mineral matter
b. air
c. humus
d. earthworms

____ 10. The factor that has the greatest effect on soil formation is ____.

a. climate
b. parent material
c. time
d. slope orientation

____ 11. A soil’s texture is determined by ____.

a. mineral composition
b. type of humus
c. water content
d. particle size

____ 12. The main source of organic matter in soil is ____.

a. water
b. plants
c. fungi
d. bacteria

____ 13. In which of the following areas will soil formation be greatest?

a. a steep slope in a warm, wet climate
b. a flat area in a cold, wet climate
c. a flat area in a warm, wet climate
d. a north-facing area on a steep slope

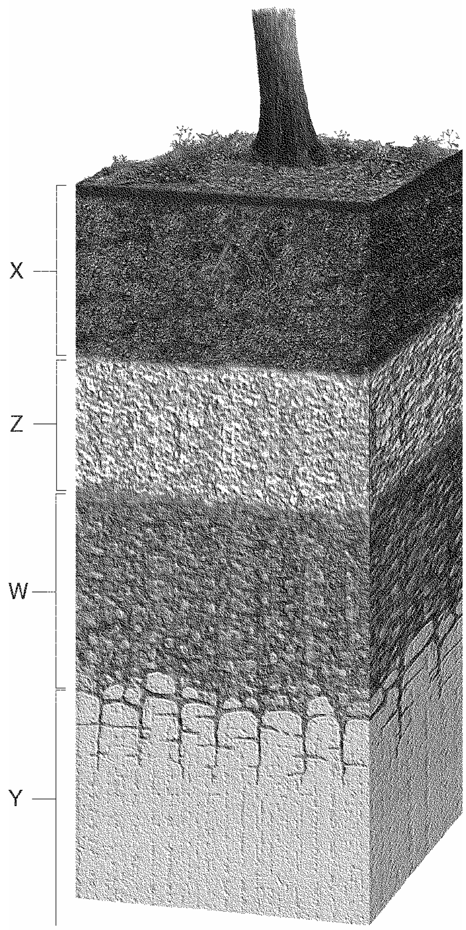


Figure 5-2

____ 14. In Figure 5-2, what is the layer labeled X?

a. the A horizon
b. the B horizon
c. the C horizon
d. the parent horizon

____ 15. In Figure 5-2, what is the layer labeled Y composed of?

a. humus
b. topsoil
c. unweathered parent material
d. subsoil

____ 16. In Figure 5-2, what layer makes up the B horizon?

a. layer X
b. layer Y
c. layer W
d. layer Z

____ 17. What kind of material is found in the C horizon of a soil profile?
a. partially weathered parent material
b. clay particles
c. hardpan
d. mineral and organic matter

____ 18. How are soil horizons ordered from the top of the profile to the bottom?
a. A, C, B
b. A, B, C
c. C, B, A
d. B, A, C

____ 19. The B horizon is also called the ____.
a. topsoil
b. unaltered parent material
c. partially altered parent material
d. subsoil

____ 20. A soil associated with the hot and wet tropics is ____.
a. laterite
b. pedocal
c. pedalfer
d. bedrock soil

____ 21. Laterite soils contain high amounts of ____.
a. organic material
b. iron oxide
c. calcite
d. calcium carbonate

____ 22. Pedalfer soils would most likely be found ____.
a. on an island close to the equator
b. in a tropical rainforest
c. in the dry areas of the western United States
d. in the eastern half of the United States

____ 23. Which of the following is NOT true of laterite soils?
a. They form in the wet tropics.
b. They are red in color.
c. They are enriched in iron oxide.
d. They are very productive agriculturally.

____ 24. What is the force behind mass movements?
a. the sun’s energy
b. flowing water
c. gravity
d. moving ice

____ 25. What factor commonly triggers mass movements?
a. saturation of surface materials with water
b. earthquakes
c. removal of vegetation
d. all of the above

Completion
Complete each sentence or statement.

26. The process called __________________________ involves physical forces that break rock into smaller pieces.
27. In the process of _____________________, water freezes and expands, enlarging cracks in rocks.
28. The process called _____________________ occurs when large masses of igneous rock, particularly granite, begin to break loose like the layers of an onion.
29. The process that changes rock into one or more new compounds is called _____________________.
30. The most important agent of chemical weathering is _____________________.
31. The layer of rock and mineral fragments produced by weathering, and covering nearly all of Earth's land surface, is called _____________________.
32. The portion of the regolith that supports plant growth is called _____________________.
33. Soils are divided into zones known as _____________________.
34. _____________________ is a soil type that has undergone intense chemical weathering in a wet, tropic area, and is rich in iron oxide and aluminum oxides.

