

Science Interests of Sixth Grade Students

by

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(ABSTRACT)

Authors of some research studies and other concerned citizens have questioned the relevance and appropriateness of the teaching of science as it is currently done for the transescents in the middle schools. Some suggest that teachers merely attempt to teach scientific facts without regard for students' characteristics, needs, interests, and input.

The premise that student input is desirable suggested the need for this investigation of the sixth grade science course. The purposes of this study were:

1. To determine the degree of interest expressed by students in topics and in specific items within topics,
2. To determine differences in the degrees of interest expressed by students of different teachers,

3. To determine differences in the degrees of interest expressed by male and female students in the topics taught,
4. To determine if student interest in science is related to achievement as indicated by final grade in science, and
5. To determine teachers' perceptions of their students' interests in topics and specific items within topics.

A survey was conducted with an instrument that listed all of the science topics covered in the sixth grade course. Beginning seventh grade students were asked to express their interest in each concept and indicate whether they thought they were taught or not taught in sixth grade. They rated each concept as definitely interesting, of some interest, or not interesting. Appropriate statistical procedures were used to analyze the data and the following conclusions were drawn:

1. Students were generally interested in the sixth grade science program. However, for most of the concepts students indicated "some" interest as opposed to "definite" interest.

2. There were significant differences among the levels of interest of students taught by different teachers on five topics: Classifying Animals with Backbones; Classifying Animals without Backbones; Elements and Compounds; Sources of Energy; and Atmosphere, Climates of the World, and Natural Cycles.
3. There were significant differences in the levels of interest between male and female students only on two topics: Life Cycles, Heredity, and Living Things; and Sources of Energy.
4. Student achievement and interest were significantly related only on the topics of Classifying Animals without Backbones; Properties of Light; Sources of Energy; and Electricity and Magnetism.
5. Teachers perceived all the science items to be of "definite" or greater than "some" interest to the students.

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Chapter One

Introduction

Humankind has made remarkable progress in the study of science and in the application of technology which has had huge impacts on our daily lives and the way we interact. Undoubtedly people will continue to vigorously search for additional scientific answers and truths in order to better understand the universe and the world in which they live.

In everyday living, though often unconsciously, people deal with scientific knowledge and issues that affect our present behavior and, indeed, our future existence. As research continues, new developments in science and technology emerge, and the emergence of new knowledge, in turn, has ramifications that directly influence the many decisions humankind will make.

According to Jacobson and Bergman (1987), science is one very important avenue through which "we seek to interpret and understand the world in which we live, it is also a way in which each individual investigates and interprets" (p. 3). Given the premise that science and technology play an important part in our lives, it seems reasonable to explore the level of student interest in science. A review of literature supported the need for this study which

investigated the degree of interest expressed by students in the topics taught in the sixth grade science program.

Children's natural curiosity and inborn proclivity for learning and wondering about their surroundings allow them to explore and demystify multitudes of toys, games, and puzzles they encounter while growing up. Science and technology have been instrumental in the production of those toys, games, and puzzles. Abruscato (1988) points out that universally "it is [the] innate curiosity that is the source of the shortest and yet most powerful words known to humankind - why, what, when, and how - questions that can, in a very real way, broaden and enrich our lives" (p. 2). However, according to Jacobson and Bergman (1987), unfortunately, too many children appear to "lose much of this beautiful curiosity [as] they grow older and move up through elementary school grades and on into the secondary school" (p. 2).

Let us begin with where children learn science in a formal setting. In the elementary school, science is taught in a broad sense with sporadic weekly coverage as reported by several investigators (Conant, 1974; Weiss, 1978; Hurd, 1978; Hurd, 1982). It is in the middle school that science receives a focus with daily instruction on a departmentalized basis for students age 11-14 years. According to the Standards of Learning (SOL) Objectives for Virginia (1983),

students in the middle school years, which are usually thought of as sixth, seventh, and eighth grades, are exposed to a wide range of topics in general, physical and life sciences.

Due to rapid advancements in science and technology, it seems certain that the content taught in the middle schools today or tomorrow will not remain constant. We must prepare students to use processes needed for value judgments, stressful decision-making, and many problems of immediate and future concern. As Yager (1986) suggests, very few programs exist today that promote student ability to grapple with immediate and societal problems. In other words, "in the absence of problems and issues relevant to them, students perceive instruction in the schools and the tasks and responsibilities in everyday life to be quite incongruent" (Heath, 1979, p. 7).

Can we say with great certainty that the modern public school system is actually preparing scientifically literate individuals for the society of the future? As Hurd (1970) pointed out, scientific literacy is a principal goal of science education in the public schools. If there is merit in this goal, then serious concern regarding student awareness is definitely justified in certain areas such as "food supplies, energy sources, population problems, health issues, environmental quality, war and peace, technological

advances, and the value of scientific inquiry" (Hofstein, Scherz & Yager, 1986, p. 22).

Review of the literature relative to science education dramatically points out that much work needs to be done to vigorously promote and achieve scientific literacy in the United States. For example, by examining The Nation at Risk (1983), and Educating Americans for the 21st Century (1983), one cannot help but become aware of an urgent message. These reports paint a gloomy picture of the current situation in science education, and propose that sweeping and drastic changes are necessary "in the breadth of student participation, in our methods and quality of teaching, in the preparation and motivation of our children, in the content of our courses, and in our standards of achievement" (Educating Americans for the 21st Century, 1983, pp. v-vi).

According to Roy (1985), after the Sputnik launch, a colossal aerospace event in 1957, a massive campaign for improving math and science education in our school system was initiated by the academic, science and engineering communities. However, those efforts helped only "the one percent of the population that eventually becomes the scientist/engineer group" (Roy, 1985, p. 14). As Roy (1985) points out, the critical question here is: how to make science education appealing to "non-scientist citizens - the 99 percent who do not go on to become scientists" (p. 14).

After all, the non-scientist citizens live in an era of rapid scientific and technological growth. As a result of new inventions and expeditious improvement in the quality of life, they are in a perpetual state of bombardment by new scientific ideas, concepts, and terminology. Although not training to be scientists, the non-scientist citizens surely need to be scientifically literate in order to function comprehensibly and successfully in the day-to-day conduct of their personal affairs and the society at large.

Perhaps one place to seek some of the answers to some of the problems students and teachers encounter in science education today is the middle school. Usually the middle school is where students first come in contact with daily, structured, departmentalized science instruction. It is at the middle school level of instruction that discussion begins as to what sciences should be taught, in what order should they be studied, and what content is most appropriate for which students.

Over the past two decades, middle school education has been the focus of serious attention and expansive consideration by a wide range of prominent educators (Eichorn, 1966; Alexander, Williams, Compton, Vynce, Prescott & Kealy, 1969; Skinner, 1973; Leeper, 1974; Curtis, 1977; George, 1977; Vars, 1977; Dilg, 1979; Heath, 1979; Klingele, 1979; Alexander, 1981; Toepfer, 1981; Harty et al., 1986).

Throughout its short history, the middle school movement has been different in terms of goals, objectives and philosophy. The major differences have been designed to address the complex nature of adolescent students who attend the middle school. These learners, often referred to as "transescents" (Eichorn, 1966, p. 3) or early adolescents, go through rapid psychological, physical and emotional changes. Transescents are experiencing these changes while the school is attempting to adequately prepare them to meet the challenges encountered in the high school years and thereafter. A good middle school education can help transescents attain their maximum potential meaningfully. This view is also supported by Alexander et al. (1969) that a middle school establishment should "promote maximum individual growth" (p. 85).

General, life, and physical sciences usually constitute the science courses for Virginia students in grades six, seven, and eight, respectively. What is to be taught in these years is ordinarily described and monitored by the state's department of education in the form of accreditation standards. Local school boards then adopt certain textbooks which are deemed compatible with state standards. Such textbooks are used as the main source from which lesson plans and instructional activities are constructed by individual teachers.

The first time students usually encounter science as a daily subject is in the sixth grade. It is clearly important to give students a solid background in science during this initial year which serves as the introduction to all subsequent study of science.

Many educators and concerned parents have asked if today's middle school teaching of science is relevant and appropriate for the transescents or merely an effort to teach scientific facts without regard for students' characteristics, needs and interests. With what certainty can one say that what is taught in the science classrooms in a middle school setting is viewed by students as interesting, practical and useful? For example, the following question recently has been raised: Are we teaching middle school students about nuclear war (Fleisher, 1985)? In the words of Fleisher, a teacher of gifted students in Richmond, Virginia, nuclear war is "one of the more fearsome features of contemporary life" (p. 214).

It is vital to take into account the changing needs of early adolescents as to content relevance as well as the usual pedagogical concerns. Middle school students are concerned with relevance between what is taught in school and their present real life problems. In discussing science for all, Fensham (1987) argues in favor of including in the criteria for science content those aspects of science that

have everyday applications and ones which students will very probably use in their daily lives.

This study was designed to seek student input in order to determine whether topics in the sixth grade science program were perceived as interesting or not interesting to them. The results of this investigation should help sixth grade teachers identify science topics and specific items within topics for pertinent lesson plans that are better suited to the needs and interests of their students.

Adolescents have relevant questions to raise about science during the evolving or transitional stage of their lives. According to Lijnse (1983), ninth and eleventh grade students do maintain a positive view of science. However, this view is presupposed by an emerging notion of science as a prompt solver of "socially oriented problems" (p. 581). Students affix much credence to the concept of the relevance of science. Supporters of the science-technology-society movement in science teaching have recognized this phenomenon. These advocates recommend that lesson plans of science teachers encompass socially relevant problems, "as these are what pupils already know about. In such a view, science teachers should therefore not only make a more relevant selection of the facts and laws to be taught, but also pay more attention to the social role of science" (Lijnse, 1983, p. 581).

The literature pertaining to students' interest in science suggests that little is done in the way of including students' input in the make-up of a science curriculum. Traditionally, textbook authors and staff members of book companies determine the science subject matter that is to be taught to students. However, because of a decline in student interest in science over the last few years and a decrease in enrollment in science classes at the secondary school and university level, science educators have expressed increasing concern about students' opinion and attitude with regard to subject matter in science classes (Lazarowitz, Baird, & Allman, 1985).

Wiles (1964), made a precise observation about the nature of the curriculum and proposed that:

The real curriculum is the one the pupil experiences. Actually the expectations of curriculum designers may be illusions and the teacher's guides and syllabi mere paper representations of hollow hopes. Many curriculum publications describe what should be. Seldom does one tell what is. Almost always the curriculum is portrayed in terms of the vision of the adult. Rarely does anyone even attempt to see the curriculum as it is experienced by the pupil (p. v).

Jacobson and Doran (1986) surveyed ninth graders regarding their opinions on science and school. These researchers stated that educators are quick and ready to "offer their view of the nature of science, school, and learning. But what are the views of the consumers, our students" (p. 59)? Reacting to statements with regard to science and its affects on their lives, ninth graders expressed a positive view of science. For instance, "86 percent of them believed that science is very important for a country's development, [and] 80 percent held that scientific inventions improve our standard of living" (p. 60). Moreover, these students agreed on the relevance of science to everyday life and its paramount utility in resolving routine problems of life. Jacobson and Doran (1986) also reported that their respondents wanted to acquire more knowledge "about the world in which they live" (p. 60). According to these researchers, such an expression of interest by students is considered "a predisposition to the study of science" (p. 60).

A survey by the National Assessment of Educational Progress (NAEP) in 1981-1982 showed that 13-year-old students found science to be enjoyable or interesting (Hueftle, Rakow & Welch, 1983). In their survey of ninth graders, Jacobson and Doran (1986) found that 49 percent of the ninth graders perceived science to be an enjoyable or interesting subject.

However, in another section of the research, the surveyed students emphatically stated that their teachers very rarely employed "their ideas in planning lessons or let them choose the science topics they wanted to study" (Jacobson & Doran, 1986, p. 60).

The premise that student input is desirable suggested the need for the proposed investigation of the sixth grade science course. The purpose of this study was to establish the level of student interest in the science concepts covered in the sixth grade course. To achieve this goal, the following research questions were investigated:

Research Questions

1. What is the degree of interest expressed by students in topics and in specific items within topics in the sixth grade science program?
2. Are there differences in the degrees of interest expressed by students of different teachers in the topics covered in the sixth grade science program?
3. Are there differences in the degrees of interest expressed by male and female students in the topics taught in the sixth grade science program?

4. How is student interest in science related to achievement as indicated by final grade in science?
5. How do science teachers perceive their students' interests in topics and in specific items within topics?

Chapter Two

Review of Previous Research

The purpose of this study was to establish the degree of student interest in the topics covered in the sixth grade science program. Attention will be focused in this chapter on literature that addresses the following topics and a Pilot Study:

- Middle School Students: Who Are They?;
- Student Interest, Attitude, Achievement, and Gender-Related Differences with Respect to Science; and
- The Importance of Surveying Middle School Students.

Middle School Students: Who Are They?

The middle school student is a youngster in a transitional stage of physical and psychological development given such designations as prepubescent, early adolescent, or adolescent. Eichorn (1966) coined the term transescent for this group of typically 11-14 year old students. Transescents go through many physical, social, emotional, and intellectual changes as well as a plethora of variable growth patterns (Eichorn, 1966; Vars, 1967; James, 1980).

Other traits such as short attention span, restlessness, and a considerable degree of distractibility are frequently displayed by transescents. Other than a wide variation in

rate of growth and development, early adolescents also manifest a burgeoning intellectual prowess and an increasing veneer of sophistication combined with a sense of curiosity. Their interests tend toward the real and practical world as opposed to the world of abstraction and conceptualization.

Piagetian concrete operational stage. Most middle school students function well at the Piagetian concrete operational stage. These students attain classification skills, that is, they learn how to classify objects. They also learn negation and reversible thinking. They can perform operations such as combining, separating, multiplying, repeating, substituting, and seriating. However, according to Good (1980), "they cannot yet handle purely abstract material" (p. 50).

Webb (1974) demonstrated in a study that average eleven-year-old boys could not pass any of three formal operational problems he administered. However, these young children showed a striking success on concrete operational problems.

Toepfer (1981) reporting the work of Shayer, Kuchemann, and Wylam (1976) stated that 88% of transescents at age 12 did not have the ability to operate at Piaget's level of formal operations.

Student Interest, Attitude, Achievement, and Gender-Related Differences with Respect to Science

Attempts have been made to assess student attitudes, interests, and perceptions of science (Harms & Yager, 1981; Yager, 1981, 1982; Yager & Penick, 1983; Yager & Bonnstetter, 1983, 1984; Yager & Yager, 1984, 1985). National Science Foundation status studies have contributed significantly to student perceptions of science (Helgeson, Blosser & Howe, 1977; Weiss, 1978; Stake & Easley, 1978).

Interest. The results of some studies indicate that students have stated their preference for a particular science subject. Very few studies were found to investigate students' specific likes and dislikes within science topics. Furthermore, research has been carried out on the overall attitude and interest of secondary school students in science. Talton and Simpson (1986) state that certain factors: self-concept, family, and classroom environment are important predictors of attitude toward science. According to Talton and Simpson (1986),

all [the aforesaid] categories of variable have a positive relationship with attitudes toward science. When each category of variables was examined separately, classroom environment possessed the strongest relationship with attitude toward science. The fact that classroom environment is under direct control of the educator is

significant. By increasing teacher awareness to the important role that classroom environment may play in the formation of student attitudes toward science it may be possible to substantially increase student interest and achievement in science (p. 373).

The importance of taking into account students' interests in science as well as classroom environment is summed up by Talton and Simpson (1986) as follows:

If classrooms are fashioned into stimulating, supporting environments in which students may question and develop their interests in science, an important educational goal may be achieved. Self-concept in science should also improve if students are given a supportive environment in which they can explore the nature of science (p. 373).

According to Simpson (1978), there is evidence to suggest that "the amount of learning that takes place in a science classroom relates positively to the initial interest and attitudes brought to class by the students" (p. 42).

A National Assessment of Educational Progress of students at ages 9, 13, 17 as well as young adults in 1977 and 1982 showed some disturbing results. "Students at these various age levels were asked whether they find science class

fun. Nine-year olds tend to think science is fun, but each year thereafter students view science as less and less enjoyable" (Penick, 1986, p. 65).

Attitude. Researchers (Keeves, 1975; Haladyna & Shaughnessy, 1982, 1983; Walberg, 1968, 1969) reported that student attitudes toward science are related to curriculum and classroom environment.

In a study reported by Yager and Penick (1986), 40% of seventh graders and 30% of eleventh graders agreed that science classes make them feel successful.

Baird, Lazarowitz, and Allman (1984) underscored the notion that today's secondary students are more vocal than ever about what they study. The authors stressed the point that students of today want to learn necessary and relevant knowledge and skills which could assist them in their vocational decisions and in unfolding day-to-day problems. "To the degree the subjects studied are seen as worthwhile then both motivation to learn and trust in the school and teacher may increase" (Baird et al., 1984, p. 47). Moreover, these researchers indicated that in order to provide students with a meaningful experience, they should be able to get involved in the "process of determining the learning objectives which will fit their needs, inclination, and abilities" (Baird et al., 1984, p. 48). This goal can be

achieved when teachers enlist students' help in selecting topics for their curriculum.

Harty, Samuel, and Beall (1986) surveyed 228 sixth-grade students and showed that attitudes toward science, interest in science, and science curiosity are highly related.

In another study, Lazarowitz, Baird, and Allman (1985) showed that interest and lack of interest in science by elementary and secondary school students were due to factors associated with affective domain, students pragmatic needs, and cognitive domain. The authors of this research recommended "a careful selection of contents and their relation to students' needs" (p. 672).

Koballa and Rice (1985) investigated strategies for improving attitudes toward science. They recommended, among other things, that teachers should identify unique students' needs, be aware of present student attitudes and skills, and involve students in the process of "sciencing."

Numerous researchers have documented declines in attitude toward science during middle and junior high school (Disinger & Mayer, 1974; Bohardt, 1975; Randall, 1975; Ayers & Price, 1975; Haladyna & Shaughnessy, 1982). Furthermore, James and Smith (1985) studied alienation of students from science in grades 4-12. Alienation was defined in terms of declining science subject preference and attitude scores of students in cross-sectional samples of adjacent grade levels.

The data from this study showed that the greatest decline occurred between sixth and seventh grades.

Simpson and Oliver (1985) reported that from the sixth grade to the eighth grade students' positive attitude toward science as well as their motivation to achieve in science invariably declined. This investigation confirmed earlier findings regarding a decline of attitude toward science among adolescents. Yager and Yager (1985) reported that negative student attitudes toward science increased by grade level. However, Simpson and Oliver (1985) stated that significantly more positive attitudes toward science were displayed by males than females across grades six to ten.

Achievement. Some of the earlier researchers investigated the factors that influence science achievement, and it was found that student interest tends to be related to science achievement (Koelsche & Newberry, 1971; Kempa & Dube, 1974). Rothberg (1984) and Rakow, Welch, and Hueftle (1984) reported that achievement scores in science have declined nationally. Blosser (1984) stated that students' interest and attitude are among factors that influence their achievement in science, and that need to be carefully considered. These findings were further substantiated by Harty, Beall, and Scharmann (1985) who found that there is a significant positive correlation between science achievement and interest in science.

Gender-Related Differences. Several investigators have reported that males are more highly motivated than females to achieve in science (Boalt, Lantz & Herlin, 1973; Fish, 1979; Ward, 1979; Peterson, Kauchak & Yaakobi, 1980; Handely & Morse, 1983; Baker, 1983; Suchner, Miller & Shanks, 1983). However, Simpson and Oliver (1985) reported that across grades six through ten female students were significantly more highly motivated to achieve in science than male students. Aiken (1971) as well as Sells (1978), and Fennema (1979) reported that males and females had similar science achievement scores in elementary school. However, females were outscored by males significantly in secondary school. Sadker and Sadker (1974) reported that in primary grades females did as well as, or in certain situations somewhat better than, males but by high school fell behind their male counterparts. According to Gardner (1975) and Kelly (1978), females disliked physics and chemistry and favored biology to some extent.

Similar attitudes toward science were documented among males and females in the lower grades (Ernest, 1976). However, Ernest (1976) found that females had begun to dislike science right before reaching adolescence. Keys and Ormerod (1977a) reported that girls preferred more life science subjects (biology and human body and health), while boys expressed a slight preference for physical science

subjects (physics, chemistry, atomic structure, and astronomy). According to Keys and Ormerod (1977b), perceptions of subject difficulty affect girls more than boys with respect to science subject preferences and choices. Keys and Ormerod (1977b) presented this rationale as a possible explanation of why physics and chemistry are preferred by males.

In a study conducted by Lazarowitz and Hertz-Lazarowitz (1979), it was found that junior high school boys tend to choose subjects such as physics, electricity, chemistry, and zoology, while girls tend to select plants, human body, and zoology. Jaus (1981) reported that, in grades three through six, girls' interests in science and science-oriented careers are equal to those of boys.

Similar findings were reported by Baird, et al. (1984) who investigated whether the preferences of junior and senior high school students in science subjects were related to the type of school, age, or gender. These researchers reported that girls preferred more zoology, human body and health, ecology, and botany. On the contrary, boys preferred more astronomy, chemistry, physics, atomic structure, and energy. No significant differences between boys and girls were found in the science subjects such as earth science, general biology, and general science.

In a recent study regarding science anxiety and science achievement among males and females, Chiarelott and Czerniak (1987) reported that females are consistently more anxious than males about learning science and science-related activities across grades four, sixth, eight, and nine. Chiarelott and Czerniak (1987) clearly showed that higher anxiety and lower achievement are linked with regard to students' performance in science.

Finally, addressing the issue of why students fail to learn science and what to do about it, Rossmann (1983) stated that children's natural fervor for learning science is quashed by the manner in which the subject is taught. Rossmann (1983) asserted that "showing kids how to apply their own unique perspectives to the world is perhaps the best way to channel their intelligence and creativity into this rewarding subject" (p. 77).

The author concludes that the information presented in the literature suggests the need for student input in the selection of science content. It matters to today's students that the knowledge they acquire in the science class is helpful to them in handling relevant daily problems more effectively. A sound and pertinent knowledge of general science can also help students understand better the world they are living in. That being the case, it is essential that science educators be aware of the vicissitudes in achievement

motivation of transescents. After all, effective and relevant instruction with a positive outcome are the optimum goals for which science educators strive.

The Importance of Surveying Middle School Students

Curriculum writers and researchers have long maintained a universal and fundamental assumption that student interests can be nurtured with proper direction and careful supervision. To improve the quality of science education and to foster student interest in science, an educator must seek novel and inventive approaches and be continuously alert to the ever-changing societal demands and complexities directly affecting our young learners. Yager and Penick (1984) stated that "if we are truly to influence and improve science education, we must place students at the forefront of our thinking" (p.143).

Referring to the 1978 results of the science assessment by the National Assessment of Educational Progress (NAEP), Yager and Penick (1984) reported that few students had any input in deciding the science content they learned.

On the question of why bother to survey middle school students, Overly, Kinghorn, and Preston (1972) who are strong proponents of student involvement state that "the middle school must adapt now to the demands of society and reflect the social changes that take place" (p. 235). Vars (1980)

state that student feedback is "directly in tune with the needs, problems, and concerns of today's transescents" (p. 354).

Overly et al. (1972) continue with the argument that middle school students should be encouraged by their teachers to get concerned about the community and the nation, not in a fault-finding manner, but in a fashion whereby constructive solutions are suggested to local as well as national problems. These authors, in their assertions concerning responsibility and involvement in the instructional process, suggested the following:

All instructional activities must be examined for meaning and relevance in the real world of the middle school student The temptation is always great for middle school staff members to say that they know what is best for students or that students are making poor or wrong choices. When the temptation to make such value judgments occurs, the staff must go back and examine what they believe about school, about the learning process, and what it is they are trying to accomplish in the middle school. Is acquiring facts of paramount concern; or is it the process of education, the involvement of students, and the

attitudes of students toward learning that are the real goals? (p. 240).

According to Butts (1982), further research is surely needed in order to establish manifestly validated goals and sound content for targeted populations of students.

Vars (1980) stated that student feedback on matters of curriculum is "directly in tune with the needs, problems, and concerns of today's transescents" (p. 354).

How much difference does it make to a sixth grader if general science is interesting or not? Benjamin Bloom's (1976) findings suggest that student interest in science is related to achievement. Bloom's research showed that interest generally accounted for 20-25 percent of the variance in academic achievement in science.

Harms and Yager (1981) showed in their research entitled Project Synthesis, that what 90 percent of students need and want does not match what the science curriculum offers. They also stated that science teaching today, ultimately, prepares students for college, and not much teaching science for their immediate needs goes on. Since not every high school graduate attends college, Harms and Yager questioned whether we are truly addressing the needs of a significant majority of students who don't go to college. They noted that textbooks are, most often, used as rigid course outlines. Not

much deviation from this established pattern has been observed.

Skinner and Barcikowski (1973) explored students' interest in various science disciplines. Such a broad approach produced little information on specific likes and dislikes within a curricular area. Understanding of students' specific interest in science is information critical for teaching children.

To recapitulate, the review of literature on students' interest in science clearly shows no extensive research on their interest in specific science items within topics. In the past, students' overall affective reaction to science has been measured.

Given the physical and psychological characteristics of sixth graders, it seems evident that there is a need for exploring and, subsequently, delineating specific general science content areas of definite interest and relevance to this age group.

The present study is designed to explore student interests in a variety of specific general science topics in sixth grade. On the basis of expressed student interests, recommendations will be made on specific areas of general science that should be revised and expanded to accommodate student needs. Finally, in view of student interests,

recommendations will be made that would guide the selection of textbooks for the sixth grade science course.

Pilot Study

A pilot study was conducted to investigate the feasibility of establishing the degree of interest expressed by sixth grade students in the science concepts included in the curriculum. The subjects in this study were 78 sixth grade students attending a middle school in Montgomery County, Virginia, during the 1985-86 school year.

Instrument

A 100-item instrument, the Survey of Student Interest in Sixth Grade Science, was designed to measure students' interest in 13 areas of science and specific items within topics.

The Heath Science: Level 6 (Barufaldi, Ladd & Moses, 1981) textbook, student's edition and teacher's edition (1981) were used as the main source of the 100 items for the instrument, because this textbook was used in the instruction of the students involved in the study. The order in which the twelve topics appear in the textbook was duplicated in the instrument. Only topic 13, Our Solar System and Gravitational Force, did not exist in the Science textbook. Because it is listed in the Montgomery County Curriculum Guide for sixth

grade science, it was added to the topic list. The following textbooks were used to prepare the items for topic 13: Heath Science: Understanding Your Environment (Mallinson, Mallinson, Brown & Smallwood, 1975); and Holt Science (Abruscato, Fossaceca, Hassard & Peck, 1986). The items included in the instrument were consistent with the Standards of Learning Objectives prescribed by the Commonwealth of Virginia Department of Education in January 1983 (see Appendix A for detail).

Response Format

Instructions for the Pilot Study instrument requested that students rate specific science items within topics according to the following scale:

- 1 = definitely interesting,
- 2 = of some interest, or
- 3 = boring.

Also, students could mark any of the following choices:

- 4 = I don't remember whether this item was taught or not.
- 5 = This item was not taught.
- 6 = I can't say whether this item was interesting or not.

Prior to the use of the instrument in the Pilot Study, a group of 10 average to upper ability sixth grade students

were interviewed to assess their level of comprehension of each item. Based on these students' recommendations, certain items were modified to make them more comprehensible for sixth grade students.

Fry's Readability Formula (Fry, 1972, p. 232; 1977, p. 217) indicated a 6.7 grade reading level. Because the instrument was to be administered to students who had completed sixth grade, this readability level was considered appropriate.

When the responses were summed over the entire instrument, the resulting internal consistency reliability estimate was over .9 for both halves of the instrument. Therefore, it was assumed that the subscale averages would be sufficiently reliable for the purposes of this study.

Procedure

A group of 78 sixth grade students participated in the study near the end of the 1985-86 school year. These students were volunteered by two general science teachers in a local middle school. To reduce fatigue for the students, the 100 item instrument was split into two parts (1-47, 48-100) and administered on two consecutive days for a period of 30 minutes each day. Students were asked to circle their choices directly on the instrument.

Results and Discussion

The statistical analysis of the Pilot Study data showed that students have a wide range of interest in various General Science topics.

In Table 1 means for each topic are arranged from the most interesting to the least interesting. The scale of 1 = definitely interesting, 2 = of some interest, and 3 = boring, was used by the students. The most interesting topic was Our Solar System and Gravitational Force (1.55), and the least interesting topic was the Atmosphere and the Climates of the World (2.09).

Furthermore, the Pilot Study revealed that some items were more interesting to the students than others. In Table 2 mean response levels for representative items in the Pilot Study are shown.

Table 1

Sixth Grade Students' Levels of Interest
in the Specified Science Topics in the Pilot Study

<u>Topic No.</u>	<u>Topic Title</u>	<u>Mean</u> *
13	Our Solar System and Gravitational Force	1.55
10	Communications	1.71
6	Electricity and Magnetism	1.72
8	Properties of Light	1.79
5	Elements and Compounds	1.81
9	Light and Vision	1.92
7	Sources of Energy	1.93
4	Life Cycles	1.94
3	Classifying Plants	1.99
2	Classifying Animals without Backbones	2.01
12	Energy for Living Things	2.03
1	Classifying Animals with Backbones	2.08
11	Atmosphere and the Climates of the World	2.09

* Scale: 1 = definitely interesting; 2 = of some interest;
3 = boring.

Table 2

Mean Response Levels of Sample Items
in the Pilot Study

<u>Item</u>	<u>Mean *</u>
Temperature and precipitation	1.46
Tides and what causes them	1.49
Color and light	1.53
Computers and their impacts	1.55
Current electricity	1.58
How to make an electromagnet	1.62
The earth's revolution and rotation	1.64
Oxidation	1.73
Reflection	1.78
Fusion	1.86
Conductors and insulators	1.89
Nearsightedness	1.92
Conifers	1.95
Lichens	2.00
Energy and its forms	2.10
Dicot plants	2.17
Climate, temperature, and precipitation	2.25
Fish and its features	2.30

*Scale: 1 = definitely interesting; 2 = of some interest;
3 = boring

The Outcome of the Pilot Study

Students expressed varying levels of interest in each topic in the general science course (Table 1). The Solar System was the most interesting and Atmosphere and Climates of the World was the least interesting. Furthermore, students perceived specific items within science topics differently, that is, a certain variation existed in the degrees of interest expressed by students in the concepts taught.

The Pilot Study showed the feasibility of taking the approach used to determine levels of student interest in topics taught in the sixth grade science program. Several modifications were made in the procedure used in the Final Study as a result of the experience gained in the Pilot Study. These modifications are described in the procedure section of this dissertation.

Chapter Three

Methodology for This Study

Subjects

In this study, 529 beginning seventh grade students who were taught by ten different teachers while attending four middle schools in Montgomery County, Virginia, in the 1987-88 school year served as the subjects who were tested. Permission was obtained from the Montgomery County School Board to conduct the study in the middle schools of the county.

Instrument

The instrument, Survey of Student Interest in Sixth Grade Science, was divided into thirteen areas and designed to measure students' interests in general science topics and specific items within topics covered in grade six. After the Pilot Study, modifications were made in the wording of some items in the instrument. Some of the long items which were a combination of several science concepts were broken into separate items to render them more lucid and precise. As a result, the instrument for the final collection of data was expanded to 122 items to better represent the broad scope of general science.

In the Pilot Study, students indicated on the instrument whether they found specific items

1 = definitely interesting,

2 = of some interest, or

3 = boring.

Also, students could mark any of the following choices:

4 = I don't remember whether this item was taught
or not.

5 = This item was not taught.

6 = I can't say whether this item was interesting
or not.

The responses available for student choice limited the respondents' ability to indicate potential interest in a topic not perceived as taught. In the revised instrument, after reading an item, students were instructed to select either choice A or choice B and then to select subchoice 1, 2, or 3 as illustrated below:

____A. It was taught, and it was

1 = definitely interesting.

2 = of some interest.

3 = not interesting.

____B. It wasn't taught, but would be

1 = definitely interesting.

2 = of some interest.

3 = not interesting. (see Appendix B)

B (1, 2, 3) correspond to B (8, 9, 10) on the instrument.

Furthermore, five additional science topics, identified as Other Topics, and a brief description of each were included in the revised addition for the following reasons:

1. They were listed in the 1987 Montgomery County Science Curriculum Guide.
2. They were addressed in some other sixth grade science textbooks (Mallinson et al., 1975; Abruscato et al., 1986).
3. To give students an opportunity to express their views on a wide range of science concepts that were not covered in the SOL Objectives or Heath Science Level 6 (Barufaldi, Ladd & Moses, 1981) currently used in Montgomery County.