APPENDIX H

SCOS EARTH SCIENCE

Science Strands:

Nature of Science: This strand is designed to help students understand the human dimensions of science, the nature of scientific thought, and the role of science in society. The earth and environmental science are particularly rich in examples of science as a human endeavor, its historical perspectives, and the development of to scientific understanding.

Science as a Human Endeavor: Intellectual honesty and ethical tradition are hallmarks of the practice of science. The practice is rooted in accurate data reporting, peer review, and making findings public. This aspect of the nature of science can be implemented by designing instruction that encourages students to work collaboratively in groups to design investigations, formulate hypotheses, collect data, reach conclusions, and present their findings to their classmates.

The content studied in earth/environmental science is an opportunity to present science as the basis for civil engineering, mining, geology, oceanography, astronomy, and the environmental technical trades. The content diversity lets us look at science as a vocation. Scientist and technician are just two of the many careers in which an earth and environmental sciences background is necessary.

Perhaps the most important aspect of this strand is that science is an integral part of society and is therefore relevant to students' lives.

Historical Perspectives: Most scientific knowledge and technological advances develop incrementally from the labors of scientists and inventors. Although science history includes accounts of serendipitous scientific discoveries, most development of scientific concepts and technological innovation occurs in response to a specific problem or conflict. Both great advances and gradual knowledge building in science and technology have profound effects on society. Students should appreciate the scientific thought and effort of the individuals who contributed to these advances. Some examples are Eratosthenes' determination of the size of the earth, Wageners' apparent "fit" of the continents, Kepler's laws of planetary motion, and James Hutton's simple yet powerful idea that the earth history must be explained by what we see happening now. Today, Hutton's uniformity of process principle is used to interpret the structure of landing sites on Mars.

Nature of Scientific Knowledge: Much of what is understood about the nature of science must be explicitly addressed:

- All scientific knowledge is tentative, although many ideas have stood the test of time and are reliable for our use.
- Theories "explain" phenomena that we observe. They are never proved; rather, they represent the most logical explanation based on currently available evidence. Theories just became stronger as more supporting evidence is gathered. They provide a context for further research and give us a basis for prediction. For example, the Theory of Plate Tectonics explains the movement of lithospheric plates.
- Laws are fundamentally different from theories. They are universal generalizations based on observations of the natural world, such as the nature of gravity, the relationship of forces and motion, and the nature of planetary movement. Scientist, in their quest for the best explanations of natural phenomena, employs rigorous methods. Scientific explanations must adhere to the rules of evidence, make predictions, be logical, and be consistent with observations and conclusions. "Explanation of how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but thy are not scientific." (1995, National Science Education Standards)

Science as Inquiry: Inquiry should be the central theme in earth/environmental science. It is an integral part of the learning experience and may be used in both traditional class problems and laboratory experiences. The essence of the inquiry process is to ask question that stimulate students to think critically and to formulate their own questions. Observing, classifying, using numbers, plotting graphs, measuring, inferring, predicting, formulating models, interpreting data, hypothesizing, and experimenting help students build knowledge and communicate what they have learned. Inquiry applies creative thinking to new and unfamiliar situations. Student should learn to design solutions to problems that interest them. This may be accomplished in a variety of ways, but situations that present a discrepant event of ones that challenge students' intuitions have been successful. For example, traditional laws, which emphasize observation of the sun or identification of sun spot activity or the factors that influence the sorting of sediments. Although original student research has often been relegated to a yearly science fair project, continuing student research contributes immensely to their understanding of the process of science and to their problem-solving abilities. Earth/Environmental science provides many opportunities for inquiry. " Why does the location of sunrise or sunset change through the year?' Why are sedimentary rock layers tipped at an angle?" Why do sunspots move faster near the sun's equator?" The processes of inquiry, experimental design, investigation, and analysis are as important a finding the correct answer. Students will acquire much more than facts and manipulative skills; they will learn to be critical thinkers.