The additional science topics were referred to as Enrichment Topics in the Montgomery County Science Curriculum Guide and included Geology, Oceanography, Flight and the Space Program, Microscopes, and Simple Machines. In the instrument these topics were listed under the title of Other Topics to avoid potential biases that might have possibly resulted from the use of the word enrichment.

Procedure

The instrument was divided in two forms: Form A contained original items 1-66 and Form B contained original items 67-132 (printed as 1-66 in the instrument). In both halves of the instrument, items 62-66 covered the Other Topics. An opscan answer sheet was attached to each form of the instrument with the Form type premarked on the opscan sheet. Students were asked to write their name, gender, and their sixth grade science teachers' name on the opscan sheet.

The researcher arranged the two forms of the instrument (Forms A and B) in an alternating sequence before distribution. This ensured that no two subjects had identical forms if they were seated beside each other. Consequently, it was not necessary to use the two-day administration of the two-halves of the instrument that was used for the Pilot Study. The reasons for the administration of the instrument in two halves using intact content categories were as follows:

- (a) The length of the instrument was shortened.
- (b) Student fatigue was minimized.
- (c) The sample size was reasonably large enough ($n=529$) which allowed for over 200 students to mark each half of the Instrument.
- (d) Students were allowed to bring to mind the whole facet of a topic. This approach permitted students to

consider all of the areas of a topic and express their opinion on the whole picture as opposed to isolated bits of information pertaining to a topic. This context consideration outweighed any statistical considerations relating to sampling adequacy.

The input from 442 students was included in the final analyses of the data. A total of 231 students completed Form A, and 211 students completed Form B of the instrument. The input from 87 seventh grade repeaters and transfer students from outside the county who were taught general science under a different program were excluded from the study. This procedure was used to remove extraneous influences and biases in this research.

Only those students' files for whom parental permission letters were returned were accessed. Of the 442 subjects' responses used for the data analyses for Research Questions 1, 2, 3, and 5, 310 were included in the analysis for Research Question 4. The letter grades were marked on the opscan sheet by the researcher.

The survey was administered during one science class period. This approach minimized the interruption of the science teachers' instructional plans.

The Final Study involved the collection of data soon after the beginning of the 1987-1988 school year. The reason

for this approach was to reduce the impact of the recency effect of science content covered by students.

Results

The following statistical analyses are presented in Chapter Four:

1. Mean, frequency, and percentage of total showing degree of interest for each item perceived as Taught and as Not Taught by the students,
2. Mean frequency, and standard deviation showing degree of interest for each topic perceived as Taught and as Not Taught by the students,
3. Statistical measures showing differences in the degree of interest expressed by students of different teachers in the topics covered in the sixth grade science program.
4. Measures of relationship between male interests and female interests with respect to specific science topics,
5. Measures of relationship between sixth grade students' achievement as indicated by final grade

in science with their mean interest across all thirteen topics,

6. Mean, frequency, and percentage of total for each item as well as mean, frequency, and standard deviation for each topic showing teachers' perception of students' interest,
7. Mean, frequency, and standard deviation showing degree of interest for each Other Topic (i.e. Enrichment Topic) perceived as Taught and as Not Taught by the students.

Chapter Four

Results

The premise that student input is desirable suggested the need for the proposed investigation of the sixth grade science course. The purpose of this study was to investigate and establish the degree of interest expressed by sixth grade science students in the concepts covered in the science course. To accomplish this goal, the following questions were investigated:

1. What is the degree of interest expressed by students in topics and in specific items within topics in the sixth grade science program?
2. Are there differences in the degrees of interest expressed by students of different teachers in the topics covered in the sixth grade science program?
3. Are there differences in the degrees of interest expressed by male and female students in the topics taught in the sixth grade science program?
4. How is student interest in science related to achievement as indicated by final grade in science?

5. How do science teachers perceive their students' interests in topics and in specific items within topics?

Research Question 1

Sixth grade students' interests in science topics and specific items within topics were investigated. Students expressed their interest or lack of interest in the items that were perceived as taught or not taught in the course of the sixth grade general science. Means, frequencies, and percentages of the specific items that were perceived as Taught or Not Taught are reported in Tables 3-15.

Tables 3-15 are composed of the following General Science topics: Classifying Animals with Backbones; Classifying Animals without Backbones; Life Cycles, Heredity and Living Things; Elements and Compounds; Communications; Properties of Light; Our Solar System and Gravitational Force; Classifying Plants; Sources of Energy; Electricity and Magnetism; Light and Vision; Atmosphere, Climates of the World, and Natural Cycles; and Energy for Living Things.

Each Table (3-15) contains the actual specific science items that make up a particular general science

topic. The means of the specific science items were used to create a single mean for each topic.

Procedure Used To Identify Significant Items in Tables 3-15

Under the heading of Perceived As Taught, if category 3 (not interesting) equals or exceeds 35%, that item is marked with a double asterisk (**). This implies that students were not very interested in that item which they perceived as being covered in the science course.

On the other hand, under the heading of Perceived As Not Taught, an item is marked with a plus (+) sign if two conditions existed.

(a) The cumulative frequency of categories 1, 2, and 3 is 25 or higher; and

(b) category 3 (not interesting) equals or exceeds 35%.

The plus sign (+) will imply that the particular item was not perceived as taught but would have not been interesting if it had been covered. The reason for the use of the first condition is that 25 generally constitutes a classroom size. The significance of 35% is that in a classroom of 25 students, more than 8 students would have to consider an item not interesting when perceived as taught or as not taught to yield this 35% figure. It does not seem that instruction is

effective if the interests of one third of the students are disregarded.

Table 3

Summary of Students' Responses for
Classifying Animals with Backbones

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A1	1	35	16	2.1	4	36	2.0
	2	130	59		3	27	
	3	55	25		4	36	
A2**	1	38	18	2.2	7	33	1.9
	2	94	45		9	43	
	3	78	37		5	24	
A3	1	51	25	2.0	7	25	2.0
	2	94	47		14	50	
	3	56	28		7	25	
A4	1	49	26	2.1	16	40	1.8
	2	79	42		15	37	
	3	62	33		9	22	
A5**	1	36	20	2.2	13	29	1.9
	2	78	42		22	49	
	3	71	38		10	22	
A6	1	46	24	2.0	6	15	2.1
	2	91	47		22	56	
	3	55	29		11	28	
A7	1	46	21	2.1	5	31	2.1
	2	103	48		5	31	
	3	66	31		6	38	
A8**	1	37	17	2.2	3	20	2.1
	2	101	47		7	47	
	3	76	36		5	33	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

** not an interesting item when perceived as taught

Table 4

Summary of Students' Responses for
Classifying Animals without Backbones

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A9** +	1	47	23	2.1	9	32	2.1
	2	81	40		7	25	
	3	74	37		12	43	
A10+	1	47	24	2.1	13	36	2.1
	2	83	43		8	22	
	3	64	33		15	42	
A11	1	48	26	2.0	15	33	2.0
	2	78	43		17	38	
	3	56	31		13	29	
A12** +	1	22	15	2.4	21	26	2.1
	2	47	32		30	38	
	3	80	54		29	36	
A13	1	40	21	2.1	17	49	1.7
	2	88	45		10	28	
	3	67	34		8	23	
A14** +	1	65	35	2.0	16	35	2.0
	2	54	29		13	28	
	3	66	36		17	37	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

** not an interesting item when perceived as taught

+ not an interesting item although perceived as
 not taught

Table 5

Summary of Students' Responses for
Life Cycles, Heredity, and Living Things

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A15	1	74	35	1.9	5	31	1.9
	2	98	46		7	44	
	3	42	20		4	25	
A16	1	59	28	2.0	7	37	1.9
	2	97	46		6	32	
	3	55	26		6	32	
A17	1	74	35	1.8	9	47	1.7
	2	95	45		7	37	
	3	42	20		3	16	
A18	1	63	33	1.9	11	31	2.0
	2	84	43		15	42	
	3	47	24		10	28	
A19**	1	59	27	2.1	6	60	1.6
	2	77	35		2	20	
	3	85	39		2	20	
A20**	1	43	20	2.2	6	46	1.8
	2	98	45		3	23	
	3	76	35		4	31	
A21**	1	40	20	2.2	14	42	1.8
	2	81	41		10	30	
	3	76	39		9	27	
A22**	1	46	23	2.1	14	45	1.8
	2	83	42		9	29	
	3	71	36		8	26	
A23	1	67	32	1.9	9	43	1.7
	2	93	45		10	48	
	3	48	23		2	10	
A24+	1	66	32	2.0	12	44	2.0
	2	76	37		4	15	
	3	62	30		11	41	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

** not an interesting item when perceived as taught

+ not an interesting item although perceived as
 not taught

Table 6

Summary of Students' Responses for
Elements and Compounds

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A25	1	73	34	2.0	3	21	2.1
	2	81	37		7	50	
	3	63	29		4	29	
A26	1	73	34	1.9	6	33	1.6
	2	79	37		7	39	
	3	61	29		5	28	
A27	1	54	26	2.1	6	33	2.1
	2	92	44		5	28	
	3	65	31		7	39	
A28	1	54	25	2.1	4	31	2.0
	2	95	44		5	39	
	3	68	31		4	31	
A29	1	68	32	2.0	5	29	1.9
	2	79	37		8	47	
	3	66	31		4	24	
A30	1	61	30	2.0	8	35	2.1
	2	79	38		5	22	
	3	66	32		10	44	
A31	1	62	29	2.0	9	47	1.8
	2	81	38		5	26	
	3	68	32		5	26	
A32	1	67	33	2.0	13	48	1.8
	2	72	36		7	26	
	3	63	31		7	26	
A33	1	89	42	1.8	7	37	2.0
	2	79	37		5	26	
	3	44	21		7	37	
A34	1	77	39	1.8	18	55	1.6
	2	76	38		10	30	
	3	45	23		5	15	
A35	1	77	42	1.8	31	67	1.4
	2	60	33		11	24	
	3	47	26		4	9	
A36	1	84	45	1.8	24	56	1.6
	2	64	34		14	33	
	3	40	21		5	12	
A37	1	69	37	1.9	20	47	1.8
	2	70	38		12	28	
	3	47	25		11	26	

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 7

Summary of Students' Responses for Communications

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A38	1	66	35	1.9	15	37	1.9
	2	70	37		14	34	
	3	52	28		12	29	
A39	1	85	43	1.8	16	49	1.7
	2	64	33		10	30	
	3	48	24		7	21	
A40	1	60	32	2.0	12	29	2.0
	2	78	41		17	42	
	3	52	27		12	29	
A41	1	70	36	1.9	16	44	1.8
	2	74	38		10	28	
	3	51	26		10	28	
A42	1	90	47	1.7	22	58	1.5
	2	63	33		13	34	
	3	39	20		3	8	
A43	1	99	56	1.6	33	62	1.5
	2	43	24		16	30	
	3	35	20		4	8	

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 8

Summary of Students' Responses for
Properties of Light

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A44	1	66	32	2.0	12	50	1.8
	2	77	37		6	25	
	3	63	31		6	25	
A45	1	91	42	1.8	3	23	2.0
	2	73	34		7	54	
	3	54	25		3	23	
A46	1	74	34	1.9	5	39	1.8
	2	81	37		6	46	
	3	62	29		2	15	
A47	1	70	33	1.9	10	53	1.6
	2	90	43		6	32	
	3	52	25		3	16	
A48	1	76	37	1.9	11	44	1.9
	2	81	39		6	24	
	3	49	24		8	32	
A49	1	106	49	1.7	9	64	1.4
	2	68	32		4	29	
	3	42	19		1	7	
A50	1	98	47	1.7	9	45	1.7
	2	72	34		8	40	
	3	40	19		3	15	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 9

Summary of Students' Responses for
Our Solar System and Gravitational Force

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
A51	1	93	47	1.8	18	56	1.6
	2	56	28		9	28	
	3	49	25		5	16	
A52	1	81	39	1.9	13	54	1.7
	2	74	36		6	25	
	3	52	25		5	21	
A53	1	79	38	1.9	11	48	1.7
	2	74	36		8	35	
	3	53	26		4	17	
A54	1	64	31	2.0	6	29	2.0
	2	79	38		8	38	
	3	65	31		7	33	
A55	1	81	39	1.9	6	27	2.0
	2	73	35		10	46	
	3	54	26		6	27	
A56	1	76	36	1.9	8	44	1.8
	2	79	37		6	33	
	3	58	27		4	22	
A57	1	77	40	1.9	13	35	1.8
	2	59	31		19	51	
	3	55	29		5	14	
A58	1	85	43	1.8	18	62	1.5
	2	76	38		7	24	
	3	39	20		4	14	
A59	1	85	46	1.8	25	57	1.6
	2	58	31		12	27	
	3	43	23		7	16	
A60	1	75	37	1.9	16	55	1.7
	2	78	39		7	24	
	3	49	24		6	21	
A61	1	82	39	1.9	12	57	1.6
	2	74	35		5	24	
	3	54	26		4	19	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 10

Summary of Students' Responses for
Classifying Plants

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
B1+	1	19	10	2.2	4	15	2.3
	2	101	55		12	44	
	3	63	34		11	41	
B2** +	1	16	10	2.3	5	11	2.4
	2	77	47		18	39	
	3	71	43		23	50	
B3** +	1	15	9	2.4	5	12	2.4
	2	69	41		14	34	
	3	84	50		22	54	
B4** +	1	26	15	2.2	9	24	2.2
	2	79	46		13	35	
	3	68	39		15	41	
B5** +	1	44	24	2.1	5	20	2.4
	2	77	42		5	20	
	3	64	35		15	60	
B6** +	1	29	17	2.2	7	18	2.3
	2	78	46		14	37	
	3	64	37		17	45	
B7+	1	42	24	2.1	11	32	2.0
	2	79	45		11	32	
	3	54	31		12	35	
B8** +	1	22	16	2.3	12	17	2.3
	2	54	40		27	38	
	3	60	44		33	46	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

** not an interesting item when perceived as taught

+ not an interesting item although perceived as
 not taught

Table 11

Summary of Students' Responses for
Sources of Energy

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
B9	1	72	36	1.8	2	22	2.2
	2	97	49		3	33	
	3	31	16		4	44	
B10	1	64	33	1.9	6	32	1.9
	2	89	46		8	42	
	3	39	20		5	26	
B11	1	53	29	2.0	3	12	2.1
	2	88	48		16	64	
	3	44	24		6	24	
B12	1	47	26	2.0	8	27	2.0
	2	81	45		13	43	
	3	52	29		9	30	
B13	1	67	34	1.9	3	27	2.1
	2	83	42		4	36	
	3	49	25		4	36	
B14	1	66	35	2.0	3	14	2.1
	2	64	34		13	59	
	3	57	31		6	27	
B15	1	67	36	2.0	2	9	2.1
	2	55	30		16	70	
	3	62	34		5	22	
B16+	1	58	34	1.9	9	23	2.1
	2	77	45		17	43	
	3	35	21		14	35	
B17	1	52	27	2.0	6	35	1.9
	2	96	50		6	35	
	3	44	23		5	29	
B18	1	56	31	2.0	14	50	1.8
	2	78	43		7	25	
	3	49	27		7	25	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

+ not an interesting item although perceived as
 not taught

Table 12

Summary of Students' Responses for
Electricity and Magnetism

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
B19	1	72	36	1.9	4	50	1.9
	2	77	38		1	13	
	3	52	26		3	38	
B20	1	103	51	1.6	2	29	2.0
	2	68	34		3	43	
	3	30	15		2	29	
B21	1	96	48	1.7	6	50	1.8
	2	66	33		3	25	
	3	37	19		3	25	
B22	1	56	30	2.0	9	39	1.9
	2	80	43		7	30	
	3	49	27		7	30	
B23	1	100	51	1.6	5	39	1.9
	2	72	37		4	31	
	3	25	13		4	31	
B24	1	82	41	1.8	3	30	2.2
	2	84	42		2	20	
	3	35	17		5	50	
B25	1	60	30	2.0	2	20	2.1
	2	84	42		5	50	
	3	55	28		3	30	
B26	1	62	31	2.0	6	55	1.8
	2	83	42		1	9	
	3	54	27		4	36	
B27	1	80	41	1.8	6	43	1.8
	2	78	40		5	36	
	3	37	19		3	21	
B28	1	63	33	1.9	3	20	2.0
	2	79	41		9	60	
	3	51	26		3	20	
B29+	1	45	29	2.0	9	16	2.3
	2	61	40		20	35	
	3	47	31		28	49	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

+ not an interesting item although perceived as not taught

Table 13

Summary of Students' Responses for
Light and Vision

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
B30	1	72	41	1.8	19	56	1.6
	2	71	40		10	29	
	3	34	19		5	15	
B31	1	57	34	1.8	19	45	1.8
	2	81	48		13	31	
	3	31	18		10	24	
B32	1	82	45	1.8	17	57	1.6
	2	60	33		9	30	
	3	39	22		4	13	
B33	1	47	29	2.0	20	41	1.8
	2	69	43		20	41	
	3	45	28		9	18	
B34	1	69	39	1.8	14	44	1.8
	2	70	39		12	38	
	3	39	22		6	19	
B35	1	52	31	2.0	17	41	1.9
	2	66	40		12	29	
	3	49	29		13	31	
B36+	1	58	35	1.9	15	35	2.0
	2	62	37		12	28	
	3	47	28		16	37	
B37+	1	51	30	2.0	12	29	2.2
	2	71	42		10	24	
	3	48	28		19	46	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

+ not an interesting item although perceived as
 not taught

Table 14

Summary of Students' Responses for Atmosphere,
Climates of the World, and Natural Cycles

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
B38	1	62	31	2.0	6	50	1.8
	2	80	40		3	25	
	3	57	29		3	25	
B39	1	66	33	1.9	6	50	1.8
	2	80	40		3	25	
	3	52	26		3	25	
B40	1	71	35	1.9	4	57	1.4
	2	76	37		3	43	
	3	57	28		0	0	
B41	1	62	31	1.9	2	17	2.1
	2	86	43		7	58	
	3	51	26		3	25	
B42	1	71	37	1.8	2	11	2.2
	2	86	45		10	56	
	3	36	19		6	33	
B43	1	63	34	1.9	6	24	2.0
	2	79	43		13	52	
	3	43	23		6	24	
B44	1	58	31	2.0	6	30	2.2
	2	73	38		5	25	
	3	59	31		9	45	
B45	1	63	33	1.9	3	19	2.1
	2	84	44		9	56	
	3	46	24		4	25	
B46	1	56	32	2.0	16	43	1.8
	2	60	35		12	32	
	3	58	33		9	24	
B47	1	58	30	2.0	7	37	1.9
	2	76	40		7	37	
	3	58	30		5	26	
B48	1	71	38	1.9	8	38	1.8
	2	68	36		10	48	
	3	50	27		3	14	
B49** +	1	43	30	2.1	14	22	2.1
	2	48	34		28	43	
	3	51	36		23	35	
B50	1	57	33	1.9	14	37	1.9
	2	67	39		13	34	
	3	47	28		11	29	

* 1=definitely interesting, 2=of some interest, 3=not interesting

** not an interesting item when perceived as taught

+ not an interesting item although perceived as not taught

Table 15

Summary of Students' Responses for
Energy for Living Things

Item	Response	<u>Perceived as Taught</u>			<u>Perceived as Not Taught</u>		
		n	%	$\bar{x}$ *	n	%	$\bar{x}$ *
B51	1	43	22	2.0	5	39	1.7
	2	104	53		7	54	
	3	50	25		1	8	
B52	1	36	19	2.1	9	40	1.9
	2	89	47		7	32	
	3	64	34		6	27	
B53	1	39	20	2.1	7	37	1.9
	2	87	46		6	32	
	3	65	34		6	32	
B54**	1	49	26	2.1	6	25	2.0
	2	68	37		12	50	
	3	69	37		6	25	
B55	1	38	22	2.1	5	16	2.2
	2	85	48		16	50	
	3	53	30		11	34	
B56	1	45	26	2.0	16	43	1.8
	2	78	45		12	32	
	3	51	29		9	24	
B57	1	48	28	2.0	17	44	1.8
	2	71	41		13	33	
	3	53	31		9	23	
B58	1	49	26	2.0	9	45	2.0
	2	86	46		3	15	
	3	54	29		8	40	
B59	1	49	30	2.0	9	20	2.0
	2	68	41		26	58	
	3	48	29		10	22	
B60	1	46	24	2.0	10	53	1.5
	2	94	49		8	42	
	3	51	27		1	5	
B61	1	42	24	2.1	10	31	2.0
	2	84	47		13	41	
	3	52	29		9	28	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

** not an interesting item when perceived as taught

By scanning Tables 3-15, one could notice that the means for most of the items that were perceived as Taught clustered around 2.0 (of some interest). Therefore, it could be said that students, on the whole, had some interest in General Science concepts. This was a very significant finding. It showed that the sixth grade science program based on the Virginia Standards of Learning Objectives and Montgomery County Guidelines was of interest to the students. Most of the items on the two portions of the instrument (i.e. Form A and Form B) that were perceived as taught were of some interest to the students. There were a few exceptions which will be discussed later.

Of the ten sixth grade science teachers in the county, only one did not cover Classifying Animals with Backbones, Classifying Animals without Backbones, Classifying Plants, and Life Cycles. This involved only 29 students or 6.6 percent of the total subjects surveyed.

Students did not show interest in some items which were perceived as Taught. These items are described below:

1. Under the topic of Classifying Animals with Backbones, fish (item A2), birds (item A5), and warm-bloodedness (item A8) were not interesting when perceived as Taught.

2. In the topic of Classifying Animals without Backbones, arthropods (item A9), worms (item A12), and

protists (item A14) were not interesting when perceived as Taught

3. For the topic of Life Cycles, Heredity, and Living Things, cells (item A19), nucleus (item A20), new cells (item A21), and chromosomes (item A22) were not interesting when perceived as Taught.

4. Under the topic of Classifying Plants, dicots (item B2), monocots (item B3), conifers (item B4), ferns (item B5), algae (item B6), and lichens (item B8) were not interesting when perceived as Taught.

5. In the topic of Atmosphere, Climates of the World, and Natural Cycles, nitrogen cycle (item B49) was not interesting when perceived as Taught.

6. For the topic of Energy for Living Things, respiration (item B54) was not interesting when perceived as Taught.

Furthermore, the following items were considered as not interesting although perceived as Not Taught.

1. Under the topic of Classifying Animals without Backbones, arthropods (item A9), mollusks (item A10), worms (item A12), and protists (item A14) were not interesting although perceived as Not Taught.

2. For the topic of Life Cycles, Heredity, and Living Things, genes (item A24) was not interesting although perceived as Not Taught.

3. In the topic of Classifying Plants, plant classification (item B1), dicots (item B2), monocots (item B3), conifers (item B4), ferns (item B5), algae (item B6), yeasts (item B7), and lichens (item B8) were not interesting although perceived as Not Taught.

4. For the topic of Sources of Energy, geothermal energy (item B16) was not interesting although perceived as Not Taught.

5. Under the topic of Electricity and Magnetism, kilowatt-hours (item B29) was not interesting although perceived as Not Taught.

6. In the topic of Light and Vision, farsightedness (item B36) and use of glasses (item B37) were not interesting although perceived as Not Taught.

7. For the topic of Atmosphere, Climates of the World, and Natural Cycles, nitrogen cycle (item B49) was not interesting although perceived as Not Taught.

The sixth grade students' interest in specific science items were shown in Tables 3-15. The means of the specific items were used to compute a single composite mean for each one of the 13 general science topics.

Table 16 and Table 17 show sixth grade students' level of interest with regard to specific science topics that were perceived as Taught and Not Taught, respectively.

Table 16

Sixth Grade Students' Levels of Interest in
Science Topics That Were Perceived as Taught

<u>Topic</u>	<u>n</u>	<u>- * x</u>	<u>S.D.</u>
1. Electricity and Magnetism	210	1.85	0.52
2. Communications	218	1.86	0.58
3. Properties of Light	229	1.89	0.57
4. Our Solar System and Gravitational Force	226	1.89	0.61
5. Light and Vision	192	1.92	0.58
6. Sources of Energy	210	1.94	0.49
7. Elements and Compounds	229	1.96	0.53
8. Atmosphere, Climates of the World, and Natural Cycles	209	1.96	0.52
9. Life Cycles, Heredity and Living Things	230	2.01	0.47
10. Energy for Living Things	210	2.07	0.51
11. Classifying Animals without Backbones	226	2.11	0.55
12. Classifying Animals with Backbones	228	2.13	0.48
13. Classifying Plants	199	2.24	0.46

Other Topics

1. Flight and the Space Program	279	1.49	0.70
2. Oceanography	291	1.60	0.74
3. Microscopes	338	1.64	0.76
4. Geology	336	1.77	0.78
5. Simple Machines	308	1.94	0.82

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 17

Sixth Grade Students' Levels of Interest in
Science Topics that Were Perceived as Not Taught

<u>Topic</u>	<u>n</u>	<u>$\bar{x}$</u> *	<u>S.D.</u>
1. Solar System and Gravitational Force	80	1.67	0.58
2. Communications	87	1.70	0.58
3. Elements and Compounds	85	1.81	0.71
4. Properties of Light	51	1.83	0.70
5. Light and Vision	71	1.83	0.70
6. Life Cycles, Heredity and Living Things	88	1.91	0.70
7. Classifying Animals with Backbones	84	1.94	0.58
8. Energy for Living Things	86	1.96	0.60
9. Atmosphere, Climates of the World, and Natural Cycles	96	1.99	0.62
10. Classifying Animals without Backbones	112	2.02	0.71
11. Sources of Energy	72	2.04	0.60
12. Electricity and Magnetism	83	2.13	0.70
13. Classifying Plants	97	2.31	0.60

Other Topics

1. Flight and the Space Program	160	1.39	0.64
2. Oceanography	146	1.57	0.80
3. Geology	103	1.71	0.81
4. Microscopes	100	1.73	0.78
5. Simple Machines	13	1.76	0.84

*

1=definitely interesting, 2=of some interest,
3=not interesting

Of the 13 topics that were perceived as Taught, students gave high ratings to topics such as Electricity and Magnetism (mean = 1.85); Communications (mean = 1.86); Properties of Light (mean = 1.89); and Our Solar System and Gravitational Force (mean = 1.89). A low rating was given to topics such as Classifying Animals without Backbones (mean = 2.11); Classifying Animals with Backbones (mean = (2.13); and Classifying Plants (mean = 2.24). However, the means of the latter topics showed that students still had some interest in them despite their relatively low ranking among topics.

With regard to the Other Topics that were perceived as taught, Flight and the Space Program ranked as the most interesting and Oceanography as the second most interesting topic. The Other Topics were rated very highly by the students. For instance, the means of Flight and the Space Program (1.49), Oceanography (1.60), Microscopes (1.64), and Geology (1.77) were higher than the means of the curriculum-based 13 topics.

Of the 13 topics that were perceived as Not Taught, students gave a high rating to topics such as Our Solar System and Gravitational Force, Communications, Elements and Compounds, and Properties of Light. A low rating was given to topics such as Sources of Energy, Electricity and Magnetism, and Classifying Plants. An examination of the mean levels of interest for the topics perceived as Not Taught

suggests that all general science topics are of interest to the students.

With regard to Other Topics that were perceived as Not Taught, Flight and Space Program was rated as the most interesting and Oceanography as the second most interesting topic.

Research Question 2

The focus of this question was on whether teachers differed in how well their students liked topics covered in the sixth grade science course.

A one-way analysis of variance was used to analyze the data for each topic. Raw scores were used in the statistical analysis and a significance level of .05 was selected. The analysis of the data showed that teachers differed significantly in how well their students liked only 5 out of 13 topics (see Table 18).

Table 18

One-Way ANOVA of Subscale Averages with
Respect to Teachers

Topics	Range of n's	Range of means	F	df	p<
Classifying Animals with Backbones	12-49	1.81-2.49	3.22	9/218	.001*
Classifying Animals without Backbones	11-49	1.86-2.42	2.19	9/216	.023*
Elements and Compounds	11-49	1.59-2.24	2.16	9/219	.026*
Sources of Energy	10-42	1.64-2.15	2.13	9/200	.023*
Atmosphere, Climates of the World, and Natural Cycles	10-42	1.72-2.24	2.57	9/199	.008*
Life Cycles, Heredity, and Living Things	12-49	1.73-2.16	0.92	9/220	.511
Communications	8-49	1.68-2.14	1.67	9/208	.097+
Properties of Light	11-49	1.61-2.09	1.42	9/219	.182
Our Solar System and Gravitational Force	11-48	1.68-2.12	1.13	9/216	.346
Classifying Plants	5-42	2.05-2.40	1.30	9/189	.237
Electricity and Magnetism	10-42	1.70-2.02	0.61	9/200	.785
Light and Vision	11-34	1.74-2.32	1.87	9/182	.059+
Energy for Living Things	10-42	1.91-2.30	1.27	9/200	.258

* p < .05

+ p < .10

Teachers differed in how well their students liked the topics of Classifying Animals with Backbones; Classifying Animals without Backbones; Elements and Compounds; Sources of Energy; and Atmosphere, Climates of the World, and Natural Cycles.

There were no differences in the degree of interest expressed by students of different teachers in the other topics covered in the sixth grade science program. These topics were: Life Cycles, Heredity and Living Things, Communications, Properties of Light, Our Solar System and Gravitational Force, Classifying Plants, Electricity and Magnetism, Light and Vision, and Energy for Living Things.

Research Question 3

The differences in the topics of interest and degrees of interest between sixth grade male and female students were investigated. A one-way analysis of variance was used to analyze the data for each gender. The analysis of the data showed that there were significant differences in the levels of interest between male and female students in only two science topics (see Table 19). The topics for which there were significant mean differences in the levels of interest between male and female students are shown in Table 20.

Table 19

One-Way ANOVA of Subscale Averages with
Respect to Gender

Topics	F	df	p<
Life Cycles, Heredity, and Living Things	4.63	1/228	.033*
Sources of Energy	10.21	1/208	.002*
Classifying Animals With Backbones	1.03	1/226	.310
Classifying Animals without Backbones	0.00	1/224	.966
Elements and Compounds	0.15	1/227	.698
Communication	0.12	1/216	.728
Properties of Light	0.10	1/227	.756
Our Solar System and Gravitational Force	2.21	1/224	.139
Classifying Plants	0.50	1/197	.478
Electricity and Magnetism	1.42	1/208	.234
Light and Vision	2.32	1/190	.129
Atmosphere, Climates of the World, and Natural Cycles	0.12	1/207	.730
Energy for Living Things	0.11	1/208	.736

* p < .05

Table 20

Topics for Which There Were Significant Mean Differences in the Levels of Interest Between Male and Female Student

<u>Life Cycles, Heredity, and Living Things</u>			<u>Sources of Energy</u>		
<u>sex</u>	<u>n</u>	<u>$\bar{x}$</u> *	<u>sex</u>	<u>n</u>	<u>$\bar{x}$</u> *
Male	132	2.07	Male	115	1.85
Female	98	1.93	Female	95	2.06

* 1=definitely interesting, 2=of some interest, 3=not interesting

A one-way analysis of variance was used to analyze the data for each item to determine whether there were gender differences. The raw scores were used in the statistical analysis and a significance level of .05 was selected. The results showed that significant differences in the level of interest existed between male and female students on the topics of Life Cycles, Heredity, and Living Things; and Sources of Energy. In other words, these data indicated that females tend to like Life Cycles, Heredity, and Living Things better than males, and males tend to like Sources of Energy better than females. For a comparison of the significant mean differences between male and female students with regard to these two topics, refer to Table 20.

The data showed that no significant differences in the levels of interest existed between male and female students on the topics of Classifying Animals with Backbones; Classifying Animals without Backbones; Elements and Compounds; Communications; Properties of Light; Our Solar System and Gravitational Force; Classifying Plants; Electricity and Magnetism; Light and Vision; Atmosphere, Climates of the World and Natural Cycles; and Energy for Living Things.

Research Question 4

The focus of the investigation for this question was on whether sixth grade students' achievement as indicated by final grade in science was related to the level of interest expressed for each topic.

A one-way analysis of variance was used to analyze the data for each topic. The interest differences in science topics based on students' achievement in sixth grade science are shown in Table 21.