Science and Technology: It is impossible to learn science without developing some appreciation of technology. Therefore, this strand has a dual purpose: (a) developing students' knowledge and skills in technological design, and (b) enhancing their understanding of science and technology. The methods of scientific inquiry and technological design share many common elements – objectivity, clear definition of the problem, identification of goals, careful collection of observations and data, data analysis, replication of results, and peer review. Technological design plays an important role in earth/environmental science. Fro example, telescopes, lasers, satellites, transistors, graphing calculators, personal computers, and seismographs have changed our lives, increased our knowledge of earth/environmental science, and improved our understanding of the universe.

Science in Personal and Societal Perspectives: This strand helps students formulate a basic understanding of and implied actions for many issues facing our society.

The fundamental concepts that form the basis for this strand include:

- Population Growth – Students should develop the ability to assess the carrying capacity of a given environment and its implied limits for population growth, as well as how technology allows environment modification to adjust its carrying capacity.
- Environmental Quality – Students should develop an appreciation for factors that influence their need and responsibility to maintain environmental quality, including waste disposal and recycling of limited natural resources. The ability to make wise-use decisions based on cost-risk analysis is an integral part of the study of earth and environmental science. "Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, solve problems, poverty, the role of economic, political, and r3ligious views, and different ways humans view the earth." (1995, National Science Education Standards)
- Natural and Human –Induced Hazards – The study of earth and environmental science encourages students to investigate the effects of natural phenomena o society. This is particularly true of spectacular natural phenomena such as earthquakes, volcanic eruptions, severe weather, and the slow changes in water quality. Students will acquire the ability to assess natural and human induced hazards – ranging from relatively minor risks to catastrophic events with major risk, as well as the accuracy with which these events can be predicted. It is particularly important for student to relate such phenomena to North Carolina and its citizens. Investigations of the economic impact of severe storms an the effectiveness of early warning systems in saving lives an property in North Carolina would be an effective way to implement this strand.
- Science and Technology in Local, National, and Global Challenges – Along with the need to understand the causes and extent of environmental challenges related to natural and man-made phenomena, students should become familiar with the advances proper application of scientific principles and products have brought to environmental enhancements. Topics such as improved energy use, reduced vehicle emissions, and improved crop yields are just some examples of how the proper application of science has improved the quality of life. This strand will help students make rational decisions

in the use of scientific and technological knowledge. "Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology-related challenges. However, understanding science alone will not resolve local, national, or global challenges. Students should understand the appropriateness and value of basic questions "What can happen? - What are the odds? – and How do scientists and engineers know what will happen?" (1995 National Science Education Standards)

COMPETENCY GOAL 1 – The learner will build an understanding of lithospheric materials, processes, changes, and uses with concerns for good stewardship.

Objectives

1.01 Analyze the dependence of the physical properties of minerals on the arrangement and bonding of their atoms.

1.02 Classify the three major groups of rocks according to their origin based on texture, mineral composition and the processes responsible for their formation.

1.03 Assess the importance of the economic development of earth's finite rock, mineral fossil fuel and other natural resources to society and our daily lives:

- Availability
- Geographic distribution.
- Wise use.
- Conservation.
- Recycling.
- Challenge of rehabilitation of previously disturbed lands.

1.04 Analyze the importance of soils.

- Soil use and conservation.
- Products from soil.
- Relate land use capabilities and major type in North Carolina

1.05 Evaluate geologic hazards and their relationship to geologic processes and materials:
- Volcanoes.
- Earthquakes.
- Mass wasting.
- Flooding.

1.06 Interpret topographic, soil, geologic, and other maps and images for:
- The location and identification of soils and rock types.
- The identification of erosional and depositional landforms.
- The evaluation of landforms resulting from tectonic activity.

Competency Goal 2- The learner will develop an understanding of tectonic processes and their human impacts.

Objectives

2.01 Analyze the evidence for the development of the Theory of Plate.
- Tectonics;
- Propelling forces.
- Plate boundary interactions.
- Features of the sea floor.

2.02 Evaluate the forces that propel tectonic plates.

2.03 Analyze the model of the earth's interior resulting from the study of earthquake waves.

2.04 Analyze the nature, location of epicenters, and magnitude of earthquakes;
- Folds.
- Faults.
- Level of seismic activity in North Carolina.

Competency Goal 3 – The learner will build an understanding of the origin and evolution of the earth system.

Objectives

3.01 Interpret the order and impact of events in the geologic past:

- Origin of the earth system.
- Origin of life.
- Relative and absolute dating techniques.
- Statistical models of radioactive decay.
- Diversity of life through time.
- Fossils evidence of past life.
- Evolution/extinction of species.

3.02 Assess evidence for and the influence on the divisions of geologic time of the major geologic events and paleoclimatic changes in global geologic history:

- Uniformitarianism.
- Unconformities.
- Stratigraphic principles.
- Floral and faunal succession.

Competency Goal 4 – The learner will build an understanding of the hydrosphere and its interactions and influences on the lithosphere, the atmosphere, and environmental quality.

Objectives

4.01 Evaluate the stream erosion and depositional processes;

- Land forms resulting from natural erosion, deposition, and mass wasting.
- Formation of stream channels with respect to the work being.
- Done by the stream (i.e. down cuttings, lateral erosion, and transportation).
- Nature and characteristics of sediments.
- Ability of running water to sort sediments.

4.02 Evaluate water beneath the earth's surface:

- Storage and movement.
- Environmental impact of growing human population.
- Impact of building and development.

- Causes of natural and manmade contamination.

4.03 Analyze the mechanisms for generating ocean currents:
- Temperatures.
- Deep ocean circulation.
- Salinity.
- Planetary wind belts.

4.04 Analyze the mechanisms that produce the various types of shorelines and their resultant landforms:
- Nature of underlying geology.
- Long and short term sea-level history.
- Adjacent topography.

4.05 Assess the formation and breaking of waves and their effect on shorelines particularly the North Carolina coast.

4.06 Evaluate environmental issues and solutions for North Carolina's wetlands, inland, and tidal environments:
- Floodplains.
- Fresh and brackish water marsh.
- Estuaries.
- Barriers.
- Inlets.

4.07 Evaluate the phenomena of upwelling in the oceans and its influence on weather.

4.08 Evaluate the ecological services provided by a healthy ocean:
- A carbon sink.
- The largest watershed.
- Climate control.

Competency Goal 5 – The learner will build an understanding of the dynamics and composition of the atmosphere and its local and global processes influencing climate an air quality.

5.01 Analyze the formation of the atmosphere and hydrosphere as a result of the phenomena of out-gassing as the primordial earth cooled.

5.02 Analyze the structure of the atmosphere:
- Temperature.

- Pressure.
- Water vapor.
- Atmospheric transparency.

5.03 Analyze weather systems:
- Movement.
- Humidity.
- Cloud formation.
- Precipitation.

5.04 Analyze atmospheric pressure:
- Planetary wind systems.
- Pressure cells.
- Altitude.
- Local breezes.

5.05 Analyze air masses and the life cycle of weather systems:
- Air masses.
- Frontal systems.
- Hazardous weather.
- Warning systems and their effectiveness.

5.06 Evaluate meteorological observing, analysis, and prediction:
- Worldwide observing systems.
- Meteorological data depiction.

5.07 Analyze the effects of human activity on the environment and the influence of issues on weather and climate.

Competency Goal 6 – The learner will acquire an understanding of the earth in the solar system and its position in the universe.

Objectives

6.01 Analyze the formation of the solar system.

6.02 Analyze planetary motion and the physical laws that explain that motion:
- Rotation.
- Revolution.
- Apparent diurnal motions of the sun and stars.
- Tilt of the earth's axis.
- Parallelism of the earth's axis.

6.03 Evaluate astronomers' use of various instruments to extend their senses:
- Optical telescopes.
- Radio telescopes.
- Spectroscopes.
- Cameras.

6.04 Assess the current scientific theories of the origin of the universe.

6.05 Examine the sources of stellar energies.

6.06 Assess the spectra generated by stars and our sun as indicators of motion:
- Doppler effect.
- Red and blue shifts.

6.07 Evaluate Hubble's Law and the concept of an ever-expanding universe.

6.08 Evaluate the life cycle of stars in the Hertzsprung-Russell Diagram (H-R Diagram).

Competence Goal 7 – the learner will build an understanding of alternative choices facing human societies in their stewardship of the earth.

Objectives

7.01 Analyze the relationship between the potential of technology to improve the quality of life and the possible causes of stress on the environment.