Raw scores were used in the statistical analysis and a significance level of .05 was selected. Given sixth grade students' achievement as indicated by final grade in science, the results showed significant interest differences between students only on the topics of Classifying Animals without Backbones; Properties of Light; Sources of Energy; and Electricity and Magnetism. Since a significant F ratio was obtained with respect to each of the aforesaid four topics, there was a need to find out exactly where the significant differences occurred. For this purpose, a multiple comparison procedure was necessary. Duncan's New Multiple Range Test was used to determine means for variables yielding significant differences across achievement levels as indicated by final grade in science. Means in ascending order for the four significant ANOVA's are shown in Table 22.

Table 21

One-Way ANOVA of Subscale Averages with Respect
to Final Sixth Grade Science Average Letter Grade

Subscale	F	df	p<
Classifying Animals w/o Backbones	2.66	4/150	.035*
Properties of Light	6.91	4/150	.0001*
Sources of Energy	4.23	3/149	.007*
Electricity and Magnetism	3.77	3/149	.012*
Classifying Animals With Backbones	1.64	4/149	.167
Life Cycles, Heredity, and Living Things	0.55	4/150	.701
Elements and Compounds	1.16	4/151	.330
Communications	0.16	4/140	.958
Our Solar System and Gravitational Force	0.96	4/149	.432
Classifying Plants	0.41	3/142	.746
Atmosphere, Climates of the World, and Natural Cycles	0.35	3/149	.789
Light and Vision	0.74	3/135	.529
Energy for Living Things	1.69	3/150	.171

*p<.05

Table 22

Means in Ascending Order for Variables Yielding
Significant Differences Across Achievement Levels

Classifying Animals
without Backbones

Grade	n	$\bar{x}$ *
A	42	1.92
C	31	2.03
B	63	2.13
F	3	2.25
D	16	2.39

Properties of Light

Grade	n	$\bar{x}$ *
A	42	1.58
C	31	1.88
B	62	1.91
F	4	2.04
D	16	2.30

Sources of Energy

Grade	n	$\bar{x}$ *
A	38	1.77
C	38	1.91
B	65	2.04
D	12	2.23

Electricity and Magnetism

Grade	n	$\bar{x}$ *
A	38	1.65
C	38	1.75
D	12	1.95
B	65	1.96

* 1=definitely interesting, 2=of some interest,
3=not interesting

Research Question 5

The science teachers' perceptions of their students' interests in science topics and in specific items within topics were investigated.

The ten teachers were asked to express their perception of students' interest or lack of interest in general science items. The teachers used the same instrument that the students were given to rate students' interest or lack of interest in individual items. The results are given in Tables 23 - 35.

Summaries of teachers' responses presented as means of individual items averaged for each topic are given in Tables 36 and 37.

Table 23

Summary of Teachers' Responses for
Classifying Animals with Backbones

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
A1	1	6	67	1.3
	2	3	33	
	3			
A2	1	4	44	1.6
	2	5	56	
	3			
A3	1	5	56	1.4
	2	4	44	
	3			
A4	1	6	67	1.3
	2	3	33	
	3			
A5	1	6	67	1.3
	2	3	33	
	3			
A6	1	6	67	1.3
	2	3	33	
	3			
A7	1	4	44	1.6
	2	5	56	
	3			
A8	1	4	44	1.6
	2	5	56	
	3			

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 24

Summary of Teachers' Responses for
Classifying Animals without Backbones

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
A9	1	5	56	1.4
	2	4	44	
	3	0	0	
A10	1	5	56	1.4
	2	4	44	
	3			
A11	1	6	67	1.3
	2	3	33	
	3			
A12	1	2	22	2.0
	2	5	56	
	3	2	22	
A13	1	2	22	1.9
	2	6	67	
	3	1	11	
A14	1	8	89	1.1
	2	1	11	
	3			

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 25

Summary of Teachers' Responses for
Life Cycles, Heredity, and Living Things

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
A15	1	5	56	1.4
	2	4	44	
	3			
A16	1	5	56	1.4
	2	4	44	
	3			
A17	1	4	44	1.7
	2	4	44	
	3	1	11	
A18	1	5	56	1.4
	2	4	44	
	3	0	0	
A19	1	4	44	1.7
	2	4	44	
	3	1	11	
A20	1	3	33	1.77
	2	6	67	
	3			
A21	1	6	67	1.3
	2	3	33	
	3			
A22	1	6	67	1.3
	2	3	33	
	3			
A23	1	9	100	1.0
	2			
	3			
A24	1	7	78	1.2
	2	2	22	
	3			

* 1=definitely interesting, 2=of some interest,
 3=not interest

Table 26

Summary of Teachers' Responses for
Elements and Compounds

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
A25	1	6	60	1.4
	2	4	40	
	3			
A26	1	6	60	1.4
	2	4	40	
	3			
A27	1	5	50	1.5
	2	5	50	
	3			
A28	1	8	80	1.2
	2	2	20	
	3			
A29	1	5	50	1.5
	2	5	50	
	3			
A30	1	4	40	1.6
	2	6	60	
	3			
A31	1	3	30	1.7
	2	7	70	
	3			
A32	1	6	67	1.3
	2	3	33	
	3			
A33	1	8	80	1.2
	2	2	20	
	3			
A34	1	9	100	1.0
	2			
	3			
A35	1	10	100	1.0
	2			
	3			
A36	1	10	100	1.0
	2			
	3			
A37	1	9	90	1.1
	2	1	10	
	3			

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 27

Summary of Teachers' Responses for
Communications

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
A38	1	1	10	2.1
	2	7	70	
	3	2	20	
A39	1	2	20	1.8
	2	8	80	
	3			
A40	1	3	30	1.8
	2	6	60	
	3	1	10	
A41	1	3	30	1.8
	2	6	60	
	3	1	10	
A42	1	5	50	1.6
	2	4	40	
	3	1	10	
A43	1	6	60	1.4
	2	4	40	
	3			

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 28

Summary of Teachers' Responses for
Properties of Light

<u>Perceived as Taught</u>		<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
<u>Item</u>	<u>Response</u>			
A44	1	1	10	1.9
	2	9	90	
	3			
A45	1	5	50	1.5
	2	5	50	
	3			
A46	1	6	60	1.4
	2	4	40	
	3			
A47	1	4	40	1.6
	2	6	60	
	3			
A48	1	6	60	1.4
	2	4	40	
	3			
A49	1	9	90	1.1
	2	1	10	
	3			
A50	1	7	70	1.4
	2	2	20	
	3	1	10	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 29

Summary of Teachers' Responses for
Our Solar System and Gravitational Force

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
A51	1	4	50	1.5
	2	4	50	
	3			
A52	1	3	33	1.7
	2	6	67	
	3			
A53	1	2	22	1.8
	2	7	78	
	3			
A54	1	2	22	1.8
	2	7	78	
	3			
A55	1	3	33	1.7
	2	6	67	
	3			
A56	1	6	67	1.3
	2	3	33	
	3			
A57	1	4	50	1.5
	2	4	50	
	3			
A58	1	4	50	1.5
	2	4	50	
	3			
A59	1	5	63	1.4
	2	3	38	
	3			
A60	1	5	63	1.4
	2	3	38	
	3			
A61	1	6	67	1.3
	2	3	33	
	3			

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 30

Summary of Teachers' Responses for
Classifying Plants

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
B1	1	3	33	1.7
	2	6	67	
	3			
B2	1	2	22	1.8
	2	7	78	
	3			
B3	1	2	22	1.8
	2	7	78	
	3			
B4	1	3	33	1.7
	2	6	67	
	3			
B5	1	1	11	1.9
	2	8	89	
	3			
B6	1	2	22	1.9
	2	6	67	
	3	1	11	
B7	1	6	67	1.4
	2	2	22	
	3	1	11	
B8	1	2	25	1.8
	2	6	75	
	3			

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 31

Summary of Teachers' Responses for
Sources of Energy

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
B9	1	5	50	1.7
	2	3	30	
	3	2	20	
B10	1	4	40	1.8
	2	4	40	
	3	2	20	
B11	1	4	40	1.6
	2	6	60	
	3			
B12	1	4	40	1.6
	2	6	60	
	3			
B13	1	7	70	1.3
	2	3	30	
	3			
B14	1	8	80	1.3
	2	1	10	
	3	1	10	
B15	1	7	70	1.4
	2	2	20	
	3	1	10	
B16	1	6	60	1.4
	2	4	40	
	3			
B17	1	6	60	1.4
	2	4	40	
	3			
B18	1	9	90	1.1
	2	1	10	
	3			

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 32

Summary of Teachers' Responses for
Electricity and Magnetism

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
B19	1	6	60	1.4
	2	4	40	
	3			
B20	1	9	90	1.1
	2	1	10	
	3			
B21	1	8	80	1.2
	2	2	20	
	3			
B22	1	5	50	1.5
	2	5	50	
	3			
B23	1	7	70	1.3
	2	3	30	
	3			
B24	1	8	80	1.2
	2	2	20	
	3			
B25	1	6	60	1.4
	2	4	40	
	3			
B26	1	6	60	1.4
	2	4	40	
	3			
B27	1	7	70	1.3
	2	3	30	
	3			
B28	1	5	50	1.6
	2	4	40	
	3	1	10	
B29	1	4	40	1.8
	2	4	40	
	3	2	20	

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 33

Summary of Teachers' Responses for
Light and Vision

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
B30	1	2	25	1.8
	2	6	75	
	3			
B31	1	5	63	1.4
	2	3	38	
	3			
B32	1	5	63	1.4
	2	3	38	
	3			
B33	1	3	38	1.6
	2	5	63	
	3			
B34	1	4	50	1.5
	2	4	50	
	3			
B35	1	3	38	1.6
	2	5	63	
	3			
B36	1	3	38	1.6
	2	5	63	
	3			
B37	1	1	13	1.9
	2	7	88	
	3			

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 34

Summary of Teachers' Responses for Atmosphere,
Climates of the World, and Natural Cycles

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
B38	1	4	44	1.6
	2	5	56	
	3			
B39	1	3	33	1.7
	2	6	67	
	3			
B40	1	7	78	1.2
	2	2	22	
	3			
B41	1	4	44	1.6
	2	5	56	
	3			
B42	1	5	56	1.4
	2	4	44	
	3			
B43	1	5	56	1.4
	2	4	44	
	3			
B44	1	7	78	1.2
	2	2	22	
	3			
B45	1	6	67	1.3
	2	3	33	
	3			
B46	1	5	56	1.4
	2	4	44	
	3			
B47	1	4	40	1.6
	2	6	60	
	3			
B48	1	5	56	1.4
	2	4	44	
	3			
B49	1	4	68	1.3
	2	2	33	
	3			
B50	1	4	57	1.4
	2	3	43	
	3			

* 1=definitely interesting, 2=of some interest, 3=not interesting

Table 35

Summary of Teachers' Responses for
Energy for Living Things

<u>Perceived as Taught</u>				
<u>Item</u>	<u>Response</u>	<u>n</u>	<u>%</u>	<u>$\bar{x}$</u> *
B51	1	4	44	1.6
	2	5	56	
	3			
B52	1	5	56	1.4
	2	4	44	
	3			
B53	1	4	44	1.6
	2	5	56	
	3			
B54	1	4	50	1.5
	2	4	50	
	3			
B55	1	4	50	1.5
	2	4	50	
	3			
B56	1	5	63	1.4
	2	3	38	
	3			
B57	1	5	63	1.4
	2	3	38	
	3			
B58	1	6	75	1.3
	2	2	25	
	3			
B59	1	5	63	1.4
	2	3	38	
	3			
B60	1	5	56	1.4
	2	4	44	
	3			
B61	1	3	33	1.8
	2	5	56	
	3	1	11	

* 1=definitely interesting, 2=of some interest,
 3=not interesting

Table 36

Summary of Teachers' Responses for Science Topics That Were Perceived as Taught

<u>Topic</u>	<u>n</u>	<u>$\bar{x}$</u> [*]	<u>S.D.</u>
1. Elements and Compounds	10	1.31	0.25
2. Electricity and Magnetism	10	1.38	0.34
3. Life Cycles, Heredity, and Living Things	9	1.42	0.38
4. Classifying Animals with Backbones	9	1.43	0.43
5. Sources of Energy	10	1.46	0.40
6. Properties of Light	10	1.47	0.28
7. Atmosphere, Climates of the World, and Natural Cycles	10	1.50	0.35
8. Energy for Living Things	9	1.51	0.42
9. Our Solar System and Gravitational Force	10	1.51	0.36
10. Classifying Animals without Backbones	9	1.54	0.38
11. Light and Vision	8	1.59	0.29
12. Classifying Plants	9	1.73	0.34
13. Communications	10	1.75	0.41

Other Topics

1. Geology	3	1.00	0.00
2. Microscopes	7	1.14	0.38
3. Oceanography	3	1.33	0.58
4. Simple Machines	3	1.33	0.58
5. Flight and the Space Program	4	1.50	0.58

* 1=definitely interesting, 2=of some interest,
3=not interesting

Table 37

Summary of Teachers' Responses for Other Topics
That Were Perceived as Not Taught

<u>Topic</u>	<u>n</u>	$\bar{x}$ *	<u>S.D.</u>
1. Oceanography	7	1.00	0.00
2. Geology	7	1.29	0.49
3. Flight and the Space Program	6	1.33	0.52
4. Microscopes	3	1.33	0.58
5. Simple Machines	7	1.71	0.49

* 1=definitely interesting, 2=of some interest,
3=not interesting

Teachers perceived Elements and Compounds as the greatest topic of interest and Communications as the topic of least interest for the students (see Table 36).

Furthermore, teachers perceived that all Other Topics were of definite interest to the students when Taught. Teachers also perceived that those Other Topics that were Not Taught to the students would have been highly interesting if taught (see Table 37).

In the Not Taught category, Oceanography was ranked as the highest and Geology as the second highest in terms of teachers' perception of students' interest (see Table 37).

Finally, the topic means in Table 37 indicated that some teachers did not teach the Other Topics, however, they perceived them to be of definite interest to the students if taught.

The interpretations and implications of the data presented in this chapter and the author's suggestions for addressing the improvement of student interest in science and general conclusions about science teaching are presented in Chapter 5.

Chapter Five

Conclusions

Concern for students' input, needs, interests, and involvement in the educational process has been gaining attention among educators. It has become increasingly apparent that students like to learn science content that is more relevant to their changing needs. Students seem to prefer to study relevant science concepts to gain knowledge that may assist them in solving their real life problems.

General Conclusions About Topics

The results of this study indicated that students gave a wide variety of responses concerning their interests in science topics. This information should be important to the general science teacher in terms of what students liked or disliked. In the preparation of more effective lesson plans, a science teacher should take into account students' interest or lack of interest in each topic presented. For instance, under a certain topic if some items are perceived as not interesting, a teacher should seek creative pedagogical methods to make those items more interesting. On the other hand, student interest in some items which were not taught suggests that there is a need to incorporate those left-out items in the overall plan of instruction.

Among the 13 topics included in the science textbook that were perceived as Taught, Electricity and Magnetism ranked the highest in terms of students' interest. Electricity has a very crucial impact on the execution of the daily matters in the world in which we live. During the past 100 years, electricity has veritably changed the way human beings live more than anything else. Our transportation, communication, outer space exploration, medical treatment and operation, food production, instruction, cooking, entertainment, and multitudes of other functions depend on electricity. Students realize that the things they can do today would have not been possible for their grandparents.

This common source of energy probably accounts for why it was rated as the topic of greatest interest to the students. This finding was somewhat consistent with Sullivan (1979) who reported that students in intermediate grades (4-8) had an average liking for electricity but expressed quite a high interest in magnets. Furthermore, the author believes that Electricity and Magnetism ranked relatively high in terms of students' interest because it is easily studied as a hands-on topic. It would be effective to supplement this topic with the help of laboratory activities and classroom demonstrations.

The second highest ranked topic in the science textbook was Communications. This topic covers the origins of the

alphabet and printing press as well as modern communication technology including the telephone, telegraph, television, radio, record player, tape recorder, videocassette recorder, motion camera, satellites, computers, lasers, and their impact on our lives. Communication systems have immediate and relevant impact on daily affairs of human beings in our society.

The dynamics of modern communication systems as a major thrust in global dissemination of information and also in narrowing the cultural gaps among the peoples of the world are quite eminent and can produce profound results. Today's students clearly recognize the relevancy and immediacy of modern communication devices as a source of daily news, weather, entertainment, contact with peers, and enlightenment. The ranking of Communications as the second most interesting topic vividly indicates that students are highly interested in the subject matter that regularly and tangibly affects them. Sullivan (1979) reported that "in the intermediate grades [4-8], almost all items showed appreciable declines in expressed liking. The physical science/mechanics items dealing with finding out how motors work, studying about electricity, and finding out how television and radio work showed little loss..." (p. 597).

Sullivan (1979) showed that in the primary grades (1-4), there is an increase in liking for learning about parts of

the body, things that live in the water, and different kinds of animals. In contrast, the findings of this study showed that the sixth grade general science topics of Classifying Animals with Backbones, Classifying Animals without Backbones, and Classifying Plants ranked relatively low in student interest. These findings may be attributed to the emphasis that animals and plants receive in the elementary school. In addition, the author assumes that students frequently come in contact with plants and animals through direct daily experiences and via media exposure. However, once they attend middle school and begin to get departmentalized science instruction, students may find it more intriguing and exciting to explore new fields of general science such as astronomy, communications, electricity, light, and chemistry.

Properties of Light was rated as the topic in the textbook of third highest interest with a mean of 1.89 when perceived as Taught. Students consider light to be an important topic because of many reasons such as: green plants need light for the food-making process, light heats land and water on earth, light helps us see things, rainbows are made as a result of the breakdown of light, and color is possible because of light.

Among all of the topics in the textbook and suggested as Other (enrichment) perceived as Taught, students gave the

highest interest rating to Flight and the Space Program. Throughout history, human beings have had a never-ending fascination with leaving the planet earth and travelling beyond. It is possible that our interest in this topic is constantly reinforced by the incessant efforts of the past two decades that culminated in the historical landing of humankind on the moon and in exploring outer space by means of space missions. There has been a lot of discussion on television and radio about dispatching a manned mission to the planet Mars or establishing human colonies in outer space to reduce the population explosion on earth. The mystery of outer space and the potential for reaching beyond our solar system fascinate children. Everyday, we are gaining new knowledge about the universe with the help of our space probes and orbiting telescopes. This topic probably is interesting and exciting to the sixth graders because it allows for further explorations into the unknown. Shows such as Star Trek on TV and movies about topics of an extraterrestrial nature seem to be exciting and mystical to today's young adolescents. Furthermore, the possibility of intelligent life elsewhere in the universe seem to be quite intriguing. All of these factors may have contributed to the ranking of Flight and the Space Program as most interesting among all topics perceived as Taught.

Oceanography (mean = 1.60) appears to be another interesting topic for sixth graders when perceived as Taught. Nearly 75 percent of the entire surface of the earth is water. Oceans, gulfs, bays, ponds, lakes, rivers and every other body of water is included in this percentage. However, oceans cover almost 71 percent of the earth's surface. People have wondered about the mysteries of oceans and seas ever since the beginning of civilization. Many scientists have turned to the oceans for answers to the formation of the planet earth. The oceans are continuously being tapped as a food source to solve some of the problems related to the food shortages in the world. The underwater explorations and related findings by the Cousteau expeditions and the efforts of other scientists during the past three decades have generated a great deal of excitement. Despite the lack of proximity to the ocean, students seem to be interested in marine plants and animals. Students' interest in oceanography is high perhaps as a result of watching the undersea explorations and other ocean related programs on television.

Microscopes allow students to discover the world that cannot be seen with the human eye. Student investigation of the microscopic organisms and their magnification for better viewing and learning are stimulating to the mind and microscopes provide another hands-on method of learning in the classroom. This approach is appealing to the students and

allows their curiosity to be nurtured. For these reasons, perhaps, microscopes (mean = 1.64) held a third order of interest among all topics included in the textbook and Other Topics perceived as Taught.

Geology held the fourth interest order (mean = 1.77) among all topics perceived as Taught. Geology allows students to learn about the earth's layers, the earth's crust, prehistoric earth, rock formation, volcanoes, earthquakes, and changes that take place on the earth. Geology was among the four Other Topics that outranked all the regularly taught topics in terms of students' interest in general science.

Of the 13 topics that were perceived as Not Taught, students gave a high rating to topics such as Our Solar System and Gravitational Force, Communications, Elements and Compounds, and Properties of Light. A low rating was given to topics such as Sources of Energy, Electricity and Magnetism, and Classifying Plants. An examination of the mean level of interest for the topics perceived as Not Taught suggests that all general science topics are of interest to the students.

Among the topics in the textbook that were perceived as Not Taught but would have been interesting if taught, Our Solar System and Gravitational Force ranked the highest. This topic should include a comprehensive coverage of time,

space, motion, light, stars, galaxies, meteors, asteroids, and other celestial bodies. It also should involve a detailed explanation of our solar system and deals with the planet earth and its features such as temperature and atmosphere, water, vegetation, animals, and minerals which make it the only suitable place for humankind to live. The current fascination of our youth with things of extra-terrestrial nature, and the modern advances in our aerospace technology possibly could have contributed to the high ranking of topic number 13 by the students. In his study of intermediate students' (grades 4-8) interest in specific science topics, Sullivan (1979) reported that the sun and planets, and the stars received average rankings of interest.

The Solar System is a topic that fascinates children. It is quite amazing that the sun with the help of its gravity holds a group of nine planets and various other bodies in orbits around it. The Solar System is one tiny part of our galaxy, the Milky Way. The field of Astronomy is exciting and adventurous to the young mind and the production of movies of extraterrestrial nature have added to this excitement. By virtue of inborn curiosity, the human mind is fascinated by the unknown and by celestial bodies that are beyond humanity's reach. One can see why this topic was rated the highest among topics perceived as Not Taught. Our scientists are vigorously exploring outer space by sending

space probes of an extraordinary nature. New findings are constantly reported on the news and in the newspapers and journals. The apparent hypothesis that life may exist in other corners of this vast universe has generated curiosity in the human mind. The thought that humankind may leave the planet earth someday and colonize other parts of our Solar System is truly exciting. Given this reasoning, it is understandable why the topic of the Solar System and Gravitational Force was given the highest rank among topics perceived as Not Taught but would have been interesting if taught. It is worth mentioning here that this topic tied for third place with Properties of Light in terms of students' interest when perceived as Taught.

With regard to Other Topics that were perceived as Not Taught, Flight and Space Program was rated as the most interesting and Oceanography as the second most interesting topic. These two topics seem to attract the attention of curious minds. The study of Space and Oceanography is exciting to sixth graders possibly due to constant scientific revelations and addition of new fascinating information to the existing body of knowledge.

As with regard to the Other Topics: Flight and the Space Program, Oceanography, Microscopes, Geology, and Simple Machines, students showed an overwhelming interest whether or not these topics were perceived as taught. The

implications of this information for textbook adoption is significant. The current general science textbook, Heath Science: Level 6 (Barufaldi, Ladd & Moses, 1981) is rather outdated and also lacks such topics. The educational implications from students' input is that not only a new textbook must be adopted for the instruction of general science, but it should be ascertained that the new book contains a discussion of the topics listed as interesting to the students.

General Reflections About Science Teaching

From informal interviews with elementary teachers and students, the author has found that science is taught sporadically in the elementary schools. Due to the lack of appropriate training in science and lack of material, teachers tend to emphasize only those topics of general science with which they feel comfortable. Plants and animals seem to fall into this category.

By the time students come to the middle school, they may be ready to try "new" science. Physical science seems to appeal to them. The experience of some of the teachers who participated in this study and that of the author has shown that sixth graders prefer to skip the chapters on plants and animals and start with physics, chemistry, geology, astronomy, and light. Perhaps, this interest in "new" topics

contributed to the low ranking of the topics of Classifying Animals with Backbones, Classifying Animals without Backbones, and Classifying Plants.

General Conclusions About Teachers

The results of this study also indicated that there were no differences among the teachers in how their students rated their interest in 8 of the 13 science topics. The five topics for which there were differences were: Classifying Animals with Backbones; Classifying Animals without Backbones; Elements and Compounds; Sources of Energy; and Atmosphere, Climates of the World, and Natural Cycles. With regard to these five topics, the individual teacher's approach, emphasis, and background possibly affected the outcome. The effect of these variables on student interest could be the subject of further study.

There were no differences in the degree of interest expressed by students of different teachers in the remaining eight topics. Teachers seem to have followed similar approaches and adhered closely to the State Standards of Learning Objectives and the county Science Curriculum Guidelines.

General Conclusions About Gender

In their studies of high school boys and girls, Entwistle and Duckworth (1977), Lazarowitz and Hertz-Lazarowitz (1979), and Baird et al. (1984) indicated that boys seem to be inclined toward so-called "hard" science (physics, mathematics, chemistry, etc.) and girls seem to be inclined toward so-called "soft" science (the human body and life, plants, zoology, etc.). Moreover, Shemesh and Lazarowitz (1988) emphasized the notion that physics and chemistry are primarily selected by boys.

Shrigley (1973) found out that there were differences between sixth grade girls and boys in their attitudes toward science. The results of the current study showed that male and female students significantly differed in their interest only in two topics: (a) Life Cycles, Heredity, and Living Things, and (b) Sources of Energy. Females tend to like Life Cycles, Heredity, and Living Things better than males. Males tend to like Sources of Energy better than females.

Students' personal experience may have played a role in this situation. In today's society, the stereotyping and attachment of certain careers or interests to male and female students are on decline. In most cases, no longer is there such a phenomenon as a male dominated or a female dominated profession. Our educational system is designed to expose both male and female students to all types of interests and

careers without emphasizing one gender over another. In sum, these factors may have contributed to the findings of this study that there were no significant differences in the levels of interest between male and female students on a wide range of topics.

Jaus (1981) reported that, in grades three through six, girls' interests in science and in science-oriented careers are equal to those of boys. Jaus's report pertaining to grade six was substantiated by the results of this study. The implications of this finding for the science teacher is to be cognizant of gender-related interests. Science teachers should be able to design lesson plans that would address the needs and interests of both male and female students without teaching one at the expense of the other.

General Conclusions About Students' Interests in Science As Related to Achievement

Blosser (1984) reported that students' interest and attitude are among factors that influence their achievement in science. Harty, Beall, and Scharman (1985) showed that there is a significant positive correlation between student interest in science and science achievement. The results of this study showed that, given sixth grade students' final grade in science, significant interest differences existed between students on the following four topics: Classifying

Animals without Backbones; Properties of Light; Sources of Energy; and Electricity and Magnetism.

In the case of Animals without Backbones, the Duncan's New Multiple Range Test yielded no (post hoc) significant difference between any pair of means. Therefore, it is only possible to conclude that the interest of the A students was higher than that of the D students.

For Properties of Light, the interest of A students was significantly higher than that of the D and F students. Also, the interest of C students was significantly higher than that of the D students.

For Sources of Energy, the interest of the A students was significantly higher than that of the B and D students. Also, the interest of C students was significantly higher than that of the D students.

In the case of Electricity and Magnetism, the interest of the A students was significantly higher than that of the B and D students.

Based on means of different achievement levels, it was possible to conclude that D students had lower interest than A students in these topics with the exception of Electricity and Magnetism. However, an anomaly occurred in the case of Electricity and Magnetism where the interest of the B students was significantly lower than that of the A students. This possibly can be attributed to a Type I error. Other than

that, no plausible explanation can be found to account for this exception.

For none of the other topics were students' interests in science related significantly to achievement as indicated by final grade in science. The implication of this finding for teachers is that they should make science interesting enough for students with a wide range of ability levels to comprehend and enjoy. Science activities ought to be designed to attract and involve students with a wide range of academic potential.

General Conclusions About Teachers' Perceptions of Students' Interests

As regards teachers' perceptions of students' interest, the outcome of this investigation showed that, on the whole, the general science teachers had a common perception of students' interest or lack of interest in science items covered during a nine month course of study. In other words, teachers perceived all the science items to be of definite or greater-than-some interest to the students when taught. There was no need to create tables of items perceived as not taught by the teachers, because almost all items were perceived as taught by the 10 teachers who were surveyed in the county with the exception of one teacher who did not teach Chapters 1-4 (i.e. Classifying Animals with Backbones, Classifying Animals without Backbones, Classifying Plants,

and Life Cycles). With regard to the Other Topics, the teachers rated them to be of high interest to the students whether or not they were perceived as taught.

This study indicated that given the classroom teachers' experience, the specific general science items as well as the 13 science topics and the Other Topics constituted content matter that was "definitely" or "nearly definitely" interesting to the students. Conversely, for most of the specific general science items, students indicated "some" interest as opposed to "definite" interest. This suggested that teachers' perceptions of students' interests were not equivalent to students' expressed interests. This suggests that teachers are naive. The educational implication is that teachers should be more in tune with what students are saying. It seems clear that more work needs to be done by curriculum planners, instructional designers, science teachers, and publishers to make science more hands-on, relevant, applicable, and interesting for the students.

There appears to be a disparity between teachers' and students' perception of what concepts were interesting in science.

A comparison of Tables 16 and 36 included the following results:

- The range of the means of students' levels of interest in the 13 science topics was 1.85-2.24, while the range of

the means for teachers' perception of students' levels of interest was 1.31-1.75.

- Students perceived Electricity and Magnetism as the topic of greatest interest, while teachers perceived it as the topic of second greatest interest for the students.

- Students perceived Communications as the topic of second greatest interest, while teachers perceived it as the topic of next to lowest interest for the students.

- Students perceived Elements and Compounds as the seventh topic of interest, while teachers perceived it as the topic of greatest interest for the students.

- Students perceived Classifying Animals with Backbones as the topic of next to lowest interest, while teachers perceived it as the topic of fourth highest interest for the students.

- Students perceived Flight and the Space Program as the most interesting Other Topic, while teachers perceived Geology as the most interesting Other Topic for the students.

The fact that none of the specific items that were perceived as Taught obtained a mean level of interest below 1.6 was also an interesting finding. It indicated that none of the general science concepts were of "definite" interest to the majority of the students. The implication is that more work needs to be done to make general science highly interesting to the sixth graders. Science, by the nature of

its content, can be a hands-on, practical, replicable, and verifiable experience.

Science ought not be a boring subject or of moderate interest to the students. The ideas and skills that children learn from science can help them survive in this technology-ridden society. The impact of science is relevant and immediate. One need not think of the use of science in the distant future, but for the present survival in a world in which the importance of science and technology is quite apparent. The role of the teacher is crucial in filling the gap for the students between understanding and application of science. One cannot be oblivious to the fact that having "some interest" in science is not exciting. It is clear that there is considerable opportunity to improve the program so that there is "definite" or "high" interest in the concepts covered.

Teachers' Recommendations for Promoting Students' Interests in Science and Improving Science Instruction

In order to promote scientific literacy and understanding of science as a vital tool for survival in today's complex world, recommendations were made by the sixth grade science teachers. The following suggestions and recommendations were compiled as a result of individual

interviews with the teachers who based their comments on classroom experiences and personal observations.

1. The Heath Science: Level 6 (Barufaldi, Ladd & Moses, 1981) is an outdated textbook written for average to below average ability sixth grade students. This book does not satisfy the needs of above average as well as gifted and talented students.

2. The activities in the present book are too simplistic and very elementary. A new book is needed that would employ scientific methods in its laboratory exercises.

3. The book contains too much life science which is covered in the seventh grade course. Out of the twelve chapters in the current sixth grade book, five chapters focus on life science.

4. A comprehensive, introductory general science textbook should be selected and adopted that will give students a true breadth and a wide exposure to general science. Perhaps the provision of more than one set of books to provide for the wide range of reading levels found in most classes would best address this need. The new textbooks should include Astronomy, Geology, Oceanography, Flight and the Space Program, Simple Machines, and Microscope activities. The science teachers' suggestions that students were interested in these topics were substantiated by the findings of this study.

5. The new textbooks should have accompanying kits for laboratory activities.

6. The new textbooks should have thought-provoking, stimulating, and practical questions at the end of each section and at the conclusion of each chapter.

7. The situation in terms of laboratory activities in general science is bleak and not very impressive. Lack of material and equipment is severely limiting. Teachers frequently have to bring material from home, scrounge for laboratory material from the nearby university, or else depend on student collaboration to provide household goods. Under present conditions, it would be folly to think that a great deal of hands-on activities could take place.

To solve this problem, teachers suggested that an individual self-sustained laboratory in each of the four middle schools in the county be established. This would be an ideal situation, not only for sixth grade general science teachers and students, but also for seventh grade life science and eighth grade physical science teachers and students. However, if this is not possible due to budgetary constraints, an alternative should be sought. The teachers proposed that it would be very helpful for them as well as for their students if a mobile master laboratory (science on wheels) is established with a full-time science coordinator in charge.