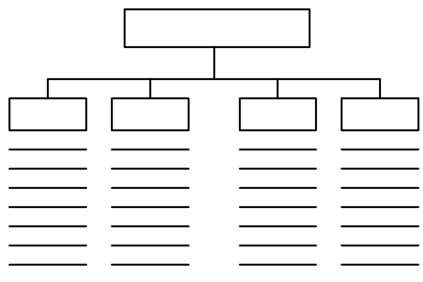
7.02 Analyze the interdependence of Earth's natural resources and systems, including land, air and water, with the need to support human activity and reduce environmental impacts.

7.03 Assess how society weighs the choices of economic progress, population growth and environmental stewardship and selects a balanced responsible course of action.

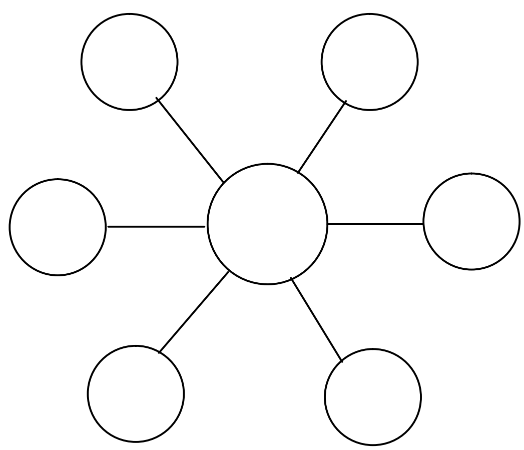
APPENDIX I

GRAPHIC ORGANIZERS

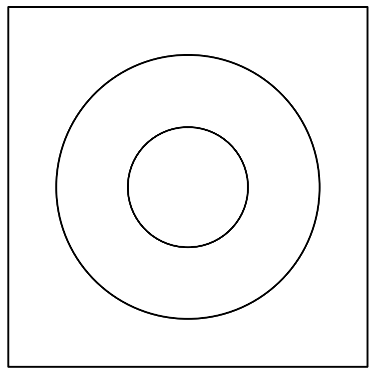
Tree Map



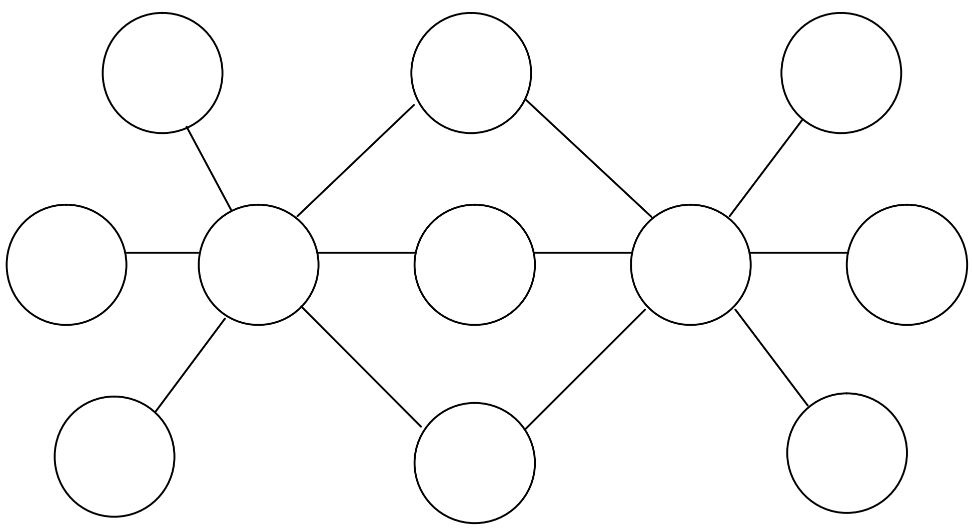
Bubble Map



Circle Map



Double Bubble Map



APPENDIX J

QUIZZES

Quiz 1

1. What is the scientific method? Describe each component.

Quiz 2

1. What is the difference between non-renewable and renewable resources?
2. Name two fossil fuels.
3. What are the four phases of coal?
4. What happens to the coal when it is burned?
5. How is oil and natural gas formed?

Quiz 3

1. What are the two types of weathering?
2. There are three processes of mechanical weathering, give an example of a biological activity.
3. Explain frost wedging.

Quiz 4

1. What is soil?
2. What are the three layers of soil called?
3. Which layer contains organic material?
4. Which layer allows plants to grow?