The science coordinator would serve as a support person. He/she would operate on an organized schedule by taking the science demonstrations and activities to individual schools as necessary. The coordinator would also arrange for field trips, guest speakers, and other science programs for the county schools. A reduction in clerical work such as scheduling trips would allow science teachers to teach.

The science coordinator also should maintain a live animal sanctuary in the school board building and bring those animals to schools for instructional purposes.

8. There is a need for more in-service opportunities for teachers to learn new ideas and techniques for laboratory activities. As Friedl (1986) points out, "instead of focusing mostly on theory, [teachers need to focus] on practical exercises that work in the classroom" (p. vii).

9. Finally, teachers stressed the notion that introductory general science is very appropriate for the sixth grade level. This verbal statement was uniformly supported by the survey of these teachers carried out earlier using the science interest instrument.

Some Suggestions for More Effectively Addressing Items Identified by Students as Not Interesting

Students did not show interest in some items which were perceived as Taught. To make these items more interesting, the author presents the following suggestions:

1. In the topic of Classifying Animals with Backbones, fish (item A2), birds (item A5), and warm-bloodedness (item A8) were not interesting when perceived as Taught.

Fish dissection and study of their anatomy are among suggestions that can enhance students' understanding of this item.

Study of the exterior anatomy of birds such as beaks and footprints perhaps can be related to their feet type and habitat, respectively. Study of wings and feather samples also can be helpful in bird identification and in learning about aerodynamics of birds.

Warm-bloodedness is an abstract concept. It should be made more relevant by citing examples of birds and mammals that survive in nature by maintaining a constant body temperature regardless of the outside temperature.

2. Under the topic of Classifying Animals without Backbones, arthropods (item A9), worms (item A12), and protists (item A14) were not interesting when perceived as Taught.

Arthropods are jointed-legged invertebrates; examples are ants, bees, grasshoppers, and hermit crabs. To increase students' understanding and interest in this area, teachers can use dissection and insect collection as well as live samples and preserved specimens.

It is not effective teaching to discuss the three groups of worms (segmented, flat, and round) just by showing their pictures. A science instructor could provide an opportunity for the students to have supervised dissection of an earthworm. This hands-on approach should provide a better opportunity for learning than rote memorization or reading the textbook.

Protists are microscopic one-celled organisms that sometimes seem to be like animals and sometimes seem to be like plants; examples are Amoeba, Volvox, Paramecium, and Euglena. More microscopic activities possibly are needed to promote an understanding of these living things. Because they are not normally and appreciably seen by the naked eye, it is possible that their importance is obscured. The Protists are not readily visible, but they serve vitally and purposefully as the crucial links for food chains and food webs in nature. These ideas can be made relevant by the instructor.

3. For the topic of Life Cycles, Heredity, and Living Things, cells (item A19), nucleus (item A20), new cells (item A21), and chromosomes (item A22) were not interesting when perceived as Taught. The importance of cells (living units of which all organisms are made) and their functions cannot be overestimated. However, teaching cells and their components by means of microscopic activities and models is

highly desirable. Students can construct models of cells and their components which will allow them to see where all the parts fit. Hands-on and audio-visual activities can be effective in teaching this concept.

4. Under the topic of Classifying Plants, dicots (item B2), monocots (item B3), conifers (item B4), ferns (item B5), algae (item B6), and lichens (item B8) were not interesting when perceived as Taught.

Monocots are plants that have only one food part in their seeds; examples are corn, wheat, and rice. These plants are extremely valuable in feeding the people of the earth. Students cannot readily differentiate monocots from dicots. Corn, wheat, and rice should be brought to class, so students can see for themselves that these plants are made of only one food part.

To increase student awareness, samples of dicots (peas, beans, and peanuts), ferns, algae, lichens as well as conifer leaves can be used for identification and classification purposes.

5. In the topic of Atmosphere, Climates of the World, and Natural Cycles, nitrogen cycle (item B49) was not interesting when perceived as Taught. This is a highly abstract concept. Perhaps through audio-visual activities such as films, filmstrips, charts, and pictures an instructor could enhance student understanding of this concept.

6. For the topic of Energy for Living Things, respiration (item B54) was not interesting when perceived as Taught. Respiration takes place when cells of most living things get energy from food by using oxygen and giving off carbon dioxide. This is a very abstract concept. A teacher may have to allude to it briefly, or else possibly use charts and diagrams that concretely explain how this function takes place in living things.

The following items were considered as not interesting although perceived as Not taught.

1. Under the topic of Classifying Animals without Backbones, arthropods (item A9), mollusks (item A10), worms (item A12), and protists (item A14), were not interesting although perceived as Not Taught.

Mollusks have soft bodies and are mostly covered by hard shells; examples are octopus, moon snail, scallop, and squid. If at all possible, use of live animals as well as preserved specimens can be helpful in teaching these invertebrates. Some of these invertebrates such as scallops and squids serve as food source for mankind. Arthropods, mollusks, worms, and protists play an important role in the food chains and food webs that occur in nature.

2. In the topic of Life Cycles, Heredity, and Living Things, genes (item A24) were not interesting although perceived as Not Taught. A teacher can point to students in

the classroom and explain how variation in genetic traits produced offsprings with different hair and eye colors. Teachers can cite examples of how new technology in genetic engineering is used to produce more diversified and drought resistant plants.

3. In the topic of Classifying Plants, plant classification (item B1), dicots (item B2), monocots (item B3), conifers (item B4), ferns (item B5), algae (item B6), yeasts (item B7), and lichens (item B8) were not interesting although perceived as Not Taught.

These items almost constitute the whole topic of plants. Classroom activities involving microscopes and lenses can be helpful in teaching this unit. Furthermore, it is highly desirable that students be taken to nearby forests for leaf collection and plant identification. A walk through the woods may aid students develop an understanding and appreciation of our ecosystem and, particularly, of plants and their importance for the survival of human species and animals.

4. For the topic of Sources of Energy, geothermal energy (item B16) was not interesting although perceived as Not Taught. Examples of geothermal energy are hot springs and geysers that are used in production of electrical energy. The locations as well as the relevance of geothermal energy in our lives can be taken into account when this item is covered in class.

5. Under the topic of Electricity and Magnetism, kilowatt-hours (item B29) was not interesting although perceived as Not Taught. We use kilowatt-hours to measure how much electrical energy has been consumed. Students can be shown through hands-on activities how the energy consumption is measured by kilowatt-hours. Perhaps, a trip to the school electrical meter can take care of any confusion. Students can also be directed to keep track of their own electrical consumption with the help of their parents. They can keep a chart by reading and recording the numbers off the meter in their homes or apartments and calculate their monthly use of electricity.

6. In the topic of Light and Vision, farsightedness (item B36) and use of glasses (item B37) were not interesting although perceived as Not Taught. A guest speaker such as a local optician, optometrist, or ophthalmologist can enhance students' understanding of light and vision.

7. For the topic of Atmosphere, Climates of the World, and Natural Cycles, nitrogen cycle (item B49) was not interesting although perceived as Not Taught. Conversion of the atmospheric nitrogen into a useable form and its importance to plants should be emphasized by means of charts, diagrams, filmstrips, and other audio-visual material.

Observations with Regard to Students' and Teachers' Responses

A certain discrepancy was noticed in the students' responses as opposed to the teachers' responses. For example, all the ten teachers marked that item 29 (melting, boiling, and freezing) was taught during the year. However, 57 students marked the same item as not-taught. There were a few examples of this sort throughout the survey. These discrepant results may possibly be attributed to the way a particular topic or item was covered in class by the individual teacher. It is possible that those items which were covered briefly or had a no-hands-on treatment stayed in the students' memory for a rather short time. Perhaps a more concrete operational approach of the same item would have resulted in longer term retention of the information.

Final Remarks

Science plays a very important role in the world in which we live. Therefore, as curriculum designers, classroom teachers, and instructional planners, we have a major task ahead of us. The crucial task is to make science interesting and to motivate students to learn science. Humankind has benefitted tremendously from the growth and expansion of scientific knowledge. This growth needs to be continued if we want to generate new information for the good of all people. There will be many opportunities for future

scientists to contribute to the well-being of this world. For example, overpopulation, hunger, disease, malnutrition, poor sanitation, and environmental pollution are only a few of the myriad of problems that are adversely affecting this planet's inhabitants. We need scientists to help solve some of these problems. To sum up, the advancement of science should be nurtured and encouraged, not impeded.

Science is verified and organized knowledge and the process by which the knowledge is discovered. The verified knowledge was crucial to Isaac Newton, the great English scientist, who said: "I stood on the shoulders of giants." The verified knowledge gathered by other great people before Newton allowed him to be inquiring and exploratory. This enabled him to forge ahead in scientific work and eventually make contributions of immense proportion. It is, indeed, very important to read the work of the people who preceded us. However, it is not sufficient to learn science only through reading from a textbook; scientific concepts are attained through theorizing, hypothesizing, investigating, inquiring, experimenting, accurately observing, recording, inferential thinking, and concluding. This art of investigation was developed by scientists. Every inquisitive mind and every young student of science at elementary, middle, or secondary level can formulate his or her own concepts and put them to the test of the scientific method.

Sullivan (1979) showed that "in general, students' expressed liking for science topics decreased as grade level increased" (p. 596). The findings in this study showed that students expressed only "some" interest in specific science items. This author as well as the other general science teachers in the study believe that students do not have many opportunities to put to practice the art of scientific investigation. Such opportunities to investigate should enable them to do experiments via testing hypotheses and inquiring into the ways the living and non-living world work. With having only "some" interest in science, it can be interpreted that students are hoping for someone to make science more interesting. The educational implication is that one must heed student input. One possible way is to increase hands-on activities or experimentation in the classroom. The author's proposition was substantiated in an earlier study by Sullivan (1979). Investigating 13,401 students' interests in specific science topics in primary grades (1-4) and intermediate grades (4-8), Sullivan (1979) reported that "prominent among the most favored items in the upper grades was one methods item [i.e. doing experiments]" (p. 595).

Finally, if the young people of middle school years are infused with alienation or indifference toward science, apparently schools are not successful in meeting their needs. The crux of the matter is that students' input should not be

disregarded in science curriculum planning, and science should be made practical and congruent with students' needs. Kindred, Wolotkiewicz, Mickelson, and Coplein (1981) point out that "the middle school program and its curricula must provide opportunities for older children, preadolescents, and early adolescents to deal with areas relevant to their lives" (p. 61).

To recapitulate, no better words can be so fitting here than what Harlen (1985) stated:

Learning science helps children to develop ways of understanding the world around them. For this they have to build up concepts which help them link their experiences together; they must learn ways of gaining and organizing information of applying and testing ideas. This contributes not only to children's ability to making better sense of things around them, but prepares them to deal more effectively with wider decision-making and problem-solving in their lives. Science is as basic a part of education as numeracy and literacy; it daily becomes more important as the complexity of technology increases and touches every part of our lives ((p. 2).

Anticipated Impact Of This Study

The outcome of this study will have possible effects in the following ways:

1. The information collected could contribute to more appropriate emphases which reflect not only scientists' and curriculum writers' opinions but students' needs and interests. The potential benefits of knowing students' opinion should permit: (a) the science teacher to provide supplemental instructional material for topics of interest which are barely addressed or not covered at all in the textbook; and (b) students' input via expression of their interest in subject matter can aid science teachers, science supervisors, and textbook adoption personnel to select one or more appropriate general science textbooks.

2. This study demonstrated a procedure for formulating an instrument and interpreting the data obtained with it for assessing student interest in subject matter.

3. Male and female students' interests in science topics were examined. Few significant differences between male and female students' interests were found in this study. Nevertheless, science teachers should prepare lesson plans which maximize the participation of both genders and accommodate their interests in day-to-day instruction.

4. The sixth grade science teachers' input suggested a number of ways to affect overall improvement of the general science curriculum.

5. Finally, the general methodology for this study could be a guide to researchers who are interested in student input at other grade levels or in different geographic locations.

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Appendix A

The Sixth Grade General Science Objectives as Outlined by the Standards of Learning, Virginia Department of Education

Note: Descriptive statements for each item can be found in Standards of Learning Objectives for Virginia Department of Education, Richmond, Virginia, 1983.

- 6.1 The student will demonstrate safety procedures in the use of laboratory equipment and materials, while working individually and in groups.
- 6.2 The student will use process skills as a basis for solving problems, answering questions, and providing explanations.
- 6.3 The student will use appropriate materials, tools, and units of measurement in conducting scientific observations.
- 6.4 The student will use various resources to explore topics of personal interest and career opportunities in areas of science.
- 6.5 The student will observe changes and classify them as chemical or physical.
- 6.6 The student will use observation and experimentation to determine chemical and physical properties of substances.
- 6.7 The student will determine the relationship between changes in temperature and the states of matter for given substances.

- 6.8 The student will construct models of or diagrams for atoms.
- 6.9 The student will determine electrical energy consumption using common units.
- 6.10 The student will observe materials and classify them as mixtures or non-mixtures (elements and compounds).
- 6.11 The student will define kinetic and potential energy and then state examples of each.
- 6.12 The student will classify the forms of energy involved in energy transformations.
- 6.13 The student will identify the life processes of organisms.
- 6.14 The student will describe the dependence of organisms upon non-living things.
- 6.15 The student will describe the differences and similarities between plants and animals.
- 6.16 The student will describe the interaction and interdependence of plants and animals.
- 6.17 The student will compare and contrast natural cycles.
- 6.18 The student will describe the movements of the earth, sun, and moon.
- 6.19 The student will describe the gravitational effects of the sun and moon upon the earth's environment.

- 6.20 The student will explain positive and negative effects of man's interaction with the environment.
- 6.21 The student will describe the uses and conservation of renewable and non-renewable resources.
- 6.22 The student will explain the relationship of the sun to most forms of energy on earth.
- 6.23 The student will describe the basic relationship between electricity and magnetism.
- 6.24 The student will identify and describe cellular components.

APPENDIX B

Survey of Student Interest in Sixth Grade Science
Form A

Directions

The purpose of this survey is to find out what topics in the sixth grade science class were of interest to you. Please rate each topic according to the following scale. First select A or B. If you select A, then darken one of the numbers in front of A on the answer sheet. If you select B, then darken one of the numbers in front of B on the answer sheet.

---A. It was taught, and it was
1 = definitely interesting.
2 = of some interest.
3 = not interesting.

---B. It wasn't taught, but would be
8 = definitely interesting.
9 = of some interest.
10 = not interesting.

Classifying Animals with Backbones

- | | |
|--|-------------------------|
| 1. Animals can be classified in two large groups:
vertebrates, which have backbones, and
invertebrates, which do not have backbones. | --A 1 2 3
--B 8 9 10 |
| 2. Fish have a skeleton, fins, scales, and
breathe through gills. | --A 1 2 3
--B 8 9 10 |
| 3. Amphibians such as frogs, toads, and
salamanders spend part of their life in the
water and part out of the water. | --A 1 2 3
--B 8 9 10 |
| 4. Reptiles such as lizards, snakes, turtles,
crocodiles, and alligators have lungs and
hatch from eggs. | --A 1 2 3
--B 8 9 10 |
| 5. Birds have two wings, two feet, a bill but
no teeth, hatch out of eggs with hard shells,
and are the only animals with feathers. | --A 1 2 3
--B 8 9 10 |
| 6. Most mammals give birth to live young and mammal
mothers make milk to feed their young. | --A 1 2 3
--B 8 9 10 |
| 7. Fish, amphibians, and reptiles are cold-blooded,
which means that their bodies have the same
temperature as their surroundings. | --A 1 2 3
--B 8 9 10 |
| 8. Birds and mammals are warm-blooded, which means
that their body temperature stays the same no
matter what the outside temperature is. | --A 1 2 3
--B 8 9 10 |

---A. It was taught, and it was
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 2 = of some interest.
 3 = not interesting.

---B. It wasn't taught, but would be
 8 = definitely interesting.
 9 = of some interest.
 10 = not interesting.

Classifying Animals without Backbones

- | | | | | |
|--|-----|---|---|----|
| 9. Arthropods are the only invertebrates (animals without backbones) that have jointed legs; examples are ants, centipedes, millipedes, grasshoppers, wasps, crayfish, and hermit crabs. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 10. Mollusks have soft bodies and are mostly covered by hard shells; examples are octopus, moon snail, scallop, and squid. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 11. Echinoderms are the spiny-skinned animals such as starfish, sea urchin, and sand dollar. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 12. There are three groups of worms--segmented, flat, and round worms. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 13. Invertebrate animals such as jellyfish, coral, hydras, anemones, and sponges live in water. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 14. Protists are microscopic one-celled living things that sometimes seem to be like animals and sometimes seem to be like plants; examples are Amoeba, Volvox, Paramecium, and Euglena. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

---A. It was taught, and it was
 1 = definitely interesting.
 2 = of some interest.
 3 = not interesting.

---B It wasn't taught, but would be
 8 = definitely interesting.
 9 = of some interest.
 10 = not interesting.

Life Cycles, Heredity, and Living Things

- | | | | | |
|--|-----|---|---|----|
| 15. Many insects such as butterflies have four stages in their life cycles: egg, larva, pupa, and adult. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 16. Some insects such as grasshoppers have three stages in their life cycles: egg, nymph, and adult. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 17. Reproduction is the process by which living things produce their own kind. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 18. A characteristic that is passed from parent to offspring is called a trait. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 19. Cells are tiny living things of which all organisms are made. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 20. The control center of every living cell is called the nucleus. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 21. New cells are needed for growing or taking the place of worn-out or damaged cells. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 22. Each cell has chromosomes which have information to help it grow and change. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 23. Half of your chromosomes came from your father and half came from your mother. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 24. Genes are places on chromosomes where information about traits is carried. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

---A. It was taught, and it was
 1 = definitely interesting.
 2 = of some interest.
 3 = not interesting.

---B. It wasn't taught, but would be
 8 = definitely interesting.
 9 = of some interest.
 10 = not interesting.

Elements and Compounds

- | | | | | |
|---|-----|---|---|----|
| 25. Matter may be a solid, a liquid, or a gas, depending on how its molecules are arranged. In a solid such as ice the molecules are held in place. In a liquid such as water the molecules slip and slide around each other. In a gas such as water vapor the molecules are far apart from each other. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 26. An element is any matter that is made of only one kind of atom. Gold, silver, iron, and oxygen are different elements. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 27. When a physical change takes place in matter, the way it looks may change. Changing ice to water and then to vapor are physical changes. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 28. When a chemical change takes place, one kind of matter is changed to a completely different kind. The burning of wood or rusting of iron are examples of chemical changes. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 29. Melting of ice, boiling of water, and freezing of water are examples of how matter changes when the temperature changes. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 30. A mixture is formed when two or more kinds of matter are mixed together without changing either of them; example: combining salt and pepper. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 31. A solution is formed when a solid is dissolved in water or in any other liquid; dissolving sugar in tea is an example. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

- | | |
|--|--|
| <p>---A. It was taught, and it was
 1 = definitely interesting.
 2 = of some interest.
 3 = not interesting.</p> | <p>---B. It wasn't taught, but would be
 8 = definitely interesting.
 9 = of some interest.
 10 = not interesting.</p> |
|--|--|
-
- | | |
|---|----------------------------------|
| <p>32. A compound is formed when two or more elements combine chemically. For example, salt is a compound of sodium and chlorine.</p> | <p>--A 1 2 3
 --B 8 9 10</p> |
| <p>33. Oxygen is needed to burn something with a flame or to make a fire. So, without oxygen we cannot light a match.</p> | <p>--A 1 2 3
 --B 8 9 10</p> |
| <p>34. Indicators such as red or blue litmus paper are used to find out whether something is an acid, a base, or neutral.</p> | <p>--A 1 2 3
 --B 8 9 10</p> |
| <p>35. Bases such as milk, ammonia, chlorine bleach, and soap turn red litmus paper blue.</p> | <p>--A 1 2 3
 --B 8 9 10</p> |
| <p>36. Acids such as vinegar, lemon juice, and orange juice turn blue litmus paper red.</p> | <p>--A 1 2 3
 --B 8 9 10</p> |
| <p>37. Neither red nor blue litmus paper change color when dipped in water which is neutral.</p> | <p>--A 1 2 3
 --B 8 9 10</p> |

---A. It was taught, and it was
1 = definitely interesting.
2 = of some interest.
3 = not interesting.

---B. It wasn't taught, but would be
8 = definitely interesting.
9 = of some interest.
10 = not interesting.

Communications

38. Through the ages people have communicated by signaling, speaking, and writing. With the invention of the printing press, it became possible to communicate written ideas to many people. --A 1 2 3
--B 8 9 10
39. Radar uses short radio waves to find things that are far away and measure their distance. --A 1 2 3
--B 8 9 10
40. The first phonograph (record player) and motion camera were invented by Thomas Edison. --A 1 2 3
--B 8 9 10
41. Telephone invented by Alexander Graham Bell and telegraph invented by Samuel Morse are used to send messages over long distances. Both telephone and telegraph are needed to speed up communications. --A 1 2 3
--B 8 9 10
42. Television is a very helpful tool in modern communications, because it presents both sound and picture at the same time. --A 1 2 3
--B 8 9 10
43. Computers have become a very important part of our lives. They are used to design cars, to translate languages, and to keep rockets on course. You can play games with a computer, just as if it were a person. Many tasks that computers can do in a few seconds would be impossible for one person to do in a year of work. --A 1 2 3
--B 8 9 10

---A. It was taught, and it was
 1 = definitely interesting.
 2 = of some interest.
 3 = not interesting.

---B. It wasn't taught, but would be
 8 = definitely interesting.
 9 = of some interest.
 10 = not interesting.

Properties of Light

- | | | | | |
|--|-----|---|---|----|
| 44. Isaac Newton presented the idea that light is made of tiny particles. Christian Huygens presented the idea that light behaves as waves. Today we describe light in terms of both particles and waves. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 45. Light travels in straight lines at about 300,000 kilometers per second or 186,000 miles per second. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 46. Light passes through transparent matter such as glass, water, and air. Light is scattered as it passes through translucent matter such as a lampshade. Opaque matter such as a piece of wood or a sheet of cardboard do not allow any light to pass through. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 47. Reflection is the bouncing of light. When light bounces off the surface of an object you can see that object. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 48. Refraction is the bending of light. A fish seen under water is really lower than it appears. This is due to the bending of light rays. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 49. Light that passes through a prism is broken up into the spectrum of 7 colors. Isaac Newton used a prism to break up light. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 50. Something is a certain color because it absorbs all the colors except the one that it reflects. For example, an apple looks red because it only reflects the color red. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

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Our Solar System and Gravitational Force

- | | | | | |
|--|-----|---|---|----|
| 51. The strong gravitational force of the sun keeps the nine planets in separate orbits (paths) around it. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 52. The earth takes 365 and 1/4 days to make one trip around the sun. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 53. The earth also rotates (turns) on its axis once in every 24 hours. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 54. The earth's axis is an imaginary line that goes through the earth from the North Pole to South Pole. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 55. While moving around the sun, the earth's 24-hour rotation on its own axis gives us our day and night. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 56. The axis of the earth is tilted. Therefore, places on the earth get different amounts of sunlight during the year. This causes the different seasons. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 57. Every 29 and one-half days, the moon makes a trip around the earth. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 58. When the moon shines, it is reflecting light from the sun. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 59. The moon seems to change shape from day to day. These changes are called different phases of the moon. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 60. Tides are the rise and fall of ocean waters and are caused mainly by the gravitational pull of the moon on the earth. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 61. Earth is the only livable planet in the solar system because of many reasons such as a 24-hour rotation on its own axis, and the right atmosphere, water, and temperature. | --A | 1 | 2 | 3 |
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This topic would include earth's layers (core, mantle, crust), rock types (sedimentary, igneous, metamorphic), minerals, volcanoes, fossils, and age of the earth which is about 4.6 billion years.

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This topic would include oceans of the world, waves, living things in oceans, and underwater exploration which allows mankind to do deep-sea study of the ocean plants and animals.

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Survey of Student Interest in
Sixth Grade Science
Form B

Directions

The purpose of this survey is to find out what topics in the sixth grade science class were of interest to you. Please rate each topic according to the following scale. First select A or B. If you select A, then darken one of the numbers in front of A on the answer sheet. If you select B, then darken one of the numbers in front of B on the answer sheet.

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Classifying Plants

- | | |
|---|-------------------------|
| 1. Plants can be classified into two groups:
1. plants that make seeds such as cherries,
peaches, apples, grapes, and so on; and
2. plants that don't make seeds such as algae
and fungi. | --A 1 2 3
--B 8 9 10 |
| 2. Dicot plants such as beans, peas, and peanuts have
two food parts in each of their seeds. | --A 1 2 3
--B 8 9 10 |
| 3. Monocot plants such as corn, wheat, and rice have
only one food part in their seeds. | --A 1 2 3
--B 8 9 10 |
| 4. Conifers are plants that make seeds in cones;
examples are pines, cypress, and sequoia. | --A 1 2 3
--B 8 9 10 |
| 5. Ferns are green plants that have roots, stems, and
leaves, and produce spores instead of seeds. | --A 1 2 3
--B 8 9 10 |
| 6. Algae are simple plants that contain chlorophyll
and fungi are simple plants that lack chlorophyll. | --A 1 2 3
--B 8 9 10 |
| 7. Yeasts, edible mushrooms, cheese mold, and
penicillin are useful fungi. Harmful fungi include
athlete's foot and certain plant diseases. | --A 1 2 3
--B 8 9 10 |
| 8. Lichens are made of two different kinds of plants,
a green alga and a fungus. The alga provides food
for the fungus by photosynthesis, and the fungus
protects the alga from drying out. | --A 1 2 3
--B 8 9 10 |

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Sources of Energy

- | | | | | |
|---|-----|---|---|----|
| 9. Energy is the ability to do work. Energy comes in different forms such as electrical, light, chemical and heat energy. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 10. Energy can be changed (transformed) from one form to another: examples are: electrical to heat (in a toaster); chemical to electrical to light (in a flashlight) and chemical to heat (in kerosene stoves). | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 11. Kinetic energy is energy of motion; for example, a moving car, a pitched baseball, and the wind show energy of motion. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 12. Potential energy is stored energy; for example, a raised hammer, water at the top of a dam have potential (stored) energy. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 13. Fossil fuels (such as coal, oil, and natural gas) are our major sources of energy. However, the sun is the original source of energy for fossil fuels, wood, wind, and water power. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 14. Fission is the splitting of the nucleus of an atom in order to release nuclear energy. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 15. In fusion, nuclear energy is given off when the nuclei (plural of nucleus) of certain atoms are forced to combine. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 16. Geothermal energy in the form of steam is used to generate electrical energy. Hot springs and geysers are examples of geothermal energy. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 17. Fossil fuels (such as coal, oil, and natural gas) are called non-renewable resources. They are not being "made" today and once we burn them we can't replace them. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 18. The use of fossil fuels and nuclear energy have caused many problems for mankind. Some of these problems are radioactive waste, limited supplies, air and water pollution, acid rain, and oil spills. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

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Electricity and Magnetism

- | | | | | |
|--|-----|---|---|----|
| 19. All matter is made up of atoms. The central part of an atom is called the nucleus which contains protons with a positive charge and neutrons with no charge. Electrons have a negative charge and move around the nucleus of the atom. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 20. When you comb your hair, electrons are rubbed off your hair and on to the comb where they begin to pile up. This build-up of electrons is called static electricity. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 21. Objects with like charges repel (push away) each other and those with unlike charges attract each other. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 22. Current electricity is created by a smooth, even flow of electrons between two points. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 23. An electromagnet is produced when a coil of wire is wrapped around a bar of iron. When an electric current flows, the iron becomes magnetized. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 24. In order for an electric current to flow, it must have a path called a closed circuit. A switch is used to open or close the circuit. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 25. Good conductors are things in which an electric current flows; examples are copper and aluminum. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 26. Poor conductors are things in which an electric current doesn't flow. Poor conductors such as cotton, rubber, and plastic are useful insulators. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 27. A short circuit can be the cause of a dangerous fire caused when the insulation wears off and bare wires touch each other. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 28. Fuses and circuit breakers are used for protection against the dangers of short circuits or overload circuits. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 29. We use kilowatt-hours to measure how much electrical energy has been consumed (used). | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

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Light and Vision

- | | | | | |
|---|-----|---|---|----|
| 30. The eyes are the sense organs that react to light. They send sight messages to the brain and help us learn much about the world. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 31. A glass lens shows a clear picture of an object only at a certain distance. But lenses in your eyes bring together light from an object in such a way that it can be seen clearly at different distances. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 32. The pupil is an opening in the center of the iris; in bright light it gets smaller, and in dim light it gets bigger. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 33. The rods and the cones are nerve cells that react to light and are found in the retina. The rods help us see in dim light; the cones help us see in bright light and see color. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 34. The brain helps you see by turning the picture formed on the retina right side up. It also changes the shape of the lenses and makes sense out of what you see. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 35. In a nearsighted person, the picture comes together before it falls on the retina. This happens because the eyes are too long. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 36. In a farsighted person, the picture does not come together completely before it falls on the retina. This happens because the eyes are too short. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 37. Glasses can help correct vision problems by changing the way images form in the eye. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

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Atmosphere, Climates of the World, and Natural Cycles

- | | | | | |
|--|-----|---|---|----|
| 38. The temperature and precipitation (snow or rainfall) together determine the climate of a certain place. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 39. There are three main kinds of temperature zones: tropical, temperate, and polar.
Hot, tropical zones are found near the equator.
Cold polar zones are found near the North and South Poles. In between them are the temperate zones. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 40. Because of the earth's tipped axis, places on the earth get different amounts of sunlight during the year. This causes the different seasons. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 41. The higher a place is, the colder its climate is likely to be. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 42. Warm and cold ocean currents can change the earth's climate. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 43. The lightness or darkness of the earth's surface affects the earth's climate. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 44. Certain instruments are helpful in the study of the weather. A barometer measures air pressure, and an anemometer measures the speed of wind. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |

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45. Rainfall, winds, and mountains can also make a difference in the earth's climate. --A 1 2 3
--B 8 9 10

46. Air is made up of four permanent gases: 78% nitrogen, 21% oxygen, 0.93% argon, and 0.03% carbon dioxide. Air also contains other gases such as neon and helium in very small amounts. --A 1 2 3
--B 8 9 10

47. Human beings and animals breathe in oxygen and breathe out carbon dioxide. Plants take in carbon dioxide and give off oxygen. These are natural cycles. --A 1 2 3
--B 8 9 10

48. The sun's heat evaporates water from the oceans. The water rises as invisible vapor, and falls back to the earth as rain, snow or some other form of moisture. This circulation of the earth's waters is called the water cycle. --A 1 2 3
--B 8 9 10

49. Most living things cannot use the nitrogen that is in the gas form in the earth's atmosphere. Certain bacteria change the atmospheric nitrogen into a form that other living things can use. After nitrogen is fixed into a useable form by bacteria, it circulates between living things and the soil. This is nitrogen's natural cycle. --A 1 2 3
--B 8 9 10

50. The atmosphere is made up of five regions. The region closest to the earth's surface is called troposphere where all weather changes take place. --A 1 2 3
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Energy for Living Things

- | | | | | |
|--|-----|---|---|----|
| 51. Living things need the sun's energy to grow, to react to different things around them, and to make more of their own kind. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 52. During photosynthesis, the chlorophyll in green plants use sunlight to make food. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 53. Green plants are called food producers because they use sunlight, water, and carbon dioxide to make food. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 54. Cells of most living things get energy from food by using oxygen and giving off carbon dioxide; this is called respiration. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 55. Plants provide us with sugar, starches, fats, proteins, vitamins, and minerals. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 56. First-level consumers such as cows, sheep, goats, and zebras depend on green plants for their energy. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 57. Second-level consumers such as lions, tigers, dogs, and cats depend on plant-eaters for their energy. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 58. The flow of energy from producers to consumers in a community is called a food chain. An example of a food chain would be when a bird eats a snake, which may eat a spider, which may eat an insect. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 59. An ecosystem (such as an ocean, a forest, a desert) is a community where living things interact with each other and with non-living matter around them. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 60. Living things (plants and animals) depend on non-living things such as water, carbon dioxide, oxygen, sunlight, soil, and minerals for survival. | --A | 1 | 2 | 3 |
| | --B | 8 | 9 | 10 |
| 61. The material that builds and repairs the body is called protein and is found in meat, milk, cheese, eggs, and other food. | --A | 1 | 2 | 3 |
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